USING PAIR PROGRAMMING TECHNIQUES IN CLASSROOM ENVIRONMENT

Carlos Alberto Ynoguti[1], Afonso Celso Soares [2]

Abstract *— For several years, software development companies have been using pair programming with great success. Pair programming is a technique that consists of two programmers working together on the same computer to develop a computer program: one of them, the driver, operates the computer, and the other, the observer, examines the work of the driver, looking for errors and thinking of possible alternatives that can improve the solution. This procedure is closely related to Collaborative Learning philosophy, extensively used in elementary and high school teaching, with very good results. Unfortunately, its use in undergraduate courses, especially in the engineering area, is almost absent. Therefore, we decided to adopt pair programming in a first semester computer-programming course, both in theoretical classes and in laboratory practical classes. This paper reports the results of a one-semester course using pair programming.*

Index Terms — pair programming, collaborative learning, computer science learning, extreme programming.

INTRODUCTION

Traditionally, students find introductory computer science courses very frustrating (in our institution, about 30% of them fail the subjects at each semester).

With pair programming learning, two students work simultaneously to solve a task (an algorithm or a computer program). In this technique, one of the students is the "driver" and has control on the pencil/mouse/keyboard and writes the algorithm or the program. The other, called the "observer", continuously and actively examines the work of the driver, watching for defects, thinking of alternatives, looking up resources, and considering strategic implications of the work at hand. Examples of things noted by the observer are erroneous syntax, misspelling, and smaller logic mistakes, among others.

The student pairs apply a positive form of "pair-pressure" on each other, which has proven beneficial to the quality of their work products. At the end of the semester, the students were given a questionnaire about the pair-programming experience and most of them reported good impressions about this technique.

Also, this technique has proven to be beneficial for the teachers too. Some minor questions are answered inside the pairs. The number of exercises to correct is divided by a factor of two, enabling the teacher to give more exercises, and consequently, making a better evaluation of what issue is or is not being absorbed by the students. One important thing to note is that the number of cheating cases is reduced because collaboration is legitimized.

Cognitive theory can help explain why pair programming might be more effective than solo programming. In 1991 Nick Flor, a master's student of Cognitive Science at U.C. San Diego, reported on distributed cognition in a collaborative programming pair he studied. Flor recorded via video and audiotape the exchanges of two experienced programmers working together on a software maintenance task. In [3], he correlated specific verbal and non-verbal behaviors of the two programmers to known distributed cognition theories. One of these theories is "Searching Through Larger Spaces of Alternatives":

"A system with multiple actors possesses greater potential for the generation of more diverse plans for at least three reasons: (1) the actors bring different prior experiences to the task; (2) they may have different access to task relevant information; (3) they stand in different relationships to the problem by virtue of their functional roles. . . An important consequence of the attempt to share goals and plans is that when they are in conflict, the programmers must overtly negotiate a shared course of action. In doing so, they explore a larger number of alternatives than a single programmer alone might do. This reduces the chances of selecting a bad plan."

In this article, an experience involving pair programming learning technique in a first semester undergraduate computation course is presented. Advantages and disadvantages of this method are also presented and discussed.

Pair programming learning strategy is based on collaborative learning theory, which has been widely researched and advocated throughout the professional literature, mainly at the primary and secondary levels. For higher level courses, it's been adopted recently in some institutions with good results. This theory is further discussed in the next section.

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COLLABORATIVE LEARNING

The term "collaborative learning" refers to an instruction method in which students at various performance levels work together in small groups toward a common goal. The students are responsible for one another's learning as well as for their own. Thus, the success of one student helps other students to be successful [5].

The collaborative learning points out the active participation and interaction, either between the students and the teacher or among the students.

Basic elements of collaborative learning

The basic elements of the collaborative learning method can be summarized into the following items[6]:

1. Group interdependency: the students, as a group, have a common goal and should work as an efficient team to reach it. The students are responsible for their own apprenticeship. This procedure helps in the apprenticeship of every member of the group.
2. Interaction: one of the goals of the collaborative learning is to develop the student's competence in working in groups. Each member of the group should accomplish his part of the task and spare some time to share his knowledge with his partner(s) and, on the other hand, receive the contributions of his partner(s).
3. Diverging thoughts: there shouldn't be a member that claims himself as the leader or the smart guy, but instead, a conscience that both of the members of the group can explain their own points of view, competence and perspectives. The activities should be created in order to demand collaboration instead of competition (complex tasks that require creativity and has several possible solutions).

Vygotsky's socio-cultural theory

The socio-cultural theory by Vigotsky about the learning process emphasizes that the human intelligence comes from our society and culture, and happens at first time because of the interaction with the social environment.

Another aspect of Vygotsky's theory is the idea that the potential for cognitive development is limited to a determined zone that he called "proximal development zone" (PDZ). He defines this concept as "the distance between the real development level, determined by the independent problem resolution, and the potential development level, determined by the problem resolution under a supervisor advising or in collaboration with more capable partners" [1].

It's important to consider that the PDZ varies with the culture, the society and the experience of each individual.

For a PDZ to be created, there should exist a joint activity that enables the interaction between teacher and students. The group work allows the confront and integration of different points of view, making the learning process richer and more interesting.

Of course, people learn by themselves naturally provided that there exist adequate and minimally stimulant contexts. However, if a teacher helps a student to analyze and reflect about his/her actions, the learning process is accelerated.

EXPERIMENTS

Class characterization

Before describing the pair programming tests results, it's instructive to characterize the classes they were performed. The studies were carried out in an undergraduate, first semester computing class. In our institution, classes have typically 70-100 students. The course is divided into two parts: a theoretical part (60 hours) and a practical one (30 hours).

In the theoretical part, the students learn how to construct algorithms to solve simple problems, and use a pseudo-code language to construct these algorithms. All the algorithms are written with pencil and paper and the students are continuously invited to debug their algorithms simulating the behavior of the compilers.

Now, in the practical part, the students are divided into smaller groups (20 to 25 students) and use the Delphi® compiler to create their programs.

Grades are distributed in the following manner: 2 theoretical tests and 3 practical tests, taken individually. Also, during the semester, 10 to 15 exercises are assigned and corrected, and add a bonus up to 10 points in the final grade (grades range from 0 to 100 points). Part of these exercises was done individually, and part with a partner, using the pair-programming technique.

In other words, the pair-programming technique was used as a learning method, not as an evaluating one, although part of the grading had been obtained using this technique.

Solo and pair programming tests

As reported earlier in this article, the pair programming technique was used in the classroom and laboratory exercises. In the first part of the semester, the students developed their activities working alone. Because of the class size (74 students) and the class dynamics (teacher was always solving students' doubts during the exercises), cheating was difficult to control, and it was common to see 4, 5 or even 6 exercises with identical (and wrong) solutions. It was clear from these results that only a few students did the exercises. The others just cheated. It was a frustrating result, because it's clear from these facts that students were more interested in the bonus points than in learning how to program.

To try to change this behavior, the students were told that if the teacher found more than two exercises with identical solutions, the grade would be divided by the number of identical exercises. After this, the number of cheating cases dropped, and so did the grades.

Of course, as a result of this scenario, the students' grades in the first tests were not good.

In the second part of the semester, they were given an article about pair-programming [2] to read and had a brief explanation about the new working method. After this, they were invited to test on the new working methodology. None of them was obligated to work in pairs, but the teacher encouraged them to try the method before deciding how they would like to work. These activities were done both in classroom, with algorithm design problems, and in the laboratory environment, with code design problems.

Pairs were formed in a free way. No constraints were made in this sense and, in general, the students chose their friends or the students that was seated nearby, and later, it was noticed that this procedure was an error, as shown in the next section.

At the end of the semester, the students were invited to answer some questions concerning the pair programming experience. The questions were extracted from a work by Williams & Kessler [2] with some minor modifications. The answers the students gave will be commented later in this article.

Results

Cheating cases dropped dramatically, and the number of different solutions raised enormously. Also, the solutions varied from very sophisticated ones to very complicated and inefficient ones, but the great majority of the designs met the specifications of the problems, a result quite different from the first part of the semester.

The classes became very noisy, but this was because the students were really discussing solutions and alternatives to solve the problems and actively participating in the class. Also, when students asked the teacher to clear doubts, they came with more elaborated questions, not trivial ones, so the easy answering doubts were cleared independently by the students.

Specifically in the algorithms made in class, syntax errors are very common because of the lack of a compiler that reports them to the programmer. With pair programming this kind of error dropped dramatically.

Now in the laboratory environment, it was noted that the students waste less time doing other activities (such as talking, surfing on the internet, etc.) because of the partner's pressure. Also, they learn not only the theoretical aspects of programming, but also get some tips from their classmates: hot keys, typing tricks, help usage and other things were learned just by observing the partner working.

A final feature of this method is that, as students work in pairs the task of correcting the exercises is approximately divided by a factor of two, and then it can be possible to give more exercises during the semester and keep a closer look on how the students are assimilating each part of the subject and reinforce the weak areas.

Questionnaire analysis

The questions taken from [2], and the most common answers, were:

1) *It has been said among teachers, "You do not know it unless you can teach it." Do you find any value to yourself in explaining your work to your partner?*

Many students reported that when explaining some subject to his/her partner, they had to elaborate it in a more detailed fashion, so they learned a little bit more and noticed several aspects of the subject during this process.

2) *Do you feel you have learned anything just by reading your partner's code?*

The great majority of the students answered "no" to this question. They reported that they learned almost nothing by observing their partners working.

3) *What was the biggest hurdle you have had to overcome as a collaborative programmer?*

Accepting another strategy, different from what they had traced in the principle, was the most common problem reported.

4) *What kinds of things does the non-driver do as he/she observes?*

Some syntax errors, erroneous indentation, and minor logic mistakes were the most frequently answers found.

5) *What do you think is the biggest advantage of collaborative programming?*

Most of the students reported that the big advantage of pair-programming is that they could perform better algorithms, with fewer errors and in less time.

One of the students reported an interesting fact: during one development section, he didn't know how to solve the first part of the problem, and his partner helped him. In the second part, the opposite happened, he found the answer that his partner couldn't. So, working separately, both of them would fail the exercise, but working together, they could accomplish their goal.

6) *What do you think is the biggest problem with collaborative programming?*

The main problem the students found in pair-programming practice was when their partners didn't accept different ideas or suggestions. Some of the students also reported that their partner simply did nothing, not cooperating for the solution of the problem.

Drawbacks

As any other learning methodology, pair-programming has its drawbacks too. Analyzing the questionnaire answers and based on our own observations, we can list the following drawbacks in using pair-programming methodology in a classroom environment:

Some students really dislike working in pairs, and prefer to work alone. Some of them not even tried to work in pairs, preferring to work alone, even scoring only poor grades.

Pair choosing is another aspect that must be addressed carefully. They must be formed with one student that has a higher knowledge/skill level than the other, so he/she can help his/her partner. Pairs with two low knowledge/skill level students didn't worked also, because none of them could help each other. A student with very low knowledge/skill level together with a very high knowledge/skill level is another kind of pair that doesn't work, because the "expert" student quickly becomes bored with his partner and resolves the problem alone, without explaining the solution to his/her partner.

Another thing that must be taken into account for the pair programming to work properly is the personality of the partners. In our classes, we observed that students with a dominant profile tend to not accept suggestions and critics and try to resolve things by themselves. On the other hand, passive students tend to accept their partners solutions and avoid giving opinions, even when they notice something that is clearly wrong.

The last thing we observed in our classes is that there are some students that became addicted to pair programming and could not develop solo programming anymore. Probably this is the case of a passive student that agrees with everything even not understanding what the partner is doing.

Conclusions and Future Work

In this article we described the pair-programming method when used as a learning tool and showed the relationship between this method and the collaborative learning theory and the Vygotsky's socio-cultural theory.

In general good results were achieved, and most of the students were satisfied with their own performance in the course. We noticed problems in some pairs due to great difference in knowledge, when one of the partners was too dominant or too passive, and when partners had personal differences.

Also, some students could not maintain the performance of pair programming when working alone. This fact may indicate that not all the problems would be solved in pairs; students have to have some problems to solve alone to identify their strong and weak points, and have a more realistic view of themselves.

In our institution, a psychological profile evaluation is made for all the students by a specialist, and for the next semester, this information will be used to try to avoid problems with dominant/passive partners in the working pairs. Also, the knowledge/skill levels should be used to form the pairs, and the first test of the semester can be used for this purpose.

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DIRECTRICES PARA LA ACTUALIZACIÓN DE PROGRAMAS DE INFORMÁTICA EN ESPAÑA

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Abstract *— Los Planes de Estudio de Ingeniería Informática se diferencian de los planes de otras disciplinas en que requieren una actualización frecuente debido al dinamismo de los conocimientos que incorpora y a distintas directrices propuestas por diversas instituciones u organismos. La efectividad de estos cambios puede controlarse a través de la valoración de indicadores de calidad de la titulación que normalmente son aplicados con fines de acreditación.*
En este artículo se analizan y organizan diferentes clases de directrices aplicables en la evolución que sufren los Planes de Estudio de titulaciones de Informática. Este problema se ilustra con un caso real de aplicación del uso de indicadores de calidad como una de los factores que deciden la necesidad de cambios en un Plan, y la aplicación de algunas de las directrices identificadas para la realización de una propuesta de actualización de un nuevo currículo de la titulación de Ingeniero en Informática de la Facultad de Informática de la Universidad Politécnica de Madrid.

Index Terms — Computer Science Education, Evaluation of Engineering Programs´ Quality, Models for Higher Education in various countries.

INTRODUCCIÓN

La Informática ha sufrido cambios drásticos durante la década pasada. Hay nuevas tecnologías que se introducen continuamente, y otras se quedan obsoletas. Los avances técnicos, como el de las aplicaciones para World Wide Web y las tecnologías de redes han incrementado la importancia de muchos temas curriculares.

Pero también ha habido cambios culturales. La informática se ha expandido enormemente gracias al desarrollo y las facilidades para el acceso a aplicaciones de software a través de Internet. Las TI tienen una creciente importancia en la economía han surgido las empresas tecnológicas, y la alta demanda de la industria para a atraer personal cualificado. Ello ha conducido a una mayor aceptación de la Informática como una disciplina académica.

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La entrada de la tecnología de la información en los ámbitos culturales y económicos han consolidado el reconocimiento de la disciplina.

En definitiva, la Informática es una disciplina especialmente viva. En los últimos 10 años los cambios habidos técnicos y culturales han cambiado el diseño de un

Plan de Estudios en Informática, así como la forma de enseñarlo. En la actualidad el alcance es tan amplio que es difícil establecer los límites y considerarlo como una única disciplina.

Esta es la razón por la que en la última revisión del "Computing Curricula", el CC2001 [1] se ha desarrollado en diferentes volúmenes. Sólo uno de ellos ha sido publicado, el de Computer Science, mientras que aún no lo han hecho los de Computer Engineering, Software Engineering e Information Systems. La conjunción de todas estas especialidades, según el criterio de ACM y de IEEE, se complementan perfectamente y la educación de la Informática debe cubrir por lo tanto, el nuevo alcance de la Disciplina.

En este artículo se tratan dos de los aspectos fundamentales que pueden ayudar en la elaboración de nuevos planes de estudio en informática: los indicadores de control referidos a planes de estudio, y las directrices que pueden ser tenidas en cuenta. Finalmente se analizará el uso de esta información en la propuesta de un nuevo plan de estudios en informática.

LOS INDICADORES DE CONTROL

Las Universidades españolas usan un sistema de indicadores que hace posible que éstas cuenten con una información de calidad y con potencial estratégico en la que se fundamentan sus decisiones y con la que los implicados pueden tener un certero conocimiento y un diagnóstico preciso de su realidad.

Cuando una universidad quiere informar a sus miembros, a los responsables políticos o a la sociedad en general sobre su calidad se pueden utilizar diversos tipos de indicadores, con significado diferente desde distintas perspectivas, pues la calidad es un concepto multidimensional. Se puede informar de la calidad a través de distintos tipos de indicadores [2]:

- **Indicadores directos**: son los resultados que obtiene la institución cumpliendo sus funciones.
- **Indicadores de impacto**: medidas de valoración o satisfacción de la institución por

parte de las distintas audiencias con los colectivos implicados.

- **Indicadores indirectos**: medidas con información de sus entradas, de sus características organizativas, de sus recursos y de sus procesos de funcionamiento.

Bajo esta clasificación los indicadores que aquí nos interesan son un conjunto de indicadores indirectos que afectan al proceso de enseñanza aprendizaje y que viene representado por el Plan de Estudios. Así, los indicadores utilizados por las universidades españolas que guardan una relación directa con el Plan de Estudios están recogidos en la tabla I, todos ellos indicadores indirectos:

TABLA I

INDICADORES REFERIDOS AL PLAN DE ESTUDIOS DEL SISTEMA UNIVERSITARIO PÚBLICO ESPAÑOL

Denominación	Explicación
Dedicación lectiva del alumnado	Media de créditos en los que los alumnos de una titulación se han matriculado. Este indicador se puede usar para analizar si la carga docente está por encima o por debajo de otros posibles valores de referencia.
Prácticas requeridas	Es la relación entre el número total de créditos prácticos requeridos y el total de créditos aprobados en el plan de estudios, dando así la importancia que tiene la oferta de docencia práctica.
Optatividad requerida de la titulación	Es la relación entre el número total de créditos optativos y de libre configuración que ha de cursar el alumno a lo largo de la carrera y el total de créditos a cursar para obtener el título. Es una manera de indicar el peso específico de la optatividad.
Oferta de optatividad	Relación entre el número de créditos optativos diferentes ofertados y el número total de créditos que ha de cursar el alumnado. Valores altos reflejan una gran oferta de optatividad.
Prácticas en empresa	Relación de créditos que el alumno debe cursar en empresas u organismos públicos, y el número de créditos prácticos que debe cursar.

Estos indicadores forman parte de un catálogo de indicadores que son aplicables al conjunto de las universidades españolas, independientemente de la naturaleza de sus disciplinas, humanas sociales o técnicas. Pero no basta con ofrecer información, sino que hay que contar con referentes para su contraste que permita decidir si el Pan de Estudios es mejor o peor. Por eso aquí se comenta también un sistema de indicadores específicos para titulaciones técnicas que forman parte del método de evaluación SECAI [3].

Los indicadores correspondientes al Plan de Estudios, según este método, se encuentran organizados en tres apartados:

- aquellos referidos al **proceso de elaboración**: indican en qué medida los elementos representados por el indicador, aparentemente, a elaborar un plan de estudios de calidad.
- Respecto del **contenido** del Plan de Estudios: señalan en qué medida los elementos representados por el indicador se manifiestan de la manera esperada en un plan de estudios de calidad.
- Sobre la **puesta en marcha**: representan en qué medida los elementos representados por el indicador se manifiestan de la esperada si el proceso y seguimiento del Plan de estudios es o fue de calidad.

TABLA II

INDICADORES REFERIDOS AL PLAN DE ESTUDIOS DEL SISTEMA DE EVALUACIÓN SECAI

Categoría	Indicadores
Proceso de elaboración	- Participación de agentes externos en la carrera - Participación de los miembros de la comunidad académica - Definición de ámbitos y perfiles profesionales de los titulados en función de la demanda social. - Análisis y valoración de los conocimientos, capacidad e intereses de los estudiantes que acceden a la carrera. - Análisis de la congruencia entre contenidos, métodos y recursos en función de los objetivos. - Posibilidades de logro en función del tiempo disponible para cursar el Plan.
Contenido	- Definición expresa del modelo de formación y de los objetivos educativos de la carrera - Estructura del Plan de estudios - Orientaciones metodológicas y su adecuación a los objetivos - Orientaciones relativas a la evaluación de conocimientos y su adecuación a los objetivos - Plan académico de cada asignatura - Contenidos de las enseñanzas. Actualización y adecuación a los objetivos - Previsión de actividades de nivelación y refuerzo
Puesta en marcha	- Previsión de las necesidades de acuerdo a los contenidos del plan - Nivel de conocimientos y aceptación del Plan por parte de los miembros de la comunidad educativa - Programa de seguimiento, evaluación y actualización del Plan

SECAI, por tanto, es más exhaustivo en la relación de indicadores que utiliza con respecto del Plan de Estudios, pues no sólo trata aspectos relacionados con sus contenidos sino con el proceso de elaboración, y su seguimiento. Su orientación a la evaluación de estudios técnicos se manifiesta al dar especial relevancia a la participación de agentes sociales en su elaboración y en la definición de perfiles profesionales, así como en el seguimiento en la actualización de contenidos. Además la descripción de cada indicador es más formal respondiendo mejor a un espíritu ingenieril, incluyendo información como criterios orientativos que deben utilizarse para evaluar el indicador, o la lista de informaciones (institucionales o resultados de encuestas) que son necesarias y están disponibles. Esto hace posible prácticamente la aplicación y evaluación sistemática de los indicadores.

Con el apoyo de la Comisión Europea, el consorcio Career Space [4], que está constituido por once importantes empresas de Tecnologías de Información y Comunicación (TIC) y por la Asociación Tecnológica Europea de Industrias de la Electrónica, la Información y las Comunicaciones, ha estado abordando la escasez de profesionales en este sector. Aparte de las iniciativas que tomaron, y que serán referidas más adelante, recomiendan que las universidades deben introducir un proceso de control de la calidad con resultados documentados. Y que la información obtenida debe aplicarse para seguir perfeccionando el programa. Según este consorcio, el proceso de control de calidad debe obtener retroalimentación del sector empresarial respecto a la evaluación de competencias de los antiguos estudiantes en áreas técnicas y de comportamiento después de su contratación. También requiere, partir de los comentarios de los estudiantes, conocer en qué medida el curso consigue los resultados esperados, y si el estudiante piensa que durante el curso ha adquirido los conocimientos y capacidades adecuados de cara al mercado laboral.

ORGANIZACIÓN DE DIRECTRICES

Hay distintas formas de clasificar y organizar las directrices que pueden considerarse en la renovación de planes de estudio de titulaciones de Informática. Dependiendo de quienes son las entidades que las elaboran pueden distinguirse directrices propias de las Asociaciones profesionales de reconocido prestigio, instituciones gubernamentales que tienen a su cargo la política educativa de un país o de una región que intenta armonizar las correspondientes a distintos países, las promovidas por las propias universidades, o las propuestas por el tejido empresarial a través de estudios de demanda de empleo.

En adelante se ilustrarán estas diferentes directrices con ejemplos en el contexto europeo y español, a los que pertenece el centro universitario que se tomará como caso real de actualización de plan de estudio.

Directrices de Asociaciones profesionales

Los estudios universitarios de la titulación de Ingeniería Informática en España se han basado tradicionalmente en los curriculums elaborados conjuntamente por los esfuerzos conjuntos de las asociaciones IEEE y ACM. En 1998 estas organizaciones formaron un grupo de trabajo para diseñar el Comuting Curricula 2001 [1], con el fin de llevar a cabo una importante revisión y mejora del anterior, fechado en 1991 [5]. Los principales cambios residieron en considerar los cambios tecnológicos, y cambios culturales en los últimos diez años. Por otra parte, el término computación se ha ampliado en estos últimos años hasta tal punto que es difícil definirlo como una única disciplina. Por ello decidieron desglosar el currículo en cuatro bloques: Computer Science, Computer Engineering, Software Engineering e Information Systems.

Directrices Gubernamentales

La universidad española inició un camino hacia un marco de autonomía e independencia con la Ley de Reforma Universitaria, en 1983. Los aspectos más novedosos fueron el régimen estatutario de las universidades, la organización departamental y la reforma universitaria mediante la ordenación académica de las enseñanzas. Al Consejo de Universidades, creado en 1985 con tal fin, le fue atribuido la competencia de proponer al Gobierno los títulos con carácter oficial y validez en todo el territorio nacional, como las directrices generales comunes y de homologación.

En 1987 se publican las Directrices Generales comunes de todos los planes de estudio de ámbito nacional y de carácter oficial [6], que establece que éstos deben ser elaborados por las universidades y posteriormente homologados por el Consejo de Universidades. Este marco legislativo presenta como aspectos fundamentales:

- **Flexibilización**: se distinguen tres bloques de materias. Troncales (contenidos mínimos comunes que deben incluir los planes conducentes al mismo título), Obligatorios (representan el carácter distintivo de la universidad), Optativas (representan una orientación elegida por el alumno para su formación), Libre configuración (con contenidos formativos que el alumno desea adquirir no directamente relacionadas con el título al que opta).
- **Estructura cíclica**: el primer ciclo comprende enseñanzas básicas y de formación general, y el segundo ciclo se dedica a la profundización y especialización en las enseñanzas. Los estudios de primer ciclo tienen duración de dos o tres años, y el segundo ciclo de dos años. La carga lectiva oscila entre 60 y 90 créditos por año académico, teniendo un crédito un equivalente de 10 horas de enseñanza.

Las directrices propias de cada titulación establecieron posteriormente el marco general que hizo compatible un mínimo de homogeneidad entre las distintas titulaciones oficiales, pues incluían la estructura y duración de las correspondientes enseñanzas, los objetivos formativos y el perfil profesional, indicando su número de créditos, su adscripción a áreas de conocimiento y una breve descripción de sus contenidos temáticos. De licenciatura y diplomatura en Informática se pasa a titulaciones de Ingeniero en Informática [7]. Según estas directrices, la carga lectiva no podía ser inferior a 300 créditos ni superior a 450. La carga lectiva semanal debía oscilar entre 20 y 30 horas, incluidas las prácticas (la carga teórica lectiva no podía superar las 15 horas semanales). Las enseñanzas prácticas consumen entre el 40 y el 50% del total de los créditos. Las materias troncales debían consumir un mínimo de 69 créditos y las de libre configuración el 10% del total.

Por otro lado, en loso últimos años se está creando el espacio europeo de la enseñanza superior, nacida en la Declaración de Sorbonne el 25 de Mayo de 1998 [8], donde se enfatiza el papel central que tienen las universidades para el desarrollo de las dimensiones culturales europeas. Posteriormente en la Declaración de Bolonia [9] los ministros europeos a cargo de la educación superior de 32 países firmaron una declaración conjunta en donde aceptan el desafío de construir el área europea de educación superior, frente a la tradicional independencia y autonomía de las universidades. Los objetivos propuestos se reagrupan en torno al pilar esencial de la valoración de la calidad para dotar al espacio europeo de confianza, pertenencia, movilidad y compatibilidad.

Directrices de Universidades

Los estudios universitarios de la titulación de Ingeniería Informática en España están organizados de distinta múltiples maneras, con universidades que sólo tienen un título o con otras que tienen una oferta en Informática con titulaciones de primer y segundo ciclo. En este último caso, incluso se dan casos en que el primer ciclo de la carrera superior es realizado por la Ingeniería técnica, y en otros o bien coexisten en el mismo o distintos centros de la titulación técnica y superior con variantes que van desde un determinado cupo de alumnos para acceder al segundo ciclo hasta planes de estudio que no facilitan el acceso de los ingenieros al segundo ciclo. Además, ha aparecido una enseñanza superior no universitaria tanto pública como privada que obliga a reconsiderara los estudios universitarios de informática. Ante esta heterogeneidad comienzan a existir unas directrices comunes, aunque no de obligado cumplimiento, que son discutidas y acordadas a través de la "Conferencia de Decanos y Directores de Informática" (CODDI), Conferencia que reúne a los responsables de la titulación de todas las universidades públicas y privadas españolas. En la actualidad el tema que ha centrado los debates se ha referido a determinar unas directrices comunes que permitan la adaptación de los estudios de las Ingenierías en Informática a la Declaración de Bolonia.

Los objetivos propuestos por la CODDI [10] han partido de la base en que la evolución de los planes de estudio basados en Bolonia debe cambiar la estructura emanada de la Ley de Reforma Universitaria en algunos aspectos importantes. En cualquier caso, se deben considerar tres elementos importantes:

- La informática forma una unidad que no permite diferenciar desde el principio de los estudios de informática de primer y segundo ciclo.
- Hay que incorporar otros conocimientos no estrictamente técnicos, como capacidades de negocio, sociales e individuales.
- Se deben mantener de la LRU dos conceptos básicos: las materias troncales y el catálogo de titulaciones.

Una vez constatados los inconvenientes de la especialización en el primer ciclo y la generalización en el segundo, para implantar las recomendaciones de Bolonia la opinión de la CODDI es que hay que adoptar una estructura en forma de un único primer ciclo, de 4 años, con una fuerte troncalidad que permitiera el acceso un segundo ciclo cuyo énfasis sería la especialización y la profesionalización, con muy poca o ninguna troncalidad, o bien el acceso al doctorado.

Las directrices proporcionadas se refieren a:

- Tamaño del Plan , utilizando como unidad de medida el Crédito europeo (ECTS). En concreto, entre 224 y 260 ECTS, siendo un crédito ETCS equivalente a 25 horas de trabajo para los estudiantes, incluyendo asistencia a clase, desarrollo de actividades y prácticas, estudio personal, asistencia a exámenes. Si se tiene en cuenta que un curso académico tiene una duración de 40 semanas, se puede aconsejar que la carga por semana para el alumno esté entre 35 y 40 horas.
- Distribución de materias de corte genérico, de arquitectura y tecnología de computadoras, de software y de proyectos para el primer ciclo.
- Para el segundo ciclo se dan sugerencias sobre materias de Arquitectura y Diseño Software, Desarrollo de Aplicaciones Software, Especialista de Sistemas de Información, Diseño de Sistemas Multimedia y Interacción Persona-Máquina, Telemática, Integración y Prueba o de Implementación y Prueba, Soporte Técnico, Diseño de Productos Digitales, Gestión de la Tecnología y de Proyectos, Informática Industrial y Sistemas Empotrados.

Directrices de empresas

En España la profesión informática no está bien definida, pues se convive con una gran variedad de títulos, tanto públicos como privados, a los que hay que añadir los diplomas públicos de enseñanza no reglada. Ante este problema de diferenciación profesional esta titulación está en permanente competencia con las Ingenierías de Telecomunicaciones, la Ingeniería Industrial y las licenciaturas en Físicas y Matemáticas, así como con titulaciones revestidas generalmente como "certificaciones" procedentes del sector empresarial, como Microsoft, Sun, Oracle o Cisco.

Frente a este problema de diferenciación el consorcio Career Space [4] cree que no existe una forma única de diseñar el currículo ideal en esta materia. Primero ha definido una serie de perfiles de capacidades genéricas básicas que se ofrecen como punto de referencia para las universidades. Pero aunque cada universidad tiene que encontrar por su cuenta la mejor solución, este consorcio ha elaborado un conjunto de directrices útiles cuya aplicación puede ayudar a las universidades a encontrar su propio camino hacia el éxito. Después de hacer un análisis de las tareas específicas de un trabajo en particular se llegó a la conclusión de que aunque las demandas de las empresas pueden ser distintas según la tarea que tienen que realizar, la estructura básica de los conocimientos necesarios es la misma. Esta es la razón por la que se pueden dar directrices comunes. Éstas fueron:

- Las calificaciones técnicas necesarias tienen un amplio espectro de conocimientos en matemáticas, ciencia y tecnología. Esa base es un requisito importante para que los graduados se puedan comunicar con colegas de otras áreas por medio de un lenguaje técnico común. Esa base se puede distribuir en un 30% de base científica, para comprender los métodos científicos para el análisis y el diseño, otro 30% de base tecnológica, que proporciona una visión general de las distintas tecnologías disponibles, y un 25% de conocimiento básico de sus campos de aplicación, de sus aplicaciones particulares según las demandas del lugar de trabajo para el perfil de un puesto de trabajo particular.

- El profesional de las TIC requiere la aplicación y el desarrollo continuos de las capacidades personales y empresariales por medio de proyectos en equipo, negociaciones, o presentaciones. Por eso se debe prestar una atención especial a la integración de la enseñanza de estas capacidades personales y empresariales esenciales en áreas temáticas más técnicas, que deben ocupar al menos el 15% del currículo.
- No basta con aprender cuestiones técnicas, sino que además hay que utilizarlos en situaciones reales, y conocer los problemas relacionados con los derechos de propiedad intelectual y el secreto comercial. Para conocer estas cuestiones, el consorcio recomienda realizar prácticas empresariales durante un período mínimo de tres meses. De esta manera se ayudará al alumno a elegir el tipo de trabajo que le gustaría encontrar después de graduarse.
- Para adquirir las capacidades profesionales es importante dedicar al menos tres meses a un trabajo en proyecto, aunque sea difícil evaluar el trabajo de un alumno individual.

El informe PACET [11] (Propuesta de acciones para la formación de profesionales de electrónica, informática y telecomunicación), promovido por ANIEL (Asociación Nacional de Industrial electrónicas y de telecomunicaciones), y el Colegio Oficial de Ingenieros de Telecomunicación, ofrece un análisis sobre el déficit de profesionales TIC en España, pero adaptando aquellos perfiles propuestos por Career Space a las demandas profesionales, identificando un total de 20 perfiles. Entre las recomendaciones recogidas en este informe destacan las siguientes:

- Recoger información sobre los perfiles profesionales, las habilidades requeridas, su oferta y la evolución en el mercado.
- Participación en los diseños curriculares de las empresas y las administraciones.
- Dar más peso a la formación de las tareas de gestión.

Este informe no ha recibido una aprobación unánime entre los colectivos implicados. Las principales críticas han sido realizadas por los Colegios de Ingenieros en Informática existentes en España. No se han tratado las acciones formativas que se precisan para el reciclaje profesional, ni se ha contemplado la formación precisa de perfiles de máxima responsabilidad de las áreas de Dirección de las TIC. Además se llega a recomendar un perfil de ingeniero superior para perfiles de programado de aplicaciones lo que demostraría un desconocimiento de los autores del informe de las titulaciones universitarias de Ingeniería en Informática y Telecomunicación.

En cualquier caso parece que existe un desfase entre la definición de perfiles obtenidos con respecto de las competencias y habilidades definidos en los planes de estudio de informática, por lo que la aplicación de estas últimas recomendaciones suponen asumir un riesgo.

UN CASO REAL: LA FACULTAD DE INFORMÁTICA DE LA UPM

En la Facultad de Informática de la Universidad Politécnica de Madrid, se llevó a cabo por primera vez un proceso de evaluación de la calidad en el año 2000.

Una de las tareas previas consistió en definir con precisión los indicadores a evaluar. Se tomaron como referencia los siguientes métodos, además de la Guía de Evaluación del Consejo de Universidades: el método SECAI (Sistema de Evaluación de la Calidad de Ingenierías), y el modelo europeo para la Gestión de la Calidad Total (EFQM). Se incorporaron nuevos indicadores que no fueron contemplados por la Guía del Consejo de Universidades. Como resultado se seleccionaron y describieron 66 indicadores relacionados con el área de enseñanza, 37 del área de Investigación y 34 correspondientes al área de tercer ciclo.

En la tabla III se resumen los resultados obtenidos referidos al Plan de Estudios:

TABLA III
RESUMEN DE CARENCIAS DETECTADAS EN EL PROCESO DE EVALUACIÓN REFERIDOS AL PLAN DE ESTUDIOS EN LA FI DE LA UPM

Categorías de indicadores	Puntos débiles
Estructura del Plan de Estudios	- Falta de definición de perfiles en el Plan de Estudios - No existe documentación registrada en la elaboración del Plan de Estudios - No hay especializaciones - Desequilibrio teoría-práctica en algunos casos. La carga real práctica es excesiva
Programas de Asignaturas	- Falta de datos para poder valorar la adecuación y coherencia de los programas de asignaturas - Falta de coordinación en la planificación de las prácticas
Organización de la Enseñanza	- Escasa participación del profesorado en la dirección de TFC - Tamaño excesivo en número de alumnos de los grupos

En paralelo, pero una vez elaborado el Informe final de evaluación de la titulación [12], un grupo de trabajo en el centro recibió el encargo de realizar una propuesta de un nuevo Plan de Estudios para que fuera debatido por los colectivos de la FI [13]. En concreto se tomaron en cuenta las siguientes directrices:

- Planes de Estudio en informática de otras universidades españolas (por ser de nuestro entorno más cercano), europeas (por la necesidad de converger con sus enseñanzas de referencia), y universidades de EEUU (por ser un país de referencia en temas informáticos). La información ha sido de utilidad para confirmar el rango de posibilidades y alternativas en la enseñanza de la informática.
- Computing currículum de ACM y de IEEE de 2001. En la actualidad es el único marco genérico internacional existente sobre curricula. Pero se ha encontrado con dificultades en aplicarlo pues la unidad de crédito no es equivalente, y el alumnado entre en la universidad con diferentes conocimientos.
- Boletín Oficial del Estado 20-11-1990, donde se establece la troncalidad mínima. Es de obligado cumplimiento para su homologación.
- Encuesta a profesionales informáticos, para conocer más de cerca la demanda profesional en nuestro entorno más cercano.
- Encuesta sobre los coordinadores de asignaturas con respecto de los contenidos de asignaturas, para asegurar el escalonamiento de las asignaturas relacionadas con el plan actual.

CONCLUSIONES

La actualización de Planes de Estudio en Informática es una tarea habitual para las universidades dada la actualización continua que requieren los contenidos técnicos que hay que transmitir, como la indefinición, quizás debida a su juventud, de la profesión informática. En este artículo se han recogido, descrito y organizado las directrices propias para este fin aplicables en el contexto español y europeo.

En la experiencia de una propuesta de un nuevo Plan de Estudios que se ha seguido se han utilizado la mayor parte de las directrices mencionadas. Algunas de ellas porque forman parte del marco jurídico español. Otras porque son directrices de reconocido prestigio. Pero las ha habido que no han sido utilizadas porque los proponentes han considerado que esas recomendaciones sólo cubren parte del problema o porque han aparecido tan recientemente que no ha sido posible aplicarlas. Este es el caso del efecto de la Declaración de Bolonia, y de los esfuerzos de armonización conjunta entre todos los directores de titulaciones en Informática. En cualquier caso es necesario tener en cuenta los nuevos perfiles profesionales, y tener en cuenta las habilidades básicas que requieren los nuevos profesionales en el sector.

Es decir, afortunadamente cada vez hay más directrices adecuadas para la elaboración de un plan de estudios en informática, aunque no todas las necesarias. Pero simultáneamente hay un esfuerzo cada vez mayor en la definición precisa de indicadores que controlen la calidad de los planes implantados. El conocimiento de estos indicadores ayudan a su vez como guías para recopilar las directrices necesarias.

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A LARGE SPEECH CORPUS DEVELOPMENT

Carlos Alberto Ynoguti[1], Thiago Pereira Raposo [2] and Fabrício Vital [3]

Abstract *— Speech recognition systems use statistical methods based algorithms, and therefore need several training samples to perform properly. Consequently such systems require huge databases for training and testing. Large speech corpora development are hard to construct, and in Europe and in the USA, their development was possible only with the cooperation among research centers, universities, private companies and the government. In these countries, the availability of such databases provided the resources for the great improvement in speech technologies observed in the last years. Here in Brazil, such consortiums are not even mentioned, and the researchers have to work with small, locally developed databases. In this article we report an effort to develop a large speech corpus for the Brazilian Portuguese to fulfill this important lack for research in this area.*

Index Terms — speech processing, speech recognition, speech corpus.

INTRODUCTION

Spoken language is the natural way human beings use to communicate each other. Its structure is based on phonological, syntactic and prosodic structures of the language, on the acoustical environment, on the context in which the speech is being produced (e.g. people speak differently in noisy and silent environments), and on the channel through which it is transmitted (telephone channel, microphone, etc.)

Each person produces the speech in a different way, and the differences are due to differences in accent, shape and size of vocal tract, rhythm, among other factors. Furthermore, speech patterns are modified by the physical environment, social context, and speaker physical and emotional conditions.

The most promising technologies in speech recognition (Artificial Neural Networks and Hidden Markov Models [6][9][12][13]) use statistical modeling techniques that learn by examples. To provide this training samples, the training database must be large enough to cover all the phonetic, linguistic and acoustic phenomena encountered in spoken language. In fact, bad modeled variables (such as channel or microphone differences, out of vocabulary words, bad trained subunits) cause a devastating effect in the system's overall performance. So, in order to provide sufficient training samples for the statistical methods to work properly, the training database should be large enough.

Speech synthesis and coding do not require such large databases but need some material for evaluation and testing.

Unfortunately, such databases are very expensive to construct. These high costs can only be accomplished by a joint effort of private institutions, research centers and public funding agencies, in order to distribute tasks and avoid doubling efforts. Also, to involve more people in this process, this material should not be specific to one area or task, but instead, serve to as many groups and research areas as possible, in several knowledge areas (speech coding, synthesis and recognition, phonetic and linguistic studies, etc.)

In Brazil, due to the disinterest of the private sector and the lack of government incentives, there is no such speech corpus available in public domain. Some private companies, such as IBM, had speech corpus in Brazilian Portuguese, but unfortunately they are for private use only.

In Brazil, such consortiums were not even contemplated, and the researchers here have to develop their research using small, locally developed databases, which try to cover the most significant aspects of the spoken language, unsuccessfully in the great majority of the cases.

For this reason, a large speech corpus is of great importance for this area to achieve the great development verified in Europe and in the USA. A 500 speakers database seems to be a reasonable goal, comparing to European databases [2][3].

The final point is that this work has a purely scientific approach, that is, it's not intended to earn money

SPEECH DATABASES AROUND THE WORLD

In Europe, France, Portugal, Italy, Germany, Greece, England, Denmark, Spain, Norway, Sweden and the Netherlands, joined in the EUROM_1 project [2], there is a multinational effort to create a speech corpus in the languages spoken in that countries. For each country, a database consisting of 60 speakers (30 males and 30 females), selected in the same way and recorded in the same conditions with common file formats was created.

In Portugal, it was also created a database called BD-PUBLICO (Base de Dados em Português eUropeu, vocaBulário Largo, Independente do orador e fala

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COntínua), with about 10 million words in approximately 156 thousands sentences, pronounced by 120 speakers (60 males and 60 females). This speech corpus was developed by a joint effort of research centers, the government and some private institutions [3].

In the USA a great effort was made in this sense and there are available in the public domain several speech databases for development and evaluation of speech processing systems.

The Linguistic Data Consortium [8] is an open consortium of universities, companies and government research laboratories. It creates, collects and distributes speech and text databases, lexicons and other resources for research and development purposes. The University of Pennsylvania is the LDC's host institution. The LDC was founded in 1992 with a grant from the Advanced Research Projects Agency (ARPA), and is partly supported by the Information and Intelligent Systems division of the National Science Foundation. Most of the well known speech corpora (TIMIT, TI-DIGITS, SWITCHBOARD, Wall Street Journal, etc.) are available at LDC.

Also, research centers as the Center for Spoken Language Understanding from Oregon Graduate Institute are making solo efforts to construct particular databases [4][5].

In the United States there are also many speech corpora available in public domain for speech systems development and evaluation.

The availability of large databases allowed an expressive improvement in the speech technologies, not only by alleviating the task of corpus development, a hard and expensive task, but also by providing a way to compare the results achieved by different researchers in a statistically significant way.

METHODOLOGY

The goal of this work is to be an initial step to the construction of a large speech database. The idea is to distribute an acquisition software among the researchers interested in this kind of material and ask them to contribute with some speakers. With contributors in all regions of the country, it would be possible to quickly construct a large corpus at a very low cost. In this sense, researchers of many universities are being contacted to help in this effort.

It is intended to collect recordings that contemplate the majority of the applications in speech technology, such as machine commands, continuous speech, connected digits and others.

Eventually, this database could became a reference in the speech area, allowing researchers to implement and test their ideas, and to compare their results in a statistically consistent way. Also, the methodology used to generate the database allows it to be in continuous expansion.

To achieve this goal, the whole project was divided in the following stages:

- Study of dialects and geographic distribution of the speakers.
- Determination of the types of locution
- Acquisition software development
- Recordings
- Phonetic transcription
- Organization of the database

Next, each topic will be described in more details.

Study of dialects and geographic distribution of the speakers.

For a database to be representative, it’s necessary that it has utterances from people representing all the accents found in the country. It’s not an easy problem and, in fact, neither the number of different accents nor the accents themselves are determined for Brazilian Portuguese.

Another problem one has to face is how many people to record from each region/accent? Which criterion should be used? The first idea that comes to mind is: the percentage of speakers of one determined region must be proportional to the number of inhabitants of that region. However, other factors have to be taken into account:

- Percentage of the people who will really use the speech technology;
- Economic importance of each region;

Clearly, these issues are not easy to handle and further study must be done in order to have a truly representative speech corpus. Despite of these issues, it’s necessary to define the number of speakers to be collected from each region, and for the first approach, the intention is to collect as many speakers as possible. Afterwards, when (and if) these linguistic studies become available, it’s always possible to collect more utterances in order to balance the database.

Determination of utterance types

The goal here is to cover all the possible applications of speech technology. After long research and exhaustive discussion, one decided to contemplate the following topics:

- **Continuous speech.** (“My son is sick and I’ll bring him to the doctor.”) – 20 utterances per speaker. In order to model all the phonetic and grammatical variations, it is interesting that this database should be as assorted as possible. Good sources of such kind of sentences are the newspapers, the internet, magazines, books and others. Up until the moment, about 10000 sentences were collected, and it’s expected to collect material enough for 1000 speakers (20000 sentences). Of course, it’s a hard and tedious work, and an acquisition software was developed for this purpose. Also, sentences were limited to have 8 to 12 words each, so that there are not too short or too long ones.It is desirable that the set of sentences sent to each speaker has at least one sample of each phoneme. Being thus, the verification of the phonetic content of the sentences assigned to each speaker becomes necessary. In the case of absence of some phoneme, one of the sentences is substituted for one that contains the absent phoneme. The counting and verification of phonemes is executed through an automatic transcription software, developed by the researchers of the Institute of Studies of the Language of the University of Campinas.

- **Connected digits.** ("five seven eight oh six zero two one") – 5 utterances per speaker. For this part, a software was developed to generate sequences of 4 to 8 digits in a random fashion.
- **Numbers in full.** ("two hundred thousands, three hundreds and forty") – 5 utterances per speaker. As in the previous case, a software was developed to generate random numbers and to transcribe them for the speaker to read.
- **Isolated words.** ("open", "print", "left", etc.) – 5 sets of 5 utterances per speaker. These words were chosen to meet applications such as computer operation, machine operation, banking services, etc. For each speaker, a set of 25 words is chosen in a random manner. For balance, it was not allowed for the same speaker to utter the same word twice, and the number of occurrences of each word in the whole database is set to be equally distributed.
- **Spelled words.** ("S-H-A-K-E-S-P-E-A-R-E") 5 utterances per speaker. Usually, the application of this kind of utterance is to give a name for a given service (e.g. banking service, air travel reservation), specially for foreign names. So, the speakers are asked to spell their first name, their last name, the first name of their father and mother, and the last name of the city they live.
- **Semantically unpredictable sentences.** ("Blue lions fall from Java's basements.") - 5 utterances per speaker. Semantically unpredictable sentences like the one from the example above are used for speech synthesis systems evaluation: when the listener cannot predict which word will be pronounced next, it's necessary to really understand what was spoken.
- **Sentences for prosodic study**. 4 to 8 utterances per speaker.
  1. "I **see** the **sea**"
  2. "I **see** the blue **sea**"
  3. "The blue **sea** is what I **see**."
  4. "I **see** that you want to go to the **sea**."

  The sentences listed above (and similar sets) are intended to evaluate the prosodic aspects of words uttered in different positions inside the utterance. Further, each sentence should be uttered in three different ways (slow, normal and fast) so that one can construct rhythm models of speech.
- **Spontaneous speech.** 1 utterance per speaker. The application for this topic is human-machine interface, and word spotting methods. For example, for utterances like "I'd like to know my credit card number", "Please tell me my credit card number", the system must understand that the information required is the credit card number. The idea here is to create situations in which the speaker is asked to formulate a question or make a comment about some topic. Examples of motivating questions are:
  "Ask for information about the movies for tonight."
  "Make a comment about the weather"
  "Ask for a pizza on a delivery service"

Construction of the acquisition software

The acquisition software is one of the most important part of this project because it will make it possible the acquisition of the utterances in a fast and low cost way. This software performs the following tasks:

- Before starting the recording session, speakers fill a register with their name, surname, age, sex, education level, profession, city where he was born, name of the father and the mother and cities where he lived. This last item has great importance because accent is defined until the fourteen years of age. The father and mother's names are asked for the spelled words section.
- After the registration part, the speaker goes to the recording session. The acquisition system shows the sentence to be uttered in the computer screen, together with recording controls, so that the recording can be made in an easy way. Also, the system check for recording saturation and, if this occurs, the speaker is asked to repeat that sentence.
- Recordings concluded, the software sends the information via ftp protocol to Inatel, so that the data can be stored and organized.

Recordings

The recording task will be distributed among the people who are interested in collaborate with this effort. An instruction manual was elaborated and will be distributed together with the software, with directions about the microphone type, recording environment, sound card type, registration and sending procedures.

For this first version of the database, it's intended to collect utterances in a office environment, with a good quality microphone.

Phonetic transcription

The ideal would be that the utterances could be manually transcribed by linguistic specialists team. But this involves costs and, at the moment, due to lack of financial resources, this task will be carried out automatically, using a software developed at the Institute of Language Studies (IEL) of the State University of Campinas (UNICAMP).

Database organization

As the recording stage ends, it is necessary to organize them in order to facilitate their manipulation. It is intended to divide the speakers into training and test sets. Also, the speakers can be clustered in terms of age, gender and accent. For this purpose a SQL based software is being developed.

CONCLUSION AND FUTURE WORK

In this article, a large speech corpus development effort is described. Researchers frequently report the difficulty to work in speech processing area without large enough databases. Also, with this database available, results can be compared in a statistically significant way.

Most of the applications of speech technology were contemplated, and further ones can be added along the time. Furthermore, the recording process can continue throughout, and the database can be in continuous expansion.

For the future, it is intended to build a telephone quality speech corpora by passing this database through a telephone line.

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A SOFTWARE FOR VQ TEACHING

Amarildo Martins de Mattos[1] *and Carlos Alberto Ynoguti*[2]

Abstract *— This article reports a Matlab® script developed to help students to understand the basic concepts of vector quantization (VQ). It shows in a very intuitive way to design and build a simple two-dimensional vector quantizer. Its graphic interface allows a quick understanding of all the phenomena involved in the quantization process. In addiction, the software makes a comparison between the exhaustive search and a tree-based search to show that the last one has a much better performance.*

Index Terms — Vector quantization, block quantization, source coding.

INTRODUCTION

Quantization and sampling are the basic steps to use the digital technology with analog signals. For unidimensional signals like voice or audio there is the class of scalar quantizers which are exhaustively studied [2] and there are several softwares for their simulation.

Vector quantization can be viewed as a generalization of scalar quantization to the quantization of a vector, an ordered set of real numbers. The jump from one dimension to multiple dimensions is a major step and allows a wealth of new ideas, concepts, techniques and applications to arise that often have no counterpart in the simple case of scalar quantization. While scalar quantization is used primarily for analog-to-digital conversion, VQ is used with sophisticated digital signal processing, where in most cases the input signal already has some form of digital representation and the desired output is a compressed version of the original signal.

VQ is usually, but not exclusively, used for the purpose of data compression. Nevertheless, there are interesting parallels with scalar quantization and many of the structural models and analytical and design techniques used in VQ are natural generalizations of the scalar case.

A vector can be used to describe almost any type of pattern such as a segment of a speech waveform or of an image, simply by forming a vector of samples from the waveform or image. Another example, of importance in speech processing, arises when a set of parameters (forming a vector) is used to represent the spectral envelope of a speech sound. Vector quantization can be viewed as a form of pattern recognition where an input pattern is approximated by one of a predetermined set of standard patterns, or in other words, the input pattern is matched with one of a stored set of templates or codewords.

Vector quantization can also be viewed as a front end to a variety of complicated signal processing tasks, including classification and linear transforming. In such applications, VQ can be viewed as a complexity reducing technique because the reduction in bits can simplify the subsequent computations, sometimes permitting complicated digital signal processing to be replaced by simple table lookups.

Thus VQ is far more than a formal generalization of scalar quantization. In the last years it has become an important technique in speech recognition as well as in speech and image compression, and its importance and application are growing.

In this article, a brief explanation of the basic principles and design methods are provided. In the sequel, a Matlab implementation of a vector quantizer is described.

VECTOR QUANTIZATION

An *N*-level *k*-dimensional quantizer is a mapping q that assigns to each input vector $\mathbf{x} = (x_0, \ldots, x_{k-1})$, a reproduction vector $\hat{\mathbf{x}} = q(\mathbf{x})$ drawn from a finite reproduction alphabet, $\hat{A} = \{\mathbf{y}_i; i = 1,\ldots,N\}$. The quantizer is completely described by the reproduction alphabet (or codebook) $\hat{A}$, together with the partition $S = \{S_i, i = 1,\ldots,N\}$, of the input vector space into the sets $S_i = \{\mathbf{x} : q(\mathbf{x}) = \mathbf{y}_i\}$ of input vectors mapping into de i^{th} reproduction vector (or codeword). Such quantizers are also called block quantizers, vector quantizers, and block source codes.

Distortion measures

We assume the distortion caused by reproducing an input vector $\mathbf{x}$ by a reproduction vector $\hat{\mathbf{x}}$ is given by a nonnegative distortion measure $d(\mathbf{x}, \hat{\mathbf{x}})$. Many such distortion measures have been proposed in the literature, and for the sake of simplicity, we'll use the squared error distortion or Euclidean distance in this work. This distortion is given by

$$d(\mathbf{x}, \hat{\mathbf{x}}) = \sum_{i=0}^{k-1} |x_i - \hat{x}_i|^2 \quad (1)$$

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Performance

Let $\mathbf{X} = (X_0, \ldots, X_{k-1})$ be a real random vector described by a cumulative distribution function $F_X(x)$. A performance measure of a quantizer q applied to the random vector **X** is given by the expected distortion

$$D(q) = E\left[d\left(\mathbf{X}, q(\mathbf{X})\right)\right] \tag{2}$$

where E denotes the expectation with respect to the distribution of **X**.

Of course, the lower $D(q)$ is, the better is the quantizer. So, an N-level quantizer is said to be optimal (or globally optimal) if it minimizes the expected distortion, that is, q^* is optimal if for all other quantizers having N reproduction vectors, $D(q^*) \leq D(q)$. A quantizer is said to be locally optimum if $D(q)$ is only a local minimum, that is, slight changes in q cause an increase in distortion.

The goal of block quantizer design is to obtain an optimal quantizer if possible and, if not so, to obtain a locally optimal and hopefully good quantizer. Several such algorithms have been proposed in the literature, and in this article we will discuss the most popular of them, due to Linde, Buzo and Gray [3], commonly referred as the LBG algorithm. The LBG algorithm is based on the Lloyd's Method I [4], which will described next.

VQ DESIGN

The Loyd's method

The Loyd's Method I is based on the solution of the two following problems:

- Given a quantizer q, described by a reproduction alphabet $\hat{\mathbf{A}} = \{\mathbf{y}_i, i = 1, \ldots, N\}$, what is the optimum partition $S = \{S_i, i = 1, \ldots, N\}$?
- Given a partition $S = \{S_i, i = 1, \ldots, N\}$, where the code words must be placed so that $D(q)$ is minimized?

The solutions for the two problems are:

- A partition that is optimum for $\hat{\mathbf{A}}$ is easily constructed by mapping each input vector **x** into the codevector $\mathbf{y_i}$ that minimizes the distortion $d(\mathbf{x}, \mathbf{y_i})$, that is, by choosing the minimum distortion or nearest-neighbor codeword for each input.
- For a given partition S, the best location for each codeword is the centroid or center of gravity of each set S_i.

The LBG algorithm

The LBG algorithm builds up the vector quantizer by solving these two problems in a recursive way. The LBG algorithm can be state as follows:

The LBG algorithm

- **Initialization:** Choose an arbitrary set of K code vectors, say $\bar{\mathbf{x}}_k, k = 1, 2, \ldots, K$.
- **Recursion:**
  1. For each feature vector **x** in the training set, "quantize" **x** into code vector $\bar{\mathbf{x}}_{k^*}$, where

$$k^* = \arg\min_k d\left(\mathbf{x}, \bar{\mathbf{x}}_{k^*}\right) \tag{3}$$

  Here $d(\cdot,\cdot)$ represents some distortion measure in the feature space. In this work, the Euclidean distance, (1) was used.

  2. Compute the total distortion that has occurred as a result of this quantization,

$$D = \sum d\left(\mathbf{x}, q(\mathbf{x})\right) \tag{4}$$

  where the sum is taken over all vectors **x** in the training set, and $q(\mathbf{x})$ indicates the codeword to which **x** is assigned in the current iteration. If D is sufficiently small, STOP.

  3. For each k, compute the centroid of all vectors **x** such that $\bar{\mathbf{x}}_k = q(\mathbf{x})$ during the present iteration. Let this new set of centroids comprise the new codebook, and return to Step 1.

There also exists a slight variation on the LBG method, which differs in the way the algorithm is initialized: the number of clusters is iteratively built up o a desired number (power of two) by "splitting" the existing codewords at each step and using these split codes to seed the next iteration. This modified algorithm is shown below:

Initial guess by splitting

- **Initialization:** find the centroid of the entire population of vectors. Let this be the (only) initial codevector.
- **Recursion:** There are a total of I iterations, where 2^I codevectors are desired. Let the iterations be i = 1, 2, …, I. For iteration i,
  1. "Split" any existing code vector, say $\bar{\mathbf{x}}$, into two code vectors, say $\bar{\mathbf{x}}(1+\varepsilon)$ and $\bar{\mathbf{x}}(1-\varepsilon)$, where ε is a small number, typically 0.01. This results in 2^i new code vectors, say $\bar{\mathbf{x}}_k^i, k = 1, 2, \ldots, 2^i$
  2. For each feature vector **x** in the training set, "quantize" **x** into code vector $\bar{\mathbf{x}}_{k^*}$, where

$$k^* = \arg\min_k d\left(\mathbf{x}, \bar{\mathbf{x}}_{k^*}\right) \tag{5}$$

  Here $d(\cdot,\cdot)$ represents some distortion measure in the feature space. In this work, the Euclidean distance, (1) was used.

3. For each k, compute the centroid of all vectors $\mathbf{x}$ such that $\overline{\mathbf{x}}_k^i = q(\mathbf{x})$ during the present iteration. Let this new set of centroids comprise the new codebook and, if $i < I$, return to Step 1.

VECTOR QUANTIZATION

Once the vector quantizer is constructed, it's ready for use. There are several ways to perform vector quantization of a input vector, and here two of them will be discussed in details: the exhaustive search and the tree search.

Exhaustive search

The exhaustive search is the most direct and simple encoding algorithm. For this encoding scheme, a codevector is selected by calculating the distortion between the input vector x and all the codevectors in the codebook. The codevector having the minimum distortion is then selected.

Tree search

The exhaustive search outline above requires, for a codebook of size N, N distortion evaluations to be performed. For the squared error distortion measure, it means that k multiplications and (k-1) additions must be performed for each of the N codevectors. Other distortion measures may have much higher computational demands. Frequently the codebook size needed in applications is very large. Furthermore, the vector rate $\boldsymbol{f}_v$ is rather high in typical communications systems and the number of distortion calculations that must be performed per unit time, given by $N\boldsymbol{f}_v$, implies a very demanding computational complexity, typically involving many millions of arithmetic operations per second.

These considerations motivated serious study of more efficient algorithms that yield the nearest codevector without requiring an exhaustive search through the codebook. Several approaches have been proposed, and here, the tree search algorithm will be presented.

Consider the two-dimensional quantizer shown in Figure 1. In this Figure, the six code vectors are indicated with dots and the labeled "hyperplane" decision boundaries (line segments) are indicated with thick lines, which separate neighbor regions. Thin lines indicate extensions of the hyperplane segments to help visualize the efficient coding operation. Each decision boundary is a segment of a hyperplane and is labeled with the letters A, B, C, … and the two half spaces separated by each hyperplane are labeled '+' and '-'. Next, a tree structure for an efficient successive approximation procedure to locate an input vector will be described.

Suppose the initial step of a search algorithm is to compute the binary decision function for the hyperplane A. If the input $\mathbf{x}$ is on the right side of A (labeled '+'), then code vectors 1 and 5 are immediately eliminated as candidates for the nearest neighbor, since they are contained entirely on the left side of A. Similarly, code vectors 2 and 3 are eliminated as candidates if the input is on the left side of A ('-'). Depending on the result of the first test, we choose one of two new tests to perform. Thus if the input lies on the '+' side of A, we then test to see on which side of the hyperplane C it lies. If the input is on the '-' side of A, we then determine of which side of hyperplane B it lies. Each test eliminates one or more candidate codewords from consideration. This kind of procedure corresponds to a tree structure for the search algorithm as shown in Figure 2.

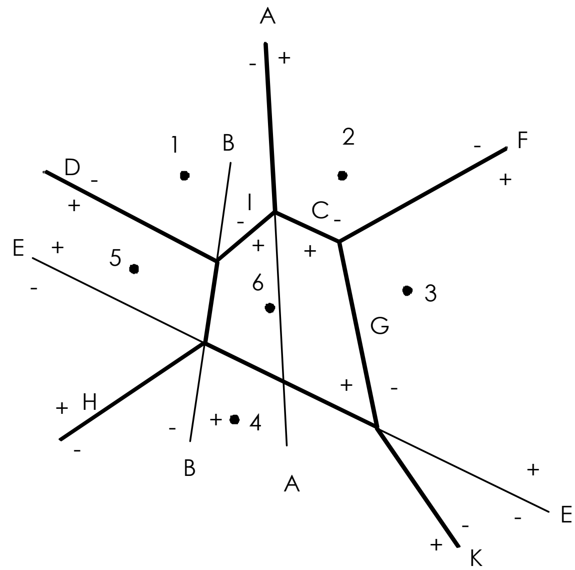

FIGURE 1
A TWO-DIMENSIONAL VECTOR QUANTIZER. (AFTER GERSHO & GRAY [1]).

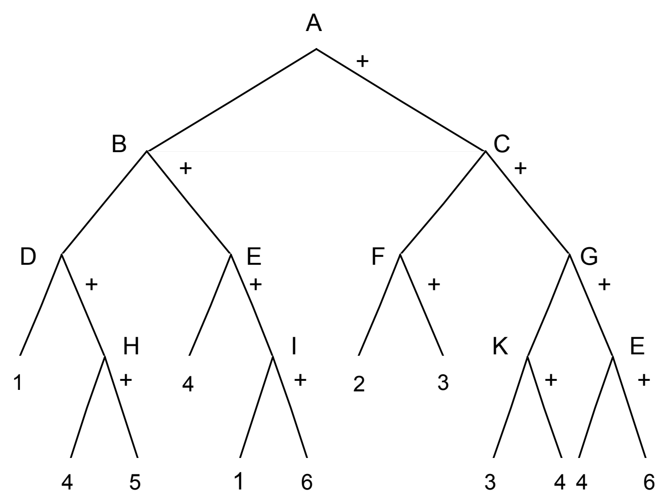

FIGURE 2
TREE STRUCTURE FOR EFFICIENT NEAREST NEIGHBOR SEARCH (AFTER GERSHO & GRAY [1]).

Note that this particular tree always leads to a final determination of the nearest neighbor code vector after at most 4 binary decisions. Hence, the search complexity has been reduced from 6 distance computations to 4 scalar product operations.

MATLAB SCRIPTS

To illustrate these concepts, three Matlab scripts were developed, one for codebooks design, and the others for search time evaluation. The first script implemented the modified LBG algorithm, the second the exhaustive search method, and the third, the tree search procedure. Next, the script outputs are shown.

VQ design

As an illustration of the VQ design using the LBG algorithm, let the training points be as shown in Figure 3.

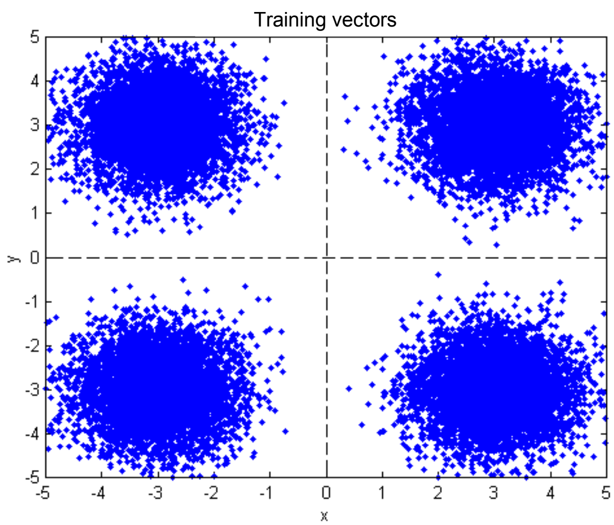

FIGURE 3
TRAINING VECTORS FOR THE VQ DESIGN.

If a codebook with 4 codevectors is desired, it's clear that these codevectors should be located at positions (-3,-3), (3,-3), (-3,3) and (3,3), as shown in Figure 4.

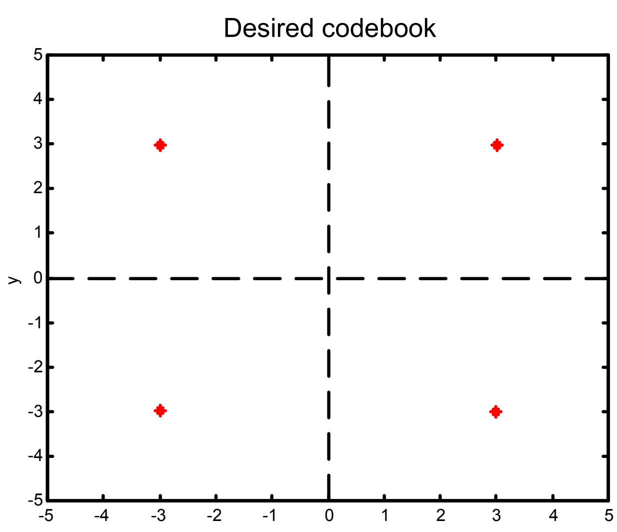

FIGURE 4
DESIRED 4 CODEVECTORS CODEBOOK.

In the first step, only one centroid is to be calculated, as the center of gravity of the entire set of training points. For the points given in Figure 3, these codevector sholud be located somewhere nearby the origin, and the output of the program is shown in Figure 5.

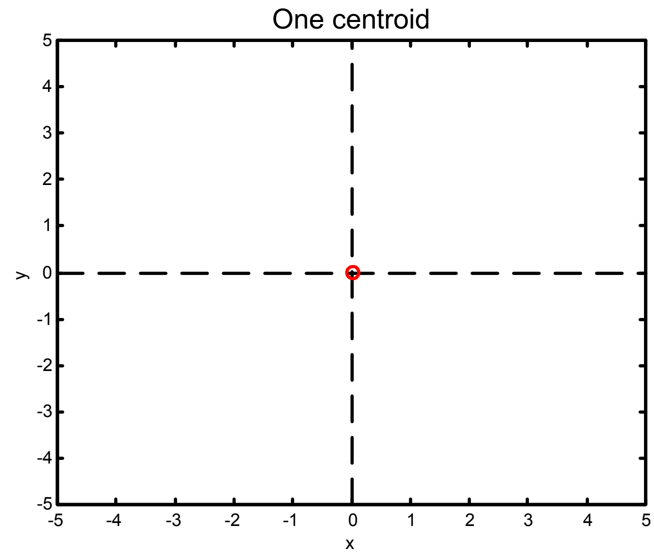

FIGURE 5
A ONE VECTOR CODEBOOK GENERATED BY THE PROGRAM.

Next, this unique codevector should be 'splitted', giving rise to two other ones. The result of the splitting procedure is shown in Figure 6.

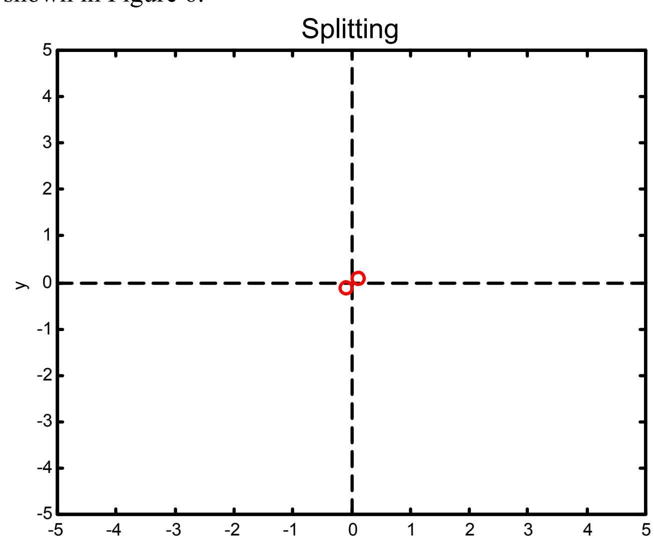

FIGURE 6
CODEBOOK AFTER SPLITTING.

The next step is to reallocate the codevectors so that a minimum distortion codebook is achieved. After a few iterations, the final codebook of order 2 is shown in Figure 7.

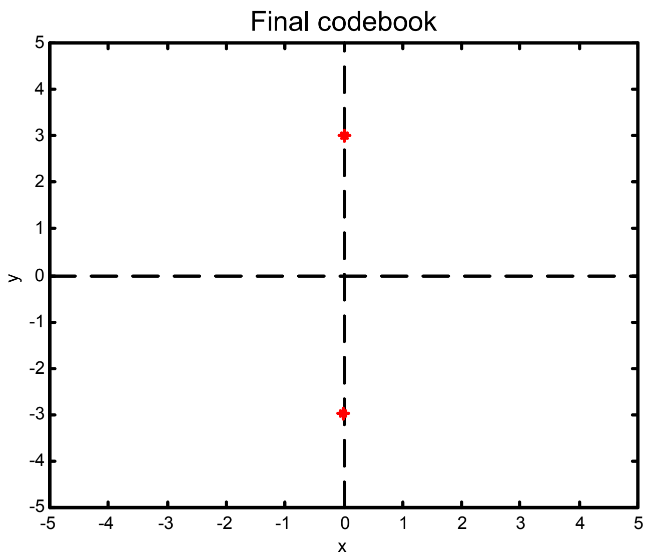

FIGURE 7
FINAL CODEBOOK OF ORDER 2.

Again, the splitting procedure is applied to both the codevectors of this codebook, yielding the configuration of Figure 8

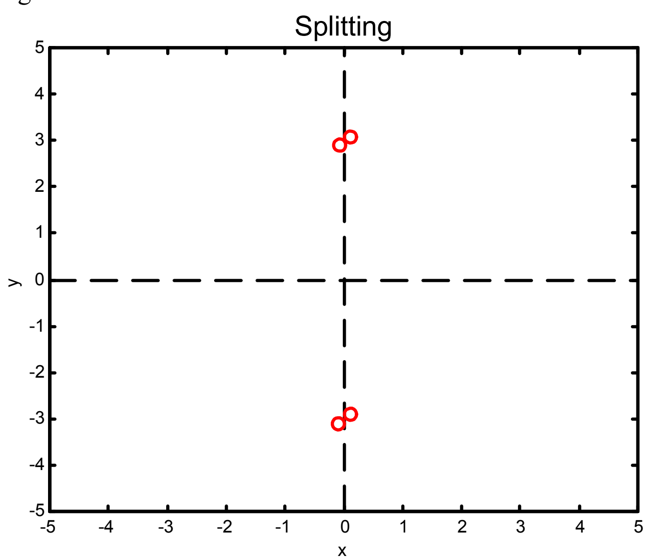

FIGURE 8
CODEBOOK OF ORDER 4 AFTER SPLITTING THE CODEVECTORS OF CODEBOOK OF ORDER 2.

After some iterations, the algorithm leads to the final codebook of Figure 4.

Quantization

After the design of the quantizer, it's time to analyze the quantization performance in terms of quantization time. For this purpose, 10000 points were generated according to a bidimensional uniform distribution, as shown in

The exhaustive search and tree search were then performed, and the quantization times were 1.047 s for the exhaustive search and 0.625 s for the tree search, showing the effectiveness of the later method.

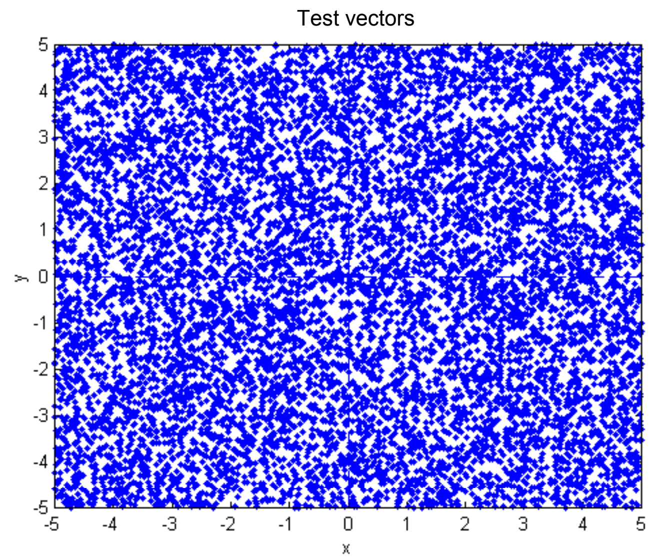

FIGURE 9
POINTS GENERATED FOR SEARCH PROCEDURES TESTS.

CONCLUSIONS

In this article a brief outline of vector quantization theory was presented, together with a Matlab® implementation of the LBG algorithm, the exhaustive search and the tree search, leading to a better comprehension of all phenomena involved.

Computational simulations are a very good way to teach because there are no 'tricks': the students can see the algorithm working and easily understand the concepts involved. As one said: 'A picture say more than a thousand of words'.

For the future, a better user interface is being planned, maybe using the Graphic User Interface provided with Matlab®.

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CONTINUOUS ON-LINE EVALUATION OF STUDENT SEMESTRAL ACTIVITY

Vladimir G. Zakharov[1]

Abstract *— An attempt is made to assess activities of a student during his academic semester in a Technical University. Lectures, seminars, laboratory works, home-work are typical activities of any student. The mark received for a semestral exam serves as the criterion to judge about student's knowledge. However, this mark very often does not reflect the real state of things. In order to make the evaluation trustworthy a quantitative approach is necessary to estimate the student activity during the whole semester. The evaluation proposed is based on a continuous assessment of results achieved by each student of a group. A feature of this method is using computers to provide each student with his individual tasks for home-work and giving him a chance to check up himself. Physics is taken as a test subject but the whole approach can be generalized for any fundamental or applied engineering discipline in a Technical University.*

Index Terms — Assessment of knowledge, Computer based examination, Home-work, Individual tasks,

INTRODUCTION

The paper appeals to one of most important problems throughout Russia and elsewhere. This is the problem of students knowledge evaluation in the context of teaching fundamental and engineering disciplines in Technical Universities [1]-[4].

In Russian higher school the four grade system of evaluation is generally accepted: "unsatisfactory", "satisfactory", "good" and "excellent" (corresponding to marks in Russian secondary school system from "2" to "5" respectively). If a discipline is taught in a University, say, during three semesters the mark for the final examination is then transferred to the "diploma annex" which is the supplement to the diploma containing the list of major subjects dominated by a graduate with corresponding marks.

Unfortunately, there is no guarantee that this mark adequately reflects the level of knowledge in a given field of science. Taking into account that the number of students in an academic group (class) of a typical Russian University is about 25 and that the number of groups attending lectures of Professor *X* is 4-6 one can imagine that the mark given by Professor *X* to Student *Y* depends upon many aspects other than academic ones:

- Psychical state of Student *Y* and the state of his health;
- Professor's individual peculiarities and habits;
- Professor's personal attitude to Student's appearance (in case of oral exams which are very common in Russia);
- General reputation of a given academic group undergoing the exam;
- Number of days between two consequent exams (Normally there are two examination sessions in Russia - in January and in June. Each consists of 5-6 strictly scheduled exams with short intervals between them).

It is also clear that Professor *X* who has 100 -150 students attending his lectures is physically unable to know personally each of them.

The situation is better with Assistant Professors who conduct seminars and laboratory works in a particular group. They have a direct constant contact with students and know their potential and their attitude to studies. However, at exams they play but auxiliary role and are not responsible for the final mark given by the lecturer – Professor *X*.

The purpose of the present paper is to highlight a student's advance during the semester by setting the quantitative assessment of his overall activity. This assessment could be expressed as a mark in any conventional mark system accepted in Russia or elsewhere and taken into account by the lecturer when he gives his final mark for the exam.

SETTING THE QUANTITATIVE SYSTEM OF ASSESSMENT

The following kinds of student academic activity undergo the quantitative assessment:

- Lectures,
- Home-work,
- Seminars (Practicals),
- Laboratory works.

These four activities are four principal components which serve as a basis for the future consequent assessment of activity for each student of any group.

At the end of semester a mark will be set for each of these activities and finally the resultant average is to be derived. This average mark should embrace the whole semestral activity of a student and strongly influence the examination mark at his final exam.

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Let us consider separately all above mentioned kinds of student activity and ways to set the semestral mark.

Lectures

The topics of the syllabus within a semester represent separate units (or modules) of the subject lectured. They should be duly controlled by the lecturer as soon as any of these units is over.

Conservation of Momentum and Energy

1). Two little balls with masses m_1 and m_2 moving uniformly in the same direction with velocities $\boldsymbol{V_1}$ and $\boldsymbol{V_2}$ so that $V_2 > V_1$. Consider their absolutely elastic collision. The resultant heat irradiated due to collision will be equal to

A. Zero.

B. $\frac{m_1 v_1^2}{2} + \frac{m_2 v_2^2}{2}$.

C. $\sqrt{(m_1 v_1)^2 + (m_2 v_2)^2}$.

D. $m_1 v_1 + m_2 v_2$.

2). The magnitude of their resultant momentum is equal to

A. Zero

B. $m_1 v_1 + m_2 v_2$.

C. $m_1 v_1 - m_2 v_2$.

D. $\sqrt{(m_1 v_1)^2 + (m_2 v_2)^2}$.

3). Consider now their inelastic collision. The resultant heat irradiated is equal to:

A. $\frac{m_1}{m_1 + m_2} \left(\frac{m_1 v_1^2}{2} + \frac{m_2 v_2^2}{2} \right)$

B. Zero.

C. $\frac{m_1 v_1^2}{2} + \frac{m_2 v_2^2}{2}$.

D. $\sqrt{(m_1 v_1)^2 + (m_2 v_2)^2}$.

4). The balls are now moving towards each other in perpendicular directions. The magnitude of their resultant momentum is equal to

A. $m_1 v_1 + m_2 v_2$.

B. $\sqrt{(m_1 v_1)^2 + (m_2 v_2)^2}$.

C. $m_1 v_1 - m_2 v_2$.

D. Zero.

5). A ball falls from the height *h* onto a flat massive plate and suffers the absolutely elastic collision with its surface. What does the total energy of the balls converts into during the interaction with the plate?

A. Into heat

B. Into potential energy *mgh*.

C. Into potential energy of elastic interaction.

D. Into kinetic energy of the resultant motion

FIGURE. 1
EXAMPLE OF A LECTURE TEST

The control can be realized at the end of each unit as a written test containing theoretical questions with multiple-choice answers. If a classroom where the lectures are delivered is equipped with computer technique the whole procedure can be computerized. The questions suggested by the professor should not imply long and boring written answers. They should be easy but appeal to profound understanding by pupils of theoretical backgrounds of a law or phenomenon considered in the topic tested. A set of questions for one student should be compiled in a way that the divergence in the evaluation should be the least possible. An example of test *Conservation of Momentum and Energy* is presented on Figure 1.

The test is intended for *multiple-choise answer* system and five correct answers (*A, B, A, B, C)* make the mark 5 (excellent). Not less than 5-6 tests should be realized during the semester and the average mark calculated.

Home-work

Home-work is considered as a very important component of the whole academic process. It should always be thoroughly prepared beforehand and duly checked. The tasks of home-work should be compiled on the *individual* basis. When a home- task is the same for the whole group it often loses its value because weak students have a habit to copy the ready solutions from exercise books of strong and honest students (at least in Russia this is a common problem). Any system which allows preparing sets of *individual* tasks will give good results. It is worth suggesting one of them.

Individual Task System (ITS). The individual student work has its enormous effect only if it is being guided and controlled by professor. Home-work as a part of ITS plays an extremely important role here and it is useful only when the problems of any home-work are compiled correctly from the methodical point of view and the individual capacities and particularities of a given student are taken into account. That is the problem - not for the student but for his teacher! And the more number of students in a class the heavier is this problem. 25-30 pupils in a class is normal for an average Russian Technical University and when a home-work (consisting of 5-6 problems from a text-book) is the same for the whole class the copying from somebody's exercise-book becomes inevitable (or even very popular). Every Russian teacher is well acquainted with this sad reality which complicates his an adequate assessment of a student activity and often makes a wrong opinion about student's personality. In order to make the assessment objective and trustworthy the ITS has been elaborated. Let us consider the basic principles of the ITS.

The ITS is realized using a PC loaded with a special program designed by the author written in *C* or C^{+} programming language which makes the whole system compact and allows to introduce any desirable changes in the easiest way.

A collection of problems and questions on Physics (or another subject) constitutes a subsystem of files called '*Bank Files'* which serves as a source of tasks to be issued for students. These files are always 'under construction': old problems can be removed, modified, corrected or substituted for new ones.

'Bank Files' itself is divided into several separate files containing problems on different chapters of the discipline. For Physics they are: *Mechanics, Molecular Physics, Electricity, Magnetism, Oscillations, Structure of Matter* etc. It is, therefore, a system of electronic files containing a collection of problems and questions which are used to compile tests, examination papers, home-works etc. If printed out it looks like a familiar book of problems with one exception: one of necessary numerical parameters in each problem is replaced by *S*. This *S* - parameter is a variable quantity which will be substituted for a number when a task is printed out for a student for his home-work or test. Its numerical value will be different even if the given problem is used twice in a class, i.e. for two students of the same group. Consequently, these two problems will have different answers. Figure 2 presents a fragment of the sub-file '*Mechanics'*. Five lines are reserved for each problem or question. The first line is never printed out and reserved for internal use by professor. It contains the number of a problem in the file, level of complexity, branch of the topic (kinematics, dynamics etc.) and another information.

#34-------*Conservation of Energy*—CmplxLevel: 3---
A sand bag of mass 10 *kg* is suspended with a 3 *m* long weightless string. A bullet of mass *S g* is fired with a speed 20 *m/s* into the bag. Calculate the energy converted to heat in the collision.
#35-------*Angular Momentum*-----CmplxLevel: 2-----
A wheel is rotating with an angular speed Ω = *S rad/s*on a shaf. A second identical wheel, initially at rest, is suddenly coupled to the same shaft What is the angular speed of the resultant system?
#36------*Dynamics of Particle*------CmplxLevel:4-----
A force *F* = 50 *N* is acted upon a particle whose

FIGURE. 2
FRAGMENT OF BANK FILE 'MECHANICS'

Two main sub-programs called TASK and ANSWER constitute the body of the ITS. Both programs are linked with the file VARIANT as shown on Figure 3.

File VARIANT consists of electronic matrices filled by professor with numbers of problems from *Bank Files*. Each row of any matrix corresponds to a student of the group and each column corresponds to a particular problem in the given task. Each matrix corresponds to a set of individual tasks on a given topic (e.g. Topic 1: *Kinematics*, Topic 2: *Dynamics* etc.). Consequently, sets of VARIANT are filled by professor gradually one by one.

When the program TASK is launched by professor, the number of set and the title of topic are entered by him. In the course of program realization reading of problem numbers and a consequent printing out of the corresponding problem takes place to compose a complete task of 5-6 problems to each student.

As it was mentioned above any problem contains one *S*-parameter to be replaced by a suitable numerical quantity. Replacing of this *S*–parameter is realized by means of a subroutine which substitutes the reasonable value of the

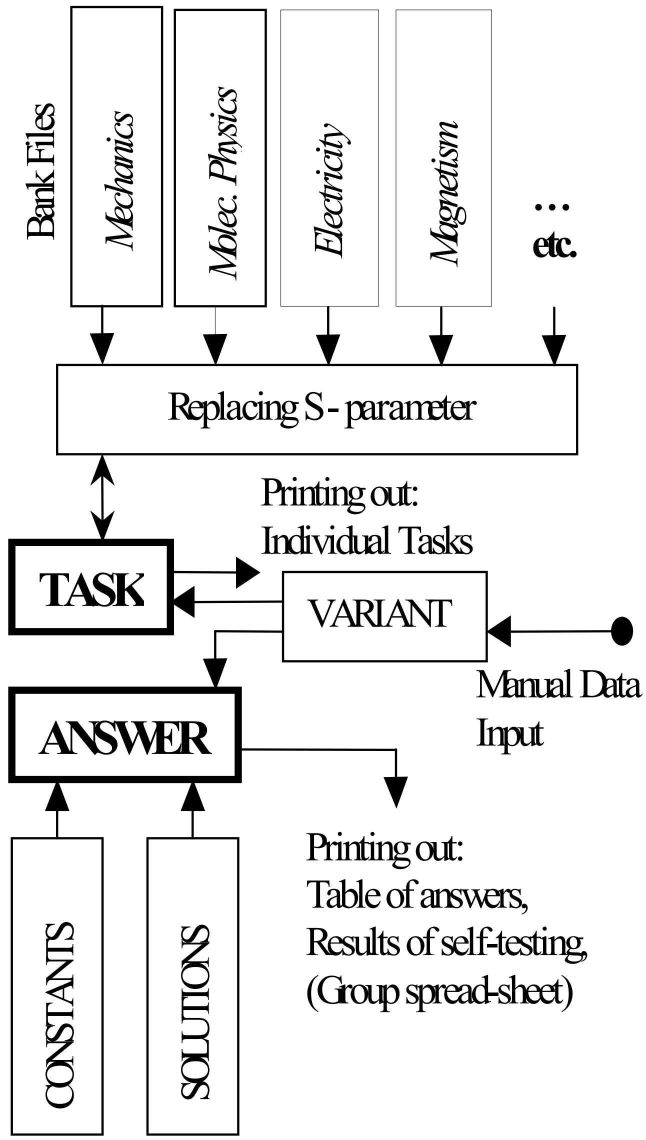

FIGURE. 3
GENERAL STRUCTURE OF THE ITS

corresponding numerical parameter. When a problem is placed several times in different places of the same set the answers will be all different.

Once printing of a given set of individual tasks is finished the program ANSWER will then be launched by professor to print *Table of Answers* to the set. ANSWER reads problem numbers and one by one calculates the numerical answers taking the general formulas from the subroutine SOLUTIONS and replacing there *S*-parameters by the numerical values.

Another function of the ANSWER is to realize *self-testing regime* which is very popular among students. This regime gives an immediate overall assessment of the whole group's activity.

The schedule for the self-testing session for a group is determined by professor. Normally, a week or two are given to let students solve the problems of the current set. Then the professor gathers students in a computer class-room where the program ANSWER is launched by him in self-testing dialogue regime. On PC's request, the *name*, *number of set*, and *number of task* are entered by each student at his PC. Then the PC requests to enter the answer of Problem 1. Once the answer is entered the PC compares it with that immediately calculated and gives out its verdict: YES or NO. The ANSWER's numerical solution in the case 'YES' may slightly differ from the result received and entered by a student. The permissible error in student's calculations is defined by the percentage (normally 5-7%) set by the professor. The options of ANSWER allow adjusting this value. As soon as the answer for the last problem is entered the session is over. The mark for the whole set is monitored on the student's display. Simultaneously, the overall spread-sheet of results (Figure 4) is being compiled on professor's display and can easily be printed out as a hard copy for his reference.

Set 3: CONSERVATION LAWS							
Task #	Name	Problems					Mark
		1	2	3	4	5	
1	Zakharov V.	Y	Y	N	Y	Y	4
2	Ivanov G.	Y	Y	Y	Y	Y	5
3	Schneider U.	N	N	N	Y	Y	2

FIGURE. 4
SPREAD-SHEET OF RESULTS

The mark not necessarily corresponds to the exact number of solved problems. There might be used other criteria which take into account the total number of problems suggested in the task, the level of complexity etc.

These spread-sheets collected by professor at a series of such sessions give him a complete picture of the state of things in the group. Namely, it enables:

- to estimate the general level of understanding of the subject (Physics, Mathematics, Civil Engineering etc.) in its practical aspect;
- to find out the most difficult for understanding topics and pay them more attention in the future;
- to let students realize themselves in their individual creative work;
- to teach students of correcting mistakes in a very productive 'Professor - Student' dialogue.

When analyzing the general results of a session the professor takes his decision to give a chance for a student to improve his results. He may easily compile (within a few minutes) a new task for U. Schneider (see Figure 4) making a particular accent on problems 1, 2 and 3 selecting carefully problems of this type for his new task.

The average mark obtained by a student for all the sessions is automatically calculated as soon as all the sessions are over. This mark is the criterion of a student's individual semestral activity at home-works.

Seminars (Practicals)

This kind of work with students gives more opportunities since it is here where a student cam demonstrate his abilities to solve the concrete problems. A seminar is normally conducted by Assistant Professor and begins with a brief excursion to theory recently delivered by the lecturer. It is necessary to underline that the seminar should never *substitute* the lecture but *support* it. Unlike traditions of the western school it is common in Russia to call a student and ask him to solve a problem (selected by professor) publicly. The author of the present paper heard many words of reproach and dissatisfaction both from students and colleagues when he experienced his teaching in Zambia and Mozambique but nobody could make him believe that this procedure was a human rights violation and normal exams (recognized by all western world) were not. It is shown by experience that it is not difficult to convince students that such a procedure is absolutely necessary. Indeed, not only professor benefits from it but student himself learns a science how to behave himself and make presentations in front of a large audience. (This is the science worth learning!)

The quantitative evaluation of activity at the seminars is made using the technique considered in details in the previous chapter. Three or four tests are compiled by the professor in the course of a semester. They are examined by the professor. Now he checks up not only answers but also the way of solving the problems. He makes his written remarks and observations in a rather 'conservative' traditional manner which can also be very useful in spite of technical progress benefits. Each set of these tests in comparison with those for home-works is more complicated. If student sessions for self-control of home-works can be compared with goods of mass consumption, the test for seminars is a 'hand-work'. As previously the average mark is derived for the whole semester.

Laboratory Works

The work in laboratories is considered by the author as very important. A laboratory is the place where all experimental and cognitive skills of a student can be realized and (what is very essential) developed.

It is needless to outline that the equipment of any student laboratory should be adequate and up-to-date. The old devices and instruments can be extremely useful for lecture demonstrations where simplicity of old instruments gives an explicit treatment of their action and lets the students penetrate into the history of science discoveries. Once a certain physical phenomenon or a law is understood by a student at lectures, some modern conventional instruments can be demonstrated by lecturer and later used at laboratory sessions [5,6]. It is the laboratory that should teach a student how to use them.

Each laboratory session normally takes place once a week and lasts 2 *academic hours* (1 academic hour = 45 min. in Russia). Eight (out of 16) sessions of a semester are intended for work performing (experimental sessions), and eight are 'to defend' the work (theoretical sessions). Each theoretical session follows the experimental one. Each work is carried out by a brigade of two students and they defend their work together. Two assistant professors are usually engaged into conducting of the whole session. A schedule of works should give the students the complete information (*what* and *when*). The works should be clearly described in special guide-books. The following points then undergo the evaluation:

- Readiness of a student to carry out his scheduled laboratory work;
- The experimental skills developed by student in the course of work;
- Understanding of theoretical backgrounds of the work performed.

The first point is realized at the beginning of a session as a free talk the professors have with every student of a group. The talk does not imply any deep understanding by students of a phenomenon underlying a given work. At this level the students must merely be acquainted with what they are supposed to do. Beforehand, they should have read the description of their scheduled work and know what to switch and what to turn. This is a rather friendly talk with the professor to get some hints and recommendations. A student's work-log should be filled with some relevant notes (formulas, brief descriptions of the experimental set-up etc.). Nevertheless, students must demonstrate someunderstanding and concern. If there is none his access to the work may be cancelled or postponed.

If a student receives professor's approval he gets the access to work and begins the experiment in accordance with the guide-book for laboratory works. At the end of the experimental session every student receives from professor a slip of paper with questions. This task is similar to those described above and compiled by professor using TASK sub-program of the ITS. The difference is that such slips do not contain numerical problems. They contain questions only – also taken from *'Bank Files'*. These questions are about theory and about methodics of the experiment as well. The real discussion with the students during the coming theoretical session is not limited to these printed tasks. Profound understanding and good experimental skills are supposed to be demonstrated by a student to get a high mark.

The results of measurements obtained during the experimental session are signed by the professor. The later data processing is carried out by students at home and presented at the following theoretical session together with answers to the questions formulated in their printed tasks. The average mark for the overall activity in the laboratory is derived at the end of the semester.

OVERALL EVALUATION

At the end of a semester the four average marks for four principle components of student activity will be available. Together with the examination mark they are supposed to give the full and objective picture of student's image.

These marks are extremely important and in many cases they are even more important that the marks received at the exams. Those are the functions of many random parameters of the examination day and can hardly present the real situation.

However, marks received in the course of the semester characterize a daily student work and reflect the state of things in a more adequate way. A correct quantitative evaluation of student's day-to-day progress helps a professor to form a correct approach and a right informal attitude to every student.

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Gaussian Mixture Models and Relaxation Labeling for Online Evaluation of Training in Virtual Reality Simulators

Ronei Marcos de Moraes[1] and Liliane dos Santos Machado[2]

Abstract — *Several approaches for evaluation of online or offline training in simulators based on virtual reality have been proposed. However great part of these approaches has a high complexity and it demands large computational structure, what is very expensive. An online evaluator must have low complexity algorithm to do not compromise the performance of simulator. We propose a new approach to online evaluation of training in simulators based on virtual reality. This approach uses Gaussian Mixture Models and Relaxation Labeling (GMM-RL) for modeling and classification of the simulation in pre-defined classes of training. This method provides the use of continuous variables without lost of information. So, it solves the problem of low complexity in online evaluators without compromise performance of the simulator and with good evaluation accuracy. Systems based on this approach can be applied in virtual reality simulators for training in several areas.*

Index Terms — *Gaussian Mixture Models, Relaxation Labeling, Training Evaluation, Virtual Reality.*

INTRODUCTION

The existence of an online evaluation tool in simulation system based on virtual reality is important to allow the learning improvement and users evaluation. Recently, new methods of evaluation for online training in virtual reality simulator have been proposed [5, 7, 11, 13, 14, 18, 19].

In medicine, some models for offline or online evaluation of training have been proposed. However, great part of these approaches depends of large computational structure, which is very expensive to be available in some Medical Centers in Brazil and several other countries.

Simulators bases on virtual reality (VR) for training need high-end computers to provide realistic haptics, stereoscopic visualization of 3D models and textures. Online evaluators must have low complexity to do not compromise performance of simulations, but they must have high accuracy to do not compromise evaluation. The Gaussian Mixture Models (GMM) can be a good option to do an online evaluation, because they can obtain good accuracy models and they are simple too. However, according to Tran et al. [22] Relaxation Labeling methods offer best performances for classification problems. In their paper, they used Gaussian Mixture Models followed by Relaxation Labeling for speaker recognition with better performance over Gaussian Mixture Models only. We propose the use of the methodology designed by Tran et al. [22] to improve performance of Gaussian Mixture Models for an online training evaluator in virtual reality simulators.

VIRTUAL REALITY AND SIMULATED TRAINING

Virtual Reality refers to real-time systems modeled by computer graphics that allow user interaction and movements with three or more degrees of freedom [24]. More than a technology, virtual reality became a new science that joins several fields as computers, robotics, graphics, engineering and cognition. Virtual Reality Worlds are 3D environments created by computer graphics techniques where one or more users are immersed totally or partially to interact with virtual elements. The quality of the user experience in a virtual reality world is given by the graphics resolution and by the use of special devices for interaction. Basically, the devices stimulate the human senses as vision, audition and touch: head-mounted displays (HMD) or even conventional monitors combined with shutter glasses can provide stereoscopic visualization; multiple sound sources positioned provides 3D sound; and touch can be simulated by the use of haptic devices [16,8].

There are many purposes for virtual reality systems, but a very important one is the simulation of procedures for training. Virtual reality systems for training provide significant benefits over other methods, mainly in critical procedures. One example of training based on VR systems is the flight simulators used for the pilots' training in the civil aviation [23]. In medicine, the use of virtual reality systems for training is beneficial in cases where a mistake could result in physical or emotional impact on patients. Systems for different modalities in medicine have been developed, as training in: laparoscopy [25], prostate examination [1], ocular surgery [9] and bone marrow harvest [6]. In some cases, the procedures are done without visualization for the physician, and the only information he receives is done by the tactile sensations provided by a robotic device with force feedback. These devices can measure forces and torque applied during the interaction [10] and these data can be used in an evaluation [5,18].

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EVALUATION IN VIRTUAL REALITY SIMULATORS

The evaluation of simulations is necessary to assess the training quality and provide some feedback about the user performance. User movements, as spatial movements, can be collected from mouse, keyboard and any other tracking device. Applied forces, angles, position and torque can be collected from haptic devices [21]. So, virtual reality systems can use one or more variables, as the mentioned above, to evaluate a simulation performed by user.

Some simulators for training have a method of evaluation. However they just compare the final result with the expected one or are videotape records post-analyzed by an expert [1]. Recently, some models for offline or online evaluation of training have been proposed, some of them use Discrete Hidden Markov Models (DHMM) [18] or Continuous Hidden Markov Models (CHMM) [19] to modeling forces and torque during a simulated training in a porcine model. Machado et al. [5,7] proposed the use of a fuzzy rule-based system to online evaluation of training in virtual worlds. Moraes and Machado [13] proposed the use of CHMM for online evaluation in any virtual reality simulators. After that, the same authors proposed another approach for online evaluation learning using Fuzzy Hidden Markov Models (FHMM) [14]. Using an optoelectronic motion analysis and video records, McBeth et al. [11] acquired and compared postural and movement data of experts and residents in different contexts by use of distributions statistics.

We are proposing the use of Gaussian Mixture Models and Relaxation Labeling (GMM-RL) to provide an online evaluation for simulators or training systems based on virtual reality. To test the method proposed, we are using a bone marrow harvest simulator [6]. This simulator has as goal to training new doctors to execute the bone marrow harvest, one of the stages of the bone marrow transplant. The procedure is done blindly, performed without any visual feedback except the external view of the donor body and the physician needs to feel the skin and bone layers trespassed by the needle to find the bone marrow and then start the material aspiration. The simulator uses a robotic arm that operates with six degrees of freedom movements and force feedback to give to the user the tactile sensations felt during the penetration of the patient's body [12]. In the system the robotic arm simulates the needle used in the real procedure, and the virtual body visually represented has the tactile properties of the real tissues. The evaluation tool proposed should supervise the user movements during the puncture and should evaluate the training according to N possible classes of performance.

GAUSSIAN MIXTURE MODELS (GMM)

This section presents the Gaussian Mixture Models (GMM) method for training evaluation. Parameter estimation equations for training expert models are presented first. After, the GMM method for training classification is then described as a maximum likelihood classifier. We follow the Tran et al. [22] explanation about GMM algorithm and classification.

Let $X=\{x_1, x_2,...,x_T\}$ be a set of T vectors, where each one is a d-dimensional feature vector extracted by T different information at virtual space, obtained by the simulator. These information can be applied forces, angles, position and torque extracted at d different interval of time. Since the distribution of these vectors is unknown, it is approximately modeled by a mixture of Gaussian densities as the weighted sum of c component densities, given by the equation

$$p(x_t\,|\lambda_k) = \Sigma^{c}_{i=1}\; w_i\, N(x_t, \mu_i, \Sigma_i) \qquad (1)$$

where λ denotes a prototype consisting of a set of model parameters $\lambda=\{w_i, \mu_i, \Sigma_i\}$, w_i, $i=1,...,c$ are the mixture weights and $N(x_t, \mu_i, \Sigma_i)$ are the d-variate Gaussian component densities with mean vectors μ_i and covariance matrices Σ_i:

$$N(x_t, \mu_i, \Sigma_i)=exp\{-1/2\,\}(x_t - \mu_i)'\,\Sigma_i^{-1}\,(x_t - \mu_i)\}\,/\,(2\pi)^{d/2}\,|\Sigma_i\,|^{1/2} \qquad (2)$$

To train the GMM, these parameters are estimated such that they best match the distribution of the training vectors. The maximum likelihood estimation is widely used as a training method. For a sequence of training vectors X for a λ, the likelihood of the GMM is done by:

$$p(X|\lambda) = \Pi^{T}_{t=1}\; p(x_t\,|\lambda) \qquad (3)$$

The aim of maximum likelihood estimation is to find a new parameter model $\bar{\lambda}$ such that $p(X|\,\bar{\lambda})\geq p(X|\lambda)$. Since the expression in (3) is a nonlinear function of parameters in λ, its direct maximization is not possible. However, these parameters can be obtained iteratively using the Expectation--Maximization algorithm [2]. In this algorithm, we use an auxiliary function Q done by:

$$Q(\lambda,\, \bar{\lambda})=\Sigma^{T}_{t=1}\, \Sigma^{c}_{i=1}\, p(i|x_t, \lambda)\, log\, [\, w_i\, N(x_t,\, \bar{\mu}_i,\, \bar{\Sigma}_i)] \qquad (4)$$

where $p(i|x_t, \lambda)$ is the *a posteriori* probability for performance class i, $i=1,...,c$ and satisfies

$$p(i|x_t, \lambda) = [\, w_i\, N(x_t, \mu_i, \Sigma_i)]\,/\,\{\Sigma^{c}_{k=1}\; w_k\, N(x_t, \mu_k, \Sigma_k)\} \qquad (5)$$

The Expectation--Maximization algorithm is such that if $Q(\lambda,\, \bar{\lambda})\geq Q(\lambda,\lambda)$ then $p(X|\,\bar{\lambda})\geq p(X|\lambda)$ [17]. Setting derivatives of the Q function with respect to $\bar{\lambda}$ to zero, we found the following reestimation formulas:

$$\bar{w}_i = 1/T\, \Sigma^{T}_{t=1}\; p(i|x_t, \lambda) \qquad (6)$$

$$\bar{\mu}_i = \Sigma^{T}_{t=1}\, [\, p(i|x_t, \lambda)x_t\,]\,/\,[\Sigma^{T}_{t=1}\, [\, p(i|x_t, \lambda)] \qquad (7)$$

$$\bar{\Sigma}_i=\{\Sigma^T_{t=1} [p(i|x_t, \lambda)(x_t- \bar{\mu}_i) (x_t- \bar{\mu}_i)' \} / [\Sigma^T_{t=1} [p(i|x_t, \lambda)] \quad (8)$$

The algorithm for training the GMM is described as follows:

1. Generate the *a posteriori* probability $p(i|x_t, \lambda)$ at random satisfying (5);

2. Compute the mixture weight, the mean vector, and the covariance matrix following (6), (7) and (8);

3. Update the a posteriori probability $p(i|x_t, \lambda)$ according to (5) and compute the Q function using (4);

4. Stop if the increase in the value of the Q function at the current iteration, relative to the value of the Q function at the previous iteration is below a chosen threshold, otherwise go to step 2.

The GMM classification

To provide GMM classification, we need several classes of performance λ. So, let λ_k, $k=1,...,N$, denote models of N possible classes of performance. Given a feature vector sequence X, a classifier is designed to classify X into N classes of performance by using N discriminant functions $g_k(X)$, computing the similarities between the unknown X and each class of performance λ_k and selecting the class of performance λ_{k^*} if [22]:

$$k^* = \arg\max_{1\le k\le N} \; g_k(X) \quad (9)$$

In the minimum--error--rate classifier, the discriminant function is the *a posteriori* probability:

$$g_k(X)=p(\lambda_k|X) \quad (10)$$

We can use the Bayes' rule

$$p(\lambda_k|X) = [p(\lambda_k)\, p(X|\lambda_k)] / p(X) \quad (11)$$

and we can assume equal likelihood of all performances, i.e., $p(\lambda_k)=1/N$. Since $p(X)$ is the same for all performance models, the discriminant function in (10) is equivalent to the following [4]:

$$g_k(X)=p(X|\lambda_k) \quad (12)$$

Finally, using the log--likelihood, the decision rule used for class of performance identification is:

Select performance model k if*

$$k^* = \arg\max_{1\le k\le N} \; \Sigma^T_{t=1} \; p(x_t|\lambda_k) \quad (13)$$

where $p(x_t|\lambda_k)$ is given by (1) for each k, $k=1,...,N$.

RELAXATION LABELING

The Relaxation Labeling (RL) was introduced by Rosenfeld et al. [20] and it is an interactive approach to update probabilities of a previous classification. This methodology is successfully employed in image classification [3]. In this case, we will use RL after applied GMM classification. So, let be a set of objects $A = \{a_1,a_2,...,a_N\}$ and a set of labels $\Lambda=\{\lambda_1,\lambda_2,...,\lambda_N\}$. An initial probability is given to each object a_t having each label λ_k, which is denoted by $p_t(\lambda_k)$. These probabilities satisfy the following condition:

$$\Sigma^N_{k=1} \; p_t(\lambda_k) = 1, \text{ for all } a_t \in A \quad (14)$$

The RL updates the probabilities $p_t(\lambda_k)$ using a set of compatibility coefficients $r_{tt'}(\lambda_k, \lambda_l)$, where $r_{tt'}(\lambda_k, \lambda_l)$: $\Lambda\times\Lambda\rightarrow[-1,1]$, whose magnitude denotes the strength of compatibility. The meaning of these compatibility coefficients can be interpreted as [22]:

a) If $r_{tt'}(\lambda_k, \lambda_l) < 0$, then λ_k, λ_l are incompatible for a_t *and* $a_{t'}$;
b) If $r_{tt'}(\lambda_k, \lambda_l) = 0$, then λ_k, λ_l are independent for a_t *and* $a_{t'}$;
c) If $r_{tt'}(\lambda_k, \lambda_l) > 0$, then λ_k, λ_l are compatible for a_t *and* $a_{t'}$;

For computing coefficients, two possible methods employ the concepts of statistical correlation and mutual information. The two methods are based on those developed by Peleg and Rosenfeld [15]. The correlation-based estimate of the compatibility coefficients is defined as

$$r_{tt'}(\lambda_k)(\lambda_l) = \{\Sigma^T_{t=1} [p_t(\lambda_k)- p(\lambda_k)][p_{t'}(\lambda_l)- p(\lambda_l)]\}/\{\sigma(\lambda_k)\sigma(\lambda_l)\} \quad (16)$$

where $p_t(\lambda_l)$ is the probability of $a_{t'}$ having label λ_l and $a_{t'}$ are the neighbors of $a_{t'}$, $p(\lambda_l)$ is the mean of $p_t(\lambda_l)$ for all $a_{t'}$, and $\sigma(\lambda_l)$ is standard deviation of $p_t(\lambda_l)$. To alleviate the effect of dominance among labels, the modified coefficients are [22]:

$$r^*_{tt'}(\lambda_k)(\lambda_l) = [1- p(\lambda_k)]\, [1- p(\lambda_l)]\, r_{tt'}(\lambda_k)(\lambda_l) \quad (17)$$

and the mutual-information based estimate of compatibility coefficient is

$$r_{tt'}(\lambda_k)(\lambda_l) = \log \{T\, \Sigma^T_{t=1} p_t(\lambda_k)\, p_{t'}(\lambda_l)\} / \{\Sigma^T_{t=1} p_t(\lambda_k)\, p_{t'}(\lambda_l)\} \quad (18)$$

The compatibility coefficients in (18) must be scaled in the range [-1,1].

The updating factor for the estimate $p_t(\lambda_k)$ at m^th^ interaction is:

$$q_t^{(m)}(\lambda_k)= \Sigma^{T}_{t'=1}\ d_{tt'}\,[\Sigma^{N}_{l=1}\ r_{tt'}(\lambda_k)(\lambda_l)\, p_{t'}^{(m)}(\lambda_l)] \qquad (19)$$

where $d_{tt'}$ are the parameters that weight the contributions to a_t coming from its neighbors $a_{t'}$ and subject to

$$\Sigma^{T}_{t'=1}\ d_{tt'} = 1 \qquad (20)$$

The updated probability $p_t^{(m+1)}(\lambda_k)$ for object a_t is given by:

$$p_t^{(m+1)}(\lambda_k) = \{p_t^{(m)}(\lambda_k)[1+ q_t^{(m)}(\lambda_k)]\} \;/\; \{\Sigma^{N}_{k=1}\ p_t^{(m)}(\lambda_k)[1+ q_t^{(m)}(\lambda_k)]\} \qquad (21)$$

The RL algorithm can be outlined as follows:

1. Estimate the initial probabilities for each object satisfying (14)
2. Compute the compatibility coefficients using (17) or (18)
3. Calculate the updating factor defined in (19)
4. Update the probabilities for each object using the updating rule in (21)
5. Repeat steps 3 and 4 until the change in the probability is less than a chosen threshold or equal to a chosen number of interactions.

THE GMM-RL CLASSIFICATION

It now becomes clear that for a successful performance of relaxation method process, the initial label probabilities and the compatibility coefficients need to be well determined. Wrong estimates of these parameters will lead to algorithmic instabilities. In the GMM-based classification, the initial probabilities in the RL are defined as the *a posteriori* probabilities. Objects are now features vectors considered in the GMM and labels are classes of performance identification. Unlike the relaxation labeling for image recognition where the m-connected neighboring pixels may belong to different regions, in performance identification, all unknown feature vectors in the sequence $X=\{x_1, x_2,...,x_T\}$ are known to belong to a certain class of performance λ. Therefore there is no need to considerer the compatibility between an input vector and its adjacent vectors [22]. This leads to:

$$p_{t'}(\lambda_l) = p_t(\lambda_l) \qquad (22)$$

which means that compatibility between different labels is only considered for same object and therefore the updating rule in (21) should be now rewritten [22] as follows:

$$p_t^{(m+1)}(\lambda_k) = \{p_t^{(m)}(\lambda_k)[1- q_t^{(m)}(\lambda_k)]\} \;/\; \{\Sigma^{N}_{k=1}\ p_t^{(m)}(\lambda_k)[1- q_t^{(m)}(\lambda_k)]\} \qquad (23)$$

The GMM-RL algorithm for class of performance identification is stated as follows.

1. Estimate the initial probabilities for each class of performance using the a posteriori probabilities in (3):

$$p_t(\lambda_k) = p(\lambda_k|x_t)= [p(x_t\,|\lambda_k)\, p(\lambda_k)] \;/\; [\,\Sigma^{N}_{k=1}\ p(x_t\,|\lambda_k)\, p(\lambda_k)] \qquad (24)$$

where $p(\lambda_k)=1/N$ and $p(x_t\,|\lambda_k)$ is computed as in (1)

2. Compute the compatibility coefficients using (17) or (18), where $t'=t$ (no neighbors considered);
3. Calculate the updating factor defined in (19), where $t'=t$ and $d_{tt'}=1/T$ for simplicity;
4. Update the probabilities for each class of performance using the updating rule in (23);
5. Repeat steps 3 and 4 until the change in the probability is less than chosen threshold or equal to a chosen number of interactions;
6. The probability of each class of performance $p(\lambda_k)$ after RL algorithm is computed by:

$$p(\lambda_k) = \Pi^{T}_{t=1}\ p_t(\lambda_k) \qquad (25)$$

where $p_t(\lambda_k)$ is the a posteriori probability used in (10). Therefore, the decision rule for class of performance identification is as follow [22]:

Select class of performance k if*

$$k^* = \underset{1\le k\le N}{\arg\max}\ p(\lambda_k) \qquad (26)$$

THE EVALUATION TOOL

The evaluation tool proposed should supervise the user movements and others parameters associated to it. In the virtual reality simulator the trainee must extract the bone marrow. In the first movement, he must feel the skin to find the best place to insert the needle. After, he must feel the tissue layers (epidermis, dermis, subcutaneous, periosteum and compact bone) trespassed by the needle and stop at the correct position to do the bone marrow extraction. In our system the trainee movements are monitored by variables as: acceleration, applied force, spatial position, torque and angles of needle.

For the evaluation an expert executes several times the procedure for each class of performance available, for example: "well qualified", "need some training yet", "need more training", "novice", etc. So, the information of variability about these procedures is acquired using Gaussian Mixture Models and Relaxation Labeling (GMM-RL). When a trainee uses the system his performance is compared with the N classes of performances and a probability of trainee's performance for each class of performance is calculated using (24). Finally, according to (26) trainee's performance is labeling and trainee receives a report with all possible classes of performance and its respective probabilities about his performance.

CONCLUSIONS AND FUTURE WORKS

In this paper we presented a new approach to online evaluation in training simulators based on virtual reality using an elegant statistical formalism of GMM-RL. This approach provides the use of continuous variables without lost of information. So, it solves the problem of low complexity of online evaluators, without compromise performance of simulator and with good accuracy evaluation.

Systems based on_this approach can be applied in virtual reality simulators for several areas and can be used to classify the trainee into classes of learning giving him a real position about his performance, through the reports of performance of each training. In medicine, it provides an appropriate methodology for blind made procedures.

As future work, we intend to make a statistical comparison between two groups of trainees when they use or not use this system to determine differences in the increasing of learning.

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AN EDUCATIONAL COMPUTER TOOL TO ANALYZE THE CORRELATOR

Luciano L. Mendes[1], Daniel Mazzer[2], Arley H. Salvador[3] and José S. G. Panaro[4]

Abstract *— Today, the knowledge about techniques of digital signals transmission is fundamental for telecommunications engineering students. As another time the COMPACT DISC substituted the vinyl, nowadays the analog transmission links are being replaced by digital ones. In digital communication systems, there are some devices that are used to optimize the signal to noise ratio in the receiver. This procedure improves the performance of the system, reducing the bit error rate. The most common technique used to receive digital signal is the correlator, which is an optimum method to detect digital signals in Additive White Gaussian Noise channels. The purpose of this paper is to show a didactical approach to analyze the correlator, using a computer program to presents each step in the detection of a digital signal.*

INTRODUCTION

In the digital communication links, the most important factor of the system is the reliability. However, there is a trade-off between reliability and transmitted power. The bit error rate (BER) [1] is the main parameter used to measure the reliability of the system. When a signal is transmitted on an Additive White Gaussian Noise (AWGN) channel, the interference of the noise in the transmitted signal depends on the signal to noise ratio (SNR). To minimize the BER, it is necessary to improve the SNR in order to reduce the effects of the noise in the received signal. The SNR can be improved by increasing the transmitted power or by reducing the effects of the noise in the receiver. The correlator is a device used in the reception of digital signals that maximizes the SNR by reducing the interference of the noise. Because of it, it is important to analyze and to study this technique. In this paper, the correlator will be simulated in a program based on block structures, named VisSim®, which facilitates the apprenticeship of this issue.

AWGN CHANNEL

The AWGN is an undesired signal that cannot be avoided [1][2]. The random nature of this signal makes necessary to analyze it based on stochastic processes, where the mean value and the variance are the main parameters to determine the behavior of the signal. The mean value represents the DC voltage of the random signal, while the variance represents the power of the AC component [1]. The standard deviation of the random signal, defined as the square root of the variance, represents the RMS voltage of the signal. Figure 1 shows a gaussian signal with zero mean and unity variance, while figure 2 shows a bipolar signal, or non-return to zero (NRZ) perturbed by an AWGN.

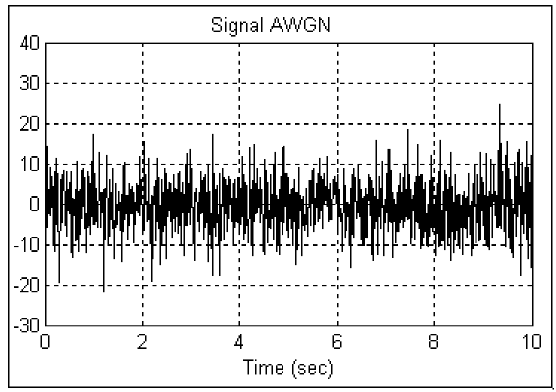

FIGURE 1
GAUSSIAN NOISE

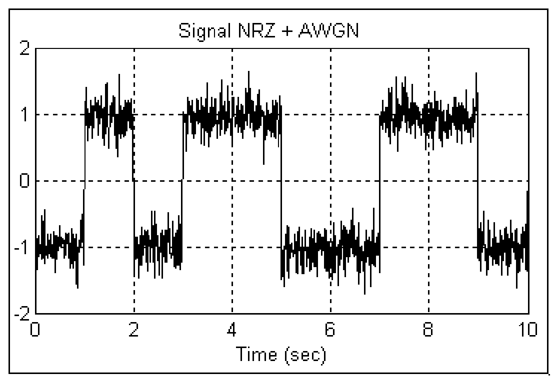

FIGURE 2
BIPOLAR SIGNAL WITH GAUSSIAN NOISE

In Figure 2, the noise may introduce errors in the transmitted data when its amplitude assumes absolute values greater than unity.

ORTHOGONALIZATION OF SIGNALS

The transmission of digital data is based on a set of waveforms of finite size. These waveforms can be represented as functions of the orthogonal bases of the set.

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In this session, the Gram-Schmidt process [1][2] will be presented. This process is used to define the bases of the waveforms set.

Suppose a set of M waveforms $\{s_1(t), s_2(t), \ldots, s_M(t)\}$. Accepting the signal $s_1(t)$ as an orthogonal signal, the function of the first base $\phi_1(t)$ will be

$$s_{11} = \sqrt{E_1} \quad \Rightarrow \quad \phi_1(t) = \frac{s_1(t)}{\sqrt{E_1}} \tag{1}$$

Where E_1 is the energy of the signal $s_1(t)$.

The second orthogonal bases, $\phi_2(t)$, can be obtained using the signal $s_2(t)$ and the first orthogonal bases found by (1), $\phi_1(t)$.

$$\begin{aligned} s_{21} &= \int_0^T s_2(t)\phi_1(t)dt \\ g_2(t) &= s_2(t) - s_{21}\phi_1(t) \\ \phi_2(t) &= \frac{g_2(t)}{\sqrt{\int_0^T g_2^2(t)dt}} \end{aligned} \tag{2}$$

The procedure above must be repeated to identify the N orthogonal bases of the set, as shown in (3).

$$\begin{aligned} s_{ij} &= \int_0^T s_i(t)\phi_j(t)dt, \quad g_i(t) = s_i(t) - \sum_{j=1}^{i-1} s_{ij}\phi_j(t) \\ \phi_i(t) &= \frac{g_i(t)}{\sqrt{\int_0^T g_i^2(t)dt}} \end{aligned} \tag{3}$$

Where $i = 1,2,3,\ldots,N$ e $j = 1,2,3,\ldots,i-1$.

The number of orthogonal bases (N) can be equal or less than the number of waveforms of the set (M). If the signals $\{s_1(t), s_2(t),\ldots, s_M(t)\}$ are linearly independent (orthogonal), then $N = M$. If the signals $s_1(t), s_2(t),\ldots, s_M(t)$ are not linearly independent, then $N < M$.

Any waveform from the set can be represented as a linear combination of the N orthogonal bases, thus the transmitter and the receiver do not have to handle with M waveforms, but only with N waveforms.

The waveforms can be geometrically represented in a vector diagram, where the axes are the orthogonal bases found in the Gram-Schmidt process. For the geometric representation of the signals, each orthogonal base must be normalized to unitary energy. Finally, any signal, $s_i(t)$, can be expressed as shown in (4).

$$s_i(t) = \sum_{j=1}^{N} s_{ij}\,\phi_j(t), \qquad \begin{cases} 0 \le t \le T \\ i = 1,2,\ldots,M \\ j = 1,2,\ldots,N \end{cases} \tag{4}$$

Where the coefficients s_{ij} represent the projection of the signal $s_i(t)$ over the base $\phi_j(t)$ and can be obtained by (5).

$$s_{ij} = \int_0^T s_i(t)\,\phi_j(t)\,dt, \qquad \begin{cases} i = 1,2,\ldots,M \\ j = 1,2,\ldots,N \end{cases} \tag{5}$$

Thus, it is possible to represent any signal from the set as a linear combination of the orthonormal bases, as shown in Figure 3.

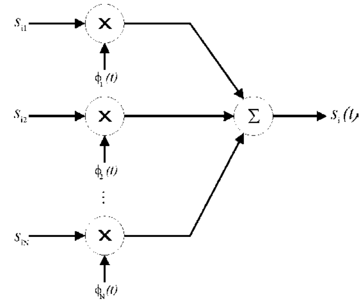

FIGURE 3.
LINEAR COMBINATION OF THE ORTHONORMAL BASES.

It is also possible to geometrically represent the signals from a set, where the number of orthogonal bases is three or less. Figure 4 shows a example of a set with three signals and two orthonormal bases (N=2 and M=3).

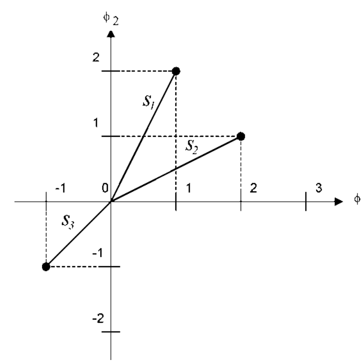

FIGURE. 4
GEOMETRIC REPRESENTATION OF SIGNALS

CONSTELLATIONS OF DIGITAL MODULATIONS

In digital communications, the symbols are represented as waveforms and are transmitted as functions of the orthogonal bases. In phase and/or amplitude modulations, the orthogonal bases usually are the sine and cosine with the same frequency. For example, the QPSK (Quadrature Phase Shift Keying) modulation [1][2] has four possible symbols that can be defined by the combination of two bits. Figure 6 shows the constellation of this modulation technique, where M=4 and N=2. The orthogonal bases are defined by (6).

$$\phi_1(t) = \cos(\omega \cdot t)$$
$$\phi_2(t) = \text{sen}(\omega \cdot t) \quad (6)$$

Where ω is the angular frequency of the carrier.

Any symbol $s_i(t)$ can be defined as a linear combination of these two bases, as shown by (7).

$$\begin{aligned} s_1(t) &= +\cos(\omega \cdot t) + \text{sen}(\omega \cdot t) \\ s_2(t) &= -\cos(\omega \cdot t) + \text{sen}(\omega \cdot t) \\ s_3(t) &= -\cos(\omega \cdot t) - \text{sen}(\omega \cdot t) \\ s_4(t) &= +\cos(\omega \cdot t) - \text{sen}(\omega \cdot t) \end{aligned} \quad (7)$$

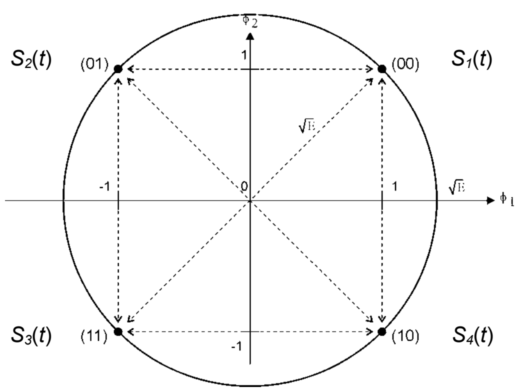

FIGURE. 6
QPSK CONSTELLATION.

CORRELATOR

In a digital communication link, the received link is corrupted by the AWGN. To minimize the number of errors introduced by the channel, it is necessary to maximize the signal to noise ratio. The correlator represents one technique that realizes this operation. Figure 7 shows the block diagram of the transmission and reception of signal from a set of *M* waveforms and 2 orthogonal bases.

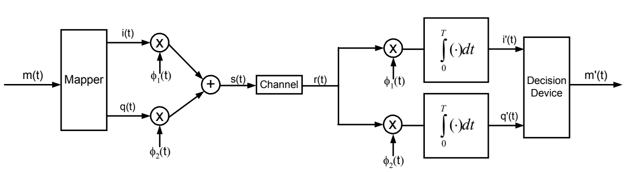

FIGURE 7.
BLOCK DIAGRAM OF A DIGITAL COMMUNICATION LINK.

The transmitted bits are mapped in two orthogonal signals ($i(t)$ and $q(t)$) that have $\sqrt{M}$ possible levels. These two signals are multiplied by the orthogonal bases of the set and then applied in the communication channel. The received signal, r(t), is multiplied by the bases and integrated at each symbol time (T), generating the estimated signals $i'(t)$ and $q'(t)$. These signals are applied to a decision device that estimates the transmitted data sequence $m'(t)$. It is desirable to have a received data sequence equal to the transmitted data sequence.

SIMULATION

In this session, a simulation based on the block diagram of figure 7 will be presented. Figure 8 shows the transmission simulator, while figure 9 shows the receiver simulator.

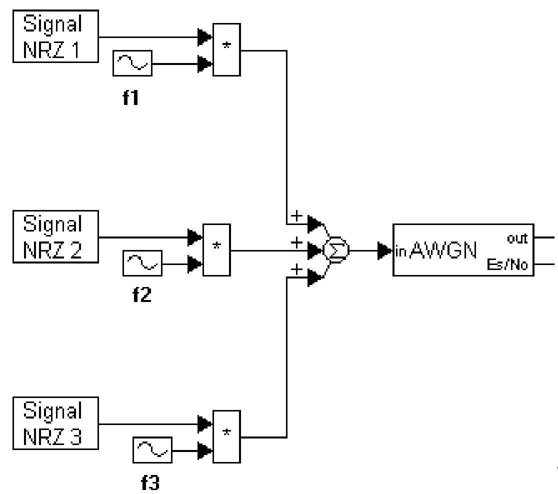

FIGURE 8
TRANSMITTER SIMULATOR

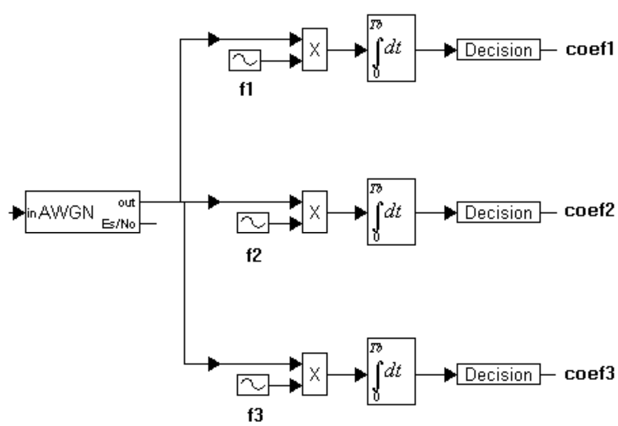

FIGURE 9
RECEIVER SIMULATOR

In this simulation, three bipolar signals are transmitted using three orthogonal bases that are sine functions with frequencies *f1*=1Hz*, f2*=2Hz and *f3*=3Hz. Figure 10 shows the added signals at the output of the AWGN channel.

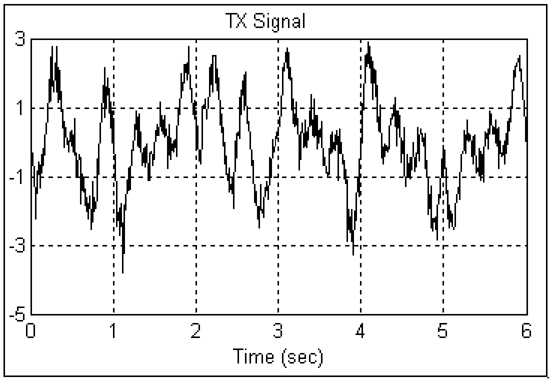

FIGURE. 10
RECEIVED SIGNAL

The received signal is applied to three correlators, one for each transmitted signal. First, the received signal is multiplied by the orthogonal bases. Figure 11 shows the received signal multiplied by the first orthogonal base.

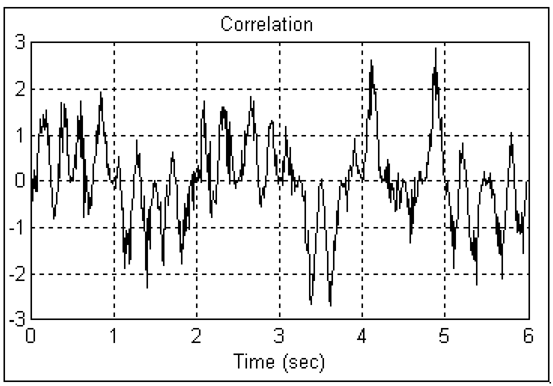

FIGURE 11
DETECTION OF THE RECEIVED SIGNAL

The second step of the receiving process is to integrate the signal during the symbol duration, *T*. In this simulation, the symbol rate is one symbol per second. Thus, the symbol time is one second. Figure 12 shows the output of the first integrator.

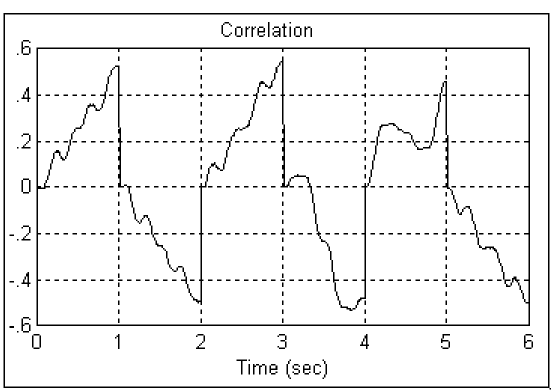

FIGURE 12
INTEGRATOR OUTPUT.

The decision device samples the integrated signal at each *T* seconds and, for each received signal, decides for bit 1 if the sample is positive, and for bit 0 if the sample is negative. Figure 13 shows the output of the sampler while figure 14 shows the output of the decision device.

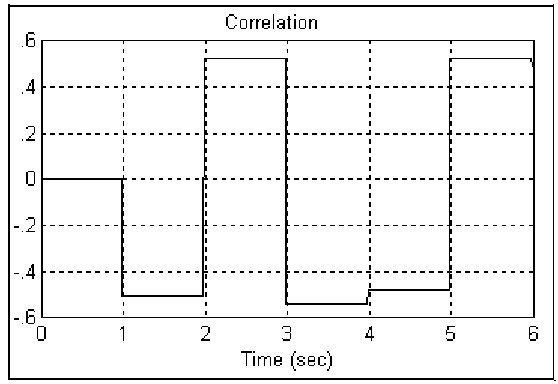

FIGURE 13
OUTPUT OF THE SAMPLER.

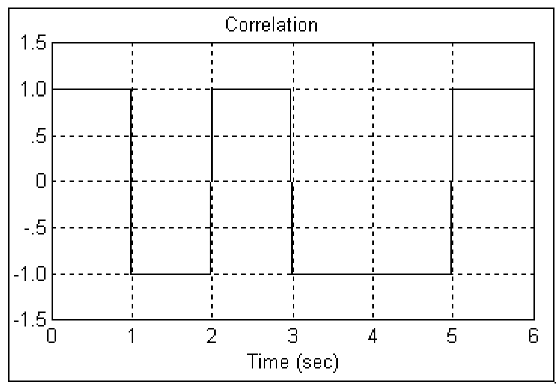

FIGURE. 14
OUTPUT OF THE DECISION DEVICE

CONCLUSION

The optimum receiving process is a very important issue in digital communications studies and must be clearly presented to Telecommunication Engineering students. This paper presented an educational approach to analyze the correlator, using a computer tool to show each step of the transmission and receiving processes. Thus, the students are able to verify how a transmitted data signal behaves in the communication block diagram.

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UMA ABORDAGEM EDUCACIONAL PARA O ESTUDO DE OFDM

Bruno A. Pereira [1], *Henrique T. Kuehne* [2], *Luciano L. Mendes* [3] *e José S. G. Panaro* [4]

Resumo — O objetivo deste artigo é apresentar um conjunto de ferramentas computacionais para análise do sistema de Multiplexação por Divisão de Freqüências Ortogonais. Apresenta-se simulações realizadas em três plataformas distintas, sendo elas, MatLab®, Mathcad® e VisSim®. Com esses programas é possível analisar e comparar o comportamento dos sinais em cada etapa do processo de transmissão e recepção, tanto na técnica com múltiplas portadoras quanto na técnica de portadora única.

Palavras-chaves — OFDM, Força Bruta, FFT, IFFT.

INTRODUÇÃO

O crescimento dos serviços digitais (Internet, vídeo sob demanda, etc.) requer um aumento na taxa de dados. Porém, com transmissão em banda larga, o sinal passa a ser susceptível ao desvanecimento seletivo causado pela propagação em canais com múltiplos percursos. Uma solução encontrada para este problema foi dividir o feixe de dados serial em vários feixes paralelos e transmiti-los em várias portadoras ortogonais, que é o princípio da técnica de transmissão digital OFDM (*Orthogonal Frequency Division Multiplexing*).

O OFDM é utilizado em padrões de transmissão comercial de áudio e vídeo, como por exemplo DAB (*Digital Audio Broadcasting*) e DVB-T (*Digital Video Broadcasting – Terrestrial*) que é o padrão usado na transmissão de HDTV (*High Definition Television*) na Europa [1]. Esta técnica apresenta eficiência em largura de faixa, alta robustez aos problemas de interferência entre símbolos, desvanecimento seletivo em freqüência e ruído impulsivo. Sua desvantagem é a maior complexidade de implementação em relação ao sistema de portadora única.

Neste artigo, foram utilizados os programas: VisSim®, Mathcad® e MatLab®. O VisSim® é um simulador de comunicações digitais que facilita a implementação do sistema, devido a sua estrutura em blocos. O Mathcad® e o MatLab® são softwares matemáticos que permitem realizar simulações através das equações que definem o comportamento do sistema.

Existem duas maneiras de se implementar um sistema OFDM: o método da força bruta ou o método que usa transformada rápida de Fourier (FFT) [2].

O objetivo deste artigo é propor uma abordagem que ajude na compreensão do OFDM apresentando simulações de ambos os métodos de implementação.

MÉTODO DA FORÇA BRUTA

O princípio de geração de um sinal OFDM pelo método da Força Bruta pode ser divido em três fases, conforme apresentado na Figura 1:

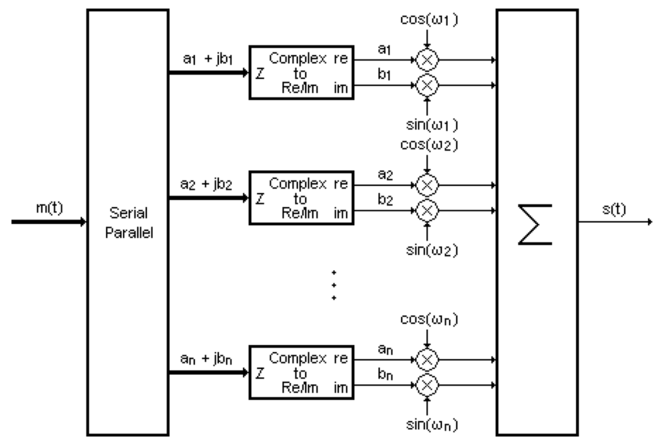

FIGURA 1
DIAGRAMA EM BLOCOS DE UM TRANSMISSOR OFDM USANDO O MÉTODO DA FORÇA BRUTA

Na primeira fase, o feixe de dados original é dividido em N feixes paralelos através de um conversor serial paralelo. Tanto o sinal de entrada quanto os sinais de saída deste conversor podem ser sinais complexos, dependendo do tipo de modulação digital utilizada [3]. A modulação BPSK (*Binary Phase Shift Keying*) utiliza apenas o eixo real para representar os símbolos da constelação, ao passo que as modulações M-PSK (*Phase Shift Keying*) e M-QAM (Q*uadrature Amplitude Modulation*) utilizam tanto o eixo real quanto o eixo imaginário.

Na segunda fase, os N feixes paralelos (N_1, N_2, ... , N_P) são modulados em N portadoras complexas e ortogonais (ω_1, ω_2, ... , ω_P) igualmente espaçadas. A parte real do sinal N_n será modulada por cos(ω_n) e a parte imaginária do sinal N_n será modulada por sen(ω_n), onde n pode assumir valores entre 1 e p. Finalmente, na terceira fase, os N sinais modulados são somados gerando um sinal OFDM.

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O sinal OFDM é detectado utilizando a propriedade de ortogonalidade das portadoras, ou seja, utiliza-se filtros casados ou correlatores para receber os sinais N_n, que são aplicados em um conversor paralelo serial e finalmente demodulados em uma seqüência de bits. A Figura 2 mostra o diagrama em blocos de um receptor OFDM genérico.

A implementação deste método pode-se tornar inviável caso o número de portadoras (*N*) seja elevado, pois nesta abordagem, são necessários *N* osciladores para fornecer as portadoras ortogonais necessárias para a geração do sinal OFDM.

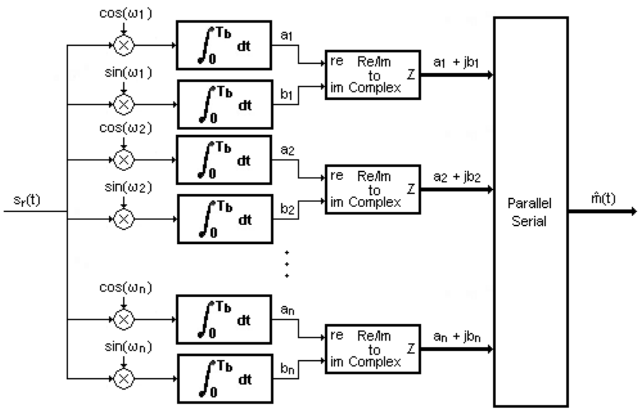

FIGURA 2
DIAGRAMA EM BLOCOS DE UM RECEPTOR OFDM USANDO O MÉTODO DA FORÇA BRUTA

A seguir são apresentados alguns resultados e comentários obtidos a partir de simulações utilizando a abordagem apresentada. Nesta simulação, um sinal OFDM de 4 portadoras é gerado pelo método da Força Bruta. Cada portadora é modulada por um sistema PAM(*Pulse Amplitude Modulation*) de 16 níveis, com taxa de 32 símbolos por segundo. A figura 3 mostra o espectro do sinal OFDM, bem como o espectro de cada subportadora, onde é possível observar a ortogonalidade entre os sinais.

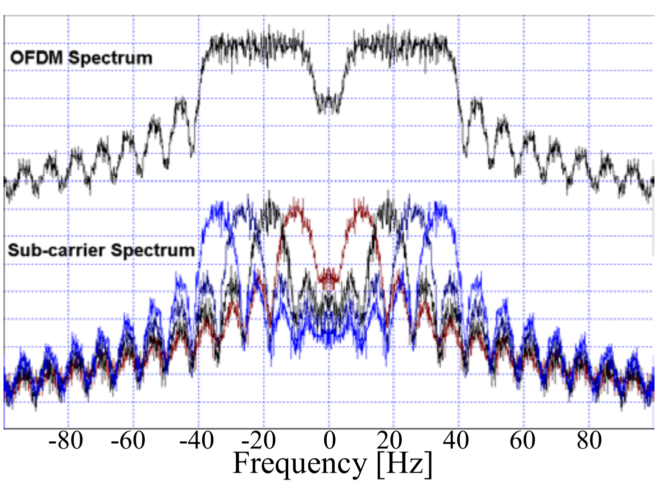

FIGURA 3
ESPECTRO DO SINAL OFDM E DAS SUBPORTADORAS .

A soma das subportadoras resulta no espectro do sinal OFDM apresentado. O sinal OFDM no domínio do tempo, possuí distribuição gaussiana, aproximando-se do ruído AWGN a medida em que o número de subportadoras aumenta.

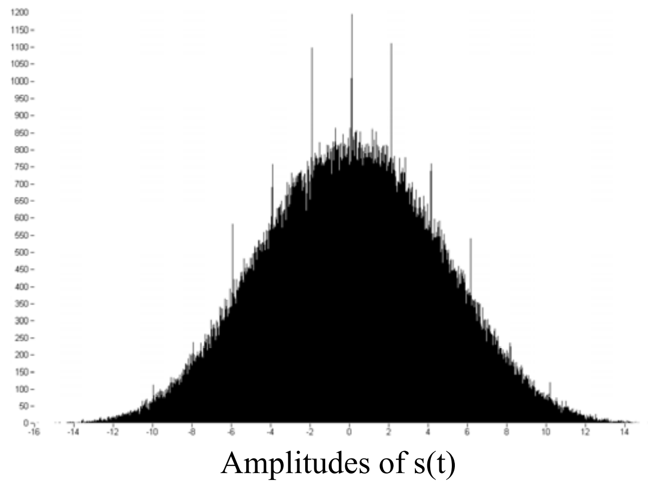

FIGURA 4
HISTOGRAMA DAS AMPLITUDES DO SINAL OFDM.

A figura 4 mostra o histograma das amplitudes do sinal OFDM, enquanto que a figura 5 mostra o sinal OFDM no domínio do tempo.

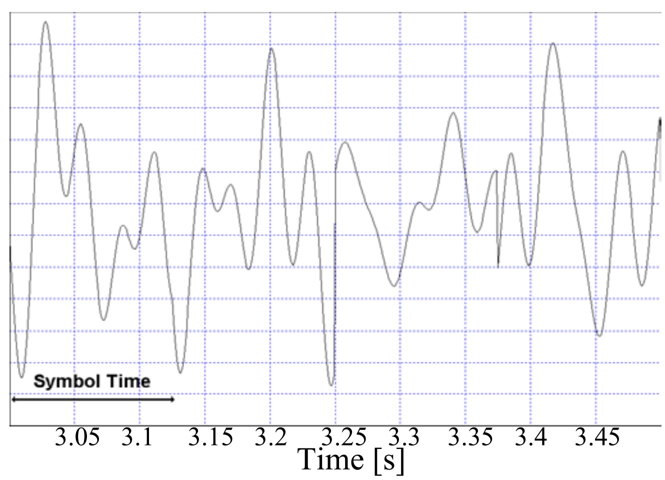

FIGURA 5
SINAL OFDM NO DOMÍNIO DO TEMPO.

GERAÇÃO E RECEPÇÃO DE SINAIS OFDM ATRAVÉS DA FFT.

No método apresentado a seguir, utiliza-se a Transformada Rápida de Fourier para gerar o sinal OFDM. Desta forma não é mais necessário gerar as N portadoras individualmente, conforme apresentado na sessão anterior. Isto permite o uso de um número maior de portadoras sem um aumento significativo da complexidade do sistema, mas com aumento da carga computacional. Neste caso, o princípio de geração do sinal OFDM pelo método da FFT pode ser separado em duas partes. A primeira parte deste método é idêntica à primeira fase do método da Força Bruta, gerando os sinais paralelos que representam as amplitudes das portadoras complexas no domínio da freqüência. Na segunda parte do processo, realiza-se a transformada rápida de Fourier inversa (IFFT) para obter o sinal OFDM no domínio do tempo, conforme apresentado na Figura 6. O sinal resultante é o sinal OFDM em banda básica. Para obter um sinal em banda passante basta transladar o sinal obtido para a freqüência do canal desejado.

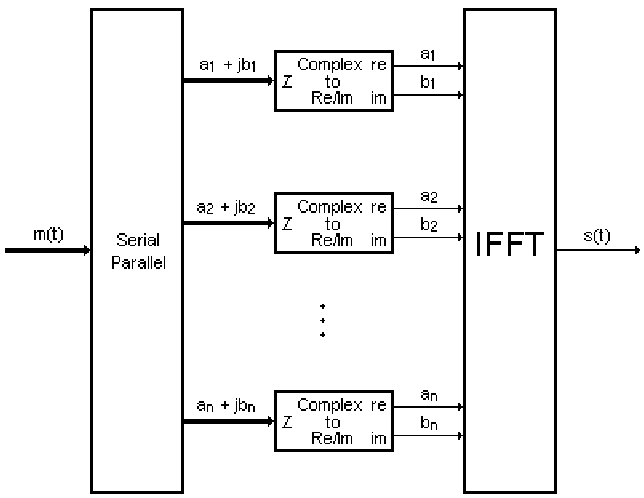

FIGURA 6
DIAGRAMA EM BLOCOS DE UM TRANSMISSOR OFDM USANDO O MÉTODO DA FFT

A recepção deste sinal por este método acontece de maneira análoga porém invertida ao processo de geração. Primeiro realiza-se a transformada rápida de Fourier (FFT) de ordem *N* do sinal OFDM em banda básica, gerando *N* sinais. Depois, estes *N* sinais são aplicados em um conversor paralelo serial e finalmente entregues ao demodulador digital para que os bits transmitidos sejam recuperados. A figura 7 mostra o diagrama em blocos de um receptor OFDM.

A seguir são apresentado os resultados obtidos em simulação de um transmissor OFDM_ utilizando o método da FFT. Os dados originais são mapeados em 16 símbolos, transmitidos a uma taxa de 32 símbolos por segundo. A figura 8 mostra o espectro do sinal OFDM em banda básica, gerado através do diagrama apresentado na figura 6.

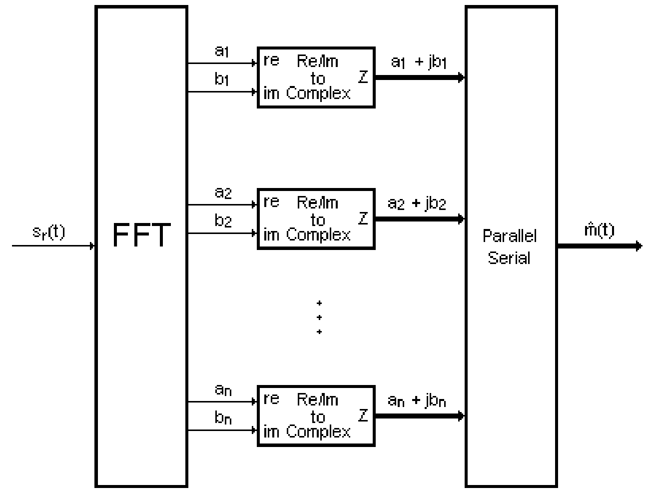

FIGURA 7
DIAGRAMA EM BLOCOS DE UM RECEPTOR OFDM USANDO O MÉTODO DA FFT

Como pode ser visto, o sinal OFDM gerado pelo método da FFT está em banda básica e necessita ser transladado para a freqüência do canal. Como o processo de translação na freqüência é um processo linear, pode-se realizar a análise em banda básica, sem perda de generalidade.

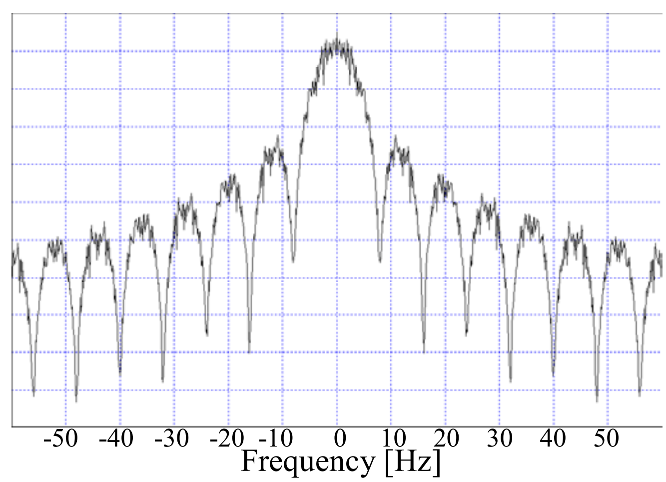

FIGURA 8
ESPECTRO DO SINAL OFDM GERADO ATRAVÉS DO MÉTODO DA FFT.

A figura 9 mostra o espectro o histograma das amplitude do sinal OFDM gerado pelo método da FFT enquanto que a figura 10 mostra o sinal OFDM no domínio do tempo.

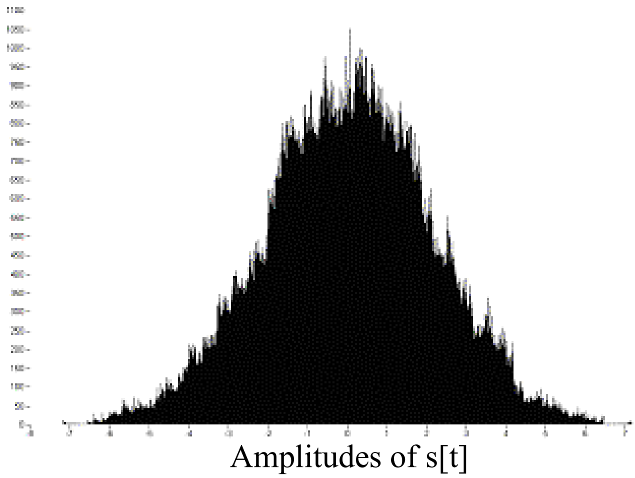

FIGURA 9
HISTOGRAMA DE AMPLITUDES DO SINAL OFDM.

Através da figura 9, é possível observar que a distribuição das amplitude do sinal OFDM gerado pelo método apresentado nesta sessão, também possui uma distribuição gaussiana.

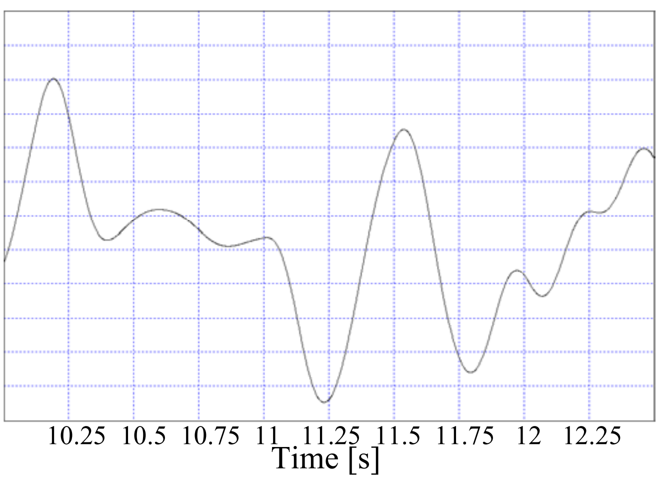

FIGURA 10
ANÁLISE DO SINAL OFDM NO DOMÍNIO DO TEMPO.

O problema inerente a sinais com distribuição gaussiana é a amplificação [4]. Os amplificadores utilizados em transmissão de sinais de RF(*Radio frequency*) possuem alto rendimento, ou seja, trabalham próximos do ponto de saturação da curva de carga. Assim, os picos de amplitude do sinal OFDM levam o amplificador a condição de corte, o que introduz um ceifamento no sinal amplificado. Esse ceifamento causa uma diminuição no desempenho do sistema OFDM, ou seja, há um aumento na taxa de erro de bit no sinal recebido.

CONCLUSÃO

Os princípios utilizados para a geração de sinais OFDM permitem que os moduladores e demoduladores sejam gerados utilizando duas técnicas distintas. A primeira técnica, chamada de Método da Força Bruta, gera o sinal OFDM através da soma de N portadoras complexas ortogonais. Neste método, cada portadora é gerada por um oscilador local, o que torna inviável sua implementação para valores elevados de N.

A método para a geração de sinais OFDM utiliza a propriedade da Transformada Rápida de Fourier para a geração das portadoras ortogonais. Neste método, os dados a serem transmitidos são tomados como amplitudes de N tons senoidais. Portanto, a Transformada Rápida de Fourier Inversa destes dados gera, no domínio do tempo, um símbolo OFDM composto pela soma de N portadoras ponderadas pelo sinal de entrada. Neste caso, não é necessário construir N osciladores complexos, o que permite a implementação de sistemas OFDM com até milhares de portadoras.

A abordagem de ambos os métodos pode apresentar resultados didáticos interessantes, uma vez que o aluno pode verificar e comparar o funcionamento do sistema OFDM de maneiras distintas, o que pode facilitar a compreensão dos assuntos abordado. O uso de ferramentas computacionais para apresentar os resultados obtidos em cada etapa do processo de modulação e demodulação do sinal OFDM também é fundamental para que a abordagem do assunto se torne clara e didática.

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Analysis of Clipping in OFDM Symbols

Luciano L. Mendes[1], Sandro A. Fasolo[2] and Geraldo G. R. Gomes[3]

Abstract *— The purpose of this paper is to present the problems introduced in a Multicarrier Modulation (MCM) symbols by a nonlinear channel. The signal at the output of a multicarrier modulator has a very high peak to average power ratio and the amplifier can clip its peak values. In this paper, a simulation showing the interference of the clipping process in the performance of a multicarrier communication system will be presented with some commented results. The program used to simulate MCM systems has been developed using Matlab® platform and has the didactical objective of showing the principles involved on this issue.*

Index Terms — Clip, Multicarrier Modulation, OFDM.

INTRODUCTION

The advent of digital television and wireless local area network (WLAN) brought the necessity of transmission of digital data at high rates [1]. One technique that has being used to archive the required data rate is the Orthogonal Frequency Division Multiplexing (OFDM). The OFDM system is a multicarrier modulation where the frequencies of the sub-carriers are orthogonal. This technique is being widely used to transmit data at high rates because of its robustness to the multipath channel [1][2].

The OFDM signal is obtained by adding N orthogonal sub-carriers, each one modulated by a sequence of data. Thus, by the Central Limit Theorem [3], the OFDM symbol can be modeled as a Gaussian Process [4], where the amplitude of the signal has normal distribution. Because of it, the OFDM signal may have high peaks, which leads to a very high Peak to Average Power Ratio (PAPR). To transmit this signal, the power amplifier must have a wide linear operation region, which is difficult to archive. It means that the power amplifier may clip the high peaks of the OFDM signal, introducing a nonlinear interference in the transmitted signal. This paper will present a computer tool developed to analyze this nonlinear interference in the OFDM system, with some commented results.

CLIPPING OF AN OFDM SIGNAL

The OFDM system is based on parallel communication, where the data sequence is convert to N parallel sequences, which modulates N orthogonal sub-carriers. Figure 1 shows the block diagram of an OFDM modulator.

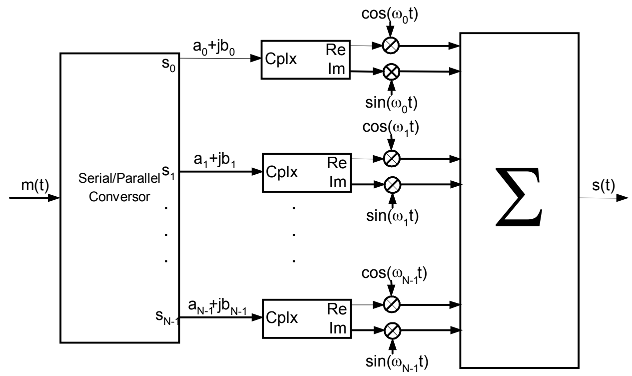

FIGURE 1
OFDM MODULATOR.

The data signal, $m(t)$, is the base band signal provided by any digital modulator, such as BPSK (Binary Phase Shift Keying), QPSK (Quadrature Phase Shift Keying) or QAM (Quadrature Amplitude Modulation), and it can be a complex signal. The data signal is converted to N parallel symbols, ($s_0, s_1, s_2, ..., s_{N-1}$), and the real component of each signal is modulated by a cosine function, while the imaginary component is modulated by a sine function. The angular frequencies of each sub-carrier are chosen to be orthogonal in order to satisfy (1).

$$\int_0^{Ts} \cos(\omega_i t)\cdot\cos(\omega_j t)dt = 0 \quad ; i \neq j \tag{1}$$

Where T is the OFDM symbol time.

If the signal $m(t)$ is a random sequence, the resulting OFDM signal, $s(t)$, can be modeled as a sum of N random variables, as shown by (2).

$$s(t) = \mathrm{Re}\left\{\sum_{i=0}^{N-1} s_i(t)e^{-j\omega_i t}\right\} \tag{2}$$

The Central Limit Theorem states that the sum of independent identical distributed (iid) random variables can be modeled as a gaussian variable with the variance (σ_s^2) and mean value (μ_s) given by (3).

$$\begin{aligned}\sigma_s^{\ 2} &= N\cdot\sigma^2 \\ \mu_s &= N\cdot\mu\end{aligned} \tag{3}$$

Where σ and μ are, respectively, the standard deviation and mean value of the iid random variables. Figure 2 shows the probability density function (PDF) of an OFDM signal, with 64 carriers, modulated using QPSK.

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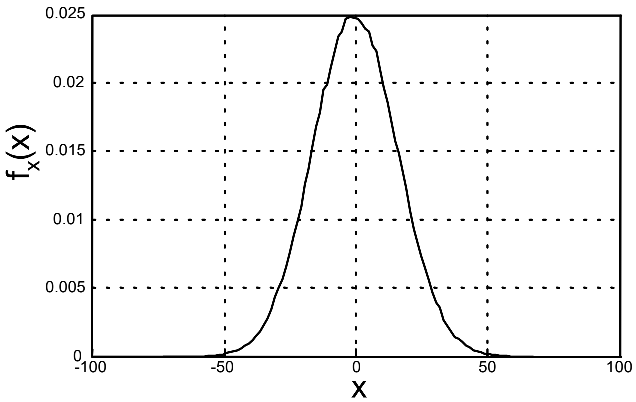

FIGURE 2
PDF OF AN OFDM SIGNAL.

It is possible to verify that the amplitude of an OFDM signal may present high values. To transmit this signal, it is necessary to apply it in an amplifier, with a very large linear operational region, but the amplifiers with this characteristic are expensive and inefficient [5]. Thus, the amplifiers usually are set for best performance and, because of it, its linear operation region is not as large as necessary to linearly amplify the OFDM signal. The high peaks of the OFDM signal may saturate the amplifier and this distortion can be modeled as a clipping effect. Figure 3 shows an OFDM signal clipped by a nonlinear power amplifier.

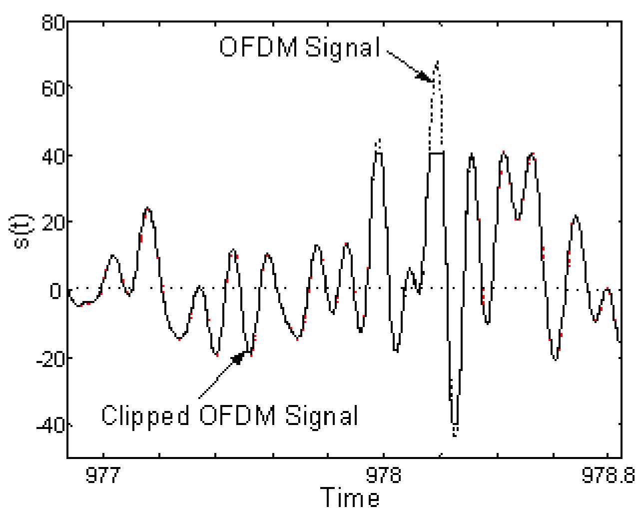

FIGURE 3
OFDM SIGNAL CLIPPED BY A NONLINEAR AMPLIFIER.

Once know why the clipping process occurs, it is important to define the influence of this interference in the system performance. In the OFDM system, the data symbols define the amplitude of each complex sub-carrier, as shown in (2). Because of this, the reception of the information is realized by detecting the amplitude of the sub-carriers in the frequency domain. Thus, the analysis of the clipping interference in the reception process should be done in the frequency domain instead of the time domain. If the number of sub-carrier (N) increases, the OFDM symbol time (T_s) also increases, as can be seen in (4).

$$T_s = N \cdot T \tag{4}$$

Where T is the symbol time of the incoming data signal, $m(t)$.

For large values of T_s, the clipped part of the OFDM signal can be approximated to an impulse, thus the clipping distortion can be modeled as an impulsive noise added to the transmitted signal, as shown in Figure 4.

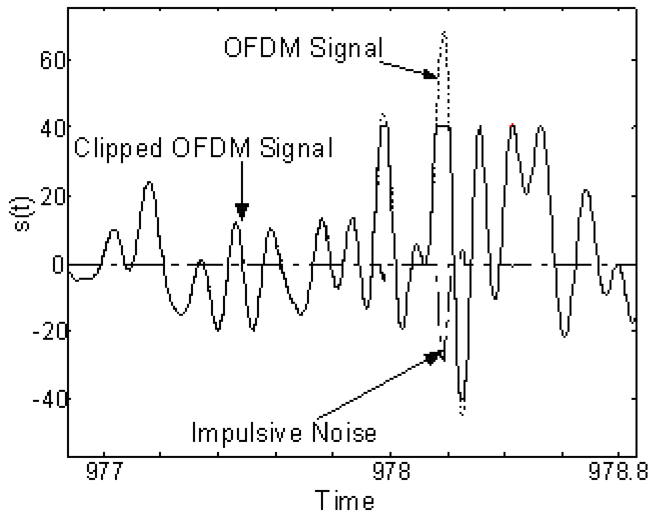

FIGURE 4
IMPULSIVE NOISE MODEL

It is known that the Fourier Transform of an impulse of amplitude α is defined by (5).

$$\mathscr{F}\{\alpha \cdot \delta(t)\} = \alpha \tag{5}$$

Equation (5) shows that the impulsive noise, in the frequency domain, represents a constant value which interferes in every sub-carrier. Thus, the impulsive noise does not destroy the information transmitted by a specific sub-carrier, but it introduces a distortion in every transmitted sub-carrier.

INFLUENCE OF THE CLIPPING DISTORTION

The reception of an OFDM signal can be implemented by a bank of correlators [6], as shown in Figure 5. The received signal, $s'(t)$, is multiplied by the N complexes sub-carriers and integrated in a OFDM symbol time. The estimated received symbols, ($s'_0, s'_1, s'_2, ..., s'_{N-1}$), are converted from parallel to serial format, generating the estimated data signal, $m'(t)$.

To analyze the effect of the clipping process, an OFDM system with 128 sub-carriers modulated with a QPSK scheme has been simulated. Figure 6 shows the transmitted data sequence, $m(t)$.

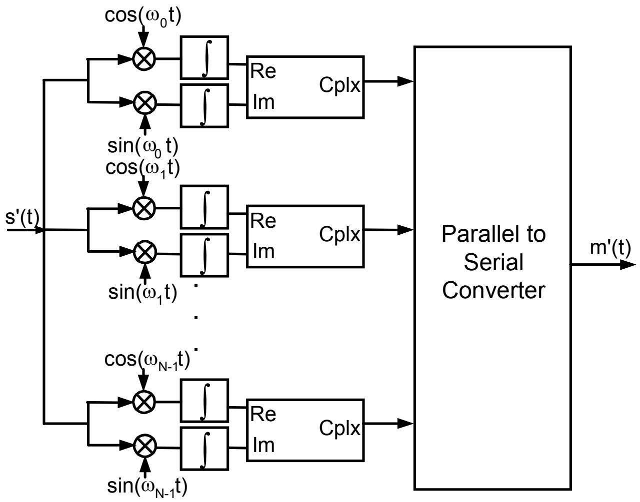

FIGURE 5
OFDM RECEIVER

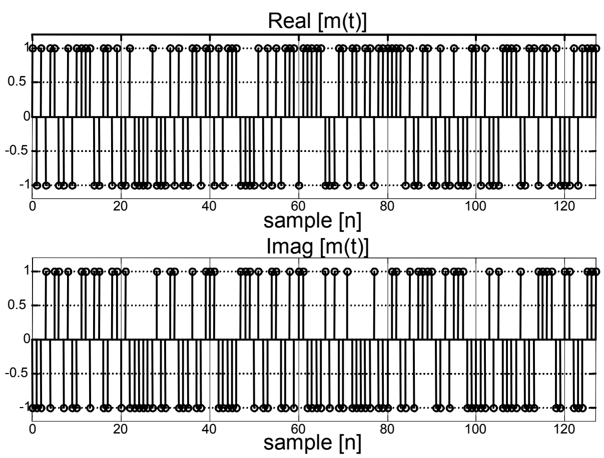

FIGURE 6
TRANSMITTED DATA SEQUENCE

The data sequence, presented in Figure 6, is applied to the OFDM modulator, generating the transmitted signal, $s(t)$, presented by Figure 7.

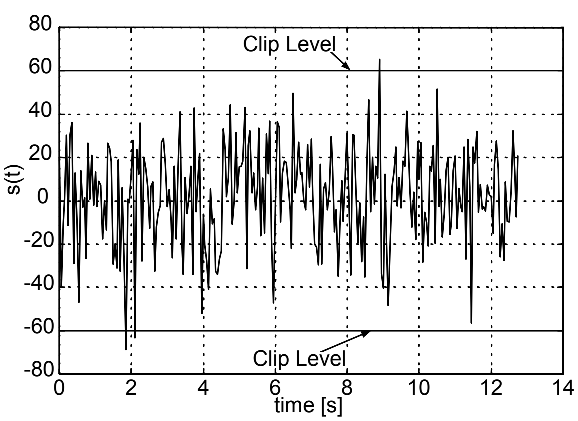

FIGURE 7
OFDM SIGNAL.

In this simulation, the clip level has been set to 60, which means that only the peaks above 60 and bellow –60 have been clipped. It is possible to observe that the introduced clipping distortion is not very high, in this case. Figure 8 shows the received data sequence, $m'(t)$.

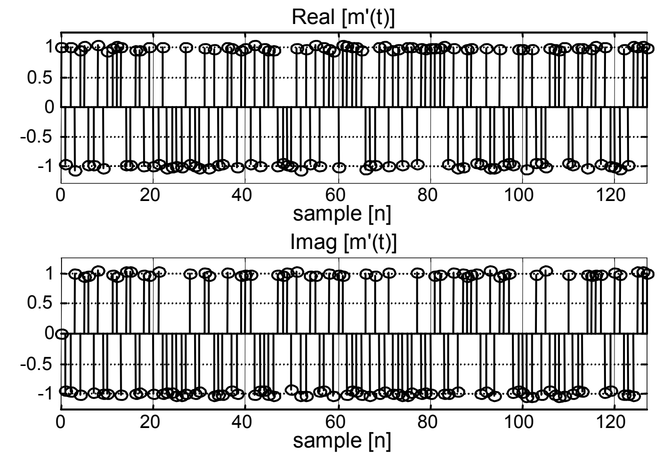

FIGURE 8
RECEIVED DATA SEQUENCE.

The clipping distortion introduces a variation in all transmitted symbols, decreasing the performance of the OFDM system.

In this simulation, the clipping occurred only in a few instants of time, because the clip level was set to a high value. In the next simulation, the clip level has been set to 30, which will introduce more clipping events to the transmitted signal, as can be seen in Figure 9.

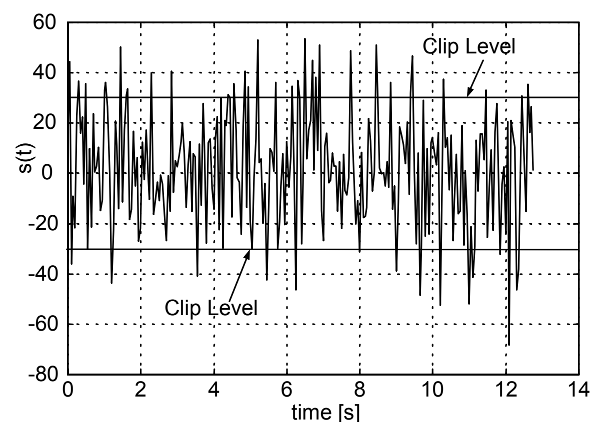

FIGURE 9
OFDM SIGNAL.

The distortion introduced by the clipping process in this simulation will perturb the transmitted data signal, reducing even more the performance of the system in a channel perturbed by AWGN (Additive White Gaussian Noise).

Figure 10 shows the received data sequence, perturbed by the clipping presented by Figure 9.

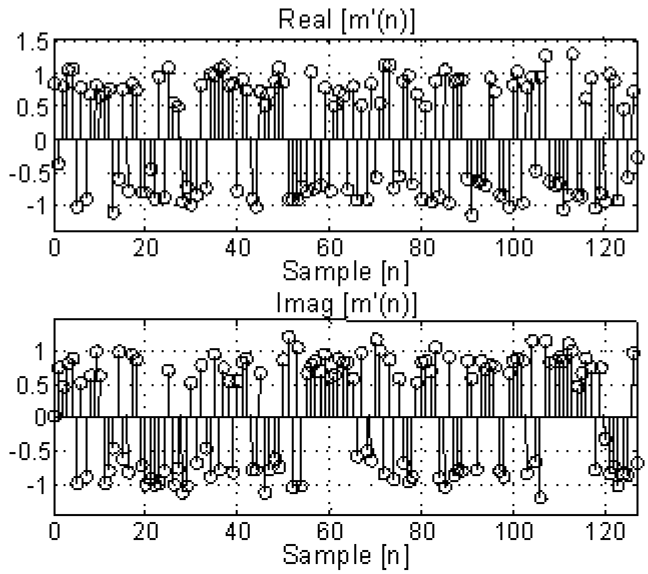

FIGURE 10
RECEIVED DATA SIGNAL.

As a quantitative parameter, the standard deviation can be used as a reference value for the clip level. In the first simulation, the clip level to the standard deviation rate was 2.66 (the standard deviation of the OFDM signal is 22.58). In the second simulation, the clip level to the standard deviation rate was 1.33. Thus, based on the simulations presented here, it is possible to observe that for ratio less than two, the interference of the clipping can be significant.

It is important to note that the clipping distortion does not introduce bit error, because the decision device can exactly approximate the received signal, $m'(t)$, to the transmitted signal, $m(t)$. However, the analysis realized in this paper, does not consider the AWGN of the channel. Thus, the clipping distortion will reduce the robustness of the system by increase the bit error rate (BER). The problems caused by the clipping can be minimized by applying a channel code for error control or by increasing the linear operation region of the power amplifier.

CONCLUSIONS

The OFDM signals can be modeled as a Gaussian Process and, thus, it may present very high amplitude values. The power amplifier used to transmit this signal usually presents a short linear region of operation due the power efficiency. Thus, the high peaks of the OFDM signal are clipped because the high values of this signal saturate the power amplifier. This distortion can be modeled as an impulsive noise that is added to the transmitted signal, and it interferes in every sub-carrier. The results presented in this paper, shows that the degradation in the system performance may be significant if the clip level is less than two times the standard deviation of the OFDM signal. It means that if the clip level is less than two times the standard deviation, the performance of the OFDM system in an AWGN channel can decrease significantly.

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An Educational Approach for the Study of Wave Propagation

Luciano L. Mendes[1] and Geraldo G. R. Gomes[2]

Abstract — *The main purpose of this paper is to present an computer tool developed to simulate a point to point digital radio link. This program allows the user to explore and study the phenomena involved in the wave propagation, as example, the Fresnell's ellipsoid and the free space attenuation. The attenuation caused by obstacles is also simulated which allows the user to realize a complete analysis about the propagation of an electromagnetic wave.*

Index Terms — *Wave propagation, simulation, Fresnell's ellipsoid.*

INTRODUCTION

Today, the digital radio links are widely used in many applications. The microwave links used to transmit telephony voice are the most common application [1]. Internet wireless access is also another important application that is growing fast. Usually, the capacity of a digital radio link varies between 64Kbps (one-voice channel) and 155Mbps (one STM-1 data stream).

The microwave digital radio links, which works with in a line of sight, has two main causes that reduce the performance of the system. The first one is the non-selective fading, which reduce the SNR (signal to noise ratio). The second one is the multipath, where a delayed version of a signal interferes in the received signal. This interference is called ISI (Intersymbol Interference) [2] [3]. The ISI provokes "notches" in the desired bandwidth, which characterizes a selective fading. Figure 1 shows the spectrum of a signal in a flat channel (non-selective), while Figure 2 shows the spectrum of a signal in a selective channel.

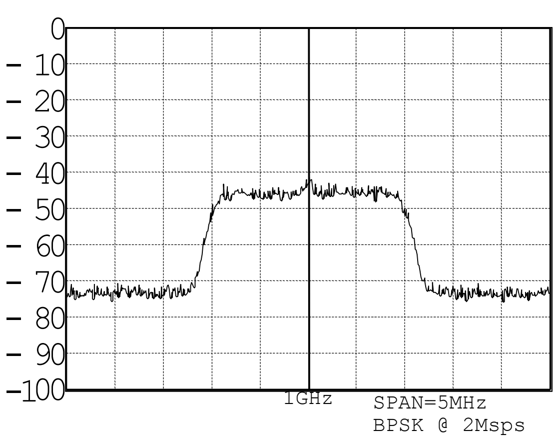

FIGURE 1
SPECTRUM OF A BPSK SIGNAL IN A FLAT CHANNEL

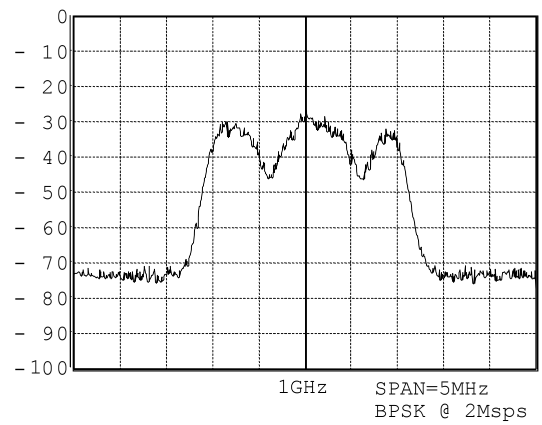

FIGURE 2
SPECTRUM OF A BPSK SIGNAL IN A SELECTIVE CHANNEL.

The weather conditions and the geometry of the links are some parameters that allow one to determine the phenomena in a link. In this paper, a computer tool to analyze microwave links is presented. This tool allows the user to verify how the parameters that define the system and the atmosphere affect the link. All results are presented in a window developed using a Graphic User Interface (GUI) over Matlab® platform [4] to provide a didactical interaction with the user.

TROPOSPHERE PROPAGATION IN LINE OF SIGHT

The trajectory described by an electromagnetic wave between the transmitter and the receiver depends, basically, on the density of the propagation medium. In the vacuum density, the electromagnetic wave propagates in a straight line, but it does not happen in the troposphere density, because it depends on the temperature, pressure and humidity. If the propagation medium does not have a uniform density, the trajectory of the electromagnetic wave is not a straight line because of the refraction phenomenon [1]. The refraction coefficient, or refraction index, n, is the ratio between the propagation speed of an electromagnetic wave in the vacuum, c_o, by the speed in the vacuum, c, as shown by (1).

$$n = \frac{c_o}{c} \tag{1}$$

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The propagation coefficient is always greater o equal to one, but for a wave propagating in the air, this coefficient is just a fraction greater than one. Thus, there is another parameter to study a wave propagating in the air, called refractivity (***N***), that is the number of parts per million that exceeds the unity, as shown by (2) [1].

$$N = (n-1) \cdot 10^6 \quad (2)$$

The refractivity ratio, for digital radio links up to 10GHz, can be obtained by (3).

$$N = 77.6 \cdot \frac{P}{T} \cdot 3.732 \cdot 10^5 \cdot \frac{e}{T^2} \quad (3)$$

Where P is the dry atmosphere pressure in *mbar*, T is the absolute temperature in *Kelvin* and e is the water vapor pressure in *mbar*.

The value of N varies with the altitude because of the pressure and of the temperature. The pressure and the humidity usually decrease exponentially with the altitude, while the temperature decreases linearly. The typical values of refractivity ratio are between 200 and 500. In general, the refractivity decreases exponentially with the altitude, in a normalized atmosphere, as shown in (4).

$$N(h) = N_0 \cdot \exp(-0.136 \cdot h) \quad (4)$$

Where h is the altitude in *Km.*

The absolute value of the refractivity ratio is not important to study the degradations introduced by the troposphere in a digital radio link but the variations of this parameter can change the trajectory of an electromagnetic wave. Thus, it is important to define the refractivity gradient (G), as shown in (5).

$$G = \frac{dN}{dh} \quad (5)$$

For a homogenous atmosphere, the value of this parameter is a constant. When the atmosphere varies with time, the refractivity gradient also varies, which affects the propagation conditions. Because of this, the trajectory described by an electromagnetic wave propagating in the troposphere is not a straight line, but a curve. The radius of this curvature (ρ) depends on the refractivity gradient and can be described by (6).

$$\frac{1}{\rho} \cong -\frac{dN}{dh} \quad (6)$$

In addition, it is important to note that the Earth does not have a flat superficies, but it can be represented as a curvature with radius a that is equal to 6371Km. Thus, a precisely analysis of the line of sight between two antennas must consider the relative distance between the two curvatures. To facilitate this analysis, one may consider that the wave propagation trajectory is a straight line and the curvature of the Earth is modified by the refractivity of the medium. The new curvature of the Earth is defined as effective radium of the Earth (R_e). The effective radium is defined as the hypothetical radium of a spherical Earth without atmosphere, where the propagation of electromagnetic waves is described by a straight line. The effective radium of the Earth can be calculated by (7).

$$R_e = k \cdot a \quad (7)$$

Where k is the effective radium factor or k factor. The relationship between the Earth radium and the propagation trajectory can be obtained by (8).

$$\frac{1}{k \cdot a} = \frac{1}{a} - \frac{1}{\rho} = \frac{1}{R_e} \quad (8)$$

Thus, the k factor can be defined using the refractivity coefficient by (9).

$$k = \frac{1}{1 + a \cdot \frac{dN}{dh} \cdot 10^{-6}} \quad (9)$$

The value of k is usually between 1 and 2, depending on the weather of the region. The reference value of the refractivity coefficient is –40, which results in ρ=4a, which is defined as standard atmosphere. In this case, the value of k can be obtained by (10).

$$\frac{1}{k \cdot a} = \frac{1}{a} - \frac{1}{4 \cdot a} = \frac{3}{4 \cdot a} \therefore k = \frac{4}{3} \quad (10)$$

SIMULATIONS

The simulator presented in this paper has been developed to show to the user how the k factor can interfere in digital radio links. The user provides the frequency of the electromagnetic wave, the antennas heights and the k factor. The relief of the digital radio link must also be provided by a .DAT archive with the heights of the relief points. The distance between these points must also be provided. Figure 3 shows the program main window.

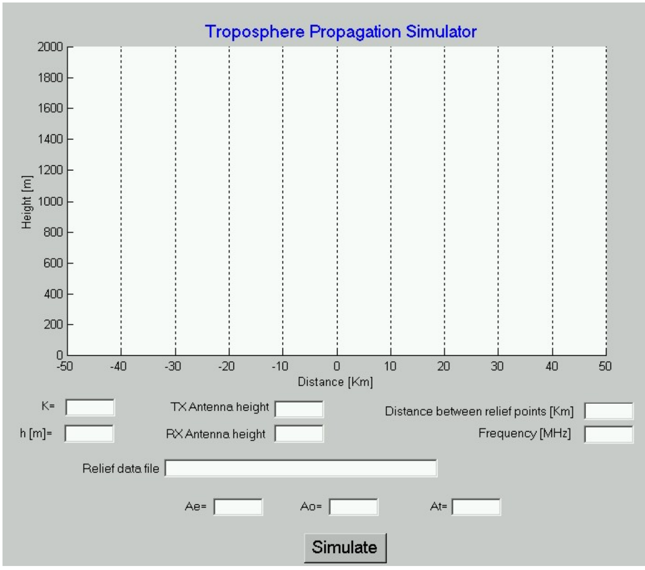

FIGURE 3
SIMULATOR MAIN WINDOW.

The parameters *Ae*, *Ao* and *At* are, respectively, the free space, the obstacle and the total attenuation. The free space attenuation is obtained by (11).

$$A_e = 32.44 + 20\log(f) + 20\log(d) \tag{11}$$

Where *f* is the signal frequency in MHz and *d* is the distance between the antennas in Km.

The knife cum model is used to define the obstacle attenuation. In this model, the obstacle attenuation can be calculated using the empiric formula given by (12).

$$A_o = \begin{cases} 0 & v \leq -1 \\ -20\log(0.5 - 0.62v) & -1 < v \leq 0 \\ -20\log\left(0.5e^{-0.95v}\right) & 0 < v \leq 1 \\ -20\log\left(0.4 - \sqrt{0.1184 - (0.38 - 0.1v)^2}\right) & 1 < v \leq 2.4 \\ -20\log\left(\dfrac{0.225}{v}\right) & v > 2.4 \end{cases} \tag{12}$$

Where *v* is the Fresnell-Kirchoff coefficient. This coefficient defines if the obstacle has affected the first Fresnell ellipsoid and it can be calculated based on the geometry of the link, as shown in Figure 4.

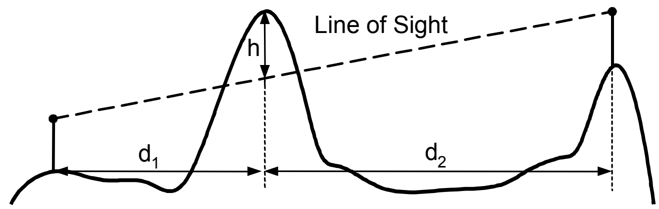

FIGURE 4
GEOMETRY OF A LINK

Finally, the Fresnell-Kirchoff coefficient can be obtained by (13).

$$v = h \cdot \sqrt{\frac{2 \cdot (d_1 + d_2)}{\lambda \cdot d_1 \cdot d_2}} \tag{13}$$

Where λ is the wavelength of the transmitted signal.

It is important to note that the height *h* may vary with the *k* factor. Figure 5 shows the simulation results obtained with a very high value of *k* (without atmosphere).

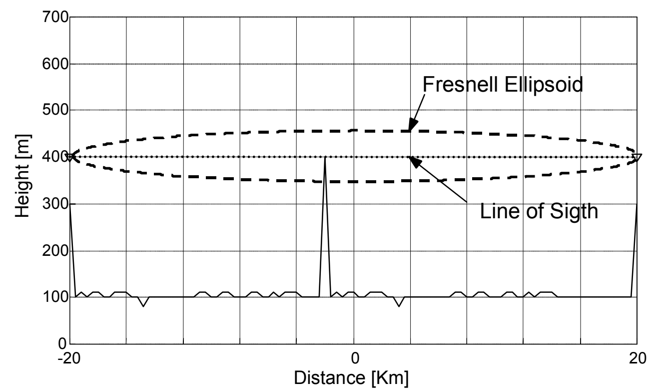

FIGURE 5
DIGITAL RADIO LINK WITHOUT ATMOSPHERE.

The results presented in Figure 5 have been obtained with a 1GHz electromagnetic wave. The free space attenuation is 244.37dB and the obstacle attenuation is 6dB. But, as showed in the previous section, the refraction in the atmosphere causes a curve trajectory in the waveform propagation. Readjusting the Earth curvature can compensate this trajectory. Figure 6 presents the results for the same simulation above, but with the standard atmosphere (*k*=4/3).

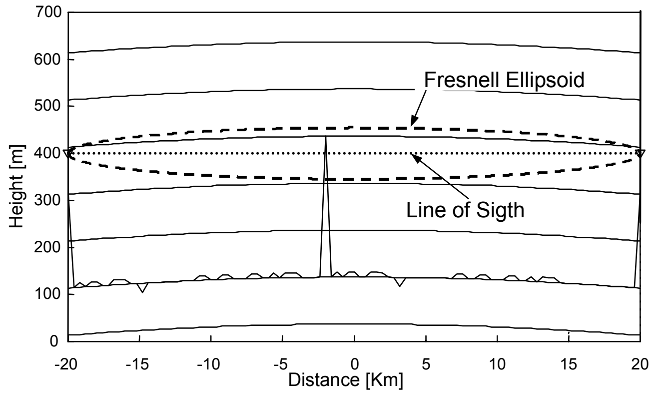

FIGURE 6
DIGITAL RADIO LINK IN A STANDARD ATMOSPHERE.

It is possible to note that the obstacle is, actually, above of the line of sight and the obstacle attenuation is, therefore, 13.14dB.

There are special conditions where the *k* factor is negative. In this case, the correction of the Earth curvature may reduce the obstacle attenuation, as can be seen in Figure 7. This result has been obtained with the same parameter used in the others simulations, but with k = -0.8. The obstacle attenuation is 0dB because the obstacle does not interfere in the first Fresnell Ellipsoid.

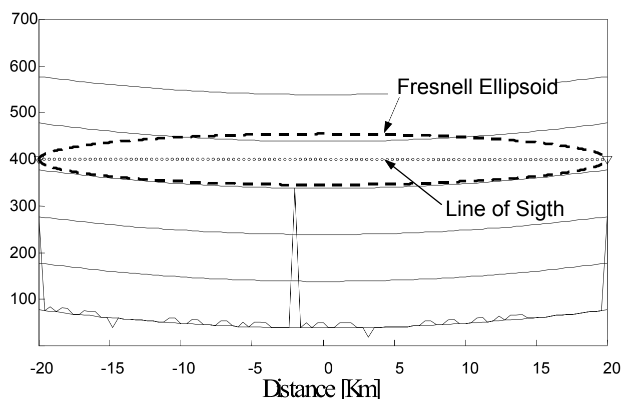

FIGURE 7
DIGITAL RADIO LINK IN ANOMALOUS CONDITIONS.

CONCLUSIONS

The propagation of electromagnetic waves is a very important issue in Telecommunication Engineering and must be presented clearly to the students. In this paper, a computer tool to simulate and analyze digital links has been presented with some commented results. With this tool, the student can visualize the effects of the different parameters in the link, as frequency, *k* factor and relief, which facilitates the apprenticeship of the issue.

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A ROBUST SPEECH RECOGNITION SYSTEM FOR CAR ENVIRONMENT

Francisco J. Fraga[1], André G. Chiovato[2] and Rodrigo B. Brito[3]

Abstract *— This paper presents a robust speech recognition system designed for the car environment. It was developed in an undergraduate research project and we carried it out in two steps. First, a specific database was designed for this speech recognition task. In the second step, an Automatic Speech Recognition (ASR) system was designed using HTK®, a software tool which is worldwide used in the development of HMM-based (HMM: Hidden Markov Models) ASR systems. We performed two experiences at different settings of training and test. In the first experience, the test conditions were matched exactly to the training conditions, and a recognition rate of 99.88% was achieved. In the second experience, using signals with high SNR for training and signals with low SNR for test, 99.16% of the total test utterances were correctly recognized. These results motivated the undergraduate students in continuing the research towards the implementation of a robust and low-cost ASR system for car environment.*

Index Terms — Robust speech recognition, Hidden Markov Models, car noise.

INTRODUCTION

The robustness of an automatic speech recognition system is strongly influenced by the capability to handle the presence of background additive noise and to deal with the distortion caused by the frequency response of the transmission channel (additive and convolutional noise).

Among the distortions caused by the environment we can include: limited bandwidth of the transmission channel, channel distortion caused by non-linear phase transfer functions, cross talk and echo [1]. These are some of the problems we have to face when treating with real-life scenarios in automatic speech recognition.

Furthermore, it is well known that in noisy environments the speaker increases the vocal effort to overcome the noise, causing a speech distortion called *Lombard effect* [2]. Other effect that changes the speaker's voice is the high gravitational acceleration when the pilot pronounces a word command in the cockpit of an aircraft [2].

In the recent past, several speech recognition systems achieved good performance working in laboratory environment, but failed dramatically when tested in real-life scenarios [1]. In order to improve the recognition rate, modern systems realize an appropriate extraction of robust features to represent speech patterns and/or match the training and test conditions to the same real-life situations. During the last years, an increasing number of researches were publicized on these topics, reflecting the importance of these issues.

This paper presents a robust speech recognition system for working in a real-life scenario that is the car environment, an application with good commercial acceptance and a real challenge for current available speech recognition algorithms.

Speech captured in a running car is perturbed by noise from engine and tires, from wind, rain and traffic. With a microphone placed 50 cm away from the mouth of the speaker, the resulting captured signal may exhibit a negative signal-to-noise ratio (SNR) in decibels [3].

The speech recognition for controlling the car functions (such as headlight, windows, lock and others) is an application we are currently working on in an undergraduate research project of the Digital Signal Processing Research Group from Inatel. This is a typical situation that is extremely appealing for an ASR application.

When a person is driving a car, his or her eyes and hands are entirely occupied on this task and the manual control over any car function can cause distraction in traffic. The use of the own voice for command the car functions could avoid this problem. Other interesting use of an ASR system is in long trips, especially during the night, when the voice control over the headlights (full beam, low beam) can diminish the possibility of an accident caused by sleeping.

In order to develop an ASR system for this application, we have divided the job in two steps. First of all we have done several speech recordings to build an organized speech database for training the speech models, a mandatory requirement for any ASR system. After that we have designed the system itself, using HTK® (*Hidden Markov Models Toolkit*), a computer tool worldwide used for developing HMM-based ASR systems.

THE SPEECH DATABASE

With the aim of developing an ASR system for the car environment, we built a specific speech database, which was composed by utterances from two male speakers. They recorded his voices when were driving a car under various conditions: in streets and roads at different speeds (35 and 80 km/h), with and without traffic noise, with asphalt or stone pavement and with the car windows opened or closed. Two microphones simultaneously recorded the speech signal; both were about 50 cm away from the driver's mouth. One microphone was placed on

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the car panel (at the same level of the steering wheel) and the other was placed near the car ceiling (this second microphone had poor quality, it costs five times less than the first one). The vocabulary contained about 50 isolated words, each of them was pronounced three times by the speakers in each recording condition. The final speech database had over 10,000 utterances.

The microphones used were: *Super Directional Desktop Microphone – M60* e *Handheld Recorder Microphone – M10* (the cheaper one), from *Telex Communications®* company, which illustrations can be viewed in figures 1 and 2. The speech recording was done by means of a portable Digital Audio Tape (DAT), model *TCD-D100* from *Sony®* company, as illustrated in figure 3. Figure 4 shows the recording scenario, which is the interior of a car from *Fiat®* company, model *Pálio 1.6 16 V*. In this figure we can see the microphones connected to the DAT through two audio cables.

After recorded by the DAT, the speech signals were transferred to a computer where they were separated and titled according to the vocabulary word, the utterance (if it was the first, second or third repetition of each word), the speaker and the recording conditions, as the example showed below:

TemperaturaInterna2_André_Av_Ab.wav

It means that the speaker *André* recorded the Portuguese word command *TemperaturaInterna* for the *2nd* time at the main *Av*enue with opened windows (the car windows were "*Ab*ertos" as we say in Portuguese)

FIGURE 1
M10 MICROPHONE

FIGURE 2
M60 MICROPHONE

FIGURE 3
DAT TCD-D100

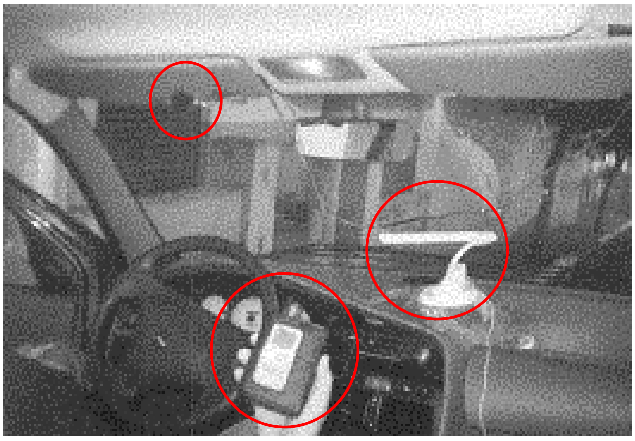

FIGURE 4
LAY-OUT OF THE RECORDING ENVIRONMENT

Table I shows the vocabulary, where we can see all the Portuguese words that the driver can say to command the car and the cellular phone functions.

TABLE I
COMPLETE VOCABULARY

Word commands for the cellular phone functions	Word commands for the car functions
1. Bloquear	
2. Desbloquear	1. Farol Alto
Menu	
3.1. Agenda	2. Farol Baixo
3.1.1. Nomes	
3.1.2. Número	3. Pisca – Alerta
3.1.3. Polícia	
3.1.4. Bombeiros	4. Travas
3.1.5. Emergência	
3.2. Chamadas	5. Capo
3.2.1. Atender	
3.2.2. Receber Mensagem	6. Porta – Malas
3.3. Personalizar	
3.3.1. Nome (do usuário)	7. Ventilação
3.3.2. Perfil original	
3.3.3. Campainha	8. Alarme
3.3.3.1. Aumentar	
3.3.3.2. Diminuir	9. Tanque
3.4. Assistente Pessoal	
3.4.1. Calendário	10. Combustível
3.4.2. Atividades	
3.4.3. Despertador	11. Óleo
3.4.4. Calculadora	
3.4.5. Administrador de contatos	12. Abaixar Vidros
3. Funções Avançadas	13. Levantar Vidros
3.1. Memória (tamanho)	
3.2.Conferência Telefônica	14. Temperatura Interna
3.3. Rediscagem	
	14.2. Ambiente
4. Serviços Internet	
4.1. Lazer	14.3. Motor
4.1.1. Teatro	
4.1.2. Restaurante	
4.1.3. Shows	
4.1.4. Cinema	
4.2. Trânsito	
4.2.1. Livre	
4.2.2. Congestionado	
5. Desligar	

The list of some speech recording situations is presented in table II.

TABLE II
EXAMPLES OF SOME SPEECH RECORDING SITUATIONS

Speaker	Place	Pavement	Windows	Speed
André	BR 459	Bad asphalt	Closed	80 km/h
André	BR 459	Bad asphalt	Partially opened	80 km/h
André	BR 459	Bad asphalt	Opened	80 km/h
André	Pouso Alegre	Good asphalt	Opened	35 km/h
Rodrigo	Pouso Alegre	Good asphalt	Opened	35 km/h
Rodrigo	Pouso Alegre	Good asphalt	Partially opened	35 km/h
André	Pouso Alegre	Good asphalt	Partially opened	35 km/h
André	BR 381/km 794	Acceptable asphalt	Partially opened	80 km/h
Rodrigo	BR 381/km 775	Acceptable asphalt	Opened	80 km/h
Rodrigo	BR 381/km 794	Acceptable asphalt	Closed	80 km/h
Rodrigo	BR 459	Bad asphalt	Opened	80 km/h
André	BR 459	Bad asphalt	Opened	80 km/h
André	Ave. João de Camargo	Good asphalt	Closed	35 km/h
André	Ave. João de Camargo	Good asphalt	Opened	35 km/h
Rodrigo	Marques Street	Stone	Opened	35 km/h
Rodrigo	Marques Street	Stone	Partially opened	35 km/h
Rodrigo	Marques Street	Stone	Closed	35 km/h

The final recorded speech database consists of 5.344 files (.wav). In order to perform this task, we have to pronounce the word commands while driving the car in roads and streets for 266 km .

THE ASR SYSTEM

In the second step of our undergraduate research project we have designed an ASR system using some tools of the HTK® software.

In the front-end stage, we have extracted 12 mel-cepstral coefficients from speech frames with 30 ms duration and an overlapp of 33%, which leads us to a frame rate of 100 Hz. For each utterance, the mean of the mel-cepstral coefficients were computed over all frames and then were subtracted from the coefficients vector with the aim of neutralize the channel distortion [2].

In order to form the observation vector, the first and second time derivatives were added to the end of the 12 mel-cepstral coefficients vector.

A single left-right HMM was used for modeling each vocabulary word. The number of states of each model was variable according to the number of phonemes of the vocabulary words.

Five gaussian mixtures with diagonal covariance matrix were used to estimate the acoustic emission of each state of the HMM's.

The models were trained with a third part of the utterances; the remained utterances were used to evaluate the system performance.

Two experiences were carried out: In the first one, the test conditions were matched exactly to the training conditions, which is the ideal way of developing a robust ASR system, although it is difficult to realize in a real-life application [4].

The performance achieved with this set up, in terms of correct word recognition rate, was **99,88%.**

The second experience was carried out at just the opposite situation: the utterances used for training were the best ones (high SNR) and those used for test were the worst ones (low SNR). Although running at these adverse conditions, **99.16%** of the total test utterances were correctly recognized.

CONCLUSIONS

We conclude that these good results were achieved because we extracted robust features from the speech signal (mel-cepstral coefficients with mean cepstral subtraction). We observed also that the same performance was achieved by the two microphones. This fact leads us to the conclusion that the distortion caused by the cheap microphone was neutralized by the robust feature extraction scheme.

The speech database will serve also for other research projects involving robust speech recognition and speech enhancement.

Finally, we want to remark that the students that worked in this undergraduate research project became enthusiasts of the speech recognition area and both have already started his master level studies in speech processing.

ACKNOWLEDGMENT

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INTERACTIVE CHAT: AN EXPERIENCE IN A VIRTUAL ASSESSMENT

Luciana A M Zaina[1,2], Graça Bressan[3] and Wilson V Ruggiero[4]

Abstract — *The increase of distance education in the world has been a reality in universities and companies encouraging researchers to create ways to keep track of the virtual classes. And at a distance it is very important to have ways to provide interaction between the teacher and the students, because there is no physical contact in a distance system environment. The integration activities might be used not only in distance classes, but in traditional classes too. This work has been presented a methodology to plan and to handle educational chats and how to evaluate the students in these events. The methodology was applied, by the teacher Luciana Zaina, to a group of learners from the Computer Engineering course at the Engineering College of Sorocaba aiming to discuss a practical application of the Deterministic Finite Automata Theory.*

Index Terms — *chat, classroom support, interactive tool, virtual discussion, virtual learner assessment.*

INTRODUCTION

Using a synchronous tool such as chat allows the students to develop new syntheses, analysis and evaluation abilities, because it forces the students to write what they know, their ideas and to give solutions to problems proposed by the teacher.

The chat discussion gives the students the opportunity to develop a critical sense development but this is not the only point. The synthesis process is essential to make the students able to expose their points of view more clearly allowing the teacher to track of the student's performance along the course. And it can be used as an environment to eliminate learner doubts or as a way to introduce new challenges to the students, making the classes more dynamic [5],[9].

The chat may be a good option when the teacher wishes to make questions and to have immediate answers from the students, because they can exercise their ability to come to a conclusion fast. The chat is applied to situations when the teacher needs to check if the student has assimilated the concepts and if he knows how to use the topic studied developing the synthesis, analysis and evaluation abilities in the learner. The chat discussion is a good experience for many students because they may feel more comfortable to show their opinions, they don't need to stay face to face with other students, they are not be afraid to present their ideas to other persons.

METHODOLOGY TO EVALUATION

The methodology propose in this work to evatuate the student in a chat event is composed by the points that are presented in this session.

Event Planning

Before the chat assessment event the teacher must plan how he/she will conduct the discussion and how he/she will validate the knowledge process checked in the chat. The teacher should define the discussion goal and inform the learners of the expected result at the end of the event in order not to lose the focus of the discussion. Getting an objective discussion is essential to define the questions or themes that will be made to the students, questions that encourage student's reflection about the theme, but the teacher should be prepared to ask new questions during the event if the bypass is interesting and if it doesn't damage the discussion focus [1],[7],[9].

The discussion should stimulate the student to organize his ideas and to express his conclusion about a question or about another student's opinion, constructing an interesting knowledge network. The teacher make use of questions that analyze a topic deeply such as "what do you think about...?" or "do you agree or disagree with...?". Table I presents some question suggestions to be used in a chat event [1],[9].

TABLE I
QUESTION SUGGESTIONS TO BE USED IN THE ON-LINE ASSESSMENT [1] APUD SAVAGE

Questions
Why did the author use this statement ?
Do you agree/disagree with this point of view ?
What do you think about... ?
Can you explain this statement better ?
How do you compare topic A and B ?
Why did you use this statement ?
Doesn't what you are saying now contradict what has been said before?

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The planning must approach all the concepts of the theme, without being rigid, because unplanned topics may come up and they might be interesting for the discussion. In these cases, the teacher should redirect the discussion without losing its main goal and come back to the point where the discussion was interrupted [9] as it is shown in Figure 1.

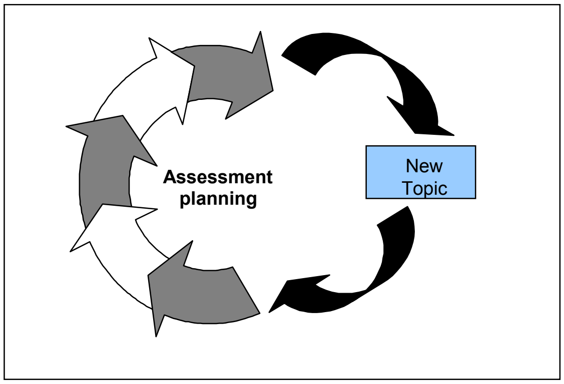

FIGURE. 1
THE CHAT EVENT MAY HAVE NEW TOPICS TO BE DISCUSSED

The teacher must determine a deadline for the discussion so that it doesn't remain unfinished. It is important to plan how much time the participants will spend talking about a topic, although this can be changed during the event if it is important for the discussion. The moment the group finds the solution for the problem is another way to establish the end of the discussion, but it is fundamental that all the participants agree with the solution and conclude the discussion [7]. Table II presents a suggestion to track the chat event.

TABLE II
ASSESSMENT PLANNING

ASSESSMENT VIRTUAL PLANNING			
Goal:		**Total discussion time:**	
Start date:		**Finish date:**	
No.	**Question**	**Discussion Time**	**Doubts/ New Questions**
1			
2			
3			
...			
n			
Result:			

The student should be oriented to identify himself in the beginning of the chat session helping the teacher to know who exactly is talking at the moment [2]. The chat tool can implement ways for the teacher to recognize the students through the user login or photos which are stored in the tool's database. Besides this, the teacher must highlight the use of netiquette*(*etiquette used among the participants of a virtual event*)* avoiding the sending of rude messages among the chat participants [9].

The teacher must plan how to guide the virtual session and he should present this plan to the students before the beginning of the event, emphasizing the following points:

- **Discussion main goal:** the student must be aware that he is the center of the discussion and not the teacher. The learner may conclude a discussion topic, he doesn't need to wait for the teacher's conclusion.
- **Respect for the other participants' opinion:** the student may be critical, but he cannot disrespect another participant. He can expose his opinion without arguing with the colleague, exercising his ability to explain his point of view about a theme [5].
- **Controversy themes:** the learners may disagree with the others opinion but they cannot ridicule the other participant's ideas, because this might cause an embarrassing situation and the students may be afraid to show this opinion again [7].
- **Add new knowledge to the discussion:** answers like "I agree" or "I disagree" add nothing to the discussion. The students should feel motivated to explain why he agrees or disagrees with a subject, giving new values to the discussion. The learner may come to a good conclusion and a good explanation without adding different ideas to the discussion [1].
- **Interruptions during the discussion:** a participant cannot interrupt another participant's explanation. When the student wishes to express his opinion about a topic, he must wait for his colleague's conclusion and he might ask the teacher if he can talk his ideas about the topic. The teacher must use ways to control the time of each student in order to avoid having all the participants sending messages at the same time [5],[7].

Assessment Applying

After the planning, the teacher should schedule the day and hour of the event and expose to the students the real aim and what results he/she wishes to achieve, indicating the way that the learners should follow during the chat. This is the same as determining the assessment content.

The chat is an efficient tool when all the students have the opportunity to exchange their ideas and it may become chaotic if there are a lot of people “speaking” at the same time. Thus, it is ideal to create chat groups from five to seven learners and to put these groups in different rooms mainly when there are a lot of students in the class [3]. This way the teacher can handle the discussion more easily, avoiding difficult situations where only some students show their opinions.

Technological problems such as connection failures may cause participants not to feel motivated and the teacher must avoid these situations by checking the chat environment where the discussion will occur before the event to start. The student must feel that he is contributing to the discussion, he must feel he is improving his skills about the subject and this kind of problem may be a critical issue [4].

The teacher should provide the group integration, in the beginning of the chat, reminding them of the discussion important points: respect between the participants concerning different viewpoints, the discussion goal and the importance of the students' participation to the success of the event. Afterwards, the discussion can start according the teacher planning [9].

It is very important for the teacher to observe if there are students monopolizing the discussion, because some may be shy and not show their ideas. The isolated students should be invited to talk about their opinion and the teacher might use sentences like: "Bob, what do you think about Susan's statement ?". In case of problems with the learner's behavior, the teacher must send private messages to him referring to use of impolite language without exposing him to the other chat participants. The incentive to the students is necessary for the discussion and they may feel that their contribution is valuable [1],[2],[3].

The teacher must decide what will be the ideal topic to be discussed at first in case of message collision, when two different learners send different messages at the same time, but the teacher cannot forget that the second message can be discussed later. The teacher may use a way, as a token pass for instance, to organize the order of each participant's talk and he determine to the students the order of the token will pass to the students.

Confirming a student's statement should always be used when his explanation is not clear and the teacher may use questions to force the learner to explain his point of view better and in more details [8].

Divergent ideas must be extensively discussed during the event, but the participants cannot forget to be always respectful to one another. It is worth forcing the students to discuss different ideas and come to an agreement, about a topic exercising their critic thinking and their ability to synthesize their opinions.

Analising and Mensuring Assessment

The chat evaluation is not an easy task, as in any kind of discursive test, but if the teacher plans the virtual event before applying it he will spend less time correcting the assessment.

Analyzing the chat event result is difficult for two reasons. The first one is that a lot of information needs to be checked. Besides, as the ideas were expressed without a sequence during the chat, the teacher must reorganize the content in order to correct it. The teacher must check the chat log to have a concrete result of the assessment, because it is impossible to obtain an accurate measurement when the chat finishes. A premature evaluation may lead to a mistake when giving the student's grade [8].

It is ideal that the teacher control the discussion using a table, so that he can verify the essential points in each theme. The loss of focus must be handled by the teacher and the teacher should consider this in his evaluation. The teacher must check the development of analysis, synthesis and evaluation skills and be concerned with the truth of student's statement, checking if what he said makes sense.

The teacher should determine the weight of the questions or themes that will be used in the assessment and at the end of the event, to measure the student contribuition in important points.

The teacher should present the event result to the chat participants to give them the opportunity to evaluate their flaws as well as the correct conclusions of each student. The learner can verify his correct and incorrect statements, the difficulties he had to express his ideas and he can decide which direction he should take [2],[7].

The final result can provide the teacher with valuable information, helping him analyze the event planning. This way, he can check if he needs to change his strategy when conducting and planning the discussion.

THE STUDENTS' EXPERIENCE

Based on the proposed methodology, a virtual event was planned and applied as an alternative way to evaluate the students of an engineering course in the Deterministic Finite Automata Theory syllabus. The main goal was to demonstrate that this theory can be applied in the development of real systems.

"A System for Web Based Instruction Using Sequential Automata" was the article chosen to be analyzed and discussed, which approaches the Mealy and Moore Automata used to model the Web courses. The article emphasizing that the best organization of material and the hypermedia documents provide facilities of the maintenance and reuse of the course content through automata implementation, eliminating the redundancy of the material [6].

Planning

First, the event was carefully planned concerning in the main points such as discussion goal, the themes that will be discussed, what is important to observe about the student's opinions and the expected result. The discussion goal was "Analysis of the automata applications to systems development in the Web", focusing on the programs functionality modeled by automata. The teacher thought the article content was very important to the discussion goal.

According to the article the student must show the teacher that he understands how the theory can be applied to practice. Bringing the knowledge learned in the class to the application described in the article the student develops synthesis skills, because he will make a connection between conception and practice. The event was planned based on the article and it is showed in the Table III.

TABLE III

THE EVENT PLANNING

VIRTUAL ASSESSMENT PLANNING			
Goal: discuss the relation between the automata theory and a practical application of it in a Web system		**Total discussion time:** 1 hour	
Start date: 09/11/2001 - 2:00 pm		**Finish date:** 09/11/2001 - 3:00 pm	
No.	**Question**	**Discussion Time**	**Doubts/ New Questions**
1	Based on the article, do you think the finite automata is ideal to develop Web programs using the hypermedia conception ?	10 minutes	
2	How are the Mealy and Moore Machines used in the model presented in the article ?	10 minutes	
3	How can the non-determinism automata be used to model a Web course ?	15 minutes	
4	How can the finite automata be applied to model the study personalization ?	15 minutes	
The result: The students understood the relation between theory and practice.			

Discussion Handling

Before the event the teacher talked to the students about the essential points for conducting a successful discussion. According to the methodology the teacher highlighted the important topics of the discussion to learners [9]:

- **The main object of the discussion:** the student cannot forget that he is the main object of the discussion. The teacher will interfere only in extreme situations.
- **The respect to other students' opinion:** the student must be careful when criticizing another learner's point of view. He must stimulate the students to participate in the event, and at the same time, keep unpleasant comments and jokes to themselves.
- **Add knowledge to the discussion:** remind the students that they should express their opinions through clear ideas, adding new values to the discussion.
- **Interruptions:** the teacher will use a virtual token to control who is talking in a determinate moment preventing the student to be interrupted by another learner. The token will be passed to the student when he wishes to say something and it must be returned to the teacher after a student finishes exposing his opinion and then the teacher will decide who is the next learner to talk.

By adopting a process to control the time that each one can talk, it was possible to prevent students from interfering in one another's explanation, mainly because the chat tool allows only text messages. The teacher used the token system, which determined who should express his opinions about a subject, and when somebody wished to talk they could ask for the token. Sometimes, it was worth breaking the normal procedure of the discussion to approach interesting topics such as the necessity to explain the relationship between hypermedia and automata according to the article.

The discussion elapsed normally and the number of interruptions was practically zero. Some students wished to expose their ideas and, because of this, sometimes asked for the token at the same time. The priority always given to whoever was talking and after he finished the teacher passed the token to another student that had requested it.

The major problem was the phone connection failure that caused the discussion to be interrupted three times. When we managed to connect again we had to restart the discussion point spending more time than necessary with the event. The time event estimate had an overload in the chat plan and part of this was caused by the connection problems.

The event started when planned and all the participants were in the chat room. The teacher welcomed everybody and started to make questions determining who was the first to answer it. All the time, the teacher passed the token to the student that she thought was the best one to expose his idea at the moment, and sometimes another participant asked for the token to explain his position about the topics. This kind of control prevented the shy student from standing only as an observer, encouraging him to explain his point of view.

During the event it was possible to observe that the students understood the article conceptions and they could relate the theory learned in the lectures to the work presented in the article. In general, they expressed their thoughts clearly and the teacher didn't need to make many interventions.

After one and half hour of discussion the teacher finished the event. He could not ask all the planned questions, because there were connection problems and it was necessary to explain some conceptions during the event. Besides these, the students' participation was higher than the teacher expected causing more time of discussion that had been planned.

Log Analysis

During the event the teacher must be concerned about conducting the discussion so she will analyze the results of the event by the log file comparing it with the event plan. Based on the questions made to the students, the weight of each question and the log chat, the teacher could conclude the real effect of the event. The Table IV shows how the teacher made the chat participants' evaluation.

TABLE IV
THE EVALUATION BASED ON THE ANALYSIS OF THE CHAT LOG

	Weight					
		1	1	1		3
	Participant	**Does he lose the discussion focus?**	**Does he add information?**	**Do his statements make sense?**	**Observations**	**Final Grade**
Question 1	Student A	1	1	1	He interrupted another student. He focused on the article.	3
	Student B	1	1	1	He asked me to explain a formal conception about hypermedia.	3
	Student C	1	1	1		3
	Student D	1	1	1		3
	Student E	1	1	1		3
Question 2	Student A	1	1	1	He explained the relation between the course content.	3
	Student B	1	1	1		3
	Student C	1	1	1	He made a technical explanation	3
	Student D	1	1	1	He asked me to compare the model to the distance learning.	3
	Student E	1	1	1		3
Question 3	Student A	1	1	1		3
	Student B	1	1	1		3
	Student C	1	1	1		3
	Student D	1	1	1		3
	Student E	1	1	1	He had doubts about the use of the non-determinism in the distance courses.	3

When analyzing the chat log it was possible for the teacher to verify the concrete result of the discussion. The student could get three points as a maximum grade which was divided in three sub topics and each one was worth one point. The topics available were:

- **Does the student miss the discussion focus?:** it was checked if the student didn't forget the real discussion goal.
- **Does the student add information?:** it was verified if the student understood the themes and if he related practise to theory.
- **Do his statements make sense?:** it was checked if the student said absurd statements.

The students had an active participation in the event and they didn't lose the main focus of the discussion. Sometimes the teacher had to explain some conceptions such as the formal definition of hypermedia, but this didn't disturb the event. On the contrary, it enriched the discussion with the participants conclusions. The target change was excellent to the discussion, but the trouble was to be attentive to bring students back to the break point and not to lose the real discussion objective, and this was controlled all the time when the students had doubts.

All the participants made sense in their affirmations adding valuable information to the theme. They provided the relationship between theory and practise showing their understanding about the automata finite application. Besides this, the teacher could observe that the students exposed the main article points, always associating it with the automata finite concepts.

During the event some expressions and sentences were split making it difficult for the teacher to make an immediate analysis. The chat log was fundamental to be sure of the student's contribution to the event, because the statements could be joined to the general context of the student's affirmations.

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CONCLUSION

The teacher asked the learners to send e-mail messages expressing their opinion about the chat experience. They should especify what they had felt and what they thought about their participation in an educational assessment chat. They had to evaluate the following points:

- Did he find difficulty expressing his ideas?
- Did he feel comfortable to talk in a virtual event?
- How does he compare the assessment in a chat to the traditional evaluation form?

Studying the student's answers it was possible to conclude that all the participants thought that this kind of event was very important to their learning, but they highlighted positive and negative points. The positive points pointed by the students are:

- They need to express their ideas in a writing and in a virtual way, developing their capacity to be consistent and coherent in their explanation so as not to have a misinterpretation of their point of view. Normally people have difficulty writing their ideas, they prefer speaking to writing about something. This kind of event it is a great opportunity to develop this ability.
- The interaction between the participants during the test. It is very difficult to the students exchange information and ideas to construct a problem solution step by step in a traditional test in group. The synchronous event like a chat permits learners to reach a conclusion with all the participants ideas, building a network of information.

The students pointed as negative points:

- Although the students' interruptions didn't occur frequently in this event, some students caused interruptions when another had the token. The interruptions were controlled and they demonstrated the students' wish to participate in the discussion.
- The Internet disconnection interrupted the event three times. We had problems with the Internet connection during the event and the discussion had to restart when this problem occur.

The students' information showed us that a different way of work or assessment can motivate them. They emphasized in their answers that the event allowed them a better integration during the problem resolution.

We could conclude that planning an event is fundamental because it can avoid a lot of common problems and help the teacher to deal with difficult situations. Although problems will always exist, there are ways to minimize them. Showing the students the discussion goal and what is expected from them allows them to prepare and to study the event theme.

The number of times there is loss of focus in the discussion can be reduced through a well-handled event. The teacher must try to let learners feel relaxed and encourage them all the time to express their opinions about the theme.

The event evaluation must be done after the chat avoiding flaws in the analysis and allowing the teacher to check the truth of the students' messages. Besides this, the teacher may misunderstand a point of view and he can analyze the statement better through the chat log.

When the interactive tools like chat and forum are used in distance courses, they may be a way to get concrete data about the student's evolution in the course and, in some cases, to detect failure in the course material. The plan in a virtual discussion is a prerequisite to the success of the event, because an unplanned chat without a mediator will be chaotic.

The use of interactive chat to support a traditional class brings advantages to the teacher and to the students. The learners can improve their capacity of expressing their opinions and the teacher provides the students with different ways to discuss the syllabus, motivating them to study outside the classroom.

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MÉTODOS EFICIENTES DE ENSINO DE ENGENHARIA: A FERRAMENTA COMPUTACIONAL DE SIMULAÇÃO COMO UM COMPLEMENTO NO ENSINO DE PRINCÍPIOS DE COMUNICAÇÃOES.

Flávia Mendonça Teixeira[1], *Luciano Leonel Mendes*[2]

Resumo *— O objetivo deste trabalho é mostrar como o método de ensino de engenharia pode ser melhorado através do uso de ferramentas computacionais de simulação. Procura-se introduzir a simulação computacional como ferramenta decisiva na aprendizagem rápida dos conceitos de princípios de comunicação.*

A metodologia consiste no desenvolvimento de um programa, utilizando a plataforma MatLab®, que fornece auxílio aos usuários na assimilação dos conceitos básicos de modulação. Este programa conta com duas interfaces gráficas: uma permite a entrada e visualização dos parâmetros necessários à modulação em amplitude e a outra permite a entrada e visualização dos parâmetros necessários à modulação em freqüência. São apresentados gráficos de todos os sinais envolvidos no domínio do tempo e da freqüência, possibilitando um método eficiente de ensino/aprendizagem através da análise e da comparação entre os vários sinais gerados.

INTRODUÇÃO

Um dos grandes desafios em cursos de base científica e tecnológica é acompanhar os avanços da ciência e da tecnologia sem deixar de lado o ensino de seus princípios básicos. Os avanços tecnológicos obtidos nas últimas décadas são surpreendentemente grandes e o número de tecnologias a serem estudas por alunos de graduação, é muito volumoso. O curso de engenharia elétrica com ênfase em telecomunicações caracteriza-se, dentre outras coisas, por seu aspecto dinâmico no que diz respeito ao ensino de novas tecnologias. Assim, os conceitos básicos da engenharia, por se tratarem de assuntos de extrema importância e por criarem condições que permitam a melhor compreensão das tecnologias emergentes, devem ser passados aos estudantes com muita clareza e consistência.

A disciplina de princípios de telecomunicações, existente na maioria dos cursos de engenharia elétrica com ênfase em telecomunicações, retrata de maneira clara a necessidade da implementação de um método dinâmico e eficiente de ensino/aprendizagem. As técnicas de modulação em amplitude (AM – *Amplitude Modulation*) e freqüência (FM – *Frequency Modulation*) [1], vistas dentro desta disciplina, fazem parte dos conceitos básicos de comunicação analógica sendo amplamente utilizadas nos atuais sistemas de radiodifusão comerciais.

Tanto a modulação em amplitude quanto a modulação em freqüência decorrem de fenômenos físicos que possuem um modelamento matemático conhecido. Entretanto, verifica-se a latente necessidade de visualização gráfica de todos os sinais envolvidos nestes processos bem como a implementação de ferramentas computacionais de simulação.

O uso de tais ferramentas torna-se imprescindível ao estudo dessas técnicas, pois permitem a visualização de todos os sinais envolvidos no processo de modulação nos domínios do tempo e da freqüência. Assim, um software de simulação, utilizando a plataforma MatLab® e desenvolvido para dinamizar o processo de ensino/aprendizagem na disciplina de princípios de comunicações será descrito ao longo deste artigo. Neste artigo, serão apresentadas metodologias, abordando sua metodologia de ensino dos programas desenvolvidos e exemplificando seu modo de operação para tornar a disciplina mais interessante.

O USO DA PLATAFORMA MATLAB®

Dentre uma gama de softwares de simulação existentes no mercado, o MatLab destaca-se por possibilitar a implementação de modelamentos matemáticos utilizados em diversas áreas da engenharia e da física.

O MatLab [2] [3]pode ser utilizado tanto como ferramenta de cálculo interativa quanto linguagem de programação científica. Entretanto, ele apresenta algumas vantagens que justificam sua predileção entre profissionais do meio acadêmico: simplicidade, rapidez de processamento e interface gráfica avançada para visualização e análise dos resultados. Todas as variáveis do MatLab são definidas de forma matricial, o que torna seu ambiente de trabalho ideal para resolver problemas de cálculos envolvendo matrizes e vetores. Logo, o desenvolvimento do software de simulação para princípios de comunicação, que será descrito neste artigo, utilizou-se de todas recursos oferecidos pelo MatLab, como o uso de vetores, funções predefinidas e principalmente o uso das interfaces gráficas tanto para que o usuário possa organizar os parâmetros de entrada quanto para visualizar os efeitos destes parâmetros na modulação escolhida.

SIMULAÇÃO DE MODULAÇÕES AM E FM

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O software para simulação de modulações em amplitude e freqüência foi dividido em dois módulos: um para modulação em amplitude e outro para modulação em freqüência.

Com o objetivo de estimular a interação entre aluno e software, foram criadas interfaces gráficas para organizar as informações a serem processadas, isto é, o usuário tem a possibilidade de visualizar todos os parâmetros e sinais escolhidos antes de iniciar o processo de simulação.

No caso da interface gráfica para o módulo de AM, pode-se definir a amplitude, a freqüência e a fase da portadora e do sinal modulante, sendo que este também pode ser definido como um sinal senoidal, quadrado, triangular ou aleatório.

Os sinais a serem processados são mostrados na tela, juntamente com os valores de índice de modulação e potências do sinal modulado AM-DSB e AM-DSB/SC. A Figura 1 a seguir ilustra a interface gráfica do software para o módulo de modulação em amplitude.

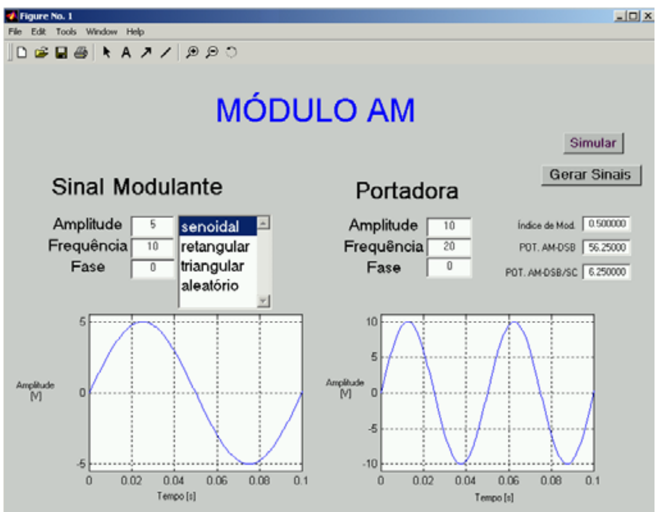

FIGURA. 1
INTERFACE GRÁFICA PARA SIMULAÇÃO DE MODULAÇÃO EM AMPLITUDE.

A interface gráfica do módulo para simulação de modulação em freqüência possui basicamente as mesmas características do módulo AM, sendo que a diferença é marcada pela necessidade do valor do desvio de freqüência como parâmetro para realizar a simulação.

No módulo FM, a interface gráfica, ilustrada a seguir, retorna os valores de índice de modulação e potência dos sinais modulados.

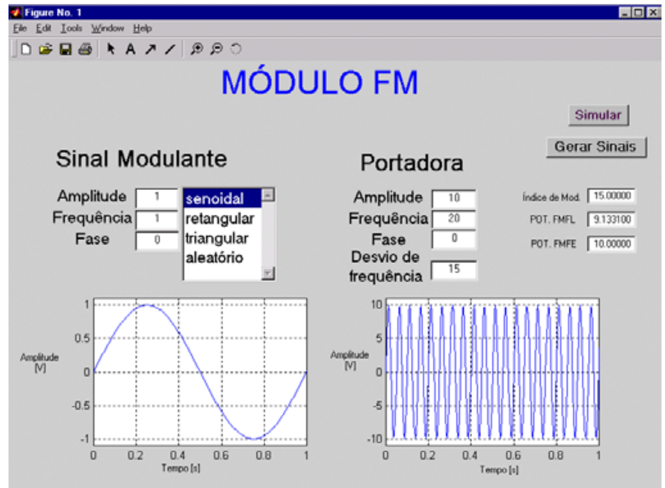

FIGURA. 2
INTERFACE GRÁFICA PARA SIMULAÇÃO DE MODULAÇÃO EM FREQÜÊNCIA.

SIMULANDO MODULAÇÕES EM AMPLITUDE

Para realizar a simulação de modulação em amplitude é necessário que todos os parâmetros de entrada da interface gráfica estejam devidamente preenchidos, isto é, o sinal modulante e a portadora devem ser predefinidos pelo usuário.

Como ilustração para o processo de simulação, tomemos como exemplo uma modulação AM gerada por um sinal modulante senoidal, descrito por (1) [1].

$$f(t) = A\cos\omega_m t \qquad (1)$$

Onde A é a sua amplitude e ω_m é a sua freqüência angular. Os valores adotados para a simulação foram, respectivamente, 5V e 20πrad/s. A portadora senoidal possui amplitude a e freqüência angular ω_o, cujos valores adotados para a simulação foram, respectivamente, 10V e 200πrad/s. Assim, a portadora pode ser expressa por (2).

$$c(t) = a\cos\omega_o t \qquad (2)$$

Os gráficos resultantes do sinal AM/DSB ficam descritos nos domínios do tempo e da freqüência conforme definido, respectivamente, por (3) e (4).

$$s(t) = [A + a\cos\omega_o t]\, sen\,\omega_m t \qquad (3)$$

$$S(f) = \Im[s(t)] \qquad (4)$$

A Figura 3 apresenta o sinal AM/DSB gerado pelo simulador, no domínio do tempo, enquanto a Figura 4 apresenta este sinal modulado no domínio da freqüência.

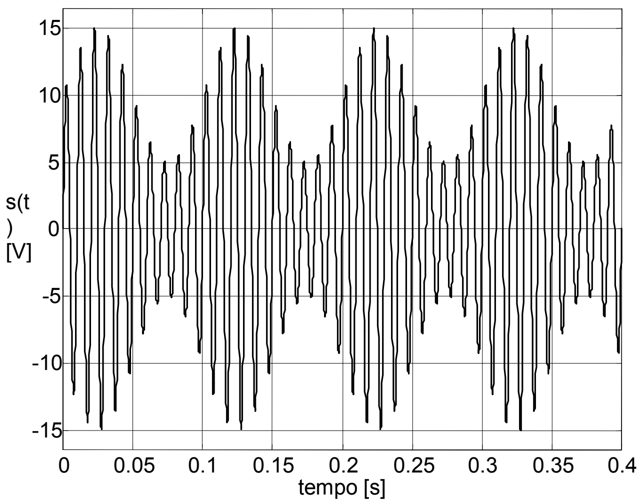

FIGURA. 3
SINAL AM/DSB NO DOMÍNIO DO TEMPO

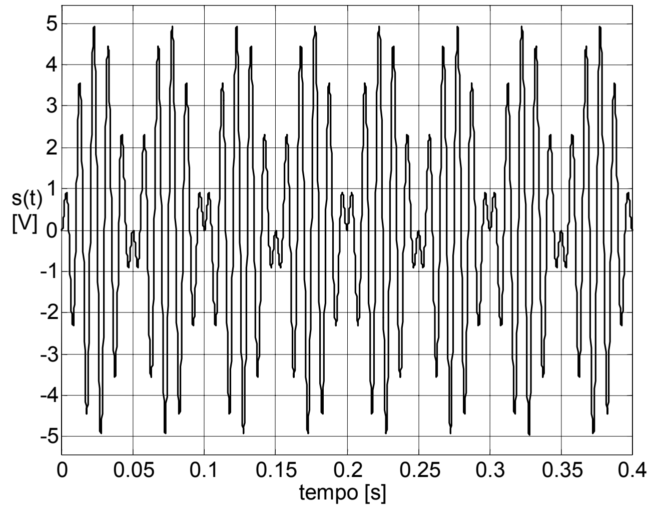

FIGURA. 5
SINAL AM/DSB-SC NO DOMÍNIO DO TEMPO.

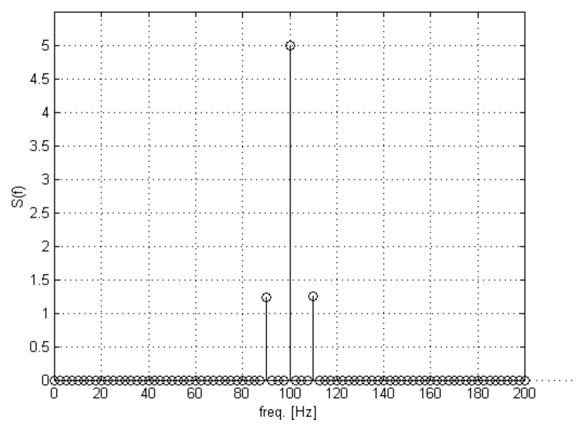

FIGURA.4
SINAL AM/DSB NO DOMÍNIO DA FREQÜÊNCIA

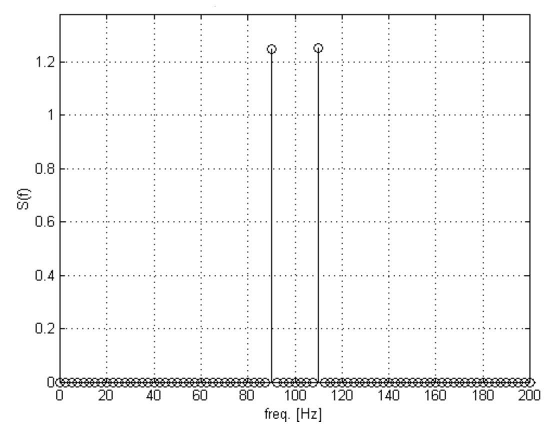

FIGURA. 6
SINAL AM/DSB-SC NO DOMÍNIO DA FREQÜÊNCIA

O simulador também gera o sinal AM/DSB-SC (*Amplitude Modulation – Doble Side Band with Supressed Carrier*), que é definido no domínio do tempo por (5) e no domínio da freqüência por (6).

$$s(t) = a\cos\omega_o t \times \operatorname{sen}\omega_m t \qquad (5)$$

$$S(f) = \Im[s(t)]\,. \qquad (6)$$

Nota-se que nesta técnica, a portadora não está presente no sinal modulado. Isto pode ser visualizado no domínio do tempo através da Figura 5, e no domínio da freqüência, através da Figura 6.

SIMULANDO MODULAÇÕES EM FREQÜÊNCIA

Para realizar a simulação de modulação em freqüência é preciso fornecer à interface gráfica do módulo FM os parâmetros que definem o sinal modulante, a portadora e também o desvio de freqüência, definido por $\Delta\omega$.

Para ilustrar o processo de simulação, considere um desvio de freqüência igual a 30πrad/s e um sinal modulante senoidal descrito por (7) [1].

$$f(t) = A\cos\omega_m t \qquad (7)$$

Onde A é a sua amplitude e ω_m é a sua freqüência angular, com valores de 1V e 2πrad/s respectivamente. A portadora possui amplitude (a) de 10V com freqüência angular (ω_o) de 40πrad/s, cuja expressão é dada por (8)

$$c(t) = a\cos\omega_o t\,.$$

8)

Desde modo, pode-se obter o sinal FMFL (FM Faixa Larga) utilizando a expressão apresentada em (9).

$$s(t) = a\,cos\left[\omega_o t + \frac{\Delta\omega}{\omega_m} sen(\omega_m t)\right]. \qquad 9)$$

Onde $\Delta\omega$ é o desvio de freqüência do sistema FM.
O sinal FM contém um número infinito de harmônicos em seu espectro, o que acarretaria para sua transmissão a necessidade de canal com largura de faixa infinita. Na prática, no entanto, pode-se limitar a faixa de transmissão do sinal FM a um valor finito, pois os harmônicos com freqüências acima de um limiar apresentam uma contribuição desprezível para a composição do sinal.

O gráfico do espectro de freqüências do sinal FMFL teve sua largura de faixa limitada, pelo simulador, a partir da regra de Carson, isto é, o espectro do sinal terá componentes harmônicas nas freqüências apresentadas em (10).

$$\omega_n = (\omega_o \pm n\omega_m), \quad n = 1,2,...,n_\alpha \qquad (10)$$
$$n_\alpha = (\Delta\omega/\omega_m) + 1$$

As amplitudes de cada componente espectral é definida por (11).

$$A_n = J_N(\Delta\omega/\omega_m)a \qquad (11)$$

Onde $J_N(\Delta\omega/\omega_m)$ é a função de Bessel de primeira espécie, com argumento $\Delta\omega/\omega_m$ e ordem N, com N variando entre $-n_\alpha$ e $+n_\alpha$.

A Figura 7 mostra o sinal modulado no domínio do tempo, enquanto que a Figura 8 mostra o sinal modulado no domínio da freqüência.

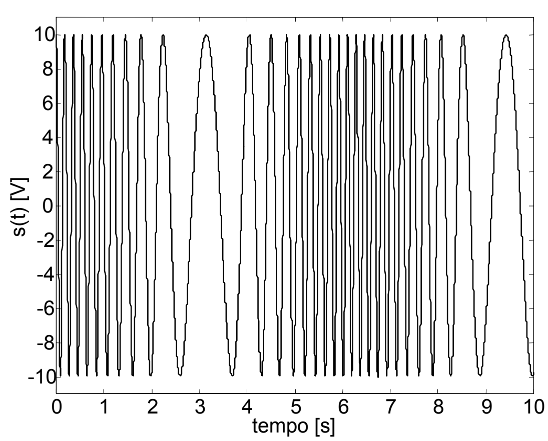

FIGURA 7
SINAL FMFL NO DOMÍNIO DO TEMPO

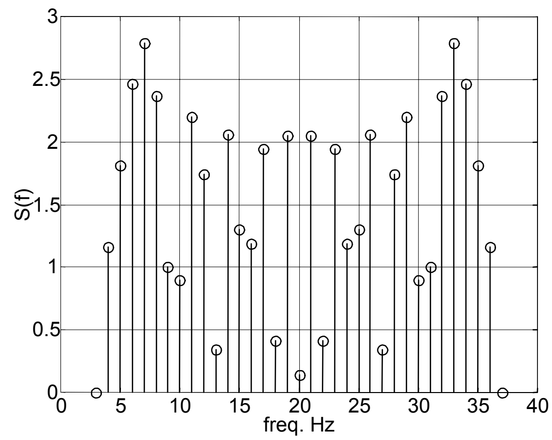

FIGURA 8
SINAL FMFL NO DOMÍNIO DA FREQÜÊNCIA

O módulo FM do software de simulação também é capaz de gerar sinais FMFE (FM Faixa Estreita), e FMFL segundo outros critérios para limitação de componentes espectrais de ordem elevada.

CONCLUSÃO

Aulas expositivas sobre princípios de telecomunicações, apesar de ser um meio muito econômico de ensinar, leva a um aprendizado passivo e de baixa intensidade devido ao fato de se ter uma elevada quantidade de informações que deverão ser visualizadas através de vários gráficos.

Logo, com o advento das ferramentas computacionais de simulação, é possível aumentar a qualidade das aulas expositivas, isto é, além de ilustrar rapidamente os fenômenos ocorrentes nos vários tipos de modulação, consegue-se também atingir aos alunos cujo aprendizado se dá com maior eficiência por métodos visuais e participativos, fazendo com que o método de ensino/aprendizagem torne-se mais eficiente.

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A Computer Tool to Analyze the LMS Equalizer

Luciano L. Mendes[1], Francisco J. Fraga[2], Sandro A. Fasolo[3] and Estevan M. Lopes [4]

Abstract *— The purpose of this paper is to explore the concepts involved in adaptive equalization, using a didactical computer tool. The software developed uses the Least Mean Square algorithm to equalize a bit sequence transmitted in base band through a channel defined by the user. The program allows the user to define the size and the nature of the signal used as training sequence, the number of the taps of the equalizer filter and also the channel impulse response. All results are presented in graphics, which allow the user to analyze each step of the equalization process. This program was developed using the Matlab® platform with a Graphic User Interface (GUI).*

Index Terms — Adaptive Equalizer, Didactical Computer Tool, Training Sequence.

INTRODUCTION

This paper presents an educational approach for the study of adaptive equalizers using the LMS (Least Mean Square) algorithm [1]. This approach is realized using a simulation program developed with Matlab® platform, which allows the user to define the parameters of the system, and them analyze the effects of these parameters in the equalization process.

Equalization is fundamental in the reception of digital signals transmitted in channels that presents multiple paths and introduces Intersymbol Interference (ISI) [2][3]. The concepts involved in this process are complexes and must be clearly presented to the students. For this reason it is important to present approaches that allows the students to analyze the system and verify each step of this process. In this paper, the results obtained with the simulator will be presented and analyzed to demonstrate the didactical potential of the developed computer tool. Figure 1 presents the block diagram of a generic adaptive equalizer used in this paper.

SIMULATION STRUCTURE

The simulator was based in the block diagram presented by Figure 2 [1]. In this structure, at the beginning of the communication ($t = t_0$) the transmitter sends a training sequence (a_n) that is known by the receiver. The channel introduces ISI using the impulse response (b_n) provided by the user. The additive white gaussian noise (AWGN) can also be added to the signal and the received signal (r_n) is delivered to the adaptive equalizer. The LMS algorithm uses an error signal provided by the difference between the signal at the output of the equalizer and the training sequence generated at the receiver (reference sequence) to calculate the coefficients. The channel and the equalizer can be modeled as FIR [4] filters that can introduce delays in the signal. Thus, in this case, the training sequence must be properly delayed at the receptor to provide an accurate error signal to feedback the equalizer, allowing the equalizer to compare the reference signal (a_n) with the signal at the equalizer output. The obtained error signal (e_n) is then introduced in the LMS algorithm to update the coefficients that will be used to minimize the ISI introduced by the channel.

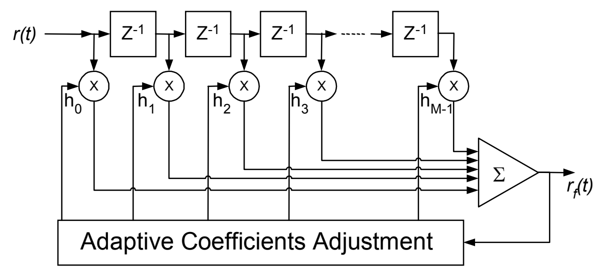

FIGURE 1
BLOCK DIAGRAM OF AN ADAPTIVE EQUALIZER.

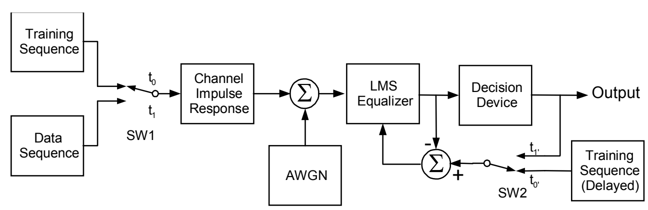

FIGURE 2
SIMULATION BLOCK DIAGRAM.

At the end of the training sequence ($t = t_1$), the equalizer has estimated the channel and the switches 1 and 2 change their positions. The transmission of the data sequence (c_n) begins and, at the receiver, the equalizer assumes that the decision device always estimates the received sequence correctly. The estimated sequence ($\hat{c}_n$) is then used to calculate the error signal that will be used as a feedback to the LMS algorithm. The bit error rate (BER) must be low enough to guarantee that the estimated sequence corresponds to the desired reference sequence. It means that the training

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sequence must be long enough to allow the equalizer to estimate the channel correctly and, thus, to reduce the BER.

All sequences involved in this simulation are shown in graphics that allow the user to analyze each step of the equalization process.

SIMULATOR

Following, a group of simulations are presented to demonstrate the use of the simulator.

Simulation with Square Training Sequence

In this simulation, a square training sequence with 256 bits has been used to estimate the channel frequency response. The number of taps of the equalizer has been set to eight and the channel has been modeled for Medium ISI (which means that the channel impulse response is [1 0.2 -0.2 0 0]), with signal to noise ratio (SNR) of 60dB, which almost eliminates the interference of the noise. The data sequence length has been set to 512 bits. Figure 3 shows the transmitted training sequence and this sequence at the channel output. Note that the training sequence is a cyclic square waveform where each period is formed by five bits 1 (+1) and five bits 0 (-1). The amplitude distortion in the signal at the channel output is caused by the ISI.

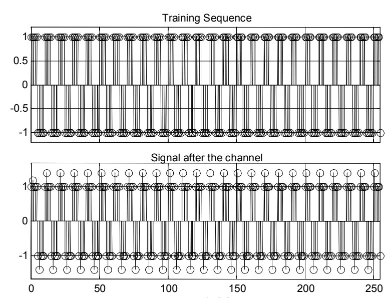

FIGURE 3
SQUARE TRAINING SEQUENCE AND THE OUTPUT OF THE CHANNEL.

The equalizer updates its taps at each received bit from the training sequence. Once defined the delay introduced by the channel, the received training sequence is subtracted from the reference sequence to obtain the error signal, which will be used to feedback the LMS algorithm and update the taps. The update process can be viewed in a dynamic graphic that shows the equalizer impulse response. This graphic is displayed whenever the taps are update. Figure 4 shows the equalizer impulse response at the end of the training sequence, where it is possible to note that the channel has not been correctly estimated, because the equalizer impulse response does not annul the channel impulse response. The distortions introduced by the channel are canceled when (1) is satisfied.

$$c(n) * h(n) = \sum_{k=0}^{N+K-1} h(k) \cdot b(k-n) = \delta(n) \quad (1)$$

Where $\delta(n)$ is the discrete-time impulse function and $h(n)$ is the equalizer impulse response.

Equation (1) shows that the convolution between the channel and equalizer impulse responses must result in a Dirac impulse. Figure 5 shows that the condition presented in (4) has not been reached.

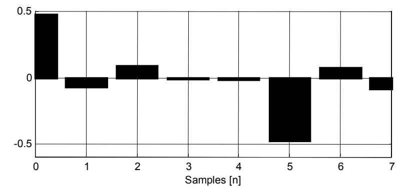

FIGURE 4
EQUALIZER IMPULSE RESPONSE.

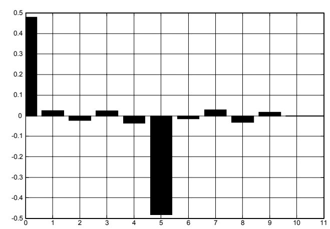

FIGURE 5
CONVOLUTION: EQUALIZER AND CHANNEL IMPULSIVE RESPONSE.

It is also important to analyze the equalization process in the frequency domain. The Fourier Transform of (1) allows one to define the condition to obtain a perfect equalization of the channel, in the frequency domain. Equation (2) shows this condition.

$$\begin{gathered} H(k) \cdot C(k) = 1 \\ \left| H(k) \cdot C(k) \right| = 1 \\ \angle H(k) + \angle C(k) = 0 \end{gathered} \quad (2)$$

Where $H(k)$ is the equalizer frequency response and $C(k)$ is the channel frequency response.

Figure 6 shows the frequency and phase response of the equalizer and channel, where it is possible to observe that the equalizer frequency response only satisfies (2) for some specifics values of frequency (-π, -0.6π, -0.2π, 0.2π, 0.6π e π). This occurs because the square training sequence has discrete spectral components, as shown in Figure 7.

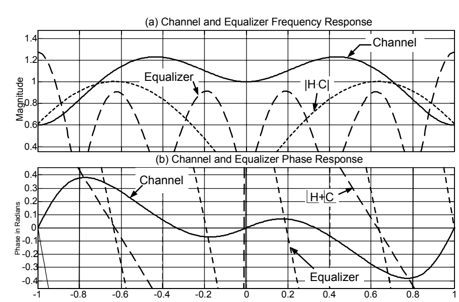

FIGURE 6
CHANNEL AND EQUALIZER FREQUENCY RESPONSE.

If the training sequence does not have spectral components in all frequencies, the equalizer cannot estimate the channel correctly. Because the equalizer corrected the channel in the frequencies where the training sequence has components, the interference in the sequence at the equalizer output has been eliminated.

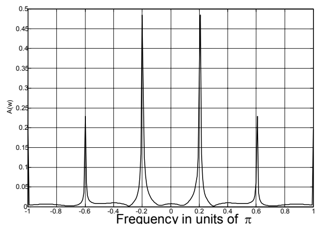

FIGURE 7
SPECTRUM OF THE SQUARE TRAINING SEQUENCE.

Figure 8 shows the error signal during the training sequence, where it is possible to note that the LMS algorithm is able to update the equalizer taps to minimize the error signal.

It can be seen that the equalizer approximates the received sequence to the desired sequence, removing the ISI introduced by the channel, as shown in Figure 9.

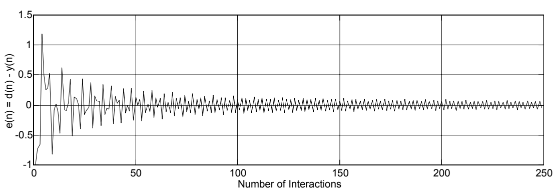

FIGURE 8
ERROR SIGNAL AND MEAN SQUARE ERROR.

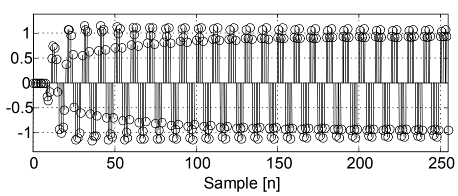

FIGURE 9
EQUALIZED TRAINING SEQUENCE.

At the end of the training sequence, the transmitter begins to send the data sequence and the equalizer begins to use the sequence at the output of the decision device as reference signal. To simulate a data sequence, the program generates a random bit sequence with uniform distribution [5]. The spectrum of a random sequence can be approximate to a constant value for all frequencies of interest, as showed in Figure 10.

To demonstrate the performance of the equalizer, the channel impulse response is randomly changed at the end of the training sequence. This procedure allows the user to analyze if the equalizer proposed is able to update its taps when the data sequence is transmitted. Figure 11 shows the transmitted data sequence and the received data sequence.

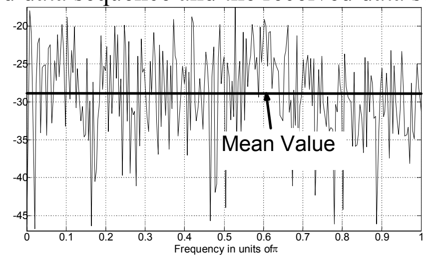

FIGURE 10
SPECTRUM OF THE DATA SEQUENCE.

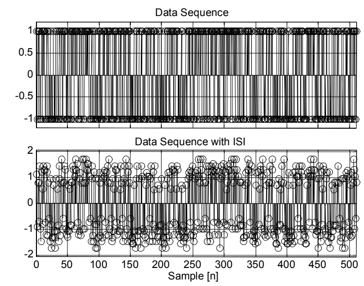

FIGURE 11
DATA SEQUENCE BEFORE AND AFTER THE CHANNEL.

Because the equalizer did not correctly estimate the channel during the training sequence, the BER at the beginning of the data sequence could be high. Thus, the reference sequence, that is the sequence estimated by the decision device, does not correspond to the desired sequence and the equalizer cannot remove the ISI from the received sequence. Figure 12 shows the equalizer and the channel frequency response. The equalizer frequency response does not represent the inverse of the channel frequency response, hence the data sequence delivered to the decision device is distorted by the ISI and the BER could be high. Figure 13 shows the equalized sequence.

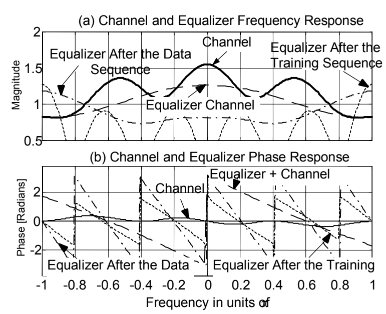

FIGURE 12
CHANNEL AND EQUALIZER FREQUENCY RESPONSE.

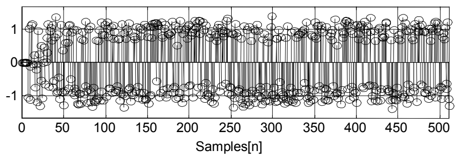

FIGURE 13
EQUALIZED SEQUENCE.

Simulation with Random Training Sequence

As showed in the previous session, it is not possible to use a square waveform to estimate the channel, because square waveforms have discrete spectral components. In this simulation, a random bipolar bit sequence with uniform distribution is used to estimate the channel. Any other parameter of the simulator has not been changed. Figure 14 shows the transmitted and received training sequence.

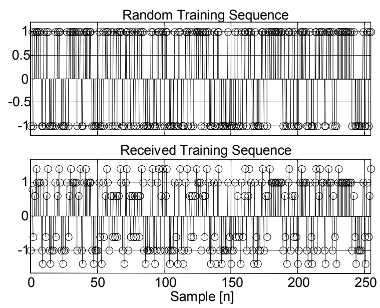

FIGURE 14
TRANSMITTED AND RECEIVED TRAINING SEQUENCE.

As showed in Figure 10, the spectrum of random sequences has components in every frequency. Thus, the equalizer can estimate the channel correctly and update its taps to remove the ISI introduced by the channel. Figure 15 shows the convolution between the channel and equalizer impulse responses, where it is possible to note that the equalizer was able to estimate and compensate the distortions introduced by the channel, once the condition presented in (1) has been satisfied. This conclusion can also be confirmed through Figure 16, where the channel and equalizer frequency responses are presented, as well the product between them.

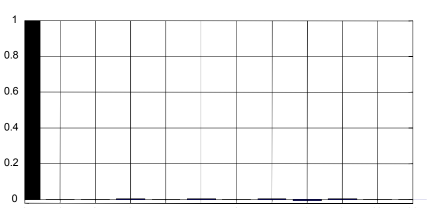

FIGURE 15
CONVOLUTION OF THE CHANNEL AND EQUALIZER IMPULSE RESPONSES

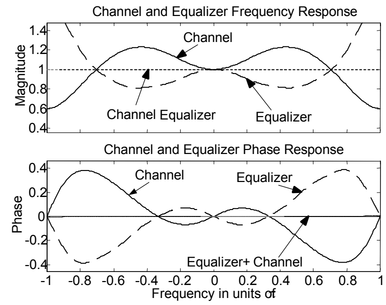

FIGURE 16
CHANNEL AND EQUALIZER FREQUENCY RESPONSE.

The equalized sequence is presented in Figure 17. Note that, after 90 interactions, the equalizer is able to remove the ISI from the signal, which means that after 90 bits of the training sequence, the reference sequence is almost equal to the equalized sequence. Figure 18 shows the equalizer and the channel frequency response after the transmission of the data sequence.

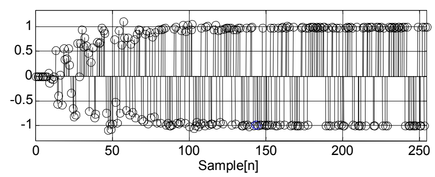

FIGURE 17
EQUALIZED TRAINING SEQUENCE.

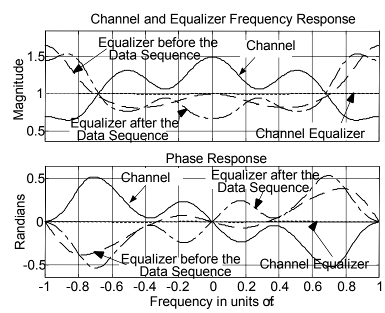

FIGURE 18
CHANNEL AND EQUALIZER FREQUENCY RESPONSE.

The equalizer frequency response is the inverse of the channel frequency response, therefor the statement presented by (2) was satisfied. Figure 19 shows the equalized sequence, where one can note that there are ISI in the beginning of the data sequence, because of the random variation in the channel impulse response, but the equalizer successfully update its taps to remove any interference introduced by the channel.

Although the random training sequence has characteristics that allow the equalizer to estimate correctly the channel, its use is not practical because the receiver can not generate the same random sequence generated by the transmitter. Thus it is not possible to obtain a reference sequence in the receiver to calculate the error signal.

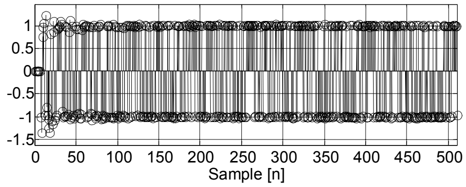

FIGURE 19
EQUALIZED DATA SEQUENCE.

Simulation with Pseudo Random Training Sequence.

The pseudo random sequences or pseudo noise (PN) sequences [2][3] present a solution for the training process because it behaves as a random sequence during each cycle of *N* samples. Once known the generator polynomial and the initial conditions, the receiver is able to generate the same sequence used by the transmitter. Thus, it is possible to use a PN sequence as a training sequence to estimate the channel frequency response. In this simulation, a PN sequence is used to train the equalizer with the same configuration presented in the previous sessions. Figure 20 shows the transmitted and received training sequence and Figure 21 shows its spectrum. It is possible to note that PN sequence does not have a uniform spectrum as a random sequence, but it presents a spectrum with energy well distributed in the bandwidth of interest. This allows the equalizer to estimate the channel and avoid high bit error rates during the transmission of the data sequence. Figure 22 shows the equalizer and channel frequency responses, as well, the product between them.

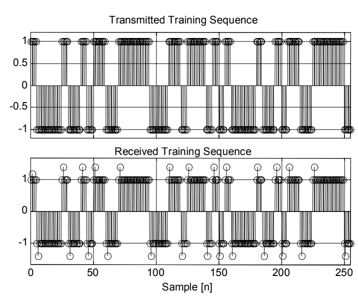

FIGURE 20
TRANSMITTED AND RECEIVED TRAINING SEQUENCE

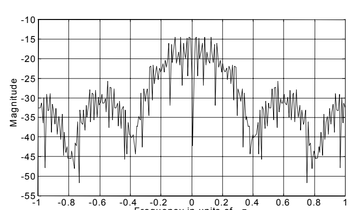

FIGURE 21
SPECTRUM OF THE TRANSMITTED TRAINING SEQUENCE.

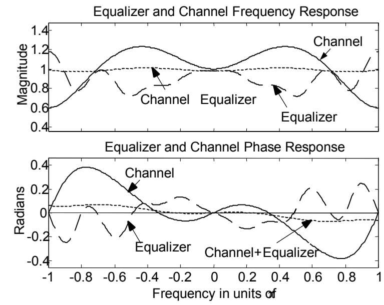

FIGURE 22
CHANNEL AND EQUALIZER FREQUENCY RESPONSE AFTER THE TRAINING SEQUENCE.

The resulting frequency response is not perfectly flat, but it is flat enough to avoid high BER during the transmission of the data sequence. Figure 23 shows that the equalizer has been able to correctly estimate the variation of the channel impulse response during the transmission of the data sequence.

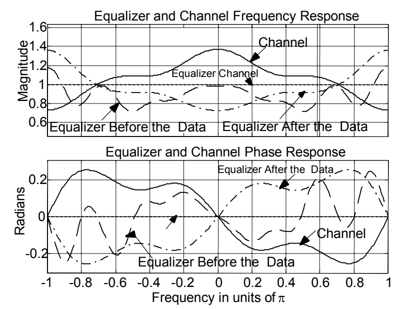

FIGURE 23
CHANNEL AND EQUALIZER FREQUENCY RESPONSE.

CONCLUSIONS

This paper has presented a didactic simulator to analyze a LMS adaptive equalizer, with some commented results obtained in three simulations. The first simulation showed that square waveform cannot be used to estimate the equalizer because cyclic waveforms have discrete spectral components, which does not allow the equalizer to correctly estimate the channel. The second simulation has presented the results obtained with a random training sequence. Although the obtained results demonstrate that a random sequence allows the equalizer to estimate the channel, this procedure cannot be used in practice because the receiver cannot generate the same random sequence used by the transmitter. Finally, the third simulation has presented a practical solution to train the equalizer properly. The PN sequences have spectra with energy distributed in the bandwidth of interest which allows the equalizer to estimate the channel. Although the energy distribution of a PN sequence spectrum is not uniform as in the random sequence spectrum, the PN sequence allows the equalizer to remove the ISI from the transmitted sequences, which can guarantee a low BER during the transmission of the data sequence.

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A SIMPLE LPC AND RELP VOCODERS SIMULATION PROGRAM DEVELOPED ON THE MATLAB® PLATFORM

Fábio A. R. Nascimento[1], Alan M. Marotta[2] and Francisco J. Fraga[3]

Abstract *— The widespread use of mobile telephones has reinforced the importance of coding and transmitting speech at low bit rates. As a natural consequence, the interest of researchers and postgraduate students in the speech coding area has increased significantly over the last years. A special attention has been focused on the topic of parametric LPC-based (LPC: Linear Predictive Coding) Voice Encoders (VOCODERS). This class of Vocoders offers the most promising bandwidth-quality trade-off. This paper presents a simulation program wrote on the Matlab® platform which allows postgraduate students understanding the basic principles of the LPC and RELP (Residual Excited Linear Prediction) Vocoders. The resulting speech signal can be heard and also visually compared with the original signal. By means of this tool, the student can also compare the trade-off between the quality of the synthesized speech and the bit-rate reduction, for both the LPC and RELP Vocoders.*

Index terms — LPC Vocoder, RELP Vocoder, Speaking Machine, Vocoders simulation.

INTRODUCTION

There are several *LPC-based* speech coding techniques with low bit rate already standardized and commercially implemented. An example is the ADPCM system that requires one half of the PCM bit rate, with the same performance. In the case of speech (or voice) transmission, there are even bolder techniques, reducing up to 8 times the PCM rate, paying the price of a slight loss of quality. To do so, a speech production model becomes necessary, where some characteristic properties of this kind of signals are applied. The systems using this approach are called Vocoders [1], a term derived from *voice encoders*.

The strategy used for the construction of this kind of circuits is based on the transmission of the voice parameters, instead of transmitting the voice signal itself, as following described. Studies on the modeling of the human speech production system are lead, officially, since 1780, with the experiments of Von Kempelem and its speaking machine [1]. Nowadays this study has already gone reasonably deep and it is possible to get a very good model of the human speech production system by a discrete-time system. Thus, it is possible to implement at the transmitter a circuit capable to analyze the input speech signal and to provide at the output the codified parameters of this signal. If we implement a speech synthesis sub-system at the receiver with the received parameters, then we have got a system that is able to transmit only the parameters of the original speech signal, but with good intelligibility at the receiver output. This leads to an enormous decrease in the transmission bit rate.

Nevertheless, in order to obtain better speech quality, we have to look for more elaborated Vocoders, where more advanced techniques are used, such as CELP (Code Excited Linear Prediction) and VSELP (Vector Sum Excited Linear Prediction) [2]. As an example, a VSELP Vocoder, which is the TIA (Telecommunications Industry Association) coding scheme for cellular telephony in the United States, is able to codify speech at 8 Kbps with an acceptable level of quality. Such low bit rate signifies almost a 10:1 bandwidth reduction factor, if compared to standard PCM (64 Kbps).

Although commercial Vocoders like VSELP present a high level of complexity, all of them are based on LPC techniques, which have not so complex theoretical principles. With aim of teaching the LPC techniques in an efficient way, it is important to develop some computer-based educational methods to make easier the comprehension of their theoretical concepts. This is the goal of the program we have developed and described here.

THE LPC VOCODER

The LPC VOCODER is a discrete-time speech production system, as illustrated in figures 1 and 2.

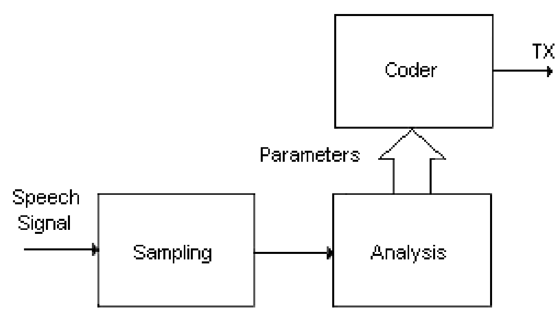

FIGURE. 1
LPC Vocoder Transmitter

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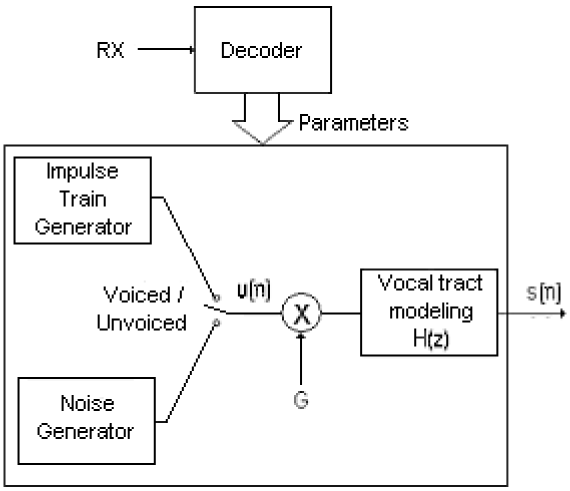

FIGURE. 2
LPC Vocoder Receiver

One can find strange the use of an impulse train generator and a noise generator at the receiver in order to reproduce the speech. But an analysis of the speech signal leads us to agree with the idea that the voiced sounds have a fundamental frequency, known as pitch frequency, and the unvoiced sounds are very similar to a noisy sound. Thus, we can admit that the excitation signal can be reasonably substituted by an impulse train for voiced sounds and by a random noise signal for unvoiced sounds [3]. In figure 3 we can see an illustration containing the speech signal generated from the pronunciation of the word "vocoder".

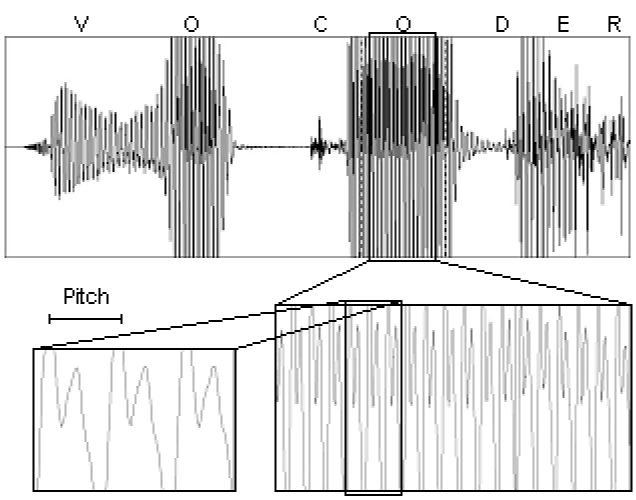

FIGURE. 3
SPEECH SIGNAL IN THE TIME DOMAIN

Another relevant point is the implementation of a vocal tract modeling filter, with transfer function H(z). Using linear prediction concepts applied to the speech signal, we are able to determine the parameters that describe such a filter. The parameters that are essential to an intelligible speech reproduction at the receiver are, as we can foresee by analyzing the figures 1, 2 and 3, the impulse train frequency, which is determined from the *pitch*; the vocal tract *modeling filter coefficients* and the *gain* of the excitation signal.

The mathematical modeling representing the output speech signal of the decoder circuit is shown below [4]:

$$s(n) = \sum_{k=1}^{p} a_k s(n-k) + Gu(n) \tag{1}$$

The expression that represents the speech modeling filter transfer function is [4]

$$H(z) = \frac{G}{1 - \sum_{k=1}^{p} a_k z^{-k}}, \tag{2}$$

where a_k are filter coefficients corresponding to the transfer function poles. As we notice, this function just contains poles; although it is able to perform a good approximation of the vocal tract, with small damage to the nasal and fricative sounds, which would require a function containing also zeros, if we desire a more accurate speech production model.

CALCULATING THE FILTER COEFFICIENTS

A proper approach to the calculus of the *filter coefficients* is related to minimum mean-square error. Following this idea, the expression of the prediction mean-square error is

$$J = E\left[e^2(n)\right]$$

$$J = E\left[\left(s(n) - \sum_{i=1}^{p} a_i s(n-i)\right)^2\right], \tag{3}$$

where $s(n)$ is the speech signal (windowed in frames with a typical duration of 20 to 30 ms) and a_i are *filter coefficients*.

Expanding the expression above, we have

$$J = E\left[s^2(n)\right] - 2\sum_{i=1}^{p} a_i E\left[s(n)s(n-i)\right] + \sum_{k=1}^{p}\sum_{i=1}^{p} a_k a_i E\left[s(n-k)s(n-i)\right] \tag{4}$$

Assuming that $s(n)$ is a sample function of a stationary process, we have

$$J = R(0) - 2\sum_{i=1}^{p} a_i R(i) + \sum_{k=1}^{p}\sum_{i=1}^{p} a_k a_i R(i-k), \qquad (5)$$

where $R(i)$ are samples of the auto-correlation function of the speech signal, which can be obtained by the auto-correlation of the speech signal in each frame [4]:

$$R(k) = \sum_{n=1}^{N} s(n)s(n+k) \qquad 1 \le k \le p, \qquad (6)$$

where p is the prediction filter order, normally chosen between 8 and 12. The idea is to minimize the mean-square error, and this approach will lead us to obtain the proper coefficients. To do so, we derive J in relation to the coefficient of order i and make the resulting expression equal to zero. Thus, we obtain the following expression [5]:

$$\sum_{k=1}^{p} a_k R(i-k) = R(i) \qquad i = 1,2,\ldots,p \qquad (7)$$

In the matrix form we have

$$\mathbf{a} \cdot \mathbf{R} = \mathbf{r} \qquad (8)$$

where

$$\mathbf{a} = [a_1, a_2, \ldots, a_p]^T$$

$$\mathbf{R} = \begin{bmatrix} R[0] & R[1] & \ldots & \ldots & R[p-1] \\ R[1] & R[0] & \ldots & \ldots & R[p-2] \\ : & : & \ldots & \ldots & : \\ : & : & \ldots & \ldots & : \\ R[p-1] & R[p-2] & \ldots & \ldots & R[0] \end{bmatrix}$$

and

$$\mathbf{r} = \left[R[1], R[2], \ldots, R[p]\right]^T$$

The set of equations (7) or (8) are called the Wiener-Hopf equations for linear prediction and their solution lead us to

$$\mathbf{a} = \mathbf{R}^{-1} \cdot \mathbf{r} \qquad (9)$$

$$J_{\min} = R(0) - \mathbf{r}^{\mathbf{T}} \cdot \mathbf{R}^{-1} \cdot \mathbf{r} \qquad (10)$$

CALCULATING THE PITCH

The algorithm used to detect the pitch requires the definition of new parameters: the auto-correlation of $\mathbf{a}$ (*filter coefficients auto-correlation function*):

$$R_a(i) = \sum_{k=1}^{p} a_k a_{k+i} \qquad 1 \le i \le p \qquad (11)$$

where a_{k+i} is zero if $k + i > p$

The convolution of $R_a(i)$ with $R(l)$:

$$R_e(l) = \sum_{i=1}^{p} R_a(i) R(l-i) \qquad (12)$$

where $R(l)$ can be calculated by equation (6) with $0 \le l \le N-1$. Normalizing $R_e(l)$, we have

$$R_{eN}(l) = R_e(l) / R_e(0) \qquad (13)$$

If the maximum value of $R_{eN}(l)$ is equal or superior to a threshold γ (the most used value for γ = 0.25), then we may consider we have a voiced frame. On the contrary, if $R_{eN}(l)$ is inferior to γ, then we may consider we have an unvoiced frame and, consequently, there is no pitch. If the frame is considered as voiced, the value of the pitch period is set by the position (sample index) where the maximum value of $R_{eN}(l)$ occurs.

CALCULATING THE GAIN

The gain of the signal is easily deducted from the following concept:

$$Gu(n) = e(n) = s(n) - \sum_{k=1}^{p} a_k s(n-k). \qquad (14)$$

THE RELP VOCODER

Unlike the LPC Vocoder, the RELP (Residual Excited Linear Prediction) Vocoder [3], instead of considering the excitation signal at the decoder as an impulse train or a random noise, it codifies and transmits the prediction error (or *residual*) signal *e(n)*, which is the proper excitation signal. This procedure requires a higher bit rate, but, on the other hand, it does a better job by capturing true characteristics of the original signal through residual signal. It is obvious that it does not make any sense to transmit a signal of such complexity like the error signal as it is. So, we use the artifice of *decimating* it (after low pass filtering) by some decimate factor of at least four (reducing four times the number of samples), before transmitting it. This requires that the decoder perform the inverse process, over-sampling the error signal received, in order to recover the original amount of samples. Then, the decimated samples at the encoder are interpreted as zero at the decoder. Even with this loss introduced for the decimate process, the subjective result is considered much better than the one obtained with the LPC Vocoder.

Thus, the parameters to be transmitted are the *filter coefficients* and the *decimated error signal* or *decimated prediction residue.*

MATLAB IMPLEMENTATION

Bearing in mind that one of our goals is to evaluate the Vocoders transmission rate, comparing it to other systems, a good approach is to use the PCM standard system as our reference. So we may consider speech signals sampled with the same sampling rate and the same number of quantization levels that those in the PCM Standard system, where the sampling frequency f_s = 8 kHz and the quantization levels are 256 (8 bits), leading us to a 64 Kbps bit rate.

In order to derive the filter coefficients we assumed that the speech signal $s(n)$ was a stationary signal. This is not true, due to modifications of the vocal tract characteristics along the time, which allow us to pronounce different phonemes. Fortunately, these modifications have a small variation rate, permitting us to consider that the voice signal is stationary in a short time interval T_q (20 to 30 ms) [1]. Considering the above concept, we notice that the speech signal must be recorded and sub-divided in N_q frames, where N_q is equal to the duration time T_s of the complete speech signal divided by the frame duration time T_q

$$N_q = \frac{T_s}{T_q} . \tag{15}$$

The number of samples for each frame is equal to its duration time T_q multiplied by the sample frequency f_s

$$N = T_q f_s . \tag{16}$$

The parameters are extracted and transmitted for each frame. The *filter coefficients* for each frame are derived from equation (9), after calculating the auto-correlation of the speech signal in each frame.

It is important to notice that the higher is the prediction filter order, the more precise is the prediction signal and, consequently, smaller the error. However, the error does not decrease significantly for a filter order above 12. Values higher than this order set more parameters to be transmitted, but with almost any improvement of the subjective performance. Therefore, the developer must find the better relation between subjective quality and the required transmission rate, when setting the filter order. The standardized LPC-10 Vocoder, as its name suggests, uses p = 10 prediction coefficients.

Then, let us consider p coefficients for each frame, being each of them satisfactorily encoded with 3 decimal points of precision, what sets 10 bits for encoding and transmitting each coefficient. The necessary transmission rate for the parameter *filter coefficients* is calculated by multiplying the amount of required bits for each coefficient by the number of coefficients in each frame and by the number of frames contained in one second:

$$R_a = 10 \frac{p}{T_q} \tag{17}$$

The parameter *filter coefficients* is necessary for both LPC and RELP Vocoders.

We will deal now with implementation issues related with the *pitch* and *gain* parameters, which are necessary only for the LPC Vocoder. Following, we will consider the *prediction error* parameter, which is required only for the RELP Vocoder.

It is possible to prove [4] that we can directly obtain the parameter *gain* using the equation

$$G = \sqrt{R(0) + \sum_{k=1}^{p} a_k R(k)} . \tag{18}$$

Typically 5 bits are needed for binary representation of the parameter *gain* for one frame [4]. Its transmission rate is calculated by multiplying the necessary amount of bits for representing the parameter for one frame by the number of frames in one second:

$$R_g = \frac{5}{T_q} . \tag{19}$$

The extraction of the parameter *pitch* is done directly through the equations (11), (12) and (13), associated with a routine that looks for the sample index of the peak of the normalized cross-correlation signal:

$$T_o = \max_l \left[R_{eN}(l) \right]. \tag{20}$$

Usually we consider that 6 bits are enough for the binary representation of the parameter *pitch* (T_0) for each frame [4]. Its transmission rate is calculated by multiplying the required amount of bits to represent it for one frame by the number of frames in one second:

$$R_p = \frac{6}{T_q}. \quad (21)$$

In case of Vocoder RELP, as mentioned above, the *filter coefficients* are obtained exactly the same way as in the LPC case. The extraction of the parameter *decimated prediction error* is made by applying the definition

$$e(n) = s(n) - \hat{s}(n), \quad (22)$$

where $s(n)$ is the original speech signal and $\hat{s}(n)$ is the predicted signal, obtained from a digital filter with unitary gain and denominator coefficients a_k.

The decimation is done by low pass filtering the error signal and by considering one sample among each group of d samples, setting as zero the other ones, where d is the decimation factor. Let us represent the decimation function and its decimation factor d by Dec_d. So, the *decimated prediction error* parameter is

$$e_d(n) = Dec_d\left[e(n)\right]. \quad (23)$$

The parameter *decimated prediction residue* requires a lot of bits, because every d^{th} sample of the prediction error signal $e(n)$ must be encoded and transmitted. A similar coding concept occurs in the case of the DPCM system. It is known that the DPCM system represents a reduction of two bits per sample in relation to the PCM system [5]. Thus, 6 bits are enough for coding this parameter properly.

The bit rate due to this parameter is evaluated by multiplying the number of bits needed for representing one sample by the number of samples in one second, divided by the decimation factor

$$R_e = \frac{6 f_s}{d}. \quad (24)$$

The LPC synthesis is obtained through the implementation of a digital filter, obtained with the received and decoded a_k, G and T_0 parameters. The input signal of the filter defined right above may be of two types: an impulse train, with period defined by the *pitch* parameter T_0, for voiced sounds; or by a random noise signal for unvoiced sounds. The total bit rate for the LPC-10 vocoder (f_s = 8 KHz, p =10 and T_q = 25 ms) will be then equal to

$$R_{LPC} = R_a + R_g + R_p$$
$$R_{LPC} = 4{,}44 \text{ Kbps}$$

The RELP synthesis is obtained through the implementation of a digital filter, with the received and decoded a_k parameters and unity gain. The input signal for the filter mentioned right above is the received, decoded and over-sampled parameter $e_d(n)$. The total bit rate for the RELP vocoder (f_s = 8 kHz, p =10, d = 4, T_q = 25 ms) is

$$R_{RELP} = R_a + R_e$$
$$R_{RELP} = 16 \text{ Kbps}$$

CONCLUSIONS

The Matlab implementation of these two Vocoders is relatively easy due to its facility of implementing routines that work with matrices and vectors, beside its variety of built-in functions that can be used. The bit rate tests and also the final subjective results show to anyone who uses the software that there is a quality enhance of the decoded signal obtained by the RELP Vocoder, but with the trade-off of a significant increase of the bit rate if compared with the LPC Vocoder.

Finally, we want to remark that our experience with the master students that helped in the development of this software and with the others that used it for learning the LPC coding techniques demonstrated to be very profitable for our educational purposes.

ACKNOWLEDGMENT

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AN EDUCATIONAL APPROACH FOR THE ANALYSIS OF PMD AND SOME LINEAR EFFECTS IN OPTICAL COMMUNICATION SYSTEMS

Josias de Lima Bernardes[1], Breno Luiz Lima Santos[2], Maurício Silveira[3], José A. Justino Ribeiro[4]

Abstract *— With the high transmission rate that the optical communication systems require nowadays, the reduction of Polarization Mode Dispersion – PMD effect is strongly considerate. The main purpose of this paper is to show how to simulate the influence of PMD effect and other linear effects. The great Companies involved in the sector of telecommunications have tested the efficiency of optical devices, using sophisticated surrounding computational tools of simulation before these can be implemented. The PMD studies, in their majority, have been idealized in simulation laboratories, which brings a considerable economy allowing them to optimize each enlace of communication. It can be used in the sizing of many parts of the system, over all, in those for long distances and in the global mapping of a determined network system, through an efficient computational surrounding of simulation - the Virtual Photonic Incorporated - VPI, considered the best and more advanced software in simulation of optical transmission systems in the world.*

Index Terms *— Attenuation, Dispersion Compensation, Polarization Mode Dispersion, and DWDM systems.*

INTRODUCTION

The attenuation, was one of the first properties of optical fibers intensely to be studied. Actually, just the optical fiber appearance with losses inferior to 20 dB/km invokes a strong use for the information transport, having the attenuation been the main limiter to the increase of the capacity of the systems during many years. However, with the development of the technology of the production of optical fibers added to the sprouting of the optical amplifiers a great technological advance it was obtained.

Though with the advent of systems with raised transmission rate, demanding the use of very short pulses, making with that the widening of the pulses provoked for the dispersion becomes the main limiting factor to increase the capacity of the systems. Several techniques have been used, with the objective to control this dispersion.

The continuous exertion in increasing the transmission rate and the length of the link imposes appearance of new restrictive factors, known as non-linear effects. In addition, in high rates the birefringence of optical fibers brings some due to fact of the light does not keep its polarization when spreading through the fiber.

ATTENUATION

The attenuation quantifies the loss of energy of the optical signal during the propagation. If P_{in}, is the optical input power applied at the input of a fiber with L_t length, in the output we have P_{out}, satisfying:

$$P_{out} = P_{in} \cdot \exp(-\alpha L_t) \tag{1}$$

where α is the attenuation constant. The equation (1) indicates that the optical power decays with an exponential law. Ordinarily, the losses of the fiber are quantified in *dB/km*.

The losses of the fiber are dependents of several factors, known as absorption, diffusion and radiation. In optical fibers, the electrical field recovers all regions between the nucleous and the covering, being the losses an average of those presented in each layers of the fiber.

It is verified that the losses have strong dependence of the wavelength in optical communication systems. The silica optical fibers present several windows of transparency comprehended between the wavelengths of *600 - 2000 nm*.

The losses for absorption can have origin in the following phenomena: the intrinsic absorption, the extrinsical absorption and the absorption for atomic defects. The intrinsic absorption is a characteristic of the used material, which in this case is the silica. This absorption is less than *0,03 dB/Km* for wavelengths between *1300 – 1600 nm*. The extrinsical absorption must to have the presence of impurities in the fiber. Owing the sophisticated methods used in the manufacture of fibers currently, we can see that the extrinsical absorption is dominated by the presence of a very small amount ions of $(OH)^-$ and they are strong responsible for the fiber attenuation curve form as a function of the wavelength.

The absorption for atomic defects, as itself name indicates, must includes irregularities in the fiber atomic

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structure. In normal conditions, the absorption due to these irregularities is worthless, comparatively to the total absorption. However, it can be significant if the fiber will be exposed in the strong radiation that provoked some the alterations in its atomic structure. The losses for diffusion must to have the microscopic variations of the material density, and result in its amorphous nature.

In microscopical variations in the density of the material, some microscopic fluctuations of the refractive index are created, that gives an origin to the diffusion of Rayleigh. This diffusion is a basic limit for all losses of the fiber, transferring part of the contained optical energy in guided modes of propagation to ways not guided. For the current processes of manufacture, the extrinsical absorption due to ions of $(OH)^-$ and the diffusion of Rayleigh are the dominant phenomena for the attenuation of optical fibers.

When microcurvatures are present or curvatures with much closed angles, the losses for radiation appear through the long of the passage fiber. These curvatures can occur at the macrocospic level, due to the passage that the fiber covers, or at the level microscope (microcurvatures), proceeding from the introduction at the fiber in the handle, twist or stress. These losses generally are quantified jointly with those due to the use of connectors and amendment in the fiber, having assigned losses in the handle. These have strong dependence on the installation and the cabling configuration of the optical communication system.

The effect of the attenuation in the fiber can be simulated, leading in consideration the input and output powers. One notices that when the input power is increased the output power also increases, which implies that the gain curve has a notable fall. The attenuation can be solved with the use of an optical doped amplifier (EDFA), as it is shown in Fig. 1.

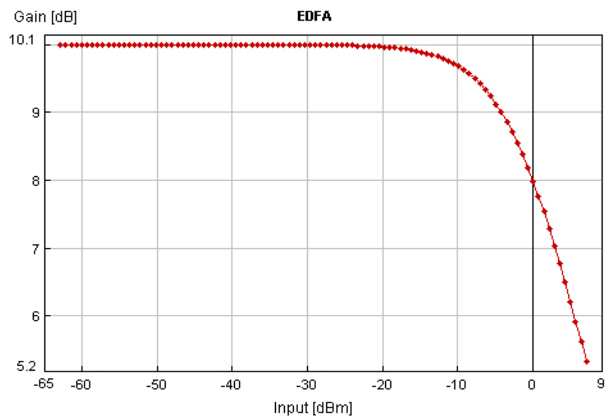

Fig.1 Attenuation Graphic

In the Fig. 2, we can see the used diagram block-type in VPI's simulation.

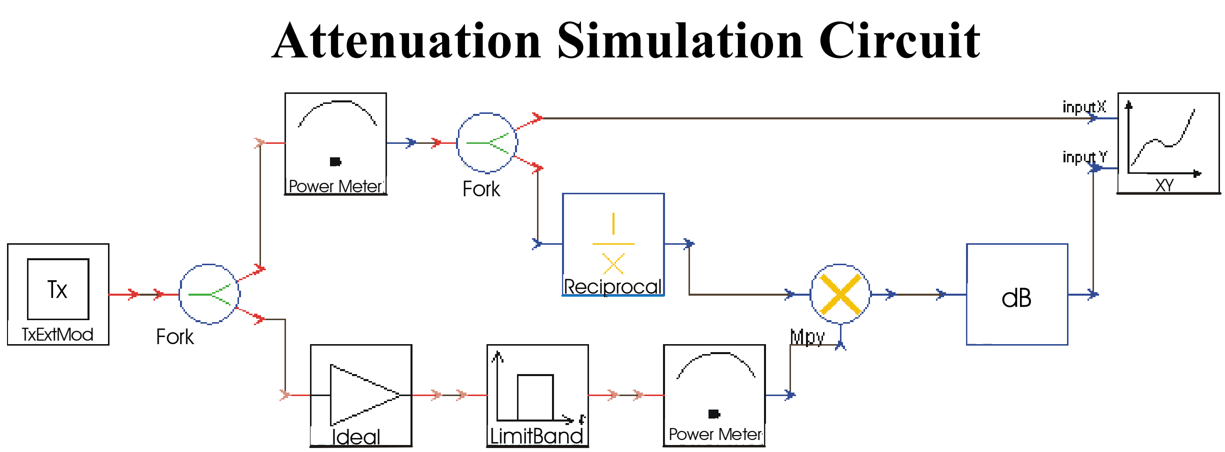

Fig.2 Attenuation Simulation Circuit

Dispersion

The development of the amount of data and the appearance of new services of telecommunication have forced continuously the increase of the capacity of transmission in all link of optical fibers. The attenuation and the dispersion of the fiber are the main obstacles in this process. The appearance of the EDFA already eliminated the barrier imposed for the attenuation.

However for the dispersion, specific strategies of compensation must be adopted in the link it order to be able to operate in rates greater than *10 Gbit/s*.

The dispersion is a transmission characteristic that represents the widening of the transmitted pulses. This widening determines the bandwidth of the optical fiber, specified in *(MHz.km)* and is related with the capacity of transmission of information in the fibers. The dispersion effects are divided in modal dispersion and chromatic dispersion.

In Fig.4 and Fig.5, by using the VPI platform, it can be proven that the pulse through the long of the fiber suffers a temporary widening, as already cited above.

This effect was simulated taking into consideration a length of *100 (Km)* of multimode fiber and with attenuation factor equal the zero *(dB/Km)*.

In the Fig. 3, we can see the used diagram block-type in VPI simulation.

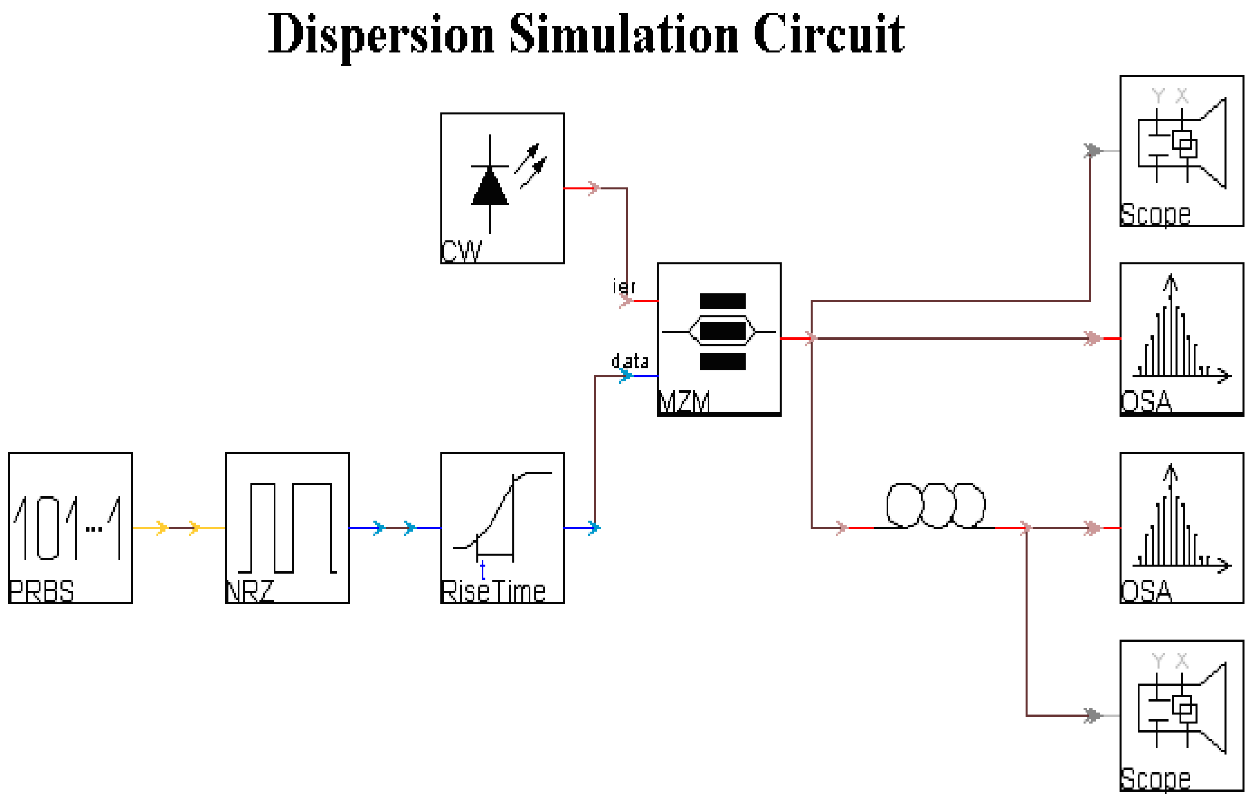

Fig.3 Dispersion Simulation Circuit

Modal Dispersion

This type of dispersion exists in multimode fibers step and gradual, being provoked for some possible ways of propagation that the light could have in the nucleous. In a step fiber, all modes travel with the same speed, therefore the refractive index is constant in the nucleous. Soon, the modes of high order, that in general cover a longer way, will delay more time to leave the fiber that low order modes. In this type, the difference between the arrival times is given by $\tau = \Delta \cdot t_1$, where t_1 is the time of propagation of the low order mode and $\mathbf{\Delta}$ is the percentual difference of refractive index between the nucleous and the covering given by $\mathbf{\Delta} = (n_1 - n_2)/n_2$.

The modal dispersion does not exist in fibers monomode therefore only one mode will be guided through the fiber.

Chromatic Dispersion

This appears due to the fact of the light to be composed for radiation of diverse wavelengths, and during the transmission, all differences in the propagation speed determine the diversity of beams of the light.

This type of dispersion depends on the wavelength and is divided in two types: material dispersion and dispersion of waveguide.

Material Dispersion

As the refractive index depends on the wavelength and as existing luminous sources are not ideal, or either, they possess a certain finite spectral width $\Delta\lambda$, we have that each wavelength is related with a different value of the refractive index in a determined point. Soon each wavelength travels in the nucleous with different speed, provoking a time difference of passage and causing the dispersion of the luminous pulse.

Dispersion of Waveguide

This type of dispersion is provoked by variations in the dimensions of the nucleous and variations in the profile of the refractive index through the long of the optical fiber and depends on the wavelength. This dispersion is observed in monomodes fibers that have material dispersion reduced.

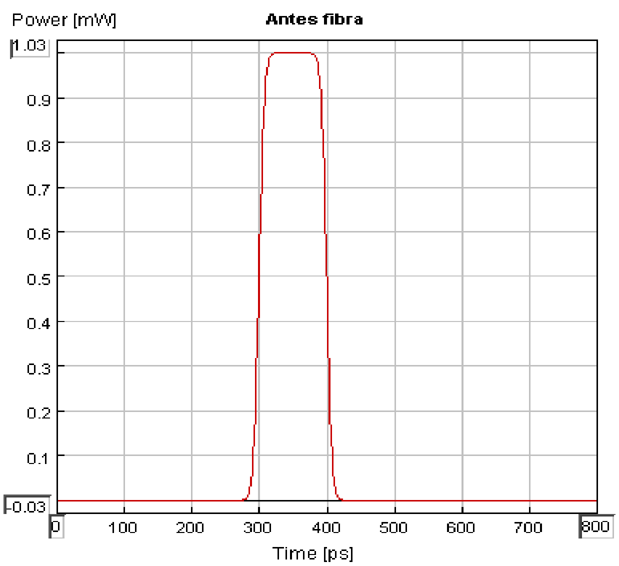

Fig.4 Signal in the input fiber

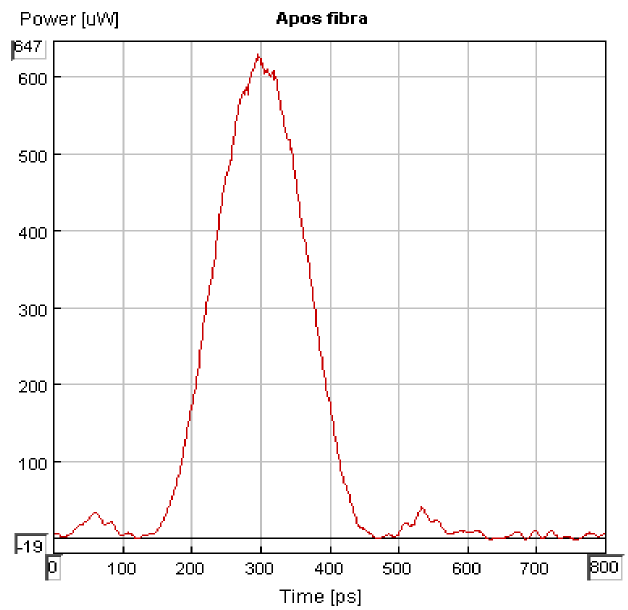

Fig.5 Signal in the output fiber

POLARIZATION MODE DISPERSION – PMD

The PMD is a fundamental effect presents in all fibers (*Dispersion Shifted - DS*) and systems operating in the region next to zero-dispersion, where the contribution of the first orders *(group delay)* increases. Due to the birefringence of the fiber, it is possible to get many different modes of propagation.

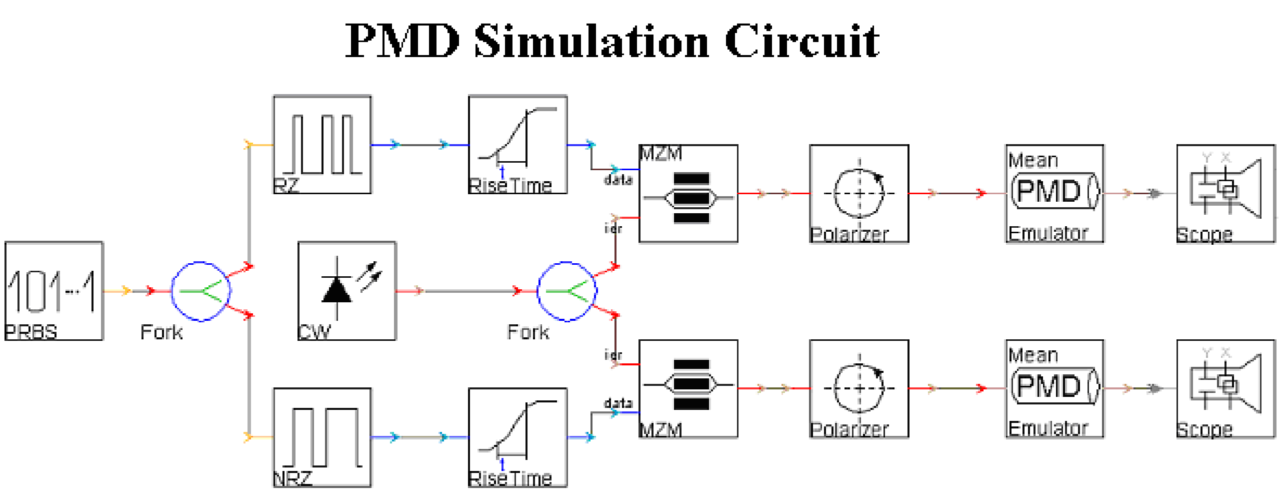

Fig.6 PMD Simulation Circuit

The *interaction* between these modes provokes the delay of a distinguished group, making with that the signal propagates in different speeds, exhausting itself. The main effect caused in the optical system is the intersimbolic interference.

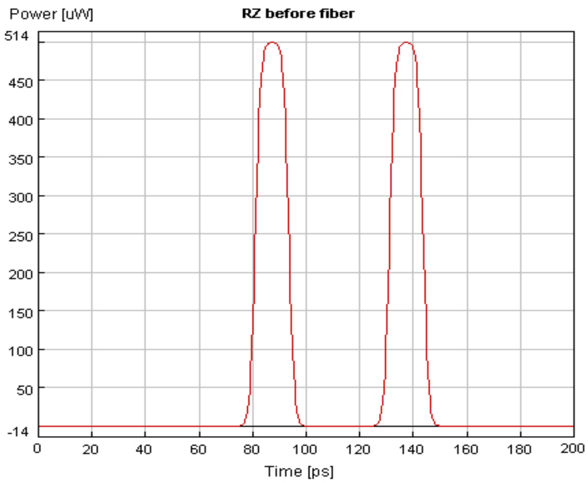

Fig.7 RZ before the fiber

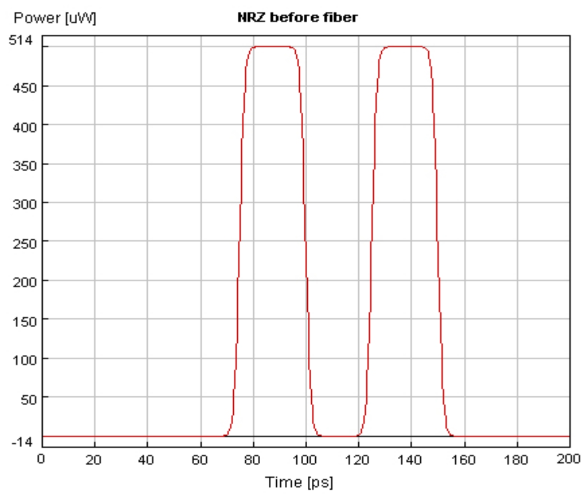

Fig.8 NRZ before the fiber

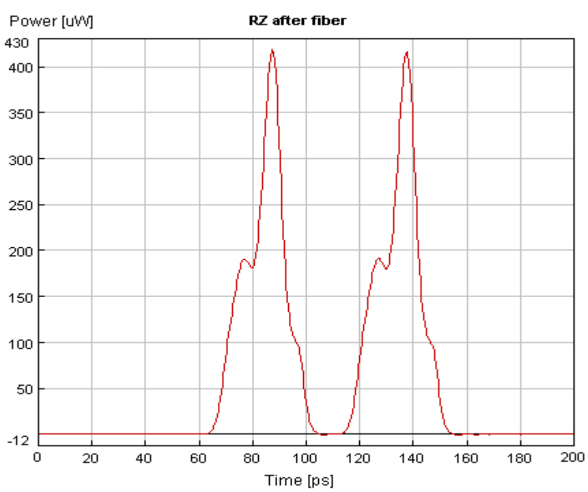

Fig.9 RZ after the fiber

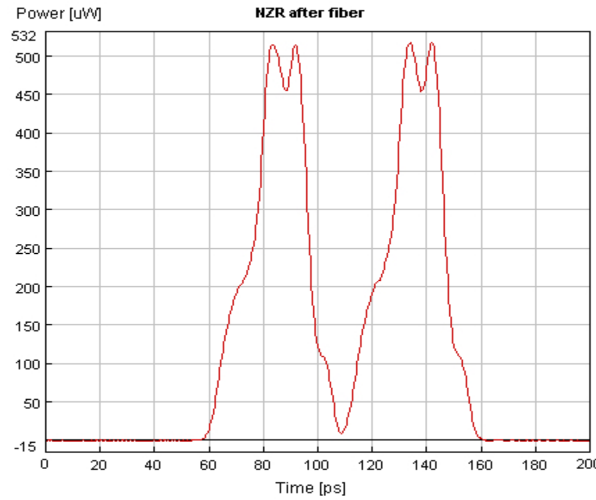

Fig.10 NRZ after the fiber

CONCLUSION

In this paper, the analysis of linear and the PMD effects in optical fibers can degrade the signal in optical communication system with high transmission rate. Practical simulations using the efficient numerical platform VPI had allowed to visualize the consequences in all transmissions that use the multiplexing with high-density wavelength (DWDM).

Despite of some evidences that make progress with the simulations, this work detached the efficiency of the use of RZ codification in comparison with the NRZ one, related with the PMD effect, using an EDFA to compensate the attenuation and, widening transmitted pulses provoked by the dispersion.

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Improvement of performance in cellular communications systems with the use of adaptive arrays

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Abstract – Smart antennas is a system consisting of antenna array and adaptive processor that can adjust the main lobe of the radiation diagram. The direction of main beam maximum and the beam width are determined by a pilot signal. The system can reject or attenuate interference signals or noises occurring outside the main lobe. This performance is obtained if the output signals of the elements of antenna array are properly combined to reduce the interference according to specified directions.

Keywords – Adaptive arrays, BER, Switched beam, Interference.

I. Introduction

The object of this paper is to present a part of the technology of smart antennas, used to improve the performance of radio communication systems. The assignment of smart antennas is an array of radiating elements, each one excited by a signal with amplitude and phase adjusted to control the format and the direction of main lobe and nulls of the radiation diagram.[1] With the control of the radiation diagram, smart antennas can reduce the effect of the interferences, to increase the amplitude of the desired signals and to guarantee increase in the reliability of some types of radio link. The improvement in quality is obtained by increasing the signal-to-noise ratio, reducing the adjacent channel interference or the interference of same channel used in different cells of a cellular telephony system, named as co-channels interference. It allows the reduction or even the suppression of interferences originated by multipath propagation. By reaching the control of the main beam maximum it can be used only the necessary power in each cell, leading to an energy save in the general equipment consumption .[2]-[4]

II. Smart Antennas Features

In radio communications systems, there are factors related to the transmission channel that produce degradation of the signal. There are alterations in the amplitude and form of the modulation signal, mainly in modern systems transmitting digital signals. A purpose of smart antennas systems is to supply resources to correct some bad effects in propagation. Among these difficulties, the co-channel and multipath interferences are critical problems that can damage the reliability of the radio link. [7][8] The co-channel interference appears in systems that use cellular architecture, because the same channels are simultaneously used in different cells and with the lesser possible distance to guarantee the quality of communication. Therefore, the base station that receives a signal from a mobile equipment in its cell also receives undesirable signals from other cells that use the same carrier frequency. There is a commitment between the degradation imposed for the co-channel interference and the reuse of frequencies.[7]

The management of the co-channel interference is an important factor in magnifying systems capacity. To mitigate this effect, smart antennas systems both appoint the radiation diagram maximum to the desired users and, in many situations, also guide null points of the radiation to undesirable users. The smart antennas systems often are presented in the form of structures with switched beam or adaptive arrays[1]. Systems of antennas with switched beam form multiples fixed main lobes, with adequate sensitivity to specified directions. The second type allows a dynamic control of the diagram format to fulfill the requirements of link. The performance of this model will be object of this presentation.

III. Adaptive Array

The advantages of a system of adaptive arrays are increase the gain of the desired signal, the orientation capacity of nulls in the undesirable signals directions, the reduction of the multipath effect and greater exploitation of the electromagnetic spectrum.[1][2] The fulfillment of all these factors guarantees a much better system performance. To radiate the resulting signal in the desirable user direction, it is necessary to adjust the amplitudes and the phases of the elements excitation sources, called sources weights. In traditional antennas arrays, the source control of the radiating elements permit the fields interact in space and construct the resulting diagram format.[5][6] The direction of the main lobe will depend on the relations among sources phases and amplitudes, to satisfy the link necessity. By modifying the element signal amplitude, it is possible to control the radiated power and the communication link length. Fig. 1 shows a system in which the antennas array is formed by L isotropic radiators. Although this type of antenna is not a realizable one, is possible to get the diagram of other structures from an array of isotropic antennas by means of the multiplication diagram principle.[5] To be possible the demanded communication, is necessary to locate the main lobe of the receiving system in direction to desired signal and the diagram nulls must be guided in the directions of the interferences.

As shown in Fig. 1, the complex weights (w_L) make the control on the array radiation diagram.[15] The signals that arrive on the elements, $x(t)$, depend on the angular position of the emitting source and include the noise of the system. For a specified element of array, the received signal can be described as

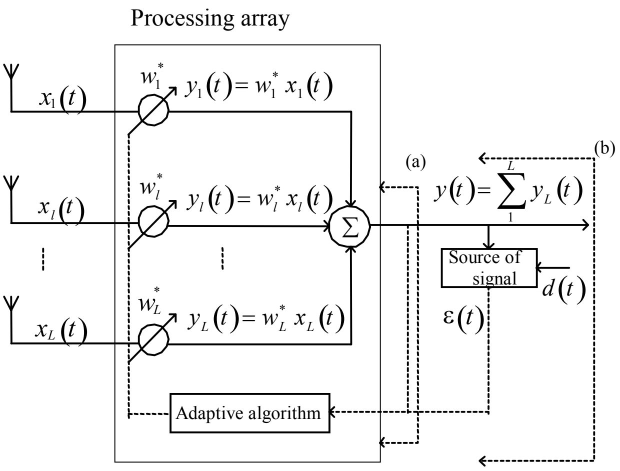

FIGURE 1.
STRUCTURE OF A BEAMFORMER WITH ADJUSTMENTS OF WEIGHTS .

$$x_l(t)=\sum_{\lambda=1}^{L} m_i(t)exp\{i2\pi f_o[t+\tau_\lambda(\phi_i,\theta_i)]\}+n_\lambda(t) \tag{1}$$

where $m_i(t)$ represents a complex envelope, a function of the modulation, depending on communication system type and on access technique, such as the time division multiple access (TDMA), the code division multiple access (CDMA), the frequency division multiple access (FDMA).[14]

The term $n_\lambda(t)$ represents the noise on λ^{th} element of the array. In general, it involves random processes and it is compound by the environment noises and those ones generated in the electronic components of the transmission and reception equipments. It includes the residual noise in the antenna elements in absence of transmitted or received signal. The term $n(t)$ is close to the white noise, with power determined by the system bandwidth and variance.

The wave front delay in one elements of the array, $\tau_\lambda(\phi_i,\theta_i)$, is calculated by

$$\tau_\lambda(\phi_i,\theta_i)=\frac{d}{c}(\lambda-1)\cos(\phi_i,\theta_i) \tag{2}$$

where index i indicates the angular position of i^{th} source of signal in the medium, c is the speed of the electromagnetic wave (3×10^8m/s) and λ is the order of the element of the array. [13] The distance between elements of array (d) is specified in function of the wavelength, usually $d \le \lambda/2$ as form to prevent the increase secondary lobes in the resulting array diagram.

In an environment as the described one, it must be guaranteed that the desired signal is always received and the interferences are reduced to minimum value. For obtaining this performance it is necessary to minimize the average power at output of the beamformer system. This is possible if the weights will satisfy the condition that its products with the position vector of the sources result in a unitary value. As the signals in basic band are represented by complex values, it must be used the conjugated values of the weights to attend this demand.[16] The output of the beamformer system of Fig. 1 are written in the form

$$y(t)=\sum_{l=1}^{L} y_l(t)=\sum_{l=1}^{L} w_l\, x_l(t) \tag{3}$$

Using the matrix notation, (1), (2) and (3) can be write as

$$\mathbf{x}(\mathbf{t})=\begin{bmatrix} x_1(t) \\ x_2(t) \\ \vdots \\ x_L(t) \end{bmatrix} \tag{4}$$

$$\mathbf{w}=\begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_L \end{bmatrix} \tag{5}$$

$$y(t)=\mathbf{w}^H\mathbf{x}(\mathbf{t}) \tag{6}$$

in which H indicate the transposed of the conjugated complex of the array elements weights. The vectors $\mathbf{x}$(t) and $\mathbf{w}$ indicate the signals arriving at the array and the elements weights. The direction vector of desired signal is represented as : [12]

$$\mathbf{a}(\theta_i,\phi_i)=\mathbf{a}_i=\begin{bmatrix} 1 \\ e^{-j\Delta\psi_2(\theta_i,\phi_i)} \\ \vdots \\ e^{-j\Delta\psi_L(\theta_i,\phi_i)} \end{bmatrix} \tag{7}$$

where $\Delta\psi_i(\theta_i,\phi_i)$ is the phase displacement given by

$$\Delta\psi_i(\theta_i,\phi_i)=2\pi f_o\tau_{\lambda,i} \tag{8}$$

The resultant radiation diagram is found by

$$f(\theta,\phi)=\sum_{\lambda=1}^{L} w_\lambda e^{-j\Delta\psi_\lambda(\theta,\phi)} \tag{9}$$

where $f(\theta,\phi)$ it is the array factor, that is, the radiation diagram of an isotropic antennas array. [2][5][6]

IV. ADAPTIVE BEAMFORMER ALGORITHMS

The adaptive algorithms provide a way to optimize the values of the weights to directed the main lobe for the desired signal source. They must adjust the weight values as a function of the position change of desired signal.[12] There are many types of algorithms used in adaptive process. The sampling matrix inversion algorithm (SMI) estimates the weight values as a function of the number of samples of the received signal. The least means square algorithm (LMS) uses a reference signal, or a training sequence, to recognize the signal, determines the error and to achieve the weights adjustments [14]. The scheme of the LMS algorithm is in Fig. 1 with start analysis from the (b) part, where d(t) is the signal reference and ε(t) the error value. The module constant algorithm (CMA) uses a blind adaptation and does not need the reference signal to achieve weight adjustments. They are used in communication systems that have constant envelope signals [1] and its design is shown in Fig. 1, with comments made from the (a) part.

V. COMPUTER SIMULATIONS

In a situation where it is desired the cancellation of interference signal, a computer simulation with the use of the Matlab® program was made. Three sources electromagnetic environment, with two interferences and one desired signal was assumed. The beamformer with four radiating elements was used, as in Fig. 2. The radiation diagram was formed with the null aiming for the positions $\phi_2 = 80^o$ and $\phi_3 = 130^o$, the undesirable signals. The main lobe appoints its maximum to $\phi_1 = 50^o$. The results had been obtained through the program presented in the appendix, elaborated from the equations that define the desired signal direction Fig. 3 shows the radiation diagram in polar coordinates system, normalized with respect to the maximum value. The main lobe was slightly displaced of desired direction , but its null angles are according to directions of undesirable signal sources. The vector weight of the beamformer showed in Fig. 2 is determined through the equations

$$\mathbf{w}^H = \mathbf{e}^T \mathbf{A}^{-1} \qquad (10)$$

$$\mathbf{w}^H = \mathbf{e}^T \mathbf{A}^H \left(\mathbf{A}\,\mathbf{A}^H\right)^{-1} \qquad (11)$$

$$\mathbf{e} = [1 \quad 0 \quad 0\mathrm{K}\ 0_i]^T \qquad (12)$$

$$\mathbf{A} = [\mathbf{a}_0 \quad \mathbf{a}_1 \quad \mathrm{K} \quad \mathbf{a}_i] \qquad (13)$$

where **e** represents the positions of maximum and nulls. The **A** matrix is formed by the direction vectors of the desired and interference signals. [14]

VI. INCREASING SYSTEM CAPACITY

The capacity increase of the system through adaptive antennas can be proven by Shannon's expression. Then, for a channel with bandwidth *B* and additive white Gaussian noise (AWGN), the capacity is

$$C = B\,log_2(1+SNR) \qquad (14)$$

where C represents the transmission rate in bits/s and *SNR* is the signal-to-noise ratio.

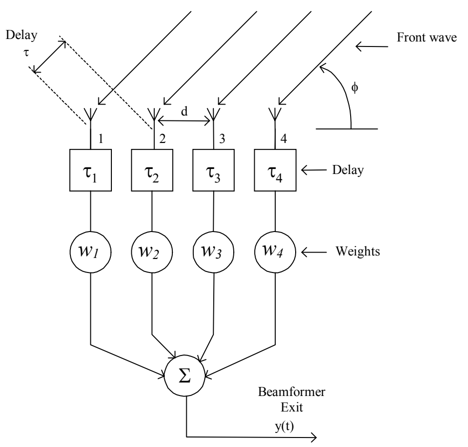

FIGURE 2.
THE BEAMFORMER STRUCTURE WITH NULLS IN DIRECTION OF INTERFERENCE SIGNALS AND THE MAIN LOBE FOR THE DESIRED SIGNAL.

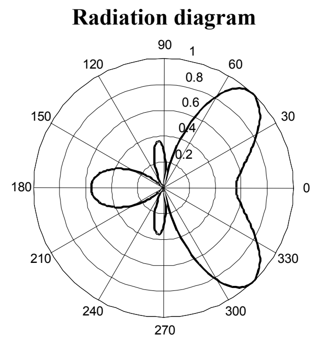

FIGURE 3.
RADIATION DIAGRAM OBTAINED WITH STRUCTURE OF FIG. 2.

In a antennas array with *L* elements, the total power of arrival signal is divided in *L* equal parts and deliver for all channels.[9] Then, the capacity of each channel is

$$C_{ant} = B\,log_2\left(1 + (SNR/L)\right) \qquad (15)$$

and the maximum transmission rate will be the sum of all terms:

$$C = L\,B\,log_2\left(1 + (SNR/L)\right) \qquad (16)$$

Fig. 4 shows the spectrum efficiency, express in bits/s/Hz, as a function of the signal/noise ratio and the number of elements of the array.

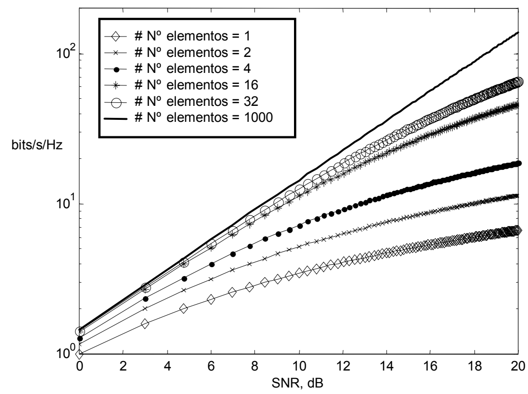

FIGURE 4.
SPECTRUM EFFICIENCY LIMITS AS A FUNCTION OF THE SNR AND THE NUMBER OF RADIATORS ELEMENTS.

VII. CONCLUSIONS

The development of smart antennas has been a very important technology because this system is a possible solution to improve the performance of radio communications link. One of the main applications is in mobile systems in order to provide ways for the solution of problems related to the channel bandwidth, the number of available channels and to cancel interference signals caused for multipath and other sources.

Simulations made in computer prove that with the use of this technology it allows an increase up to 300% in capacity of systems that use the TDMA access technique and up to 500% for CDMA systems.[1] The smart antennas are not restricted to the modulation type or protocol used. It is compatible with all the wireless communication systems. Some companies had carried through exhausting tests in radio-base stations and obtained satisfactory results for several communication systems. [10]-[11]

APENNDIX

Matlab® program for calculation of radiation diagram for an adaptive array.

```
clear all
phi1 = pi*50/180;
phi2 = pi*80/180;
phi3 = pi*130/180;
a1 =[ 1 exp(-i*pi*cos(phi1)) exp(-i*2*pi*cos(phi1)) exp(-
i*3*pi*cos(phi1)) ].';
a2 =[ 1 exp(-i*pi*cos(phi2)) exp(-i*2*pi*cos(phi2)) exp(-
i*3*pi*cos(phi2)) ].' ;
a3 =[ 1 exp(-i*pi*cos(phi3)) exp(-i*2*pi*cos(phi3)) exp(-
i*3*pi*cos(phi3)) ].';
a = [a1 a2 a3];
e = [1 0 0 ].';
y=(a)*(a')
s = pinv(y)
t = (e.')*(a')
w = t*s
W = w';
phi = linspace(0+eps,2*pi+eps,300);
fat = W(1,1)+(( W(2,1))*exp(i*pi.*cos(phi)))+((W(3,1)
)*exp(i*2*pi.*cos(phi)))+((W(4,1))*exp(i*3*pi.*cos(phi)));
fatnorm = fat./max(fat);
figure (1)
polar(phi,abs(fatnorm))
figure (2)
plot(phi*180/pi,abs(fatnorm))
grid
```

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ECOLOGY IN ENGINEERING EDUCATION

Irina A. Avenarius[1]

Abstract *— Crisis in relationship between nature and society is being increased. Perspectives of humanity development are connected not only with improvements of civilization but also, in a greater extent, with a crucial change of the proper civilization. Future engineer as a promoter of technical progress must realize the need of care towards the nature and our planet. At present many specialists from different areas of knowledge are involved into issues of ecology. The subject of Physical Ecology deals with study of natural and man-made physical phenomena (electromagnetic fields, corpuscular irradiation of the sun, Earth's magnetic field, atmospheric electricity, radioactivity, sound and vibrational oscillations etc.) and their impact on human being. Physics of Environment as a discipline has been developed and delivered in a form of lectures for the students of various engineering specializations.*

Index Terms* — *Ecology, Ecological Physics, environmental protection.

INTRODUCTION

The rapid crisis in the relationship between nature and society is ever growing and it is the education that has a challenge to stop it. The perspectives of humanity development are related not only to a technological improvement of its civilization but also to the crucial change of a proper civilization paradigm as well as to reconstruction of a human spiritual world and to the change of its scale of values. A human being has to change his self-estimation as a conqueror of the nature; now he should strive for being a room-mate of the surrounding world. He has to learn how to secure their mutual evolution and his co-development with the nature [1].

A modern man must learn to see the world in its integrity. A future engineer as a driver of technological progress is obliged in first turn to realize the necessity of his careful attitude towards the nature, our planet, the earth's bowels, atmosphere, rivers, lakes, seas and oceans. It is necessary to inculcate in a future technical specialist from the very first steps of his engineering formation the skills of the right estimation of the impact of his technological solutions on the environmental medium. In this connection, the students of all specialization in MADI Technical University are obliged to attend during one semester the course "Industrial and Transport Ecology" [2].

At present many various specialists are concerned with the issues of ecology: from physicists, chemists, biologists to engineers, lawyers, sociologists, political scientists etc. Studies of physical fields (electromagnetic, acoustic, vibrational) of natural and man-made origins, their influence upon human being and environments constitute the subject of *Physical Ecology* [3].

PHYSICAL ECOLOGY AS A SUBJECT

In 2002, at INTERTECH'2002 Conference in Santos I presented my report about the course *"Ecological Physics"* intended for the students of the 4th year whose future specialization should be *Engineer-Ecologist* [4, 5]. In 2003 the course *"Physics of Environment"* will be presented to your attention. The course has been prepared and delivered by the author to the students of the 2nd year whose specialization is *"Automobile Service"*. Based on concepts of modern Physics, this course is intended to give to the future engineers the notion of natural processes, Earth's properties, its atmosphere, lithosphere, hydrosphere that create the conditions in which the humanity and environments were being developed [5-10].

The syllabus of the course *"Physics of Environment"* is intended for 36 lecture hours. Its structure:

I. Introduction. Backgrounds of Cosmology.
II. Gravitational interaction.
III. Electromagnetic interaction.
IV. Composition and structure of Earth's atmosphere.
V. Contemporary problems of ecology.
VI. Energy pollution of environment.
VII. Conclusion.
VIII. Literature.

In *Introduction* the basic principles of cosmology are given: the Big Bang theory, age, evolution and structure of the universe. The hypotheses of formation of Solar system, planets and their satellites are considered. Data about the planets composition, their densities, masses, distances to the sun and periods of revolution are also given. A problem of mass and angular momentum distribution between the sun and planets is discussed. The physical research methods applied to the universe such as spectrum analysis of celestial objects radiation, Doppler effect for *Red shift*, Hubble's law, hypothesis of expanding or pulsing universe are also considered.

Chapter II deals with gravitational interaction, the law of universal gravity and the Earth's shape. The Earth's gravitational field is considered in the context of its anomalies and variations with the altitude. The gravitational energy of a sphere-like body is calculated. The notion of gravitational radius is then introduced and its value for Earth and Sun calculated as example. The average density observable of the universe gives rise to estimate its gravitational radius. The

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latter is compared with its dimensions. A possibility of *black holes* formation and attempts to discover them is a subject for vivid discussions.

The motion of planets and comets is considered in details and Kepler's Laws are derived from equations of motion and equations for angular momentum. The peculiarities of Earth's satellites motion are explained. Here, it is worth saying how the observable trajectories of satellites provide with means to correct the information about the Earth's shape. The influence of Earth's atmosphere on satellite braking is considered. The optimum trajectories of interplanetary cruises as well as the parameters of geocentric orbits for space communication satellites are calculated. The lunar and solar tides on Earth are explained with comparison of their scale and significance. A possibility to build the power station using the energy of tidal waves appears to be a good topic for general discussions. The Earth's nutation is also considered.

One of most interesting topics here is the use of seismic data to study the inner structure of the Earth. It is important to underline here that one of founders of seismology as a science (which was formed at the beginning of the 20th century) was Prince Boris Golitsyn (1862-1916), Russian physicist and geophysicist, Academician of Imperial Academy of Sciences in St. Petersburg. It is explained here that the velocities of longitudinal and transverse waves traveling through the Earth during an earthquake depend on Earth's density. Owing to this fact the Earth's crust, Moho's boundary, Earth's mantle and Earth's inner nucleus have been discovered.

Besides, it is worth discussing the fact that the Earth cannot be treated as an inertial frame of reference because of rotation around its axis and that an introduction of so called *forces of inertia* is necessary to describe the motion of bodies in Earth's reference frame. A centrifugal force of inertia is responsible for change in weight of a body when measured at different latidudes. The force of Coriolis is to be taken into consideration when the motion of rockets, projectiles and air masses of atmosphere are calculated.

Chapter III considers the electromagnetic interaction beginning with the elementary particles classification based on a type of interactions in which the particles participate (photon, leptons, hadrons). A short historical reference is given on the development of knowledge about electric and magnetic phenomena beginning with ancient Greek concepts up to the laws of electrodynamics and quantum mechanics. The development of knowledge about Earth's magnetic field is given in full details. A comparative table for values of magnetic induction of Sun, planets and Moon is given in a context of importance of the magnetic field for life of living things on the Earth. The quantitative parameters to describe the magnetic field are provided (vector of magnetic induction, intensity of magnetic field, its horizontal component, magnetic declination and inclination). The *SI* units of measurement *Tesla (T)* and *Amper/meter (A/m)* are compared with *Gauss* and *Oersted* prevalently used in the past. The hypothesis of the Earth's magnetic field formation is considered. The value for the magnetic induction at poles, equator, middle latitudes are given. As a subject for discussion the issue of the constant component and variations of magnetic field is raised. Brazil (Rio de Janeiro) and Siberia are given as examples of magnetic anomalies. Paleomagnetic measurements, magnetic field inversions, linear magnetic anomalies and a hypothesis about broadening of the oceanic bottom appear as the good subjects for further discussions with students.

Topics about the Earth's electric field begin with quantitative characteristics known from *General Physics* course: intensity and potential of electrostatic field and units of their measurement. The Earth's charge is then calculated starting from known values of the electric field intensity in the vicinity of the Earth. Some values of electric field intensities typical of natural phenomena are given (a good weather field, a field in the channel of lightning electric discharge). The formation of positively and negatively charged ions in the atmosphere is also considered.

This last point leads to the motion of charged particles in electromagnetic fields. Its consideration begins with the equation of motion in stationary electric and magnetic fields under action of Lorentz's force when the parameters of trajectories are calculated. The drift of particles in crossed electric and magnetic fields is also considered with an emphasis that the drift velocity does not depend upon the mass of a particle or its value and sign of charge. The drift in a non-uniform magnetic field is an interesting point which helps to comprehend the action of magnetic mirrors. The Earth's radiation belts and their role in life processes are considered together with the motion of particles in alternating electromagnetic fields.

The differential wave equation is then derived on the basis of Maxwell's equations. The expression for the velocity of an electromagnetic wave in vacuum and in media is given.

The atmosphere's composition and structure are studied taking into account the altitude. It is shown that the presence of troposphere, stratosphere, mesosphere, thermosphere and exosphere is determined by the change of temperature with the altitude. The regions of homosphere and heterosphere are considered in the context of atmosphere's composition. The impact of "small" gases upon the atmosphere's status, weather and climate is discussed. The physical reasons for change of the atmosphere's composition with the altitude in heterosphere find their full explanation. The standard model of Russia's atmosphere serves as an example. Some more complicated formations – ionosphere, magnetosphere and protonosphere – accomplish this topic.

The impact of the Sun on atmosphere's composition and structure is studied together with its astronomic data, its radiation power and temperature of its photosphere, chromosphere and corona. The energy spectrum and absorption bands of Earth's atmosphere together with the indication of absorbent gases are given. The basic laws of heat radiation are also revised (Kirchhoff's, Stefan-Boltzmann's, Wien's shift, Planck's Law of heat radiation). The basic processes of absorption of electromagnetic radiation by the atmosphere are subject for discussions (resonant absorption, photoelectric effect, Compton's effect). The Earth's energy balance is a subject of particular interest. Here we calculate the solar constant, the Earth's temperature and estimate how this temperature is affected by so called "greenhouse" effect.

Next step is the thermodynamic processes in atmosphere. Here we consider how the pressure and the density of air depend upon the altitude (in isothermic and adiabatic approximations). The Boltzmann's formula is then derived. The adiabatic temperature-altitude gradient is calculated and compared with its value obtained experimentally. The thermodynamic stability of the atmosphere is also discussed.

Studies of atmosphere's dynamics are conducted taking into account the action of the force of Coriolis on air streams. The processes of formation of cyclones and anticyclones and of geostrophic wind are explained as well as some traditional historic maritime terms ("roaring forties", "horse latitudes" etc.). The atmosphere's global circulation system is considered (Hadley's cell, Ferrel's cell, polar anticyclone, western transfer, North-Eastern trade-wind). The particular values of energy for powerful tropical cyclones, hurricanes and typhoons are given. The essence of some local winds finds here its physical interpretation and explanation: coastal and seaside breeze, monsoon, mistral. Some attention is paid to meteorological parameters and atmospheric phenomena which determine the physical state of the atmosphere the weather depends on. The climate is considered as "Synthesis of weathers". Then we consider a scheme of a mean radiation and thermal balance of atmosphere and a possibility to predict the weather: beginning from skilled meteorologists of the past and further towards the modern forecasting science based upon mathematical models of atmosphere and ocean. Speaking about models we consider deterministic and statistic methods of calculations. Points of bifurcations are also considered. The problem of global warming takes a particular place in student discussions. All contemporary ecological problems are considered from the point of view of the anthropogenic impact on environment. We consider the "greenhouse" gases of natural and man-made origin in the context of their role in global warming. The Earth's climate is considered in its ambiguity as a subject which may have different stationary states. The solar activity is considered in its action on atmosphere and biosphere.

The ozone problem is taken seriously as one of the most important problems. The following issues are considered in this topic: physical and chemical properties of ozone; absorption of UV radiation by ozone atoms; ozone concentration in the atmosphere; processes of ozone molecules formation and disintegration; chlorine-fluorine carbohydrates and their role; ozone holes. International efforts to decrease atmospheric emission of impurities which disintegrate ozone are presented.

The problem of energy sources is presented as one of the most crucial problems of humanity. For the sake of comparison we present a table of energy values for the following cases:

- gravitational interaction of Earth's particles;
- rotation of Earth;
- heat streams through the Earth's surface;
- Moon's tidal influence;
- earthquakes;
- volcanic eruptions;
- energy of falling rocks and soil erosion, avalanches, tornados, cyclones;
- energy of large power stations;
- energy liberated due to nuclear explosions, rocket start accidents, big fires at oilfields and refineries.

We draw a conclusion that the energy of man-made processes is comparable with that of large geophysical processes. The basic forms of energy influence on environment are brought to light and the ways to solve this problem are considered. The next point is the ways to save energy by means of resources-economy and energy-economy technologies. New cleaner ways to produce energy are considered. In this context we compare the rate of energy produced by power stations of different types: thermoelectric, hydroelectric, atomic. We compare their efficiencies, atmospheric emission, raw materials consumed and prospects for future. Non-traditional sources of energy are also welcome for discussion: solar power engineering (based on photoelectric and thermodynamic transformers and bioconversion of solar energy), wave engineering (with active and passive transformers of wave energy and energy concentrators), tidal power engineering (with its experimental set-up and discussions on advantages and drawbacks of working and anticipated power stations), geothermal power engineering (working stations and their prospects).

Energy pollutions of environment are considered next. Here we consider noise, vibrations, electromagnetic fields and radiations. The elastic waves are studied beginning with the process of propagation of sound oscillations in air. In adiabatic approximation the differential wave equation is derived and the dependence of velocity of elastic waves in a gas on pressure and density is determined. The notion of sound pressure is introduced and its relationship with the vibrational velocity of medium's particles is established. The energy carried by an elastic wave is then calculated and Umov's vector introduced. The intensity of sound wave is then expressed via the sound pressure amplitude and the amplitude of vibrational velocity. Other relevant issues are specific acoustic resistance of a gas, Law of Weber-Fechner, level of sound loudness and units of its measurement, limits of sound audibility and sensation of pain. Some examples of sounds having different levels of intensity are given. A problem of human ear sensibility with relation to different frequencies is discussed and the level of sound pressure (in *A* scale, *dBA* units) estimated. Other kinds of sound noise are also considered.

Next topic is man-made electromagnetic fields and radiations including their impact on human health. A particular accent is made on using cellular telephones. Some means of effective protection are considered. The ionizing radiation (UV, X and radioactive sources) are considered in the context of their impact on human health (ionizing activity, dosimetry, units of measurement, radiation background etc.).

The "grand total" is in the conclusion of the course: collective knowledge is necessary to solve the ecological problems on the Earth and it is the engineers who are to solve this problem.

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THE USE OF OPEN AND DISTANCE EDUCATION IN FACILITATING CHANGES IN MANAGERIAL DEVELOPMENT: THE MEXICO EXPERIENCE

José Gpe. Vargas Hernández[1]

Abstract — *This paper examines influences resulting in changes in managerial training and development with particular reference to the University of Guadalajara, Mexico. It starts by examining conditions at the macro and micro levels that bring about change, the nature of change, and the present and future education and training implications to increasing demands on management within diverse organizational environments that are becoming more complex and uncertain. Technology is playing an increasing role in management education and training. Through the use of open and distance education technology learners have greater flexibility of time and place of learning. In addition, where transdisciplinary approaches are used it is leading to the development of "new types of managers" with abilities, behaviors and values that better enable them to cope. Examples draw on management training institutes in Mexico.*

Index Terms — *Facilitating changes, Managerial development, México, Open and distance education*

INTRODUCCIÓN

A sign of the current times is the continuous change, which is modifying everything. This constant change drags the transition of modern organizations toward the manifestations of posmodernity, which are expressed in individual behaviors integrated by means of technological processes in the same structures. Two new variables enter in scene to define the posmodernity of organizations: their complexity and uncertainty of environments in which they are immersed.

The pace of this dramatic organizational change accelerates exponentially every time. It leaves as a a consequence an enormous human insecurity in the face of structural rigidity of economic, social, political and cultural institutions. These institutions are unable to absorb uncertainty derived from changes, hinder instead of facilitating adaptability of people and also hinder the use of benefits. These benefits can be derived from the great wave of technological revolution of information, which has become a self-transforming movement and transformer of development opportunities and human progress. Although these opportunities are increased it is also evident the increase of threatening phenomena which deepen the feelings of human fragility and insecurity. These propitiate the uncertainty that encourages the traps and dangers of mankind survival.

THE MANAGER OF THE FUTURE, THE FUTURE OF MANAGEMENT

The problem of that, as much the individuals as the organizations take advantage of the opportunities that provide this pace of accelerated change, it is reduced to its control and handling. It finds its foundation in the premise of planning changes, as the theoretical sustenance of organization development that aspire to the transition toward the new times marked by posmodernity. Organizational transitions respond to the current expressions of tendencies toward the globalization and internationalization of the markets.

TABLE I

In this diagram it is summarized some ways in which the future can be visualized:

MACRO	MICRO	FUTURE IMPLICATIONS
Changes in the global environment of the business community are the result of:	Impact on individual managers which leads to:	Alternative approaches to managers:
Productivity improvement of business.	Overload of information Demand for a greater continued absorption of knowledge	Local continued education/ Formal/informal distance learning
Globalization of Business relations	Time compression	More concentration on personal Development.
Economic and Technological Changes	Fast changes of of leadership and organizational fluid styles	Changes in careers Early retirements
Turbulence	Change requirements for administrative staff. Bigger and earlier Responsibilities	Reduced activity / without movement.

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These trends have appropriated the advances that the technological-computer science revolution provides. Meanwhile, society is more active, more participating and more demanding of better conditions. There are nowadays, bigger demands for human development and quality of life, greater social justice, formation of cultures that respect diversities, propitiate its solidarity and recognize the human rights.

Professional development in management takes into consideration not only, the emphasis of traditional curricula oriented toward assimilation of knowledge in administrative technology, but also development of the abilities, skills and required competencies for instrumental implementation of changes. But above all, a professional manager development that responds efficiently with attitudes and values as a foundation of practices to face the challenges demanded and required by derived situations of an environment characterized as complex and uncertain.

Instead of developing their work –doing it better, to end up being more experts and able – the managers will have to be achievers. They will be able to look for and to command resources, to determine strategies and to break limitations for implementing them. Instead of concentrating on the consistent use of management systems, company policies and rules, and to focus on high standards, they become operative: operators with a group of values, principles and models, but operators in spite of everything, motivated by will and ability to achieve.

Is it reasonable to ask, "to achieve what"? But the answer to this rests in the future; this future that, without a doubt, will it include the means to make better use of any available resource for us, to improve the quality of life, and therefore our growth and development. The manager of the future clearly has to be, like it was said previously, a good operator, a motivated person that can obtain and to control class resources to achieve results, a highly developed administrator and highly self-confident.

This person can be among the graduate of high ranks at universities. Until universities again can teach an action theory, it cannot be found this developed human being, in such a way that it has to be developed. In other words, the development of managers will become, much more than a necessity of survival as it is now.

To speak of manager development implies a change in education, in such a way that this is the result of experiences, not training of the memory. Education will be a creative-innovative process, (that some futurologists identify as the characteristic feature of a new phase of the technological revolution that we live in our days) in which the manager is able to develop trust, ideas, communication and interaction.

The Japanese Companies take to practice the following process, according to Raymond [1].

- **What have learned and toward where it can take this knowledge.**
- **How the previous knowledge could be incorporate and to be applied to the mark of a new position.**
- **How it can improve a new situation when continuing ahead.**

This process should also be incorporated to our organizations, because with it not only is learning continuously, but rather also it is a process of thinking and increasing the knowledge foundations, all the time, as well as applying new knowledge to the same one, and advancing toward the leadership. The above-mentioned helps us to manifest that the education should exist for the reality and for the future.

From an organizational point of view it is necessary to have, a bigger demand of administrators who will be able to cooperate, and therefore, with abilities of leadership. From the individual point of view, the manager will have more up to date knowledge.

As it was previously signaled, it is evident the existence of unavoidable revolution in managerial practices that have global impacts and that modify all the organizational variables: behaviors, structures and technologies. The current generation of professional managers has been called to be educated in the "keyboards".

One of the many ways to increase the wealth of those administrative practices, are the learning outlines at distance which have been developing some universities and other institutions until the level where the abilities and competencies of management can be self-taught. With the use of special text materials, exercises, videotaped examples, use of electronic mail and platforms, the learning responsibility can be broadly transferred. Experiments have shown that the tutor's contact can be designated successfully outside of the programs and that the assignments of tasks can be determined in such a way that a self-assessment and self-evaluation is possible.

With implementation of telematics, education was adapted to the constant change operating in organizations, giving place in this way, that education process does not center around the previously established relationships between the teacher and the student. Thus, more emphasis is given to the link between the information that receives the student and the same student. In this form, the learning process is redefined.

Lack of personal interaction can be a deficiency, but at the same time can be replaced by more modern techniques of interactive video. This allows the student to interact in managerial events on the screen and then to ask, to explore, to answer and to make decisions watching the results of his conclusions displayed in front of him. This is similar to a flight simulator where the training pilots can prove their flight skills without risking. The manager can prove different methods in any kind of problem without being exposed, in a short period of time and space.

With distance learning education, transfer of control of teaching-learning process is given to the individual; this decides what he/she needs to know and then he/she makes the best use in the available learning resources for him.

When being developed continuous education technology it is impelled more and more and designed by the individual adapting it to his own desires and necessities, motivating this way his self-development. Some approaches of this self-development are beginning to emerge. These novel education developments at distance are operated on global bases. Education institutions at distance learning will win, when having an audience in the entire world, but they will have to continue being linked with this audience of foreign countries, by means of consultants.

Of course, one in the best ways of learning at the present time, is doing it. A little less drastic are the outlines of active learning, where the executives either manage special projects inside their own areas or in any other part as a planned process of performance. These outlines that have been with us for several years, also have the advantage of the project's value and the test of managers' audacity. These projects can involve individual action or to lead to a team project, usually of a multidisciplinary nature.

In the past, the time taken to obtain experience and maturity has made to management a field of older men whose energy and forces of creativity weakening are inevitably. One only has to look back, to see that the young men have been able to create when an opportunity has arrived to people of great talent. The executive professional youths, with an urban culture, trained in private universities, also well-known as the " yuppies ", they are those that more quickly are assimilating the technological advances and incorporating them to the directive and managerial practices of the organizations.

To be in agreement with the current changes, organizations not only should incorporate to technology but rather the individuals will have a change in mentality as a change in organizational relationships and it will be a change in the managerial style. The incorporation of technology to the directive and managerial practices and the use of the telematic, make possible that organizations structure their administrative outlines in agreement with the necessities and socioeconomic conditions of the country. With this practice, it should improve the competitive position to the international level. The above-mentioned has given as a result the linking of the administrating and managerial professionals with the productive and social sectors.

CONCLUSION

Concluding, the managers of the future will have to be agents of development of those organizations to which they are integrated. They will be creative and innovative leaders with clear conciousnes and awareness of their social responsibility, with a strong discipline of work, with a high level academic development, and that they know how to appreciate cultural and social values of diverse countries.

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HYBRID GENERATION OF COLLABORATIVE LEARNING OBJECTS IN PIAGET

Ismar Frango Silveira[1], Maria Alice Grigas Varella Ferreira [2]

Abstract *— This work discuss the process of hybrid authoring of pedagogical content over PIAGET (Platform-Independent, Adaptive, Generic Environment for Teaching), a three-dimensional tool used in distance learning projects that involve knowledge building based on social interactions. More than a virtual environment for three-dimensional chatting with avatars, PIAGET combines several kinds of interaction in a way that virtually simulates many of the more frequent real interactions among teachers, apprentices and the objects inside a virtual classroom. Through a distributed virtual reality environment, PIAGET allows teachers and students to generate learning objects – like solids, blackboard or notebooks - in a hybrid, collaborative way, while they interact among them and with such objects as they were in a real classroom.*

Index Terms — Collaborative Learning, Distributed Objects, 3D Interfaces, Hybrid Authoring.

INTRODUCTION

When analyzing actual tools that can be used to support collaborative learning process over a multi-user, networked environment, it can be seen that the greater part of them consists into toolkits for building or managing pre-built, usually static, pedagogical content. In some cases, these toolkits reach very high degrees of completeness, in order that they can supply a very large range of academic management services that go since statistical control of page views – that can be used, for instance, to measure the specific points of the pedagogical content that had received more visits, through a large quantity of tools for e-evaluation and videoconferencing, among others.

However, two points deserve deeper discussions: first, the lack of interaction possibilities on these tools, since they barely go beyond chat or videoconferencing as the unique ways of doing synchronous collaboration. Second, even though they usually support a wide range of new technologies, they are commonly used to support static content that are the basis for expositive pedagogical strategies, rarely supporting interaction-based ones, like constructivism.

In this paper, it will be shown how a tool with a different approach of interaction can be used in order to support the process of hybrid authoring when building and managing pedagogical content. It is organized as follows: the next section will present an overall view of PIAGET. Following, the authoring processes will be discussed, detailing the hybrid authoring process as an extension of static and dynamic authoring. To conclude, a brief explanation about PIAGET's learning objects will take place, as well as some final considerations.

PIAGET

PIAGET [4][5][6][7] stands for Platform-Independent, Adaptive and Generic Environment for Teaching, being an inter-institutional project that consists in building a three-dimensional, distributed environment for using on a distance learning context.

Some kinds of interaction that are usually taken in a classroom are very diffuclt to be metaphorized onto a bidimensional screen, specially those ones that are based on three-dimensional elements whose manipulation might be essential for some teaching-learning context. This fact can be verified in common real situations that can vary from architecture, where students are meant to exchange scale models, through medicine, in those situations that require corpse manipulation in anatomy classes. These kinds of element, in fact, are very hard to be represented in a HTML document. Therefore, their creation, manipulation and sharing are features even difficult to be achieved.

Although some sollutions might be designed over proprietary techonologies, or even using open standars, like VRML, most of them are *ad hoc*, even if they are very effective in doing what they are meant to do. Besides, these technologies and standards usually fails in providing a multiuser, multiplatform solution.

PIAGET represents a solution that try to solve some of these problems, in order that it represents a proposal for a platform for interaction through a three-dimensional, multi-user interface built over a distributed objects-based architecture.

CONTENT AUTHORING

Since knowledge building process involves far more aspects than simply to accumulate pedagogical content, the manner by which content's authoring process is done can either limit or extend the range of pedagogical possibilities of its use.

There are different ways to classify the authoring proccess. In this work, we will consider the classifications according to creation, presentation and sharing of pedagogical content.

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Classical hypermedia systems tend to supply a very large range of toolkits for elaborating pedagogical content, often with high levels of elaboration and detail. Nowadays, this fact can be easily observed since the adoption of DHTML standard, with the use of layers, CSS, Javascript and Java, besides a vary of proprietary technologies that are meant to bring a greater kind of interaction in a user-friendly way. However, these tools barely offer interaction means enough in order to fullfill all the requirements CSCL systems usually have.

By means of its creation, pedagogical content can be basically built over three different ways of authoring. First, the static authoring, that names all content that is usually pre-built, often over an HTML basis, using or not supporting tools for this task. Such kind of content is surely the most used for building and deploying of web-based pedagogical content. Even though its spread use, the main problem with static content lies on the fact that it supports a classical, expositive pedagogical strategy, under which the student is meant to follow a guided tour or indexed schema to browse the contents that are exposed to him, and from this he is expected to built his own knowledge.

Figure 1, extracted from [1], presents an UML Use-case diagram that shows the roles that are played by actors when doing static authoring of pedagogical content.

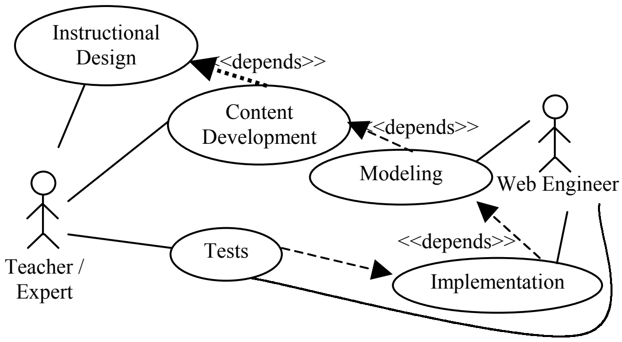

FIGURE. 1
USE-CASE DIAGRAM FOR STATIC AUTHORING

It must be noted how such diagram preserves some characteristics that are common to classical process of Experts Systems modeling: the Teacher -which plays the Expert's role- is responsible for the use cases related to the Instructional Design [10], the Content Development and Tests. Moreover, the Web Engineer has as responsibilities to model and implement that content developed by the Teacher, also acting in the Tests use case.

In other hand, we have those contents that are generated while the interaction among students, like chat sessions, or even some content that are created generally from reasoning about some subject, e.g., forum messages and mails exchanged in a group. All these content must be also considered as a part of the course's content, since it is referred to an externalizable part of knowledge building process. This way of obtaining new, on-demand content is named dynamic authoring, and a use-case diagram that contains the actors and the roles played by them during the dynamic authoring process is shown on Figure 2.

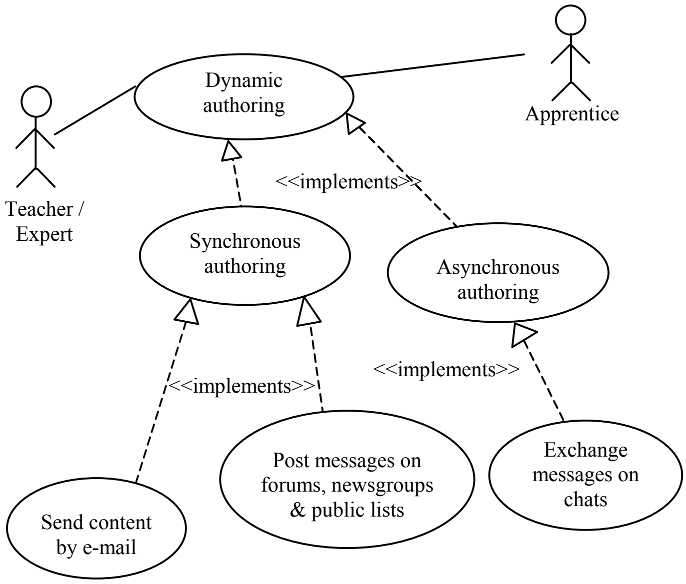

FIGURE. 2
USE-CASE DIAGRAM FOR DYNAMIC AUTHORING

The thoughts of Jean Piaget [8] reinforced the need for knowledge building by own, but this building was intended to be done through the interaction among students and subject. In other hand, Lev Vygotsky [9] proposed that such building must be taken through social interaction among learning agents. Based on this, the PIAGET Project is meant to support inter-agents interactions, as well as interactions among learning agents and learning objects or even agent-environment interactions. Clearly, those interactions would only have meaning under an authoring scenario that supports dynamic content..

In spite of the importance of this sort of knowledge, which reflects the way the information that is given to the students is transformed into knowledge, some supporting tools for learning do not comprise it as a part of the formal content for a given course. This is more evident on exposition-based learning programs, since interaction among students is not an important matter to these programs.

The hybrid authoring is achieved when dynamic authoring can be done over static, commonly pre-built, pre-deployed content. However, this way of authoring also includes the dynamic insertion of new content into some learning context.

This kind of authoring is generally obtained by mixing classic static authoring tools with CSCL systems in order to allow the organization and management of pedagogical content, integrating static and dynamic content in a well-structured, concise context.

However, it must be pointed that hybrid authoring is not solely a sort of juxtaposing of static and dynamic authoring, since this kind of authoring brings new possibilities referred to the collaboration among learning agents through the sharing of learning objects. Figure 3 shows a scenario for dynamic authoring, in which static and dynamic authoring whole scenarios are encapsulated into single use cases, in order to assure more clearness.

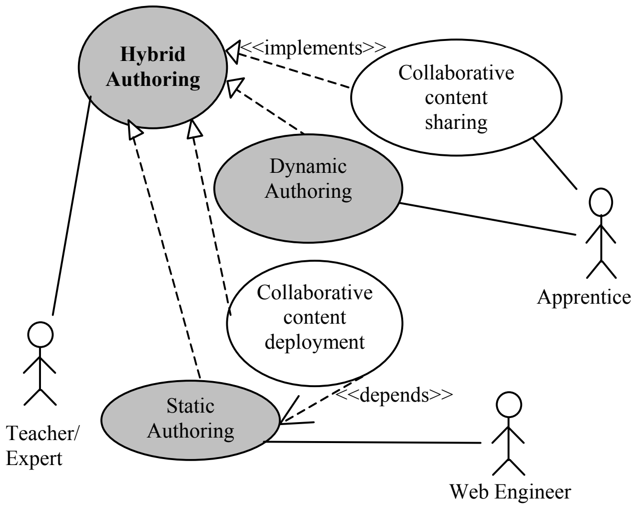

FIGURE 3
USE-CASE DIAGRAM FOR HYBRID AUTHORING

Another way to classify authoring is according to the content's presentation. In a more general way, authoring can be done even over a textual basis, involving or not graphical user interfaces. (Here, it is necessary to point that the content is meant to be textual, not the tools for doing it under this kind of authoring.)

Most of the available contents nowadays are deployed over two-dimensional, WIMP user interfaces [3], largely using hypermedia resources. PIAGET, however, brings a mixed proposal of a WIMP-based interface to control a three-dimensional world that serves as environment where interaction among learning agents might occur. The reason for mixing two distinct paradigms together was based in a Jakob Nielsen's article [2], in which he points the lack of expertise students and teachers have about manipulating a 3D interface with non-appropriated devices, like mouse and screen, as limiters to the possibilities of using a whole three-dimensional interface for interaction systems. The interface that was used for early PIAGET versions [4] had to have some of their 3-D related metaphors translated to button-triggered actions in order to improve the users' performance, since the metaphors being used seemed barely familiar to students, since it diverged from classical WIMP standard. Figure 4, adapted from shows this mixed-mode interface through a screenshot of PIAGET.

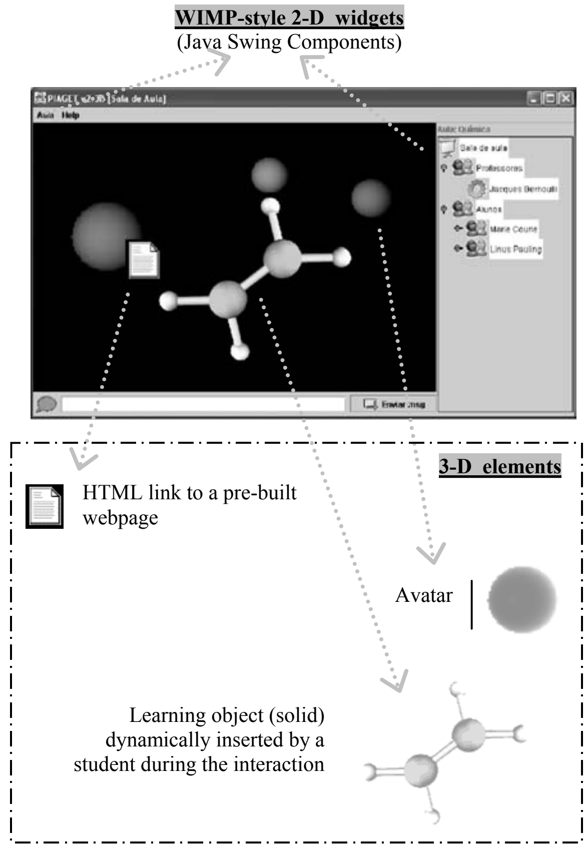

FIGURE 4
MIXED-MODE PIAGET'S INTERFACE

Figure 4 showed a screenshot of PIAGET, with some avatars, representing learning agents sharing a learning object during a chemistry class. The use of three-dimensional metaphors to represent learning objects is based on the fact that some kinds of learning objects are intrinsically better represented by three-dimensional elements that can be handled and shared by learning agents.

Collaboration is another way for authoring classification. It could be said that static authoring would lead to a non-collaborative authoring, but collaboration can occur beyond computers' limits, since a group of teachers can collaborate among themselves in order to elaborate pedagogical content.

However, by means of collaboration through a networked, computer-based environment, authoring can be done in ways that goes from stand-alone authoring, which means no collaboration at all, through collaborative authoring in a bi or even multilateral way.

Figure 5 shows an "authoring cube", which is used for classifying collaborative learning systems according to the authoring processes supported by them.

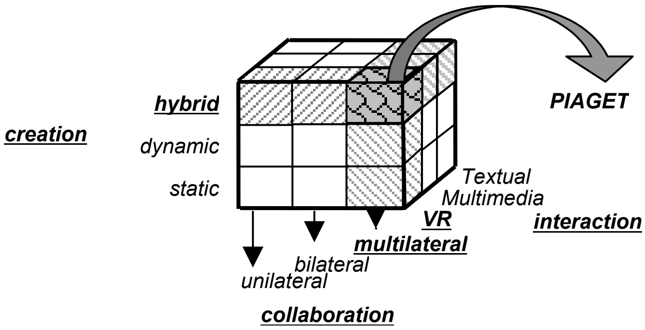

FIGURE 5
AUTHORING CUBE

Although the term "collaboration" might be interpreted in several ways, it is not meant to be a synchronous task, in order that it can be done in an asynchronous mode. In this paper, we will consider as collaborative learning every task of knowledge building that is done by two or more learning agents over learning objects shared through the learning environment.

PIAGET'S LEARNING OBJECTS

In PIAGET, every learning agent can contribute with their own learning objects, which can be pre-built content or some kind of content made on-the-fly. The PIAGET's metaphor set contains representations for the following allowed learning objects:

- *Image2D* objects, representing two-dimensional raw images that can be inserted into the three-dimensional world (normally as textures for thin rectangle parallelepipeds), and thus shared among the learning agents.
- *Solid* objects, which are three-dimensional elements (Java3D objects, VRML worlds or another supported format). PIAGET interface has some resources for their handling –rotation, translation, zooming, etc., although its execution might demand some kind of expertise when used with improper devices. It is important to note that, since PIAGET's architecture was built in a high level of abstraction, it is completely device-independent.
- *Blackboard* is a teacher's exclusive object, representing a metaphor for a place where teachers – or another learning agent with similar permissions- place pre-built content. A Blackboard object is merely a metaphor for representing a place where content is placed by the teacher, being a container for other objects with a more refined control over their sharing.
- *Register* is an object that represents annotations done by teacher during the interaction time, with limitations for sharing – it can be shared only among teachers, and is not visible by students.
- *Notebook*, which represents personal annotations done by students, which can be shared among another learning agents. A notebook is also a container for other learning objects.
- *Message* objects represent textual messages that are exchanged during interaction time. A set of all Message objects that are created during a virtual class can be serialized for a better control.

Since PIAGET's architecture is completely open-source, more learning objects can be added to the metaphor set simply using inheritance, given that its basis are entirely object-oriented. In fact, the ability for expansion can be seen at any tier of its architecture, since its interface, until the data tier. More details about PIAGET architecture can be seen at [5] and [7].

CONCLUSIONS

This work presented hybrid authoring of pedagogical content as a way to support collaborative learning through the use of PIAGET, a three-dimensional tool that is meant to cover a representative range of the steps that are taken for knowledge building.
Hybrid collaborative authoring process is expected to cover the most important aspects of social interaction that commonly occurs in a physical classroom, which is reached by the simulation of those interactions, at the same time that the possibilities for such interactions can be expanded at a limit imposed only by virtual reality technological issues.
At the moment this article had been written, PIAGET was being implemented with some beta-releases being tested under controlled situations. Therefore, future works points to a continuous optimization of PIAGET, which includes the use of ontology for managing large quantities of learning objects that can be shared in a real learning situation.

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A HIGHLY INNOVATIVE MODEL FOR EDUCATION IN ENGINEERING AND APPLIED SCIENCES

M. Kemal Inan[1]

Abstract — *Sabancı University is a private university funded by one of the largest industrial holdings in Turkey. It is ranked within the first top five universities of Turkey. The university structure and mission was meticulously planned since 1994 and the university started its undergraduate and graduate education in 1999. In this paper some of the innovative features of Faculty of Engineering and Natural Sciences are described in the context of our overall educational system, university infrastructure and the preliminary results observed within the first three years of our undergraduate and graduate education and research experience. Among the novel features is a flat faculty administrative organisation (no departments) that offers undergraduate and graduate programs mostly in information technology related areas as well as molecular biology and materials sciences. Absence of departmental separation greatly enhances the interactivity required for cross-disciplinary communications in teaching and research. Other features include liberally oriented program curriculums allowing the students a much greater space for choice and facilities that enable students to get involved in independent and hands-on project work throughout their education.*
Index Terms — Innovative university, engineering education, higher education in Turkey, liberal curriccula in science and engineering

INTRODUCTION

This paper describes a new and innovative private university with a meticulously architectured and well-equipped campus placed at the outskirts of Istanbul, Turkey. In order to appreciate the innovative aspects of Sabancı University it is important to understand the prevailing higher education system in Turkey the outline of which we present in the next section. Following that we describe the initial conception and the underlying structure of the Sabancı University. In the section on operational aspects we first describe some positive observations mostly involving the Faculty of Engineering and Natural Sciences and then discuss some problematic areas that await solutions. A few thoughts on future prospects are given in the conclusion .

THE CONTEXT : HIGHER EDUCATION IN TURKEY

According to *The Word Almanac 2000* percentage of population at or below age 19 in Turkey – with a total population of 67 million - is 38.5. The world average is 38.9 whereas the figures for the developed and less developed world are 24.8 and 42.2 respectively. The social and political context of having a relatively higher percentage of younger population becomes clear when it is contrasted to the average figure for Europe which is 24.1. Hence if education at all levels and contexts – i.e. primary, secondary, higher,vocational, other professional such as IT etc. – are taken seriously this demographic property can be turned into an advantage : if the context is taken as formal or de facto integration of Turkey into Europe then a relatively educated younger population means a driving human resource much needed by Europe. This is why education in general and higher education in particular has an immediate strategic significance for Turkey.

Turkey has 74 universities out of which 53 are public and 21 are privately governed. All universities, be they public or private, are tightly coordinated by a highly centralized bureaucracy, *Higher Education Authority* (**HEA**) according to the dictates of an one-size-fits-all higher education law. One arm of the **HEA** is the *Student Selection and Placement Board* (**SSPB**) which is responsible for organizing a centrally managed student placement examination given every year simultaneously at selected number of locations both inside and outside Turkey. New as well as old high school graduates - students attempting another go for a desired place in a university - take the exam. The number entering is approximately 1.5 million and over 10-15 %, including open education positions, are admitted to a program in a department in one of the 74 national universities. The logic of placement is that of supply and demand. In simplified terms each student specifies a priority list among available programs offered by the universities ; each university department announces its quota of student intake and the rest is an automated calculation based on these data and the points scored by the students computed according to a rather complex formula taking into account student's exam performance and individual high school standing with adjustments that take into account historical performance record of the school in past entrance exams.

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Possibly owing to a high degree of automation it is a fact that the central entrance examination managed by the **SSBP** enjoys the prestige of being free of corruption where no form of clientalism has ever succeeded in distorting the placement order of this automated process. On the other hand it has still been subject to criticisms on two accounts: the lack of social justice in the selection process; and the validity of the test evaluation system judged by the correlation between the student placement scores and their later academic performance. The social justice aspect is a problem to be solved on a different platform and thus we shall not dwell on it here. Much research has been performed on the scientific evaluation merits of the system and there seems to be some correlation with academic success especially on top echelons of performance. Yet the criticism can be radicalized in a way that calls into question the centralized process of selection judged by its negative influence on the entire secondary education. We elaborate on this below since it bears relevance to some of the innovative features of Sabancı University.

Higher education has become of great concern globally since it implies access to well-paid jobs, a commodity that is becoming more and more scarce in an age of radical automation. In addition to the economic benefits, university education is also an important status symbol in Turkey and a good university education will secure a highly respected social position as well as a good job. Consequently the competition to acquire a decent place in a high rated university has generated a sizable commercial industry of enterprises coaching the students to perform well in the test-style entrance examination. The skills involved for a successful performance are based on categorizing possible test questions in mathematics and sciences into a number of types and subjecting the students to drills on solving problems through exhausting all types. Social sciences are no exception to this approach since Turkish secondary education in social sciences has a high doze of nationalistic indoctrination which makes the contents suitable for rote memorization based on text books approved by the ministry of education. These observations have some serious consequences discussed below.

The commercialized university entrance examination market has damaged Turkish secondary education in radical ways. Students, during their last two – if not three – years in high school focus entirely on university entrance activities by choosing and attending one of the private preparatory coaching courses. The high schools, even the most reputable ones, accept this as a fact of life and simply support the students in their extra-curricular preparation activities instead of supplying them with a rigorous secondary education.

The necessary skills for solving test questions have little to do with the requirements of contemporary higher education. Nor are they related to a good secondary education. Among the qualities that lack in most high school graduates are *literacy*, *purpose guided socialization* and *hands-on experimentation* as explained in the following paragraphs.

- In general students do not possess the oral and written comprehension and self-expression skills even in their native language of Turkish, leaving aside extending those skills for a universally valid language like English.
- Students have little or no exposure to working in simple team projects whereby a group of participators organize themselves to shape a loosely defined project topic into an operational program. In such an exercise the students learn something about leadership, initiation and communication.
- Finally students lack a sense of hands-on experimentation, an important preparatory step in *learning by doing*. For example carefully designed laboratory experiments orient the youngsters to professions in science or engineering or exposure to computers orient them to professions in information technologies.

On the positive side let us, nevertheless, admit one useful attribute that all Turkish students possess before they enter a university: a strong sense of self-guidance and a fighting spirit for survival in a competitive environment.

Before we move onto the next section it is important to mention two distinct peculiarities, one linguistic the other professional, of the Turkish higher education.

In the 50'ies Turkey had a few universities which were structured in the German style where professors occupied chairs and younger faculty members did not have the authority to teach or supervise research work independently. After the founding of a new state university in 1956, the Middle East Technical University (**METU**), the entire Turkish university system gradually transformed into an US-like system. **METU** was the first example of a purely national – as opposed to foreign missionary based schools carrying over from the 19th century - education institute whose official language of teaching and research was English. Adoption of English as the official operational language of **METU** had an immediate practical consequence: students after completing a one year preparatory language course attended university courses in which internationally accepted text books were used which eliminated the necessity and dangers of being bound to a Professor's possibly outmoded notes or books in Turkish. The access to a large number of resources in English gave the students a self-confidence which culminated in a different culture and attitude of graduates coming from

METU. All of this survived among heavy criticism on grounds of cultural degeneracy. Adopting a foreign language was taken an insult to the national pride. Yet there was no viable example of any educational institute that could successfully teach professional courses in the national language and teach enough English on the side as, for example, practiced in the Scandinavian countries. The national pride criticism continue to date though with much less influence since after the example of METU the new understanding kept on proliferating. The **top** ranked five universities of Turkey perform all academic activities, including teaching, in English. This is a remarkable and unique example of cultural pragmatism with a bottom-up support in a country without a colonial past under British Empire or any other English-speaking power.

Three areas that are extremely popular in Turkey are electrical engineering, computer science and industrial engineering. According to the 2002 entrance examination statistics, students who were accepted to the departments of the top five universities offering programs in these areas come from the top 1% of those accepted to universities. Even for low rated universities in less developed regions where quality of education is questionable, students accepted to these high demand departments are in the top 10-15%. This shows an overwhelming concentration of demand for a small number of areas mostly in engineering. Other relatively high demand areas are management and economics,molecular biology and medicine. Demand for mathematics, pure sciences and social sciences are lower except for a very limited number of positions in some elite private universities that offer scholarships.

Two important conclusions can be drawn from the observations above. The first is that the demand for higher education in Turkey fits international job markets of the developed world. That is, a work force that consists of fluent English speakers trained in information technologies and other technological areas for which there is definite shortage in regions like Europe and US. This probably is no coincidence since a great number of university graduates from Turkey in these areas fill up graduate schools or silicon valley jobs in the US. The second conclusion is that this collective demand pattern overrides individual tastes or concerns of the students in choosing professions. A gifted student choosing a low demand area, such as say psychology, is viewed as an anomaly and a waste of the gift. Advisers in coaching enterprises have been successful in generating an environment in which students are already conditioned to choose areas and universities compatible with their performance.

THE FOUNDING PRINCIPLES AND STRUCTURE OF THE SABANCI UNIVERSITY

Sabancı University was officially founded – by law like all the other universities – in 1997 and started its undergraduate and some of its graduate programs in 1999. The principal investment and operational funding comes from a foundation of Sabancı Holding, one of the two largest private industrial holdings - both of which are family owned - of Turkey.

The university is composed of three faculties : Faculty of Engineering and Natural Sciences (**FENS**), Faculty of Arts and Social Sciences (**FASS**) and Graduate School of Management (**GSM**). Together with an undergraduate program in management sciences to be offered next academic year there are 12 undergraduate programs, 7 out of which are offered by **FENS**. These are: *microelectronics, telecommunications, computer science, mechatronics, industrial engineering, genetics (molecular biology) and materials science*. In addition to undergraduate programs there are graduate (MS and PhD) programs offered by the three faculties. **FENS** academic graduate programs are: electronics engineering and computer science (an integration of the first four **FENS** undergraduate programs stated above), materials science, molecular biology, industrial engineering and mathematics. In addition **FENS** offers two professional masters programs, one in IT and the other a industry sponsored double degree program in a field of engineering and management with the collaboration of **GSM**. The size of the university is small: first stage planning targets a total number of 3500 students - including the graduate students which will constitute 15-20% of the total. This target is expected to be reached in 2007. The campus is built on an area of 900 acres with 10 large buildings and a small artificial lake.

The actual planning of the university formally started in 1994 and in 1995 an international search conference was held with participants from 25 countries ranging from academicians, technocrats, businessmen to students and parents. The purpose of the search conference was to brainstorm in order to generate an outline of the founding principals of a university for the 21st century. There were no constraints or preconceptions other than the fact that the university was to be built in the outskirts of the 1500 year old city of Istanbul. Much of the innovative aspects, which we discuss next, of the Sabancı University has its origins in this search conference.

Sabancı University enjoys a *departmentless* system. That is, there are no formal administrative units under the faculties. This puts some additional load on the faculty deans where an informal and flexible delegation is used for coordinating activities like the academic programs. The existing faculty sizes have rendered this arrangement of flat organization administratively manageable. On the other hand the advantages have already began to reap their fruits. Recent internal projects such as using liquid carbon dioxide as a coolant in high-speed machine tooling or synthesizing micro-surfaces for automated biological sample analysis are just a few examples of research collaboration between materials science, mechatronics and biology disciplines. What is, however, more important is the multidisciplinary atmosphere of the **FENS** building within which the students get educated and do research. **FENS** building is the largest building in the campus that occupies 17500 meters squared of space with over 50 research labs, auditoriums and classrooms and faculty and graduate student offices. To take a striking example consider a biology student that is constantly in *contact* with students in computer science mechatronics, electrical engineering, materials science or mathematics. By the word *contact* we mean sharing common elective courses, participating in common informal discussions, participating in undergraduate or graduate projects possibly of interdisciplinary nature etc. This is a remarkable feature that is non-existent in any Turkish university or even in other world universities, at least at undergraduate level.

Sabancı University stands unique in Turkey in allowing students to declare their diploma areas at the end of their second year in an absolutely unconstrained manner – i.e. no program quotas, no performance requirements etc. The purpose of this liberal principle is to maximize student motivation and responsibility. In a patriarchally oriented and hierarchically organized educational system - and in general a society - this comes as a cultural shock to all the students. There is a faculty advising system that informs and helps students in choosing their diploma areas and that supports them in solving their academic and social problems. In addition to faculty tutoring and advising system there is a *Center for Individual and Academic Development* (**CIAD**) in which professional staff as well as bright junior and senior students perform tutoring activities to freshman and sophomore students.

Sabancı University is also unique in the country in its well-designed IT infrastructure. All undergraduate and graduate students are given a laptop computer for their use as soon as they enter the university. After two years all laptops are renewed through an agreement made with the company that leases the laptops. The university has a high bandwidth internal fiber network and external connectivity is one of the best in the country. There are nearly 9000 network entry points at a large number of classrooms, student dormitories and faculty housing, all information center (library) study desks, faculty and graduate student offices, all labs etc. Access to information is smooth and uninterrupted. Such an infrastructure helps students become computer literates at an early stage after they enter the university even before taking a single formal course in computer science.

Sabancı University is structured to make up for the gaps in the Turkish secondary education mentioned in the previous section. These are very briefly summarized below:

- **University courses.** These are mostly first year courses to make up for the lack of literacy both in sciences and mathematics and social sciences . All students are required to take these courses. The emphasis is more on concepts and less on background building and technicalities. For example there is a two semester freshman course *Science of Nature* integrating concepts in physics, chemistry and biology where, for example, in physics, rather than exhausting all topics three concepts : mathematical formalization, action at a distance and the universe of small particles are covered in the context of classical mechanics, electromagnetic theory and quantum theory respectively. *Humanity and Society* is an introductory anthropology-history course which presents to the students a well-designed set of topics rich and meaningful in intellectual contents and not overridden with indoctrination concerns. Taken together university courses expose students who aspire to become engineers or scientists to historical and social concepts to enlarge their vision of the world in their post-university lives as professionals and citizens. On the other hand it exposes students who want to study arts or human sciences to the concepts and culture of sciences without overburdening them with technicalities.
- **Faculty courses.** These are mostly second year courses offered by **FENS** and **FASS**. These courses are basic professional or background courses of the diploma areas. Faculty courses give the students a deeper understanding of a diploma area and in that sense can be used as instruments of window shopping in making their choices.
- **Independent team projects.**
    a) All students, either in their language preparatory year or first year are required to participate in a community activity for a total of 40 hours. For that purpose the university has established close links with NGOs such as Earthquake Relief, Human Rights, Amnesty International, Care for Street Children etc. both in the vicinity of Istanbul and in more remote and deprived parts of Turkey. This sharpens the students' socialization habits with a strong

component of commitment and responsibility.

b) All **FENS** students are required to take a team project course at the spring semester of their first or second year. The project topics are suggested mostly by the faculty members and sometimes by the students themselves.

c) At the end of their third year all **FENS** students are required to complete an 8-10 weeks of internship in an industry. The internship is also structured on a team project where a technical representative of the industry and a faculty member either jointly advise the project or at least maintain a reasonable amount of coordination. All internship projects are publicly presented in poster sessions within a specified week of the following semester.

d) Finally FENS students are required to take a two semester design and implementation course in their senior year. Since students have already acquired prior experience in independent project courses or activities as summarized above, our professional expectation from the design and project course is more ambitious. The outputs of these projects are desired to be at most one step away either from a commercializable or a precompetitive product or process of high calibre. The evidence so far neither confirms nor negates our ambition. More time and experience is needed for further structuring this course into a positive and fruitful experiment.

To summarize, independent team projects described above enrich the hands-on learning, communication, presentation and socialization abilities and skills of the students.

Sabancı University can be viewed as a managerially run university in the fashionable parlance of university management theories. At the topmost layer of management is the board of trustees that usually meet four times a year . The administration of the university has a dual structure. Non-academic administrative tasks are run by an administrative staff managed by the general secretary of the university. The administrative functions of the faculty members are reduced to purely academic matters such as tasks in committees for curriculum improvement, juries for graduate theses or undergraduate projects etc. The rector, as the highest administrative and academic officer of the university plays a key role in maintaining a healthy communication between the business or bureaucrat minded administrative staff and the academic community. There is a separate office directly responsible to the rector that manages all external relations such as funded projects, relations with other research institutions or commercial companies etc. Because of the widely differing cultures of managers and academicians the system requires good communication between the parties involved. It is a common hope that as the system evolves, institutional learning will gradually build a unique collective culture.

So far we have described features of the university related to education and administration. The research vision of the university is aptly summarized in the understanding stating that *the dissemination of the research results for the good of the society at large is a distinct mission of the university*.
In the context of **FENS** this translates itself as getting involved in activities like technology transfer to public or private companies, assuming a primary role in founding hi-tech start-up companies, actively participating in technoparks etc.

FENS research strategy is founded on three pillars. The first pillar is basic research, the output of which is scientific publications and practical know-how accumulated within the research labs. The second pillar is possibly commercializable research in knowledge intensive hi-tech areas. So far as the university mission goes this is the pillar of greatest strategic importance The third pillar is fund generating activities or projects. Such a project may have been originally initiated by a faculty member as an R&D activity and after reaching a saturation phase where things become routine the project can be continued by specially hired staff or university related companies to generate steady funds for the university. The most desirable R&D projects are those for which the three objectives above overlap. However, reality is not always that generous and maintaining a suitable balance between these activities is important.

The undergraduate and graduate programs as well as research interests in **FENS** constitute interwoven, future-looking and knowledge-intensive areas. There is a definite harmony between the choice of areas, research strategies and interdisciplinary concerns. Short term research concerns heavily lean on applications of information and communication technologies in all aspects of life whereas longer term research concern is that of *engineering in the small* in materials, biology, mechatronics, microelectronics and optics.

PRINCIPLES IN ACTION

In this section we summarize some of our observations and comments based on the past four years of experience.

An interesting example of unleashed student energy occured a year after the introduction of student team projects in Spring 2000. Motivated by this project course and through the efforts of the mechatronics faculty members a number of first and second year students decided to enter a national competition in robotics which was part of a world wide competition organized by Japan. As a result of hard and arduous work these students were able to win the national competition by eliminating groups of fourth year mechanical engineering students coming from two of the best rated and well established state universities. They then went to Tokyo and were able to end up within the first eight contestants out of approximately 25 nations and won a prize for that. This has set an example within the university making mechatronics a popular choice and further accelerating the competition between the seven programs for attracting the best students.

A program that has proved extremely popular is the community projects done in cooperation with the NGOs as described previously. A significant number of junior and senior students still maintain their ties with the NGOs with which they had first worked a number of years ago. Aside from having developed a sense of social responsibility and political maturity this activity has been the *first* occasion in which they improve their computer literacy by becoming fluent power point and excel users and by learning to make ample use of information resources of the library and the internet.

In a liberal environment where students were forced to make their personal choices and program their daily routines under academic pressures two problems became visible. These were time and stress management problems faced by the students. Special courses were organized by **CIAD** on both time and stress management which in time became popular and are still repeated every now and then.

On the research side there have also been spiriting developments. Sabancı University recently became a partner in a technopark company that is now actively launching training and recruiting activities for attracting progressive hi-tech companies. This technopark is placed within a privately funded industrial site about ten kilometers away from the campus. The expectation is that at some stage this technopark to become an outlet for our enterpreneural students and the creative technological research carried out in the university labs.

As an example for progress in commercializable research activities two short term projects have been completed for a multinational German company , one in computer vision applied to industrial production process and the other a control problem involving removal of a belt instability problem in a serial production system. Sabancı University has again set a unique example in successfully completing research projects for a reputable European company in a very *professional* manner.

Notwithstanding these positive moves and success stories there are also problems. In order to meet the challenges in education and research faced by **FENS,** high calibre students are needed. This however depends on the scholarship policy, which in turn depends on the business plan according to which the ratio of students with full scholarships will have to drop to less than 30% from the original 50%. This means that systematic and creative publicity and promotion campaigns of the university targeting high schools with highly rated students who can afford to pay tuition fees must be repeated intensively and frequently. Or other creative arrangements must be seeked for generating repayable loans for good students who cannot afford to pay.

Students usually respect the views of their peers and seldom trust advise coming from academic or administrative officials. This means that as the new culture starts settling in inter-student communication is the most effective means of proliferating and transforming the new mentality into a liberal academic tradition owned up by the students. This takes time and the university management must exhibit persistence and determination to guard the liberal environment within which students can freely express their views and practice their creative activities.

Another difficulty is to generate a common culture among faculty members whose origins constitute a heteregenous mix: either fresh PhDs mostly from US universities or engineers or scientists from other academic institutions, research institutions or industry. The correct balance between academic or scholarly activities and technologically creative activities that fit the **FENS** research strategy mentioned above requires an unorthodox academic performance system that must be designed and implemented in support of a common culture and understanding. We are at best halfway in our efforts in this direction.

CONCLUSIONS

As we approach the end of the first four year undergraduate program cycle this year, Sabancı University has already established a reputation for being one of the most innovative universities in the nation.

In the last fifty years two universities in Turkey have made history by setting examples to others. The first one was a milestone for moving the entire system to a US–like structure from the old Germanic model and normalized English as a universal language of communication. The second one was the first private university in Turkey that proved that by moving outside the boundaries of the state system one can build a world class institution measured by its scholarly activities. Sabancı University aspires to become a third such milestone through its impact on society by gearing its activities to transfering technological innovations into industry through its agents, namely its faculty and its graduates. This is why and how education meets research in the context of **FENS** of Sabancı University.

Sabancı University will perhaps resemble in time to one of the five enterpreneural European universities thematized in Burton Clark's celebrated book:

Creating Enterpreneural Universities : Organizational Pathways of Tranformation, Elsevier 1998.

Yet there are a few differences in the nature of innovations reported here. The innovations in Clark's examples stem from very creative managerial maneouvers in the context of highly rigid state university systems in four European countries. The managerial dynamism to transform the income base of universities by an order of magnitude by mobilizing the technological and educational capability of the faculty is no trivial matter. The same challenge is valid, important and indeed even a greater one for Sabancı University in view of the less developed technological base of existing industries in Turkey. On the other hand the strong student-centered and faculty-involved internal component of innovations mentioned here is non-existent in Clark's examples.

AN EMPIRICAL COMPARISON OF BACCALAUREATE PROGRAMS IN COMPUTING

Barry Lunt[1], Han Reichgelt[2], Tina Ashford[3], Andy Phelps[4], Erick Slazinski[5], Cheryl Willis[6]

Abstract *– When a new academic discipline emerges, it is often difficult to distinguish it from the disciplines closely related to it. Information Technology (IT) is just such an emerging discipline. This paper outlines the emergence of the Society for Information Technology Educatioin (SITE), a definition of IT curriculum, and positions IT relative to similar disciplines by empirically comparing it to programs such as Computer Science, Computer Engineering, Electrical Engineering, EET/ Telecommunications Engineering Technology, Information Science, and Management Information Systems, at a total of 12 institutions.*

Index Terms – academic disciplines, computing, curriculum, information technology,

INTRODUCTION

Recently, a number of Universities in the United States and elsewhere have started baccalaureate programs in Information Technology (IT). In addition to the universities with which the authors are affiliated, other institutions include Capella University, Illinois State University, Indiana University, Pennsylvania College of Technology, State University of New York at Morrisville, the University of Baltimore, and the University of South Alabama. Most of the institutions in question have added the baccalaureate degree in Information Technology to other computing-related baccalaureate degrees already in their portfolio, such as degrees in Computer and/or Electronic Engineering, Computer Science, Information Systems, Computer Information Systems, Management Information Systems, and so on.

While some (e.g., Denning, 2001) welcome this development, others are less accommodating and argue that there is nothing that would make a baccalaureate program in IT sufficiently distinct from a baccalaureate program in an existing computing discipline to warrant a separate degree program.

There are two popular methodologies that one can use to try to refute the proposition that there are no significant differences between a baccalaureate program in IT and other computing programs. The first one is to engage in a more philosophical debate about the nature of IT and to distinguish it theoretically from, say, Computer Science or Information Systems. While such debate is not without merit, the results are often inconclusive, and opinions that were closely held when entering such a debate are, in general, not likely to be modified.

In this paper, we therefore adopt a second methodology that one might use in support of a particular position, namely an empirical investigation. The aim of this paper is to provide an empirical comparison between the structure of IT programs and the structure of other computing programs in support of the position that IT programs have a character of their own and are distinct from other computing programs.

METHODOLOGY

The problem with any empirical comparison is of course the measure that one uses. In this particular instance, the question is specifically how to determine the structure of a degree program. Courses that were required in each of the degree programs were classified into one of 7 categories, namely

- Business related courses;
- Courses concentrating on interpersonal communication;
- Software related courses;
- Courses on networking, web-related technologies or databases;
- Electronics and signals;
- Hardware;
- Physics, mathematics or chemistry.

Absent from the above categories are general education courses that were taken by all students at that particular institution because they are not unique to a given major, and therefore do not help define differences between majors.

The reason for classifying courses in this way was not arbitrary. In December of 2001, 15 representatives from schools currently offering baccalaureate programs in IT attended the first Conference on Information Technology

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Curricula (CITC I) in Aspen Grove, Utah, to discuss a number of IT related issues. One of the topics for discussion was IT curricula and delegates at the conference engaged in an exercise to capture their views on what a core IT curriculum should contain. Each delegate was asked to write down ach topics that they felt were important in an IT curriculum on a separate piece of paper. Some 700 pieces of paper were collected, with some obviously mentioning the same topic.

The topics thus collected were then classified into a number of categories, and their frequencies noted. 28 categories emerged from this exercise, of which the most frequent were

- Networking;
- Interpersonal communication;
- Software;
- Web systems design;
- Databases;
- Business related issues (e.g., project management, e-business, organizational structure);
- Digital communications;
- Data security/privacy;
- Mathematics;
- Systems design;
- Hardware.

Further details can be found in Lunt et al (2002).

The first author used these topics as a starting point in a pilot study to analyze the various computing and related degrees offered at Brigham Young University (BYU), Utah. In addition to Information Technology, BYU-Utah offers baccalaureate degrees in Computer Engineering, Computer Science, Electrical Engineering, and Management Information Systems. It was on the basis of this pilot study that he combined several of the categories to arrive at the seven categories mentioned earlier, and used throughout this study.

The numbers used in the study represent unit courses, the equivalent of 3 semester credit hours. This was done to simplify understanding of the comparison. If a course was listed as 2 semester credit hours, it counted as .667 classes.

One further issue that needed to be resolved was the fact that many programs allow students options and the question was how to rate these options. The methodology that we used was simply to score each course by a ratio. Thus, if the student was required to choose 2 out of 5 courses, then each course was given a rating of .4 (2/5).

In addition to his or her own institution, each author also analyzed the programs offered at one other institution. The only requirement was that the institution in question should offer a baccalaureate program in IT. This led to programs at the following institutions being analyzed:

- Brigham Young University, Provo (BYU);
- Capella University (Capella);
- George Mason University (GMU);
- Georgia Southern University (GSU);
- Macon State College (MSC);
- Pennsylvania College of Technology (PCT);
- Purdue University (Purdue);
- Rochester Institute of Technology (RIT);
- University of Baltimore (U of B);
- University of Houston (U of H);
- University of South Alabama (U of SA).

RESULTS

The summary table of the results of this study are given in Table 1 below. The study covered seven main academic disciplines, shown in alphabetical order in Table 1. In some cases, the names of these disciplines were a combination of similar programs, as in the cases of Computer Eng/Eng Tech (a combination of programs in Computer Engineering and Computer Engineering Technology), EET/Telecomm ET (a combination of programs in Electronics Engineering Technology and Telecommunications Engineering Technology), and Mgmt Information Systems (a combination of programs in Information Systems and Management Information Systems). This was done only after it was evident from the data gathered that these programs were similar enough to be counted together; it is not suggested by this study that these programs are identical.

One of the first things a person will notice when looking at Part 2 of Table 1 is the large number of programs found under the discipline of Information Technology. This is due to two factors: 1) every institution included in this study had to have a program in IT, or it would not have been included; and 2) some of the institutions included have multiple specializations within their program of IT, and they were different enough that they were included separately. This gave a total of 22 IT programs in the study. This was followed by 8 programs in Computer Science, 8 in Management Information Systems, 5 in Computer Eng/Eng Tech, 2 in Electrical Engineering, 2 in EET/Telecomm ET, and one in Information Science.

The number of courses required for the programs included in this study ranged from a high of 35 (Information Technology at Capella) to a low of 15 (Computer Engineering at GMU), with the average being just under 26 courses. The seven program areas had averages ranging from a high of 29.8 courses for EET/Telecomm ET to a low of 23.25 for Computer Science.

COMPARISON

It can be seen from the data in Table 1 that there is a great degree of variation in programs between institutions, even in programs as well-established as Computer Science. However, when one looks at the trends of the averages, the respective disciplines become very distinct. This is perhaps best shown in Figure 1, which is a graph of the percentage of classes required in each sub-area. For example, Figure 1 readily shows where the emphasis lies for programs in MIS: about 58% of all their required classes are in Business, with the other 42% being made up of Networking, Web & Databases (18%), Software (11%), Interpersonal Communications (6%), and Physics, Math & Chemistry (6%). There is essentially no required coursework in Hardware or Electronics & Signals.

This can be contrasted with programs in Computer Science, where the main components are Software (39%), Physics, Math & Chemistry (30%), Networking, Web & Databases (10%), Hardware (8%), Interpersonal Communications (4%) and a bit of Business (3%). This comparative view of the courses required in each topic area for each of the programs is best seen in Figures 2-7, one for each of the respective academic programs.

A comparison between the topics areas required for each program is the focus of this paper. Figures 2-8 show the relative ranks between the topic areas for each of the programs included in this study.

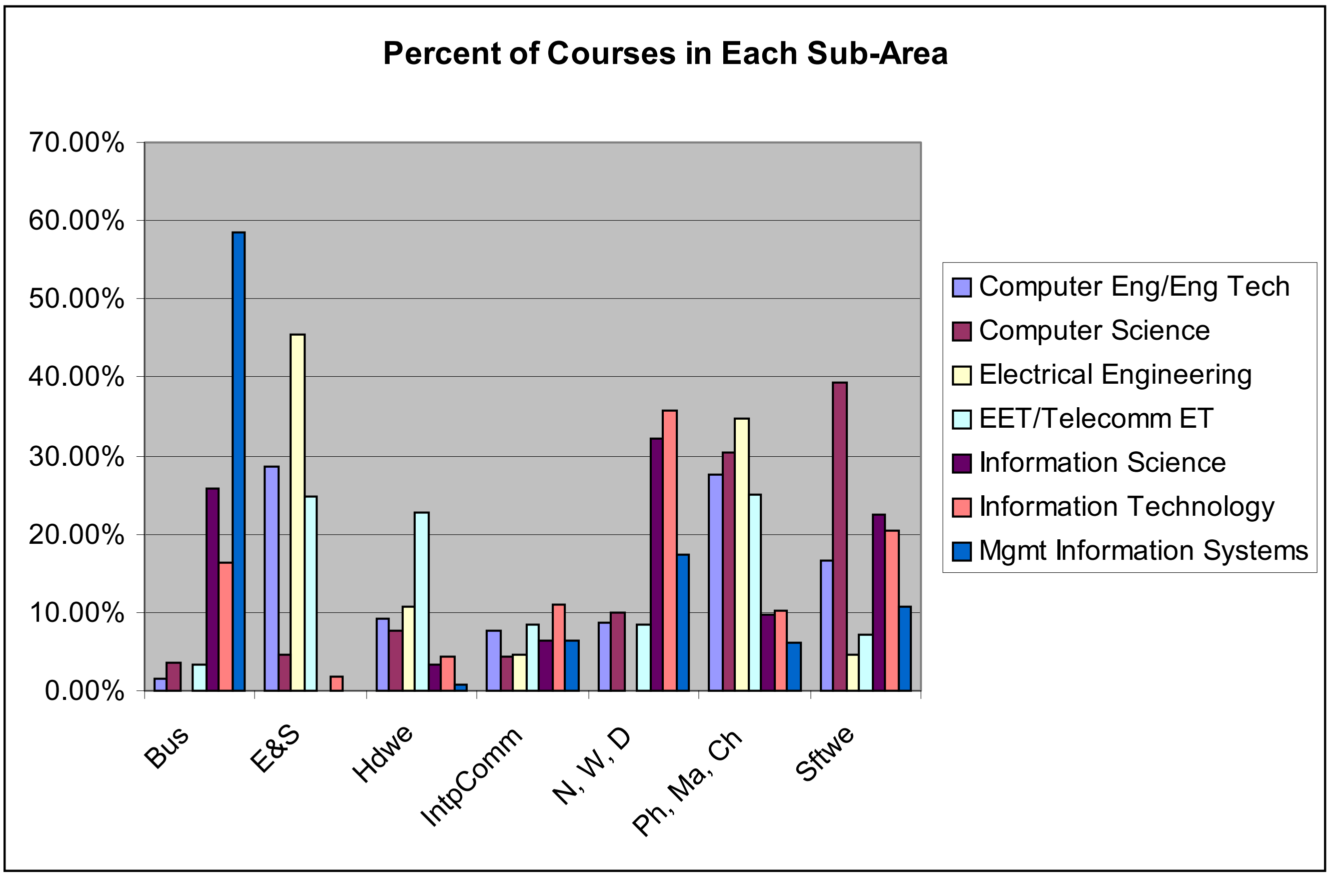


FIGURE 1

NUMBER OF COURSES REQUIRED BY EACH PROGRAM IN EACH SUB-AREA

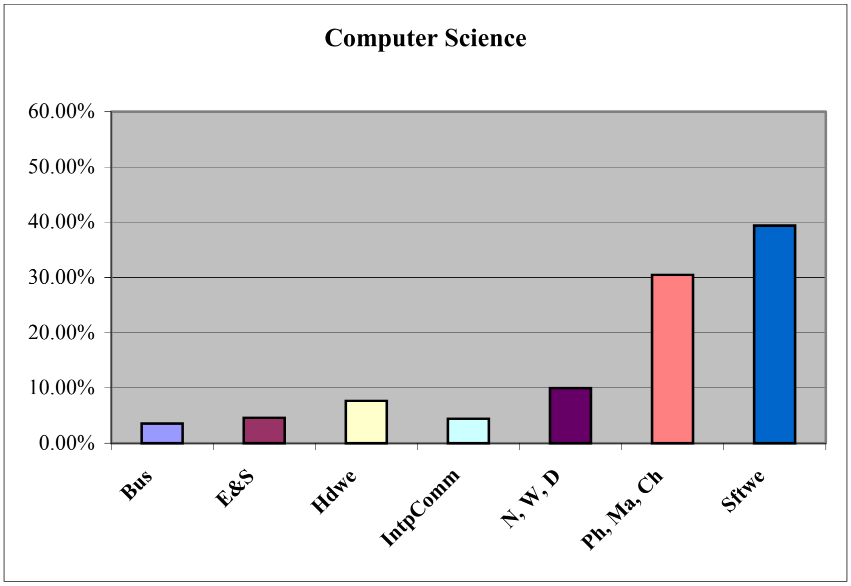
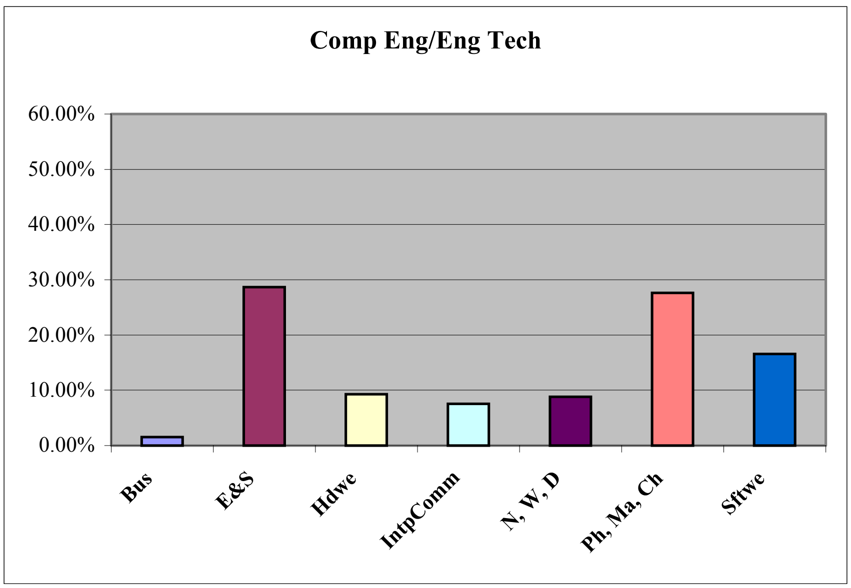


Figure 3
TOPIC AREAS BY RANK FOR PROGRAMS IN COMPUTER SCIENCE.



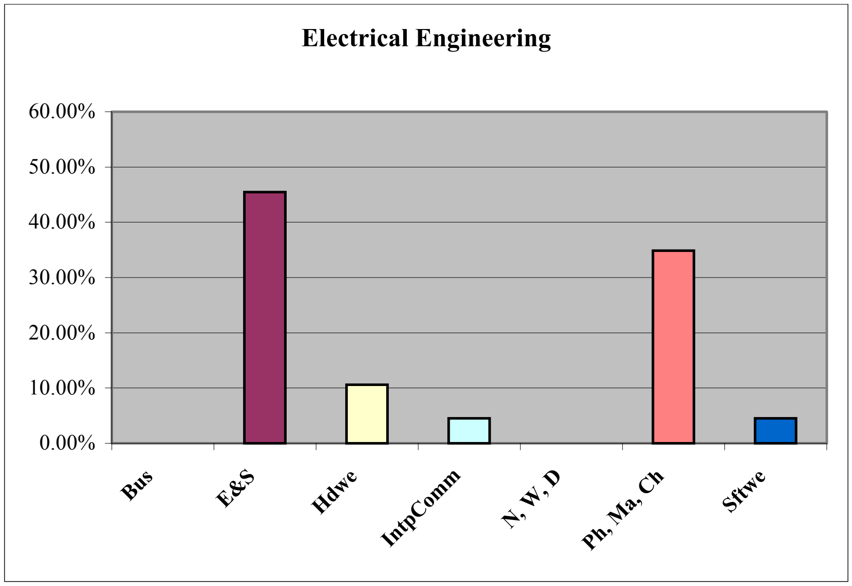


Figure 4

TOPIC AREAS BY RANK FOR PROGRAMS IN ELECTRICAL ENGINEERING.

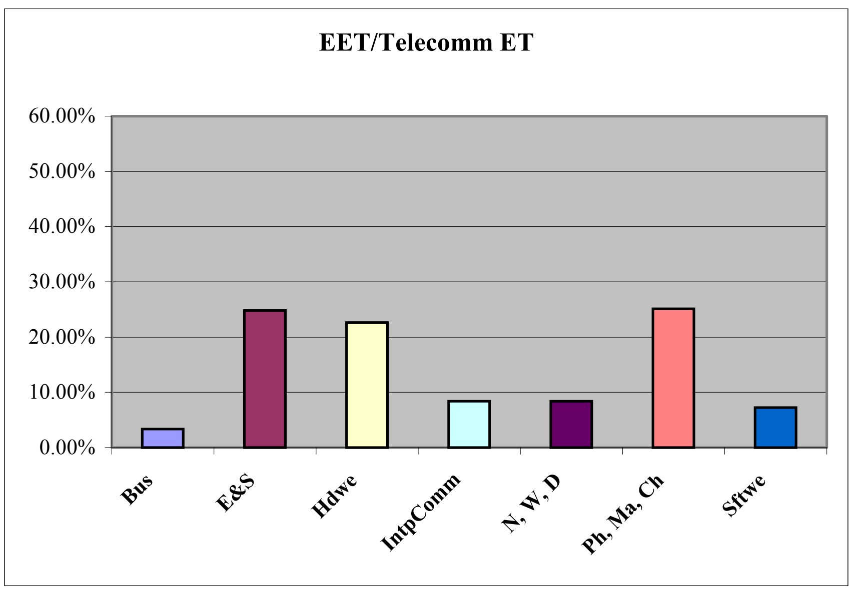


Figure 5

TOPIC AREAS BY RANK FOR PROGRAMS IN ELECTRONICS ENGINEERING TECHNOLOGY AND TELECOMMUNICATIONS ENG. TECH

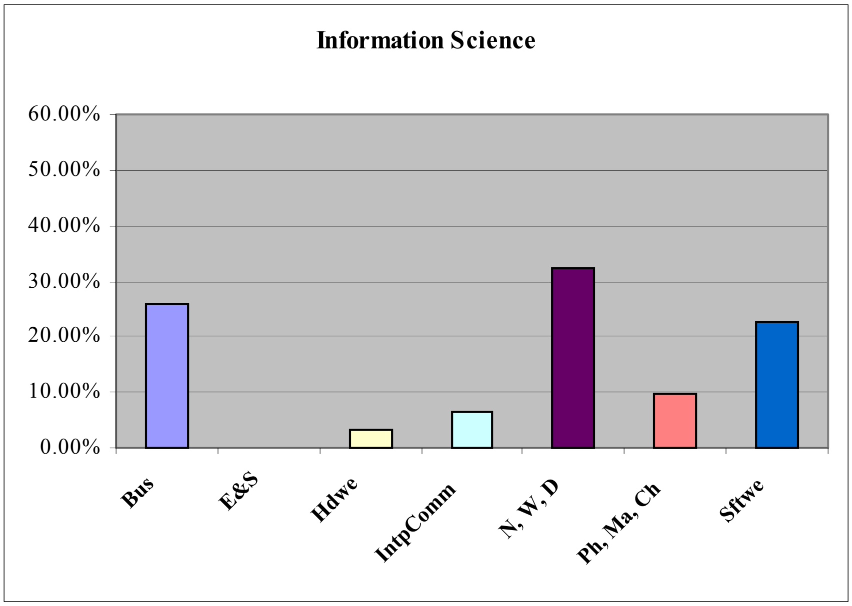


Figure 6
TOPIC AREAS BY RANK FOR PROGRAMS IN INFORMATION SYSTEMS

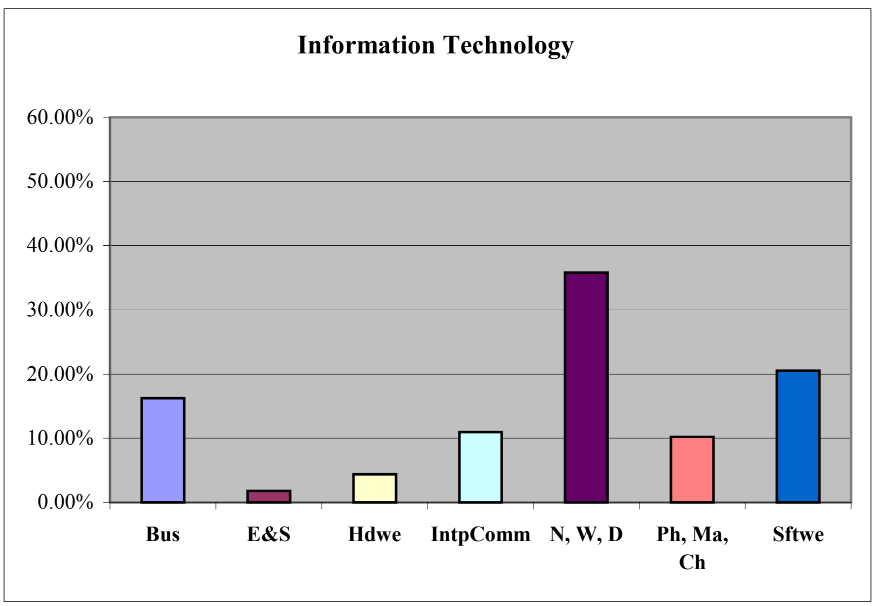


Figure 7
TOPIC AREAS BY RANK FOR PROGRAMS IN INFORMATION TECHNOLOGY.

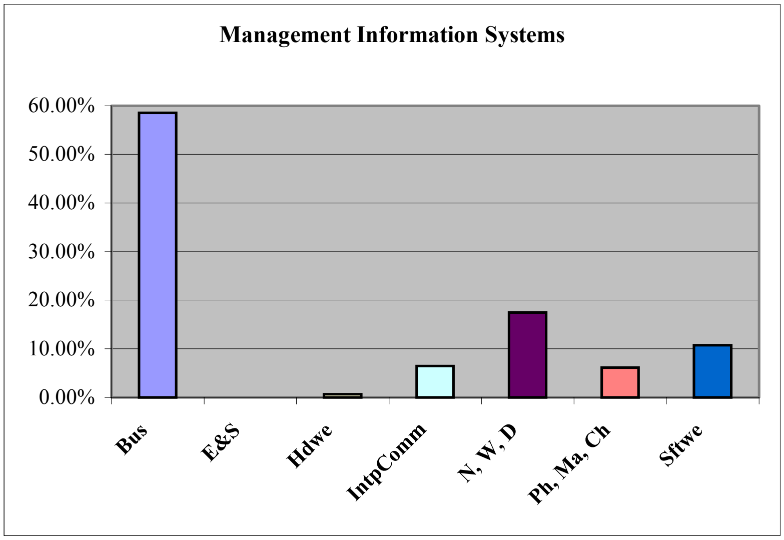


Figure 8
TOPIC AREAS BY RANK FOR PROGRAMS IN MANAGEMENT INFORMATION SYSTEMS.

It is typical for any program to have two or three strength areas, followed by appropriate support topic areas. It is evident from Figures 6 and 7 that the strength areas for programs in Information Systems and Information Technology are 1) Networking, Web & Databases; 2) Software; and 3) Business, with only a slight difference in the #2 and #3 areas. The strength areas for programs in Computer Engineering or Computer Engineering Technology are 1) Electronics & Signals and 2) Physics, Math & Chemistry, which shows their strong emphasis on electronics and basic engineering principles. A similar emphasis is seen in programs in Electrical Engineering, where the strength areas are the same, but make up a much greater part of the curriculum. Similarly, the strength areas in programs in Electronics Engineering Technology or Telecommunications Engineering Technology are 1) Physics, Math & Chemistry; 2) Electronics & Signals; and 3) Hardware, making up a combined 72% of the curriculum.

As one would expect, the strength areas of programs in Computer Science are 1) Software and 2) Physics, Math & Chemistry, with an emphasis on the Math. And also, as implied by the name, the focus of programs in Management Information Systems is Business, making up over 50% of the curriculum,

with a secondary emphasis in Networking, Web & Databases making up about 18% of the curriculum.

CONCLUSION

It is the hope of the authors of this study that the preceding information, especially the tables and graphs, will be helpful in two main endeavors: clarifying the differences and unique characteristics of existing programs in Information Technology, and assisting in academic advisement in the field of computing. When any new program emerges from closely related programs, it is often difficult for those in the closely related programs to clearly distinguish the differences between these programs, and to understand the unique focus of the new program. This paper has presented information which should significantly promulgate a better understanding.

Many are the students who are interested in the broad area of computers, but a large number of these students are quite unaware of the different programs that deal with computing and their respective emphases. This paper should be very helpful in clarifying this situation as well. For example, a student interested primarily in the Networking, Web and Databases part of computing would be well advised to go into either Information Systems or Information Technology. Those interested primarily in the software should go into Computer Science, while those whose interests lie most strongly in computer hardware should be advised into programs in Computer Engineering, Computer Engineering Technology, Electronics Engineering Technology, or Telecommunications Engineering Technology. Students who love the business applications of computers should be advised into Management Information Systems.

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COLLABORATIVE LEARNING IN INTERDISCIPLINARY AND INTERCULTURAL TEAMS

Arvid Andersen

Abstract*— *Many observers consider that Engineering courses in general should turn out graduates who

- *Are proficient with open-ended problem solving*
- *Are familiar with multidisciplinary problems*
- *Posses teamwork skills*
- *Posses appropriate entrepreneurial and social skills*
- *Are able to plan and run a project effectively*
- *Have the ability to communicate efficiently*
- *Are proficient with computer systems and applications*

Let us admit that the Paradigm has changed and adjust accordingly. Various avenues of teaching, learning and assessment, such as those described in this paper, are required to develop soft and hard skills needed. The educational concept described i.e. simultaneous cross-cultural and interdisciplinary teamwork influences the individual personal attributes. Through project organized teaching/learning mental agility as well as inner resilience are influenced and strengthened. After completing this semester course students posses a blend of personal attributes and soft and practical entrepreneurial skills. Further it has been shown that students learn good judgement tinged with sagacity. In using our modern computer facilities students become rather proficient in management of engineering projects and applications.

Index Terms—*Avenues of learning, diversity, international teamwork, project performance, theory and practice*

INTRODUCTION

Global awareness is of paramount importance. International collaboration and cooperation are developing very fast and require knowledge and understanding of cross-cultural business behaviour. In order to deal and compete on the global market, we must make sure that the qualifications of our engineering graduates are appropriate. Future researchers predict, that work in future life will merge with leisure time and family life making things more blurred. It is expected that engineers in the future will be given a special task rather than being employed in a company from nine to five. In Denmark there is already a tendency to employ people on short-term contracts buying competence and expertise rather than employing people, as we know it to day. This requires a solid basic engineering knowledge combined with the ability to tackle problems alone and solve them in cooperation and collaboration with people across disciplines and cultures. Understanding of a broader area of disciplines such as economics, marketing, environmental subjects, management of engineering projects and a solid training in teamwork are required. Both Society in general and engineering have become increasingly more technologically advanced. This produces a demand for many new skills that our graduates must posses. The new skills base is no longer just technological. There is now an increasing demand for our graduates to be proficient with open-ended problem solving and with computer systems and applications. In addition, to have the ability to plan, navigate and manage complex engineering projects, work systematically and be able to work in multidisciplinary teams with international participation where the common language is English.

A major supporting activity in engineering courses in Denmark is the use of an extended project based activity. This is to day considered to be such an important part of the general teaching technique of learning that it is being extensively employed. This teaching and learning technique is based on the dual concepts often referred to as Collaborative learning and Scaffold Knowledge Integration.

COURSE DELIVERY

As described in the Scaffold Knowledge Integration framework, autonomous learning is facilitated on the course by having students work in project groups to allow them to:

1. Serve as social supports for each other
2. Share design ideas and provide feedback
3. Provide critical assessment of the ideas of others
4. Discuss, negotiate, debate and compare

The assignments undertaken are designed to make students listen actively to each other, to make mistakes, to argue, to discuss and to explain their ideas to other students, to members of the academic staff and to experts from industry.

FINDINGS

Interdisciplinary working combined with the participant's diversity in cultures needs careful scrutiny by lecturers, supervisors, mentors and participants. A number of key issues are the differences between the deal focused and the relation focused way of conducting meeting and negotiating between different suggestions. The level of informality in some cultures such as Denmark and the UK and the formality-structured relation ships in several mainland Europe cultures can cause strained relationships. Sensitivity to status differences and the

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rigid hierarchies frequently displayed in a number of Universities can also provide initial uncertainty in students.

DIVERSITY

To appreciate diversity and take advantage of it in collaborative learning is essential. However, to do so we need to be aware that each individual has a perception and understanding of the way things are or should be. This situation is strongly accentuated when dealing with students mixed in multi-cultural and multidisciplinary teams. All involved i.e. students, supervisors or staff should know that diversity in cultures means different mind-sets and therefore many individual paradigms. Normally we do not question such differences in our individual perception of life. However, this is exactly what we need to do when dealing with mixed teams of different disciplines and cultural backgrounds. Each team is typically a mix of three different cultures and four to six different disciplines working as an integrated engineering group. All projects are real projects done in cooperation with Danish or foreign industry. Language of communication is of course English.

STUDY DISCIPLINES INVOLVED

The basic structures of the programme of study are designed to give participants an overview of the diverse fields of engineering business and technology and to break down barriers between disciplines and promote a common approach. This course has shown to familiarise the students with the practice of engineering analysis, design and problem solving. This is achieved by providing a set of project-based activities designed to simulate the real world engineering practice. In this case practice relates to the skills required to achieve a successful project. At the start of the project student teams struggle with their project/problem formulation and planning trying to allocate activities related to the individual fields of study involved. As the project progresses the differences between each of the technical disciplines begins to disappear, and the class begins to extract engineering and technical skills that are consistent across disciplines involved. This is where student starts to recognise the interdisciplinary nature of the operation and see the possible solutions to the various parts of their project.

PROJECT PERFORMANCE, LIMITATIONS AND DIFFICULTIES

It is well known that it is necessary to have a certain amount of knowledge and insight to be able to resolve problems and to be creative. To accommodate a wide range of student disciplines requires a great number of broadly based projects within engineering, business and technology. To accommodate different cultures and disciplines in the same team requires certain skills, patience, time and understanding. It further requires consideration and courage to resolve cognitive, political and social problems as they occur. Although students technical background/knowledge is similar it can be very difficult to communicate. Also conflicts in student's individual aims and ambitions must be published and discussed among team members to promote the project performance. Further it is important to tell each other what is required of the home university. In case of trouble a facilitator, usually a supervisor or a qualified tutor is consulted.

AVENUES OF LEARNING

Following is a list of avenues of teaching and learning applied:
Project Organized Teaching i.e. problem oriented or discipline oriented.
Self study
Independent and autonomous learning
Traditional class teaching
Working together where students share and distribute the responsibility of learning
Helping each other
Collaborative learning
Supervisor consultation
Practice of making things (prototyping)
IT, Blackboard, web learn
Ad hoc teaching according to immediate need
Group meetings
Tutorial sessions with Oral Presentation exercises and written feedback from the audience

METHODS AND TECHNIQUES USED

A mix of different situations and events deliberately designed reflects the avenues of learning practised on this semester. These events enable students to present, discuss and defend their professional work and discuss other matters of concern such as communication problems, cognitive and political problems in their group. Teaching and learning methods such as autonomous learning, tutorial discussion sessions where oral presentations are performed and discussed, group meetings where teams present, defend and discuss their work with each other, weekly meeting with supervisor, here students plan, organise and prepare the meeting, they work out the agenda for the meeting, they take minutes and they take turns in chairing the meeting. As we express it: We pay attention to the 3P´s as we have defined it: The PRODUCT i.e. the documentation set, the PROCESS performed i.e. the teamwork and the PEOPLE involved. Also use of our web-based blackboard system should be mentioned which is used as a distant learning tool. It is also used as a forum for discussion. Here the professor can work on distance and participate in discussion with students.
Each team of international students is involved in defining, systematizing, planning and navigation of their project. Two supervisors, a commercial and a technical, are allocated to each team. On compulsory weekly meetings things of concern such as project development, teamwork problems and

communication difficulties and if needed cognitive and political problems are discussed. From those meetings students learn good meeting techniques and disciplined behaviour. Further they learn to work out a good agenda for the meeting and to write a good minute of the meeting. Abilities such as awareness, self- confidence, responsibility and communication in English are improved through those activities. Also the ability to listen actively, discuss and negotiate solutions in place is developed. Company advisors do join the weekly meetings if their busy timetable allows. All team supervisors meet regularly to discuss matters of concern.

THEORY AND PRACTICE

It is essential that University reach out to Industry to establish a good relationship. It is crucial to get industry involved and committed in education of engineers. The Engineering College of Copenhagen is an undergraduate institution. The study is vocational i.e. a mix of theory and internship in industry. Students enrolled here find this combination very useful and relevant and a real eye-opener to many students. To illustrate their concern for a proper mix of theory and practice the following statement, expressed by a by a student representative at a graduation ceremony, will serve. Quote: " Theory is when you know everything but nothing works. Practice is when everything works but nobody knows why. Therefore keep calm and combine your knowledge or else you might find out that: Nothing works and nobody knows why" Unquote.

ASSESSMENT

Interim report, self and peer assessment, project report and oral exam. Assessment procedure for the team-based project:
1. Oral presentation of the written report
2. Discussion of professional, technical and specific content of the report
3. Discussion of the precise communication value of the written report
4. Evaluation of the project-process

MOBILITY OF STUDENTS ACROSS BOARDERS

Since the inception of the European Union student funding programmes such as Socrates/Erasmus, Leonardo, Tempus and Comett students have been increasingly encouraged to move part of their study to a foreign University. The number of students and the range of countries annually involved in international exchange of students have increased dramatically. The EORUPEAN PROJECT SEMESTER (EPS) programme reflects this general trend. From six students in 1995 coming from three countries to 80 international students per year coming from 14 different countries in 2002.

STUDENT STATEMENT

Andrew Perez, a participant in 2001, graduate from University of Notre Dame 1999 with a degree in Mechanical Engineering says about this international teamwork semester: "This semester programme is essentially a semester devoted to a final design project, which is provided and partially supervised by Danish companies. Just like at Notre Dame it entails a team based approach, a lengthy final paper and also a final project presentation. The differences, however, is that my team-mates were from different countries. My team consisted of three women from Spain, The Netherlands and Lithuania. Likewise, the six other groups comprised of multinational teams presenting most of the countries in Europe. Within my group there were two engineers and two business majors, which was tailored perfectly to our project.

Let me start by saying that I cherish this experience as much as I do my four years at Notre Dame. I have learned more about world, the life and myself in the last five month than I have in my previous 24 years of living. I came to the programme believing that with my credentials and experience, I would be able to easily succeed in this setting; I have never been so wrong I my life. My error was that while I have experience working with Americans of various ages and egos, we are all American and therefore predominantly of the same mindset. When I started working within a multi-national team, I found myself having to reinvent my work habits, my communication skills and my choice of words. It was a huge and complete paradigm shift.

Personally, I am forever changed because of this program. I can assure you that this sentiment was also shared by the other American attending and by every single other participant. I am not sure how this program would fit into Notre Dame's strict four-year curriculum, but if you are serious about improving the quality of the degree, then look no further than across the Atlantic to a small country in the north".

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CONSTRUINDO UM PORTAL PARA CRIANÇAS COM CRIANÇAS: UMA ABORDAGEM PARTICIPATIVA AO DESIGN

Amanda Meincke Melo[1] *and M. Cecília C. Baranauskas*[2]

Abstract *— Sistemas de Informação na Internet ampliam a possibilidade de construção de conhecimento através do acesso à informação e da interação entre as pessoas. Enquanto educadores reconhecem a influência dessa mídia na educação de jovens e crianças, ainda são necessários muitos esforços com o objetivo de oferecer ambientes na Internet que atendam às especificidades das crianças e façam sentido para elas. A literatura de Interação Humano-Computador tem mostrado a importância de trazer o usuário para o processo de design de software e várias propostas metodológicas têm sido discutidas. Uma vez que reconhecemos a relevância de trazer as crianças para o processo de design, nossa proposta inclui atividades planejadas com o objetivo de ter crianças como co-autoras de um site na Internet. As crianças que participaram dessas atividades apontaram que desejam um espaço para se divertir, aprender e trocar experiências. Suas idéias para o espaço infantil na Internet – sugestões sobre conteúdos, atividades, suas formas de apresentação e acesso – foram utilizadas para informar a modelagem do sistema. Esse artigo tem como objetivo discutir o processo de design de um site infantil com a participação de crianças.*

Palavras-chave — Internet, crianças, design participativo, sistemas de informação.

INTRODUÇÃO

Sistemas de informação na Internet ampliam as possibilidades de construção de conhecimento através do acesso à informação e a mecanismos de interação entre as pessoas.

Enquanto o uso desta mídia pelas crianças tem crescido cada vez mais e sua influência na aprendizagem tem sido reconhecida por educadores, ainda são necessários muitos esforços com o objetivo de oferecer ambientes na Internet que atendam às especificidades das crianças e façam sentido para elas [14, 2].

Ainda hoje, a participação das crianças na mídia está bastante restrita ao acesso a informações, sendo poucas as iniciativas que garantem às crianças o direito à liberdade de expressão e definição dos conteúdos e suas formas de apresentação [8].

A importância de trazer o usuário da tecnologia para o processo de design de *software* tem sido largamente reconhecida. Áreas do conhecimento como a Engenharia de *Software*, Sistemas de Informação e principalmente a área de Interação Humano-Computador (IHC) mostram diferentes maneiras de envolver o usuário no processo de criação de artefatos computacionais: em atividades de avaliação e testes [17]; em observações e/ou entrevistas [5]; como parceiros nas atividades de design [20]. Esse envolvimento não tem ocorrido da mesma maneira quando o usuário é uma criança. No máximo as crianças são chamadas a participar de atividades de teste de novos produtos, em geral em cenário escolar.

Trabalhos de pesquisa como os de Druin [10], Barcellos e Baranauskas [3], Barcellos [4], Baranauskas e Barcellos [1] mostram que, assim como o adulto, a criança como uma categoria de usuário, tem muito a contribuir no processo de design de tecnologia para seu uso. Como bem coloca Druin [9], as crianças são capazes de falar sobre o que gostam ou não gostam, têm curiosidades e necessidades que não são as mesmas dos *designers* de *software*, de seus pais ou professores.

Este trabalho tem como objetivos apresentar a abordagem participativa utilizada no design do portal Caleidoscópio Júnior e discutir como a significação de crianças para o espaço infantil na Internet, a partir da sua atuação com elementos de design, foi carregada para o processo de desenvolvimento do portal.

O artigo está organizado da seguinte forma: a Seção 2 apresenta o referencial teórico para o trabalho; a Seção 3 apresenta as atividades realizadas com crianças para envolvê-las no design do portal Caleidoscópio Júnior e seus principais resultados; a Seção 4 discute como esses resultados derivaram no sistema e apresenta alguns aspectos da implementação do portal; a Seção 5 conclui.

DESIGN PARTICIPATIVO E O CONTEXTO DA CRIANÇA

O Design Participativo (DP) [16, 6, 11] teve início na Escandinávia na década de 70, com suas bases fundamentadas no princípio da democracia no ambiente de trabalho. Nesta abordagem os sistemas computacionais são "desenhados" pelos *designers* e usuários em conjunto, contrapondo a abordagem tradicional ao desenvolvimento de sistemas computacionais, onde muitas vezes os interesses dos usuários do sistema não são considerados, ou não são

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captados de maneira satisfatória. Na abordagem tradicional, em geral, prevalece somente o interesse de quem contrata o sistema e a vontade dos próprios *designers* do sistema.

Outro aspecto a ser destacado no DP é a possibilidade de melhorias no próprio processo de design. A colaboração dos usuários no processo de desenvolvimento provê subsídios e o *feedback* adequado para os *designers*. Além disso, o DP surge como uma abordagem capaz de aprimorar a qualidade de design e do sistema resultante, através da melhor compreensão da atividade do usuário e da combinação das experiências dos diversos participantes do processo de design [7].

Em adição aos aspectos políticos conseqüentes do design participativo em sua versão escandinava original, a pesquisa em DP ganhou novos contextos socioculturais em outras partes do mundo e em geral visa desenvolver práticas que promovam uma cooperação produtiva entre *designers* e usuários.

Druin [10] observa que essa abordagem ao design, que tenta capturar a complexidade e aspectos do contexto do trabalhador pela sua própria perspectiva, poderia ser útil também para capturar aspectos do contexto da criança. A criança como parceira de *designers* e educadores no design de tecnologia tem sido apresentada nos trabalhos pioneiros de Druin [9], que propõe como equipe de design um grupo que a autora denomina *intergenerational*. Essa equipe inclui membros de diversas idades, disciplinas e experiências, sendo que algumas crianças têm feito parte da equipe juntamente com educadores, cientistas da computação e artistas.

Enquanto reconhecemos a importância de trazer a criança ao processo de design, estamos igualmente interessadas em entender o processo de significação da criança a partir da atuação delas com os elementos de design e refletir no sistema, através de sua interface, esse entendimento. Em função do estágio de desenvolvimento cognitivo em que se encontra, a criança nem sempre consegue expressar, da mesma maneira que o adulto, idéias abstratas [19]. Assim, o *designer* deve interpretar as ações da criança com os objetos concretos e simbólicos utilizados e gerados nas atividades participativas.

Participação e Significação como Base do Processo de Design

O entendimento do contexto de significação, capturado em atividades participativas, deve ser representado de maneira a informar a modelagem do sistema. Argumentamos que métodos da Semiótica Organizacional (SO), em especial a Análise Semântica, podem facilitar essa transição do que resulta de atividades participativas para o design do sistema. Dessa maneira o significado é construído como resultado da cooperação entre os *designers* e as crianças, usuários prospectivos da tecnologia.

A Semiótica Organizacional é uma disciplina que explora o uso de signos e seu efeito em práticas sociais. Baseada nas escolas de Peirce [18] e Morris [15], a SO propõe um conjunto de métodos para o design de Sistemas de Informação. Organização é entendida num sentido amplo como um grupo de pessoas, uma sociedade, uma cultura, que não somente compartilham regras de linguagem, costumes e hábitos, mas também participam da construção social dessas regras. A Análise Semântica é um método utilizado para produzir modelos semânticos ou diagramas de ontologia do domínio do problema. A Análise Semântica apoia-se em dois conceitos principais: agente e *affordance*. Agentes possuem *affordances* manifestadas por padrões de comportamento, e, ao mesmo tempo estão sujeitos a *affordances* dos objetos e agentes com os quais interagem.

O conceito de *affordance* foi proposto por Gibson [12] e utilizado pelos estudiosos da abordagem ecológica à percepção visual, para designar o comportamento de um organismo possibilitado por alguma estrutura combinada do organismo e seu ambiente. Por exemplo, se uma superfície terrestre é horizontal, plana, rígida, relativa a um determinado animal, então essa superfície "*affords*" suporte. Da mesma maneira, artefatos da nossa cultura *afford* um tipo de utilização. O formato da maçaneta da porta *affords* o tipo de movimento necessário para abrir a porta. O que percebemos quando olhamos para objetos são suas *affordances*, não suas qualidades. *Affordances* não são propriedades físicas ou fenomenológicas; são propriedades tomadas relativas a um observador [12: 143].

Conforme apresenta Gibson, entretanto, o conjunto mais elaborado de *affordances* do ambiente é fornecido pelas outras pessoas que interagem com o observador, umas com as outras e com os objetos do mundo. Comportamento *affords* comportamento.

A definição dos conceitos de agente e *affordance* em SO é sensível ao contexto; um agente pode ser simplesmente uma pessoa e ser ontologicamente dependente de algum agente mais complexo, por exemplo, a sociedade. Nesse caso o agente pessoa é, ele próprio, uma *affordance* de sociedade [13].

O método de Análise Semântica possibilita modelar um sistema computacional com o foco em agentes e *affordances*. O método pode ser sumarizado em quatro fases principais: definição do problema, geração de *affordances* candidatas, agrupamento de *affordances* e criação do diagrama ontológico.

A definição do problema é a primeira fase da Análise Semântica, onde o problema a ser modelado é introduzido basicamente através de um enunciado. Esse enunciado pode servir como uma fonte inicial de agentes e *affordances*. Mas em geral o enunciado do problema é muito vago, e atividades de design participativo podem colaborar na descoberta das atribuições do sistema e de seus usuários. Na fase de geração de *affordances*, o enunciado do problema é investigado e toda a documentação que colabora para a definição do problema, na busca de unidades semânticas que podem indicar agentes, *affordances* e suas relações. O agrupamento de *affordances* e o diagrama de ontologias construído pelo *designer* como resultado de seu entendimento da significação, por sua vez, podem realimentar novas práticas participativas e refinar esse processo de entendimento do problema e significação dos participantes a partir dos elementos de design. A Figura 1, a seguir, ilustra a abordagem proposta, envolvendo atividades participativas de design e Análise Semântica.

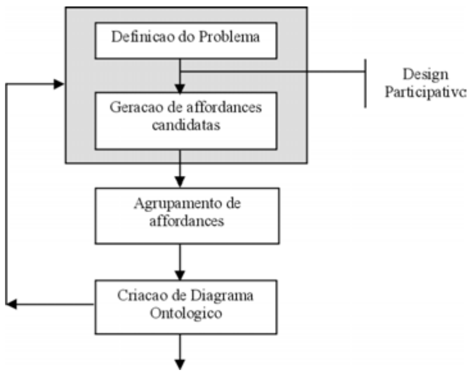

FIGURA. 1
DESIGN PARTICIPATIVO COMBINADO À ANÁLISE SEMÂNTICA.

DESIGN COM PARTICIPAÇÃO DE CRIANÇAS: UM ESTUDO DE CASO

Para participar do processo de design do portal Caleidoscópio Júnior, dez crianças entre 6 e 10 anos – meninos e meninas com diferentes níveis de acesso à tecnologia – foram convidadas a atuar em uma diversidade de atividades. O planejamento dessas atividades foi realizado por pesquisadores das áreas de educação, computação e IHC.

Os encontros com as crianças ocorreram durante 4 sessões de 2 horas cada, nos meses de outubro e novembro de 2001, no NIED/UNICAMP. Para registrá-los, foram utilizadas máquinas fotográficas, câmeras de vídeo e gravadores de som.

As crianças foram envolvidas em várias atividades, incluindo criação de protótipos do portal Caleidoscópio Júnior, exploração de uma ferramenta de comunicação para crianças na Internet, exploração de *sites* infantis e conversas que colaboraram para a troca de idéias sobre o espaço infantil na Internet.

Pela criação de protótipos, ilustrada na Figura 2, as crianças puderam expressar sua compreensão sobre a Internet, as atividades que gostariam de realizar em um espaço infantil na rede mundial de computadores, bem como os conteúdos desse espaço, sua forma de apresentação e acesso.

FIGURA. 2
PARTICIPAÇÃO ATRAVÉS DA PROTOTIPAGEM.

Na atividade que promovia conversas entre as crianças via Internet, o Papo-Mania – desenvolvido para o público infantil no contexto da educação inclusiva [3] – foi utilizado como ferramenta de bate-papo. Por meio da conversa estabelecida através do Papo Mania, as crianças puderam vivenciar uma das formas de interação e comunicação oferecidas pela rede mundial de computadores. Da atuação com a ferramenta e dos diálogos mantidos entre os participantes emergiram sugestões de modificações e incorporações de opções à interface da mesma.

Durante a navegação em *sites* infantis, as crianças mostraram algumas atividades de maior aceitação, suas expectativas em relação a esses espaços, os problemas relacionados aos conteúdos e às formas de apresentação dos mesmos e questões de segurança dos *sites* visitados.

As trocas de idéias sobre o espaço infantil na Internet ocorreram em diversos momentos e ofereceram indícios aos *designers* sobre o que havia sido representado pelas crianças nos protótipos do portal, além de complementarem as observações realizadas por eles durante a navegação nos *sites* infantis.

Pela participação nas atividades de design, as crianças mostraram que elas querem um espaço na Web para se divertir, aprender e trocar idéias com outras crianças, inclusive, de outros países. Sugestões de conteúdo, estrutura e atividades emergiram durante essas atividades e foram utilizadas para informar a modelagem do sistema.

Entre os conteúdos que elas querem acessar estão incluídas informações de como montar um caleidoscópio, sobre quem fez o *site*, sobre como o *site* foi inventado, informações sobre cinema, sobre plantas e links para outros *sites*.

Através dos protótipos, as crianças sugeriram diferentes estruturas de navegação para o portal. Entre as estruturas sugeridas – amparadas pelas metáforas de livro virtual, canais de televisão e mesa de trabalho, por exemplo [14, 2]–, as que fazem uso de menus laterais parecem ser mais fáceis de navegar, conforme apreendido da navegação em portais infantis.

As atividades que elas querem realizar no espaço infantil na Internet incluem trocar idéias com outras crianças sobre os mais variados assuntos – jogos, cinema, trabalhos escolares, entre outros –, jogar – jogos de tabuleiro, de estratégia e outros jogos –, fazer pesquisa escolar, desenhar e fazer agenda.

As crianças utilizaram cores, brilhos e elementos de interface comuns em ambientes computacionais como menus, caixas de seleção, botões (voltar, avançar, sair), ícones e textos para compor a interface do portal, indicando que já possuíam alguma familiaridade com o computador/Internet. Ao conversarem sobre as idéias que elas têm de *site* infantil, acrescentaram que alguns elementos são dinâmicos e interativos.

O DESIGN DO CALEIDOSCÓPIO JÚNIOR

Além de contribuírem para a definição da interface, os resultados das atividades participativas geraram os elementos semânticos básicos que compõem o portal e definem seu contexto de uso: agentes e *affordances*. Tais elementos foram, então, representados em diagramas de ontologias, conforme proposto na Figura 1. Os diagramas de ontologias representam, portanto, o entendimento e a expressão do *designer* para espaço infantil na Internet, a partir de sua interpretação da significação da criança para os elementos de design do portal. A Figura 3, a seguir, ilustra um dos diagramas de um conjunto que, combinados, compõem o projeto do portal como um todo.

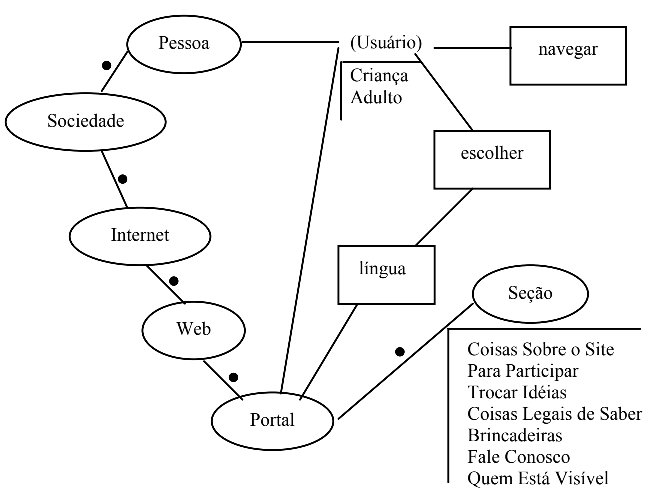

FIGURA. 3
UM DIAGRAMA DE ONTOLOGIAS: VISÃO PARCIAL DO PORTAL.

No diagrama de ontologias da Figura 3, existe um agente raiz: a sociedade, onde os significados sobre as ações das crianças na Internet são compartilhados de forma coletiva. A relação ontológica entre agentes e *affordances* é representada da esquerda para a direita. Por exemplo, a *affordance* "escolher" depende da existência de um "Usuário" – papel de "Pessoa" no "Portal" – e da *affordance* "língua", que depende da existência do agente "Portal". O diagrama também apresenta as "Seções" principais do "Portal", que agrupam os conteúdos do *site* e as atividades que as crianças querem realizar.

Os diagramas de ontologias, que descrevem o contexto do sistema de informação, serviram como fonte para a modelagem da base de dados do portal, juntamente com os materiais gerados durante as atividades de design com as crianças. Por exemplo, a idéia de que o portal fosse acessível para crianças de outros países – internacionalização do *site* – apareceu durante as atividades de *design* participativo e foi contemplada no diagrama de ontologias, sendo carregada para a modelagem da base de dados do portal.

A Figura 4, abaixo, mostra como os resultados das atividades com as crianças e os diagramas de ontologias derivaram no sistema.

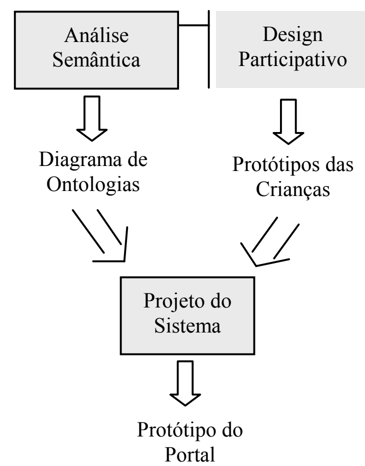

FIGURA. 4
DO REFERENCIAL TEÓRICO AO PROTÓTIPO.

Aspectos de Implementação

Entre as tecnologias utilizadas para implementação do portal estão HTML, CSS, JavaScript, MySQL e PHP.

A linguagem HTML, interpretada pelos navegadores Web, é utilizada para descrever a interface do portal Caleidoscópio Júnior. As folhas de estilo (CSS) permitem especificar a apresentação das páginas HTML – cor de fundo, formatação da fonte, estilo de bordas, etc –, independente de seu conteúdo. A linguagem JavaScript é utilizada para responder a algum evento no navegador. O MySQL é o servidor de banco de dados utilizado, enquanto que PHP é a linguagem de programação empregada para implementação da aplicação interpretada no servidor Web.

O uso dessas tecnologias permite a programação de interfaces customizáveis e de fácil manutenção. Um exemplo de customização da interface Caleidoscópio Júnior se refere à possibilidade de escolha de diferentes estilos de apresentação do conteúdo do portal pelo usuário. A Figura 5, a seguir, apresenta a página inicial do Portal Caleidoscópio

Júnior e destaca alguns de seus estilos de apresentação, que podem ser selecionados.

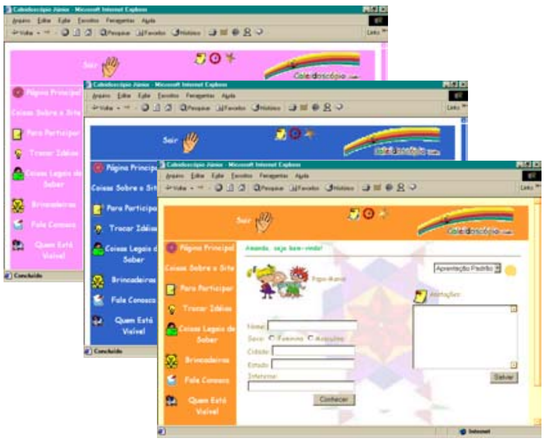

FIGURA. 5
INTERFACE DO PORTAL CALEIDOSCÓPIO JÚNIOR.

CONCLUSÃO

A metodologia de trabalho apresentada serviu como base para definição da estrutura do portal Caleidoscópio Júnior e configuração de uma primeira versão a ser avaliada com crianças.

Seu desenvolvimento continuará através de um processo incremental, ou seja, sua utilização irá definir os conteúdos e outras ferramentas adequadas ao seu contexto de uso.

Além da criação de novos conteúdos e ferramentas, faz-se necessário o projeto e a implementação de um ambiente de administração dos dados do portal. Hoje essa administração é realizada através de uma interface Web que possibilita o envio de consultas SQL ao servidor de banco de dados da aplicação – uma tarefa que ainda requer conhecimento especializado do sistema.

Ainda, como uma das propostas do portal é permitir que crianças troquem idéias de forma mais livre, através dos mecanismos de comunicação já disponíveis no portal, será preciso restringir seu uso, em um primeiro momento, a projetos e atividades escolares, onde elas não ficariam tão expostas às "inseguranças" da Web.

AGRADECIMENTO

Agradecemos a participação valiosa de Maria Cecília Martins e Raquel Zarattini Chebabi no planejamento, participação e discussão das atividades realizadas com as crianças. Este trabalho contou com apoio do CNPq.

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THE IMPORTANCE OF ENVIRONMENTAL PROTECTION AND PROFESSIONAL ETHICS TO ENGINEERING AND TECHNOLOGY DEPARTMENTS IN HIGHER EDUCATION

Muthar Al-Ubaidi[1] and Mark Fritz[2]

Abstract — *As nations spend billions of dollars cleaning up environmental mistakes from decades of abuse, the question arises of what role institutions of higher education may play in preparing future professionals to prevent environmental destruction. Primary and secondary educators in the United States have, over the past decade, incorporated programs into their curricula designed to develop student sensitivity to the environment. Institutions of higher education, however, may lag behind. We believe that assessing the current practices of higher education in teaching environmental protection and professional ethics could provide critical information for improving educational practices. To obtain this critical information, we developed a pilot survey to explore the extent to which courses in environmental protection and professional ethics are taught within higher education. The survey was sent to 2000 educators representing undergraduate and graduate programs in engineering, science, and technology. The survey results suggest that professional ethics courses may be widely taught, but environmental protection courses are not.*

Index Terms — *environment, ethics, pollution.*

INTRODUCTION

Human survival depends on a number of natural resources. Water is certainly one such resource; air is another; and energy sources such as fossil fuels are a third. Reviewing the presence and effects of pollutants in each of these natural resources is a helpful way to begin a discussion of the role of higher education in preparing future professionals to prevent environmental destruction.

Water. Water is a resource with unique properties, essential to all life. It is a basic factor in the growth of natural communities and human civilizations. The safety of a drinking water supply is influenced by impurities that fall into three classes: organic chemicals, inorganic chemicals, and microorganisms. Discharge of wastewater represents a growing threat to water supplies by adding all three of these impurities to water resources. Wastewater from cities, industries, mining operations, farms, and rural homes contains organic, inorganic, and microorganism impurities that can and do contaminate drinking water supplies. If organic pollutants present in wastewater are not removed, they can rob water of the dissolved oxygen normally present. Also, organic chemicals such as pesticides may directly poison aquatic organisms, including those connected to human food supplies. Inorganic chemicals in wastewater such as certain phosphorus and nitrogen compounds can cause excessive overgrowth of algae. Microorganisms in discharged wastewater are a major cause of disease [1]. For many years industrial and municipal wastes have been buried in landfills, in abandoned wells and mines, or discharged directly into rivers and other bodies of water. Only recently have we come to better understand how these practices can pollute groundwater which was once thought to be the safest source for drinking water.

Air. Air is as essential as water; however, numerous pollutants taint the air we breathe. Misuse of fossil fuels has polluted the air so severely that in some regions it is a significant cause of death [1]. Solid particles such as lead, asbestos, and soot are dispersed in the air. Liquid droplets of hydrocarbons and sulfuric acid float in the atmosphere. Gases such as carbon monoxide, nitrogen oxides, and sulfur dioxide are mixed in the atmosphere that surrounds us. These pollutants may impair breathing and exacerbate heart and lung diseases. The landscape is also influenced because forests and other vegetation are sensitive to air pollutants. Construction materials such as mortar and metal are corroded by some of these pollutants. Smog and acid rain are a few other examples of the effects of air pollution.

Energy Sources. Energy sources are essential and commonly used in three ways. First, the energy released by mining and burning fossil fuel may be used directly as heat. Second, the heat energy might be converted into work, using refined oil to run machinery and power automobiles. Third, the heat energy from either fossil fuel or nuclear sources may be converted to electricity. All of these uses of energy discharge pollution in forms that can range from waste heat, to many of the air pollutants mentioned above, to radioactive materials.

The last few decades have seen a strong movement begin to clean the environment from these pollutants released by new technologies and lack of concern for their effects. This lack of concern may be due to the dearth of understanding by engineers of the effects of these technologies on the environment, and also to a preference

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for economic factors over ethical factors. Nonetheless, cleanup costs may be shown to be many times greater than the cost of educating engineers to protect the environment and to build in them strong ethical behavior to protect natural resources.

EXAMPLES OF CLEANUP COSTS

Cleaning up pollution is expensive. The average cost to clean a contaminated groundwater site under the U.S. Superfund cleanup program, for example, is $25 million [2]. Cleaning up some polluted sites is even more expensive than this average. For example, cleaning up lead-contaminated soil and groundwater from an eastern U.S. site where automobile batteries were discarded will cost an estimated $40 million [3]. And the cleanup cost of toxic metal and acid releases from California's Iron Mountain Mine is estimated to approach $1 billion [4]. Thousands of such polluted sites can be found worldwide, and estimating the cost to clean up all of these sites is likely to yield a staggering number. In the U.S. alone, estimates place the total cost of cleaning up all the private and public polluted sites as high as $500 billion to $1 trillion [5].

In addition to paying for cleanup, the high cost of pollution is often incurred in terms of human health. Some human costs are local. For example, in the Great Lakes region of the U.S. and Canada, children born to women who have high levels of PCBs (polychlorinated biphenyls) from widespread improper disposal suffer retarded growth and score significantly lower on certain memory tests [6]. Other human costs are global. In 2002, the World Health Organization listed unsafe water as one of the top ten health risks worldwide [1]. Widely-read publications indicate that an estimated 1 billion people worldwide drink contaminated water [7]. Also worldwide, urban air pollution killed an estimated 800,000 people in 2002. Lead pollution killed an estimated 234,000 people [1].

These few examples illustrate the high cost of pollution, both in terms of the money required for cleanup and in terms of the impact on human health. The cost of pollution is many times greater than the cost of educating engineers to protect the environment and its natural resources.

A CHALLENGE FOR ENGINEERING AND TECHNOLOGY EDUCATORS

Most engineering and technology educators would agree that environmental protection is a matter of primary importance to humans and to the future of humanity. Some of us also feel a sense of frustration, of "where can I begin?", "how can I help?" or "what are my roles and responsibilities?" Some of us fear that we do not know enough or that we are just "amateurs," unlikely to have any significant impact whatever we do. Others ignore the issue hoping that it will go away. These thoughts were the driving force behind our desire to survey educational institutions regarding their courses in environmental protection and professional ethics.

PILOT SURVEY OF EDUCATIONAL INSTITUTIONS

A four-question pilot survey was designed to explore the extent to which environmental protection and professional ethics are taught in undergraduate and graduate institutions in engineering, science, and technology. The survey was sent by e-mail to over 2000 educators around the world. The four survey questions are listed below as the captions to Figures 1-4.

Sixty educators responded to the survey. Almost all of the respondents taught in engineering and technology programs. Most of the respondents (42) were in the United States. Other respondents were in Latin America (8), Asia (5), the Middle East (4), and Europe (1). Survey results were tabulated by location and by discipline. Two locations were considered, the U.S. and other countries as a whole. Other countries were considered as a whole because of the small number of non-U.S. respondents. Three groups of engineering and technology programs were considered: those in the civil, mechanical, and electrical/computer disciplines.

RESULTS

The first survey question asked respondents if their institution has a department in the field of environmental or green engineering. As illustrated in Figure 1, 64% of all respondents indicated that their institutions have no such departments. When responses from the U.S. were collected and compared to responses from other countries as a whole, the results for the two groups were almost identical. In the U.S., 64% indicated no environmental or green engineering department. In other countries as a whole, 65% indicated no such department.

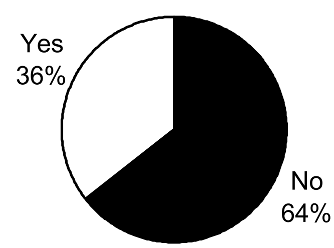

FIGURE 1
DOES YOUR INSTITUTION HAVE AN ENVIRONMENTAL OR GREEN ENGINEERING DEPARTMENT?

The second survey question asked respondents about required courses in their department on environmental protection. As illustrated in Figure 2, 69% of all respondents indicated that they have no required courses in environmental protection. When divided into responses from the U.S. and responses from other countries as a whole, the results were 70% no required courses for the U.S. and 66% no required courses for other countries. Among disciplines, respondents from civil engineering departments were most likely to indicate one or more required courses. In these civil engineering departments, only 34% of respondents indicated no required courses, in contrast to the 69% rate for all respondents shown in Figure 2. Electrical/computer engineering departments were most likely to indicate no required courses. In these departments, 92% of respondents indicated that they had no required courses in environmental protection.

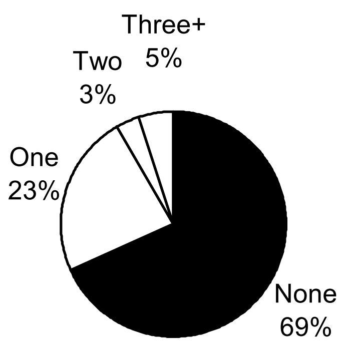

FIGURE 2
IN YOUR DEPARTMENT, HOW MANY REQUIRED COURSES ON ENVIRONMENT PROTECTION DO YOU HAVE?

The third survey question asked respondents about optional or elective courses in their department on environmental protection. As illustrated in Figure 3, about half of all respondents—52%—indicated that they offer no optional or elective courses in environmental protection. Results from the U.S. suggest that other countries as a whole may be more likely than the U.S. to offer optional and elective environmental protection courses. In the U.S. 55% indicated no optional or elective courses; in other countries as a whole only 44% indicated no optional or elective courses. Among disciplines, the results were similar to those above for required courses, with respondents from civil engineering departments being least likely to indicate that they had no optional or elective courses. Respondents from electrical/computer engineering were most likely to indicate that they had no optional or elective courses.

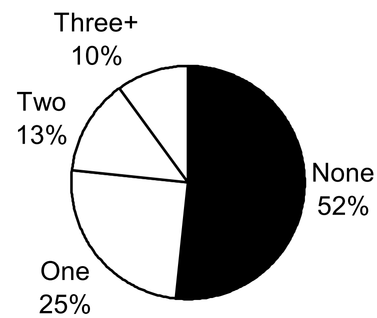

FIGURE 3
IN YOUR DEPARTMENT, HOW MANY OPTIONAL OR ELECTIVE COURSES ON ENVIRONMENT PROTECTION DO YOU OFFER?

The fourth and final survey question asked respondents about courses offered in ethics and professional responsibilities. As illustrated in Figure 4, 24% of all respondents indicated that their department or college offers no such courses. Results by location suggest that other countries as a whole are more likely than the U.S. to offer no ethics and professional responsibility courses. In other countries as a whole 44% of respondents indicated offering no such courses. In the U.S. only 15% of respondents indicated offering no such courses. Among disciplines, civil engineering respondents were most likely to offer no such courses (56% indicated none.) Mechanical engineering respondents were least likely to offer no such courses (30% indicated none.)

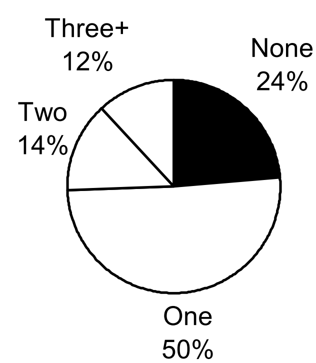

FIGURE 4
IN YOUR DEPARTMENT OR ELSEWHERE IN YOUR COLLEGE, HOW MANY COURSES IN ETHICS AND PROFESSIONAL RESPONSIBILITIES DO YOU OFFER?

CONCLUSION

The results of the pilot survey help reveal the extent to which environmental protection and professional ethics are taught in undergraduate and graduate programs in engineering and technology. The survey results suggest that professional ethics are widely taught in these programs. Adding percentages in Figure 4 shows that a total of 76% of the respondents indicate offering one or more courses in ethics and professional responsibilities. In contrast, except for civil engineering, most engineering and technology programs appear to pay little attention to environmental protection courses. Adding percentages in Figures 2 and 3 shows that a total of only 31% of respondents indicate courses in environmental protection that are required; only 48% indicate courses that are optional or elective.

The low response rate to the pilot survey (60 respondents out of 2000 contacted) is consistent with the conclusion that most programs pay little attention to environmental protection courses. Also, educators in programs with interest in environmental protection may be more likely to respond to a survey on that topic. As a result, the survey results may even overestimate the true extent of environmental protection coursework in engineering and technology disciplines.

Why so little interest in environmental protection courses? One possible explanation lies with the industries that we serve. Because educators adapt curricula to meet industry needs, industry is a major driving force in the curriculum. Industry may simply not be interested in students who have completed courses in environmental protection. We propose that educators could improve the engineering and technology disciplines, however, by being proactive. The huge costs of pollution and its cleanup are borne by all of us, either directly through our health or through the cleanup costs to industry and taxpayers. By improving education for our students about the consequences of pollution, we can lead change in industry and reduce the costs of pollution and its cleanup.

To build on this pilot study, we plan to survey educators further to increase the number of respondents. Our goal is to create a more complete picture of the state of environmental protection education in engineering and technology departments.

ACKNOWLEDGMENT

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EFFECTS OF CONTROLLED RAMP-DOWNS/UPS FOR CRYOGENIC PROCESSING OF RAPID PROTOTYPED MATERIALS

J. Jackson[1], G. Chapple[1], J. Do[1], X. Zhuang[1], M. Mendelson[1], R. Noorani[1], B. Fritz[2]

Abstract — *Rapid Prototyping (RP) turns a virtual three-dimensional drawing into a solid structure and useable part. Increasing the material properties of RP materials allows rapid prototyped parts to be employed in a wider variety of applications. The major goal of this study is to increase the scope of usage of RP materials through cryogenic processing by optimizing the combination of strength and ductility for the stereolithography photopolymer epoxy resin DSM Somos 8110. The research will investigate (1) the effects of cryogenic processing of prototyped samples, (2) the effects of controlled ramp-downs/ups on the ultimate and tensile strengths of samples,(3) the equipment and procedures used, (4) the results and analysis of the experimental data. Test specimens of RP thermosetting resin (DSM-Somos 8110) were fabricated and cryogenically aged from 10-25 hours. The tensile strength and impact toughness were measured.*

Index Terms — *Rapid prototyping materials, cryogenic processing, tensile and ultimate strengths*

INTRODUCTION

The primary objective of this research is to apply cryogenic processing to Rapid Prototyped materials. Cryogenics is the science and art of producing cold. It started in 1877 when two scientists, Cailletet in Paris and Picet in Geneva, developed a procedure to liquefy oxygen in a laboratory[1-2]. Nowadays, nitrogen and helium are the most common cooling media. Since the normal boiling points of nitrogen and other permanent gases such as helium, oxygen and argon are about 120K (approx. –244 ^{o}F), the cryogenic temperature is generally considered 120K or below [3-4].

Cryogenic processing is one of the most important fields in industry today [4]. It helps to reduce costs for industry and increase industrial efficiency. For example, industrial application has reported 195% to 817% increase of wear resistance for standard steel that was cryogenically treated [5]. The cryogenic process consists of 3 stages based on time and temperature variables. This process starts with gradual ramping down of temperature to a specific point, then the temperature is held at that point for a period of time, then the temperature is brought up to room temperature . As a result of this deep cooling and heating cycle, molecular changes occur, binding the atoms in the metal together [4].

Over the last 10-20 years, not much research has been conducted on cryogenic processing. Most research that was done on cryogenics was on metals. Rapid Prototyping (RP) is a new technology that takes information from a computer-aided design file and makes a 3D part by building it one layer at a time [5]. When RP was first introduced in the late 80's, the materials used to produce the parts had low yield strength. Our research attempts to show that the strengths of RP materials can be increased by cryogenically processing the samples before its industrial applications. As mentioned before, in all the cryogenic work, the scientists and engineers basically lowered the temperature of the sample to cryogenic condition very fast, held it to the temperature for a few hours and then ramped up the temperature as fast as possible [4,5]. Two years ago, the author did research on the cryogenic processing of both ABS plastic from Fused Deposition Modeling (FDM) and DSM SOMOS 8110 using Stereolithography Apparatus (SLA)-250 machines. While the cryogenic processing did not have much effect on ABS plastic, the yield strength of DSM SOMOS was increased between 25-50% [6]. The author believes the ramp-down and ramp–up conditions might make a significant contribution to the increase in strength of the polymer samples.

The author has recently developed a Data Acquisition System (DAS) using LabVIEW from National Instruments that provides us the programming power for the ramp-down and ramp-up conditions. The conventional and proposed cryogenic processes are shown in Figures 1and 2.

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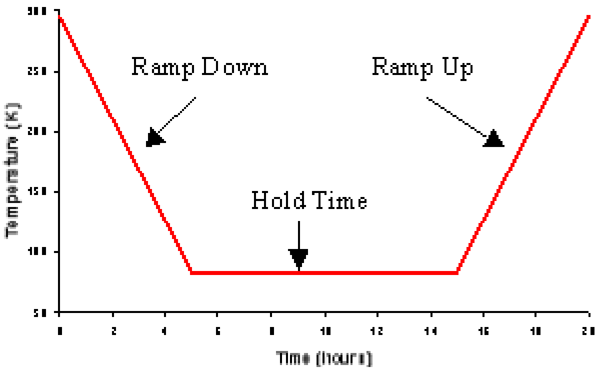

FIGURE 1 CONVENTIONAL CRYOGENIC PROCESSING

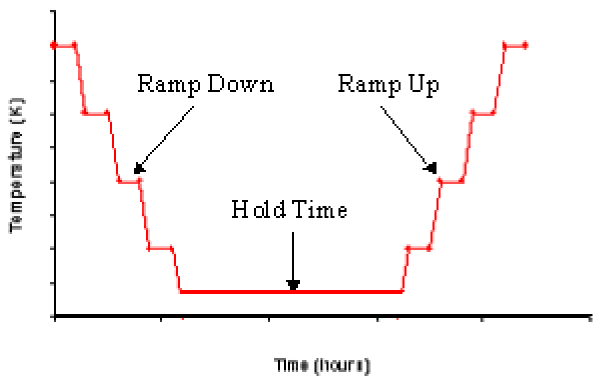

FIGURE 2 PROPOSED CRYOGENIC PROCESSING

NSF REU PROGRAM AT LMU

LMU received an NSF grant two years ago to establish a research experience for undergraduates (REU) site. The objective of the proposed REU site program is to provide, each year, 20 community college students and four LMU students the opportunity to engage in engineering research on meaningful projects during a ten week summer period. Community college participants are recruited from the twenty community colleges in closest proximity to LMU. A further objective is to attract students from those groups traditionally under-represented in the engineering profession. The work is conducted under the guidance of two faculty who has much successful experience in directing undergraduate students in research work. The results of the research are published in journals and reviewed conference proceedings. The goal of the program is to inspire the students to complete their undergraduate study and go on to participate in research at the graduate level.

EXPERIMENTAL PROCEDURE

Equipment and Process

The following major equipment was used in this research.

1. Northrop Grumman SLA-250 RP Machine
2. Cryogenic Treatment Equipment
3. Instron Tensile Testing Machine
4. Izod Impact Tester
5. Scanning Electron Microscope (SEM)

The experimental setup if shown in Figure 3.

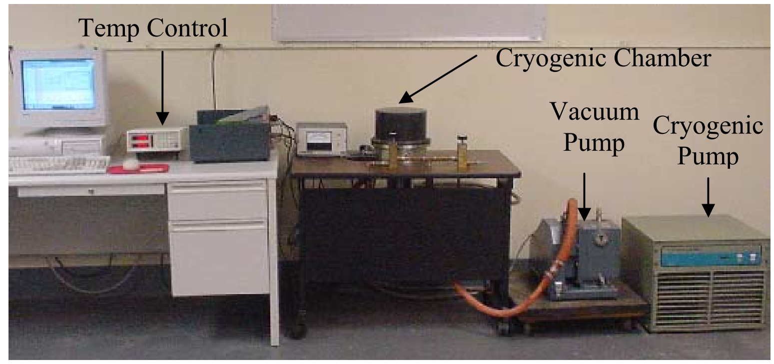

FIGURE 3. EXPERIMENTAL SETUP FOR CRYOGENIC PROCESSING.

The following outlines the steps used in the experimental process that was used to design, fabricate, test and analyze the samples.

1. Design Dog Bone and V-Notch Samples
2. RP Machine Builds Parts from Design
3. Expose Parts to Cryogenic Treatment with Liquid He.
4. Tensile and Impact Testing

The programming of the temperature controller using LabVIEW 6i is shown in Figure 4.

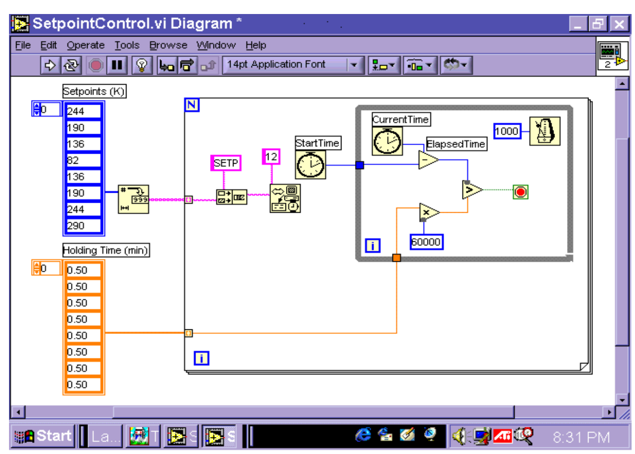

FIGURE 4. TEMPERATURE SETPOINT VI DIAGRAM

Designing and Prototyping the Samples

Drawings of the dog bone and v-notch shaped samples were created using AutoCAD (Figs. 5A and 5B) and these were saved as separate .DWG files. These files were then converted into STL format for use with stereolithography software. SLA-250 (Northrop Grumman) RP machines was then used to rapid prototype the parts.

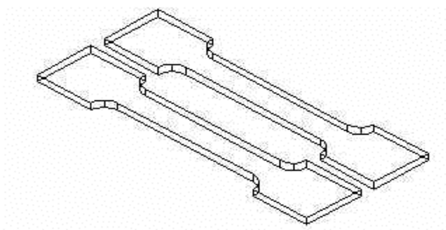

FIGURE 5A. TWO DOG BONE-SHAPED SAMPLES.

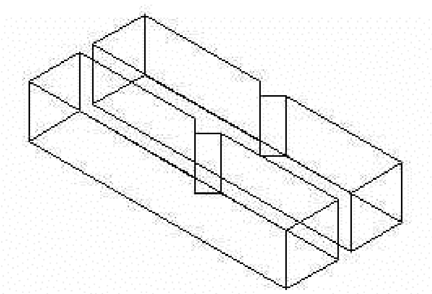

FIGURE 5B. TWO V-NOTCH-SHAPED SAMPLES.

Cryogenic Treatment

The following process was used to cryogenically treat each sample.

1. All samples except the baseline went through cryogenic treatment before testing. The samples were prepared at Northrop Grumman, and cryogenically aged at Loyola Marymount University.
2. The cryogenic process is characterized by three parameters: ramp-down time from room temperature to 88K (–300^{o}F), hold time at 88K, and ramp-up time from 88K to room temperature.
3. Preliminary experiments were performed on cryogenic treatment. The ramp-down time of 14 hours was used. Three holding times of 10, 15 and 20 hours, and ramp up times of 14 hours were used.

Samples are labeled as follows: XX-XX-XX. The numbers represent the ramp-down time, holding time and ramp up time, respectively, in hours. (e.g: 14-10-14 means that the samples were ramped-down in 14 hours, cryogenically aged 10 hours, and then ramped-up in 14 hours.)

Tensile Testing and Izod Impact Testing

The yield and ultimate strengths of the samples were measured using the Instron Universal Testing Instrument 4500. The cross-head speed of the test machine was 0.0212 mm/s. The interface with the machine was performed using the front panel and a software program running on a desktop computer. Izod impact testing is performed to determine the toughness of a material. The sample is made with a centered v-shaped notch. During the impact testing, the sample is subjected to a quick and intense blow by a hammer pendulum. The impact test evaluates the material's resistance to crack propagation. The impact energy absorbed by the sample during failure is determined by calculating the difference in potential energy of the hammer.

RESULTS AND DISCUSSION

Tensile and Impact Testing

The results of the yield strength and ultimate strength vs. cryogenic treatment time (0-20 hours) are shown in **Figures 6A, 6B.** In both cases, the strengths appear to be affected by aging time. To verify these results, the data were statistically analyzed using multiple t-testing, which compared the means of two treatments at-a-time at a 0.05 level of significance [7]. A one-way analysis of variance (ANOVA) could not be used, because the variances of the treatments were unequal. For the yield strength data (**Figure 6A),** it was determined with 95% confidence that the means of the treatments were statistically insignificant. Due to the large variances at 15 and 20 hours, we can say that there was no significant increase in the yield strength with aging time.

For the ultimate strength (**Figure 6B)** vs. aging time, the data were analyzed in the same way. Again, one-way ANOVA could not be used. Multiple t-testing on the treatment means showed that for 95% confidence two conclusions were reached: (1) the mean strengths at 0, 10 and 20 hours were equivalent, and (2) the mean strength at 15 hours was significantly lower than that at 10 and 20 hours. Hence, aging time produced a drop in the ultimate strength between 10 and 15 hours. Otherwise, there was no significant effect of cryogenic aging on the ultimate stress.

The effects of ramp-up times on the yield strength and ultimate strength are shown in Figures 7A and 7B. In both cases, the strengths appear to be negatively affected.

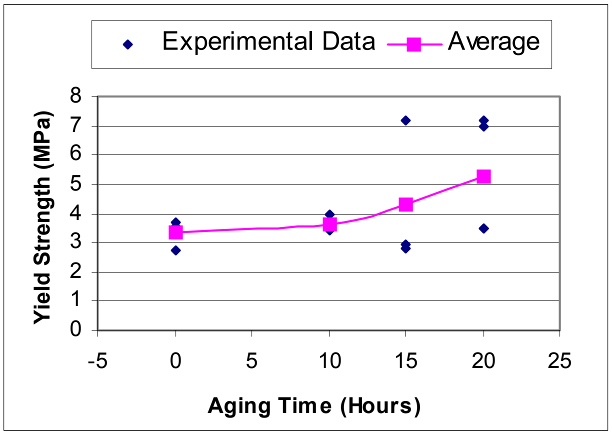

FIGURE 6A. YIELD STRENGTH VS. CRYOGENIC AGING TIME.

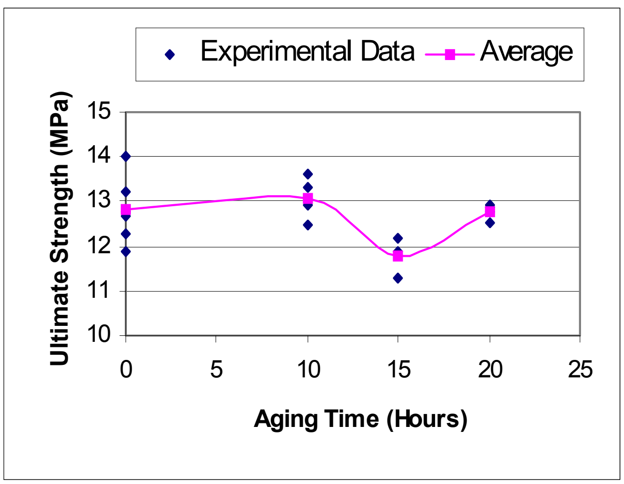

FIGURE 6B. ULTIMATE STRENGTH VS. CRYOGENIC AGING TIME.

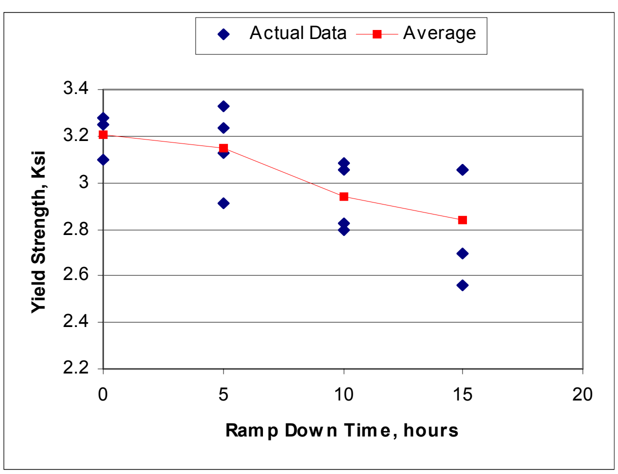

FIGURE 7A. YIELD STRENGTH VS. RAMP-DOWN TIME

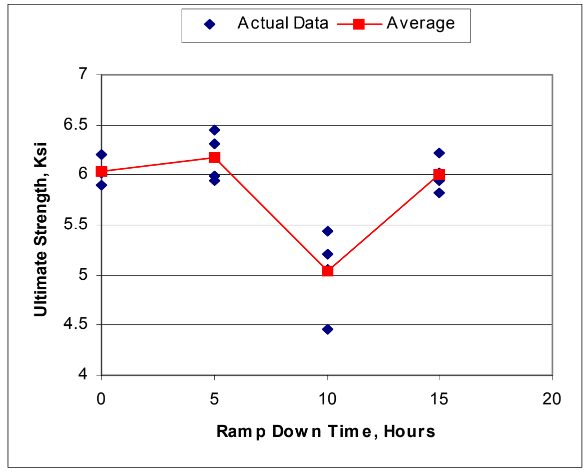

FIGURE 7B. ULTIMATE STRENGTH VS. RAMP-DOWN TIME

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings from our research, the following conclusions and recommendations can be made:

1. DSL-Somos 8110 test specimens were fabricated by stereo-lithography using SLA-250 RP equipment. The specimens were laser cured by pulling the specimens parallel to the tensile axis.
2. The test specimens were cryogenically treated by a ramp-down cycle from room temperature to 88K in 14 hours, a hold cycle of 10 - 20 hours, and then a ramp-up cycle from 88K to room temperature in 14 hours.
3. Due to large data scatter, the yield strength and impact energy were not affected by cryogenic aging treatment. Only the ultimate strength exhibited a significant decrease with aging treatment from 10 to 15 hours.
4. The yield strength of slower ramp-down decreased exponentially while the ultimate strength did not show any positive increase, indicating that the slower ramp-down did not have any effect on the cryogenic processing of DSM SOMOS 8110.
5. It was expected that the wide data scatter was caused by microscopic steps and their associated defects at the fillet radius of the tensile specimens. Samples with steps and defects had lower strengths, and those without steps and flaws had high strengths. The variability in the surface texture of the fillet radius caused a wide variability in the tensile strength and impact energy.
6. For future work, it is recommended that the SLA specimens be rapidly prototyped normal to the face of the dog-bone specimen. This will hopefully reduce the data scatter, which currently masks any potential effect of cryogenic aging time on the tensile strength and impact energy.

ACKNOWLEDGEMENTS

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EDUCATIONAL PROGRAMS IN HIGH-TECH

Alexander I. Chuchalin, Mikhail A. Soloviev

***Abstract** – During the last years Tomsk Polytechnic University (TPU) has successfully followed world trends in the evolution of education. One of the prospective strategies is innovative international educational programs development and implementation. Now the stress is laid upon innovative activity in Masters Degree Programs in Hi-Tech. The basis these programs is integration of the scientific and educational potential of TPU and academic research institutes in Tomsk; international cooperation with the foreign universities; innovative technology of studies. In the 2003/04 academic year TPU calls students' attention to six M.Sc. Programs: in Material Science (Computer Design of New Materials, MegaElectronics), in Electrical Engineering (Discharge and Plasma Technology, Methods and Instruments for Non-Destructive Quality Testing), in Applied Physics (Physics of Condensed Matter, Generation and Application of Electromagnetic Radiation). The aim of this paper is to present the TPU practical experiences in development of innovative educational programs, and to encourage foreign partners to take part in the implementation and development of new educational programs.*

Index Terms – Masters degree program, e-learning studies, international cooperation, innovative technology of studies.

Tomsk Polytechnic University, the first higher educational institution (HEI) in Siberia, established on the initiative of the enlightened minds of the Russian intelligentsia, marked the beginning of the engineering education in the Asian part of Russia and trained more than 100 000 engineers for the years of its existence. [1] Today TPU includes eight institutes: The Institute of Language Communication, The Institute of Geology and Oil & Gas Industries, The Institute of Distance Learning, The Cybernetic Center, The Professional Development Institute, The Institute of Electrical Engineering, The Institute of International Education and The Institute of Engineering Education; eight faculties: Applied Physics & Engineering, Electrophysics & Electronic Equipment, Mechanical Engineering, Chemistry & Chemical Engineering, Thermal Power Engineering, Economics & Management, Humanities and Natural Science & Mathematics; three research institutes: Nuclear Physics, High Voltage and Introscopy. More than 20000 students take their studies in the university.

Tomsk Polytechnic University is the leading HEI, focused on the mobilization of intellectual elite, training of highly qualified specialists with the broad scientific views. Its' graduates work in the leading Russian and foreign scientific centers. The university actively pursues a policy of integration in world educational space; international contacts of the university are intensively developed, including contacts with educational and scientific establishments in the USA, Great Britain, Germany, France, Japan, Cyprus, Southern Korea, China, India, Vietnam and others. [2]

One of the prospective trends is development and realization of international educational programs. In 1998 the strategy of educational services export to ex-USSR countries and foreign countries was developed at TPU.

The first experience was gained by realization of international Bachelor Degree Programs. At present more than 60 international students take their Bachelor Degree studies at TPU (Electrical Engineering, Material Science, Chemistry, Computer Science, Environmental Protection and others). The Global Alliance for Transnational Education (GATE, USA) awarded certification to TPU Bachelor Degree Programs. Today the programs are in the process of accreditation and validation by Open University Validation Services (OUVS, UK) and the Accreditation Board for Engineering and Technology (ABET, USA). [3]

The next step was the development of international Masters Degree Programs. The year 2000 saw the initial preparation of Masters Degree Programs in High-Tech. Multi-stage system of education and Masters Degree Programs have existed in Russia since 1994. At present Tomsk Polytechnic University has 65 Masters Degree Programs in 16 fields of study. Special requirements are established for Masters Degree Programs for the international market. In accordance with the results of the university contest, the development of the six pilot Masters Degree Programs in High-Tech were started in cooperation with the leading scientific and research institutes of Tomsk (Nuclear Physics, High Voltage, Non-Destructive Testing, Institute of Strength Physics and Materials Science of Russian Academy of Science and others). It represents a uniquely innovative project. The Masters Degree Programs are synthesized on the basis of the Russian educational standards and the educational programs of the leading foreign universities. As a result, foreign students recognize the programs, which retain the best traditions of Russian high school, scientific and the methodical experience of Tomsk Polytechnic University.

These Masters Degree Programs in High-Tech represent three fields of knowledge:

Material Science
Specialization: Computer Design of New Materials
Specialization: MegaElectronics

Electrical Engineering
Specialization: Discharge and Plasma Technology
Specialization: Methods and Instruments for Non-Destructive Quality Testing

Applied Physics
Specialization: Physics of Condensed Matter
Specialization: Generation and Application of Electromagnetic Radiation

Masters Program – Computer Aided Design of Advanced Materials and Technologies (M.Sc. in Materials Science)

The Masters program is developed and administered by Mechanical Engineering Faculty, TPU. Institute of Strength Physics and Materials Science (ISPMS) of The Russian Academy of Science highly qualified professors, modern laboratory equipment of ISPMS (automated laser measuring system, optical microscopes, atom and scanning tunneling microscopes, X-ray installations and a unique optic-television installation for the testing of plasticity and strength of materials of the new generation) are engaged in the studies process. The scientific basis of the program includes the following topics:

Metals science and Mesomechanics of materials after surface hardening;

Materials Science and Technology of new constructional and tool materials;

Metals science, Computer aided design and the technology of surface treatment.

Masters Program – MegaElectronics (M.Sc. in Materials Science)

“MegaElectronics” is widely used in the modern industry with products whose value is in the trillions of dollars.

“MegaElectronics” studies:

Fundamental principles and technology of the particles fluxes generation and forming;

Principles and mechanisms of the sources of fluxes operating;

Principles and laws of the interaction between particles and plasma fluxes and substance;

The basic processes and phenomena, initiated by particles and plasma fluxes;

Modern technological equipment for beam and plasma treatment of materials.

The Program is run by the Faculty of Natural Sciences and Mathematics in cooperation with the TPU Research Institute of Nuclear Physics in company with our highly professional foreign partners – the University of Rostok, Germany and Ecole Polytechnique, Palaiseau, France.

TABLE 1
M.SC. IN MATERIALS SCIENCE

	M. Sc. in Material Science	
	MegaElectronics	Computer Design of New Materials
1st semester	Core Courses	
	• Modern Issues of Science (in Material Science)	
	• Computer-aide Technology in Science	
	• Theory and Properties of Crystals and Disordered Materials	• Diagnostics of Loaded Materials and Constructions
	Electives	
	• Effectiveness of High Technology • Project Management	
2nd semester	**Specialization Courses**	
	• Interaction of Charged Particles and Radiation with Matter • Physics of Atoms, Ions, Molecules, and Chemical Bonds. Plasmochemistry • MegaElectronics of Dielectrics, Semiconductors and Metals	• Mesomechanics and Computer Simulation of Materials • Modern Technology of Coating and Surface Hardening • Thin Films and Multilayer Materials for Electronics
3rd semester	• Defects in Solids • Generation and Application of Synchronized Pulse Electron and Ion Beams • High-Energy Pulse Electron and Ion Treatment of Materials	• Metal and Ceramic Based Nanostructural Materials • Simulation of Ceramic Materials Based on Silicate and Oxide Systems
4th semester	Master’s Thesis	

Masters Program – Discharge and Plasma Technology (M.Sc. in Electrical Engineering)

At present “Discharge and Plasma Technology” includes:

Destruction of materials and products;

Rock crushing;

Fragmentation of products and wastes;

Recovering and cleaning of heat exchangers;

Generation of ozone and ultraviolet radiation, air, water and sewage refinement;

Materials and products hardening;

Products and materials functional coating;

Modification of substance surface and properties.

The Masters Program is run by the TPU Institute of Electrical Engineering, The TPU High-Voltage Research Institute and the Institute of High-Current Electronics of the Russian Academy of Sciences.

Masters Program – Methods and Instruments for Non-Destructive Quality Testing (M.Sc. in Electrical Engineering)

The scientific basis of the Masters Program is exemplified by the advanced achievements of TPU Research Institute of Introscopy. The Department of Physical Methods and Instruments for Non-Destructive Quality Testing and the TPU Research Institute of Introscopy comprise a unique scientific and technical complex, which undertakes research in the field of Methods and Instruments for non-destructive quality testing and diagnostics of products, materials and constructions. The devices and methods, developed here, enable to test a wide range of products from miniscule objects of radioelectronics to large-sized constructions. The program is run in cooperation with the University of Saarbrucken.

TABLE 2
M.SC. IN ELECTRICAL ENGINEERING

	M. Sc. in Electrical Engineering	
	Discharge and Plasma Technology	Methods and Instruments for Non - Destructive Quality Testing
1st semester	**Core Courses**	
	• Modern Issues of Science (in Electrical Engineering)	
	• Computer-aide Technology in Science	
	• Computational Mathematics	• Electronic Devices and Systems
	Electives	
	• Effectiveness of High Technology • Project Management	
		• Optical Electronics • Microprocessors • Power Electronics
2nd semester	**Specialization Courses**	
	• Generation and Measurement of High Voltage and High Current Signals • Theory and Properties of Crystals and Disordered Materials • Physics of Low-Temperature Plasma and Technology for Material Treatment	• Radioactive Diagnostics • Acoustic Diagnostics • Measuring Instruments
3rd semester	• Electrical Discharge Technology for Material Treatment and Fragmentation • High-Energy Pulse Electron and Ion Treatment of Materials • Beam-Radiation Technology of Materials' Modification	• Electromagnetic Diagnostics • Infra-Red Testing • Statistical Analysis and Quality Management • Methods of Direct Diagnostics
4th semester	**Master's Thesis**	

Masters Program – Physics of condensed Matter (M.Sc. in Applied Physics)

This Masters Program is aimed at training specialists in the field of research of surface, nearsurface layers of solids and thin films; development of new technologies for creating materials with particular electrophysical properties; nuclear physics; the interaction of radiation with substance. The Masters Program is run by the Faculty of Natural Sciences and Mathematics in cooperation with the TPU Research Institute of Nuclear Physics, Universitat des Saarlandes and the Frauhofer Institut Zerstorungsfreie Pruferfanner (Saarbrucken, Germany).

Masters Program – Generation and Application of Electromagnetic Radiation (M.Sc. in Applied Physics)

Training of Masters in the field of generation of electromagnetic radiation beams is carried out by the Faculty of applied Physics and Engineering, TPU. The department studies new techniques of generating electromagnetic radiation in cooperation with the scientists of Hiroshima University in Japan. The educational process uses modern laboratory equipment of the departments of the TPU Research Institute for Nuclear Physics, the Institute of High-Current Electronics of the Russian Academy of Sciences and the Department of Applied Physics at TPU.

TABLE 3
M.SC. IN APPLIED PHYSICS

	M. Sc. in Applied Physics	
	Physics of Condensed Matter	Generation and Application of Electromagnetic Radiation
1st semester	**Core Courses**	
	• Modern Issues of Science (in Applied Physics)	
	• Computer-aide Technology in Science	
	• Forecasting of the Fatigue Properties of Materials	• Macroscopic Electrodynamics
	Electives	
	• Effectiveness of High Technology • Project Management	
	• Non-Linear Physics • Quantum Mechanics • Fractal theory	
2nd semester	**Specialization Courses**	
	• Special Physical Practicum • Isotope, Chemical and Structural Analysis of the Surface • Experimental Methods for Studying of Solids • Theory and Properties of Crystals and Disordered Materials	• Special Physical Practicum • Interaction of Charged Particles and Radiation with Matter • Physics of High-Energy Accelerators • Modern Sources of X-ray and Gamma Radiation • Application of Accelerators in Industry and Research
3rd semester	• Hydrogen in Metals and Alloys • Computer Simulation in Physics • Scanning microscopy	• Radiation Effects in Condensed Matter • Generation of Radiation with Relativistic Electron Beams • Monte-Carlo Method in Theory of Radiation Transport • Simulation of Radiation Transport by Using "GEANT" Code
4th semester	**Master's Thesis**	

The technology Masters Programs realization is interesting enough. The normative period of studies for Masters

Degree is two years in accordance with the State educational standard. The educational program includes core courses, specialization courses, electives, scientific and research students' work and the preparation of a master's thesis.

TABLE 4
PROGRAM OF STUDIES

Courses	Credits
Core Courses	12
Specialization Courses	16
Electives	4
Research	4
Master's Thesis	6
Total Required for Graduation	42

The technology of studies assumes an element of distance learning (1st year) and laboratory practicum with preparation of a master's thesis based at TPU (2nd year). Distance learning assumes direct contact between student and professor at adjusting lectures and examinations (10% of the total time for distance learning) and independent work on the part of the student with teaching materials (textbook, tasks, testing materials), which are available in an Internet teaching environment. In the process of Internet teaching the student – professor dialogue is carried out by e-mail and by means of specialized chat-seminars. The first semester (17 weeks) is devoted to distance learning of core courses and electives. During the second semester (21 weeks) study process is structured as follows: 14 weeks of distance learning of theory of specialization courses of Masters Program and 8 weeks of studies in Tomsk laboratory and practical studies. The third and the fourth semester (2nd year) assumes studying of specialization courses, work on unique laboratory equipment in Tomsk, and as a result the defense of the master's thesis. Depending on his or her participation in research the student can be coauthor and coowner of any resulting project.

The unique aspect of any given Masters Degree Program is the fact that a part of the program (core courses, theory of specialization courses) is carried out on the branches of the university. This technology allows international students a portion of their period of study to live in their home country, to contact with the professors through Internet and listen toour professors' lectures in TPU branches. The TPU branch on the basis of Czech Technical University in Prague can serve as an example.

Thus, the TPU Masters Degree Programs have the following specific features:

The use of the newest scientific and technical developments, as well as the results of fundamental scientific researches, recognized in the world market;

The close integration of the TPU educational potentiality and scientific potentiality of Tomsk Research Institutes;

Joint realization of educational programs with the foreign universities-partners;

The innovative mechanisms of its' realization.

The Masters Degree Programs at TPU are original, fundamental and of universal application. They are characterized by the width of subject fields combined with the balance of theoretical and practical skills. The experience of pilot realization of the given programs in Tomsk Polytechnic University for Russian students in 2002/03 academic year demonstrated an interest from both students and the enterprises, which may employ them. It gives us hope that the given programs during the academic year 2003/04 will find consumer interest among international students. We hope as well that it will attract the attention of foreign universities with the aim of future cooperation in realization of TPU Masters Degree Program.

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ENHANCING STUDENTS LEARNING IN ELECTRONICS THROUGH THE USE OF COMPUTERS AND LEARNING BOARDS

Smail Djirar[1]

Abstract — *This work uses available software tools to enhance student learning and to improve online delivery by the practical aspect added to the courses. Through the use available and easy to use software packages and applications learning boards online courses can be more interesting and attractive to students. The boards can also used to enhance the students learning outside normal classes. These learning boards are designed for Electronics Engineering courses. They can also be used in different modules of the curriculum. Students will get more skills by the use of more simulation packages such as Electronic Work Bench and Lab View. Through the whole process students get also to use different software applications such as PCB design software, Office applications. Several learning boards have been designed and built already.*

Each learning module can consist of but not limited to:

- *Construction guidelines of the circuit;*
- *Computer –based simulation to analyze the circuit;*
- *Practical activities related to the appropriate topic;*
- *Mathematical activities.*

A set of language activities for developing both written and oral skills, based on the technical content of the module can be added because our students are Arabic speakers.

The online teaching will be improved and the practical aspect is enhanced. The Virtual instruments are generated by Lab View software package. The Virtual Instruments are used for the necessary signal generations and measurements. All signal generations and measurements are done through a data acquisition card.

Once the goals and objectives of each module are specified, the boards can be used in different courses according to their mapping into the curriculum.

Index Terms — *E-learning, E-Lab, Online, Virtual Instruments.*

INTRODUCTION

This paper describes how the use of software and the introduction of computers (Laptops) have made easier and enhanced the learning of electronics courses.

Learning boards [4] have been developed to be connected to the laptops. The learning boards are give students the opportunity to have an e-lab. The e-lab consists of these learning boards and a virtual instruments software package.

The whole system consists of a set of software applications, a set of vitual instruments, a data acquisition card, and a set of learning boards. The method is then to give students a set of activities in Electronics related to theie courses. In the following sections all these components are described.

LEARNING MODULES

Learning modules are constructed by students on 160 mm over 100 mm printed circuit board. Students are asked to build a practical circuit on a pre-designed printed circuit board. They are are provided with construction guidelines and the necessary components. At this stage, students use also PCB design software (e.g. Niche).

The other software application, students after the construction of the board , is the use of a simualtion package. The simualtion allows studens to observe the behaviour of the circuit . The comptuer –based simulation for the whole project is Electronics Work Bench [1].

Once the test measuremnts are passed, students are rady to use their boards with laptops.

Each module contains the goals and objectives. Practical activities related to the appropriate topics have been designed.

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ELAB

The boards can be connected to a computer or a laptop. The connection is done through a data acquisition card. The card used in the project is a National Instruments card [2]. It has channels for analog inputs, anlog outputs, digital inputs and outputs.
Virtual Instruments are available, from National Instruments LabView [3] package, such as variable power supply, function generator , oscilloscope and digital multimeter. These instruments and the learning boards allow students to undertake all the practical activities designed for the learning modules. Figure 1 shows the elab system consisting of a laptop containing adata acquisition card connected to a learning module.

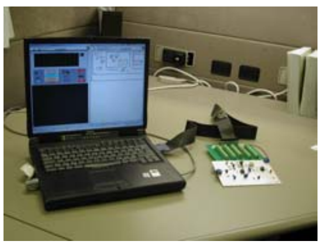

Figure 1: Elab system

The elab will be used soon in an online course. The course is on instrumentation and control fundamentals. One goal of this course is on signal conditioning. Students will be have the opportunity to do practical experiments related to this topic anywhere and anytime. They will have the possibilty to have more hands on activities outside the normal college hours.

ACTIVITIES AND CORRESPONDING SOFTWARE

As it was mentioned before, each learning module consist of several activities. Following are the acticities and their associated software:

- **Module construction**: At this stage students use a PCB design software such as Niche. A pre-designed printed circuit board
- **Simulation:** Simulation package such Electronic Work Bench helps students to investigate the behavior of the circuit. They can add, modify components. The aim is to get a clear idea about the response of the circuit for a given input.
- **Practical activities:** Pre-designed practical experiements are undertaken by students through the elab system, described previously.
- **Mathematical activities:** A maths activity sheet related to essential skills for circuit analysis is alos provided to students. This will give students a better of the theoritical concepts of the circuits.
- **Software applications activities:** A spreadsheet-based analysis of the circuit is also provided to students.

EXTENSION TO ONLINE COURSES

The Elab system is being extended to be used to online courses. It is being tested in particular with an online course. It is an introduction to instrumentation and control systems. The course investigates the basic principles of instrumentation and control systems, practical laboratories and industrial field trips. Topics include: examples of process control and automation systems, measurement systems, final control elements, signal conditioning systems, piping and instruments diagrams.

The focus is on signal conditioning. The goal is to investigate to the possibilty for students to undertake practical experiments using a laptop, a practical board and some Virtual Instruments as was mentioned previously.

CONCLUSION

The learning boards were tried with some students and they were very useful. Students enjoyed learning electronics. The main issue is that students were more interested because it applies to students with different learning styles.

The extension to the online course. The students were less confident at the beginnig but later they become more confident as they learned the logging process, and they other features of WebCT. They can build and test the learning boards. The next stage is to try the learning modules with their laptops.

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INTEGRATING ENGINEERING CURRICULUM USING COMPUTER BASED MANUFACTURING TECHNOLOGIES

Vedaraman Sriraman[1]

Abstract *— Pressures due to global competition have forced manufacturers to continually diminish the product development time. In response to this challenge, time compression technologies are being used by industries to speed up the product development time. Time compression is effected through the application of such technologies as rapid prototyping (RP), Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), rapid tooling and various casting and molding processes. It is important to expose engineering students to these computer-based tools. Rather than present these diverse tools in a piece meal fashion, it is important to expose students to the integrated applications of these tools in a capstone fashion. This paper details a National Science Foundation (NSF) funded project that was conducted at Southwest Texas State University (SWT) in which students were made to experience the entire product cycle from design through manufacture, using a "hands-on", integrated laboratory approach featuring the application of several time compression technologies such as rapid prototyping, rapid tooling, CAD and CAE.*

Index Terms — Curriculum Integration, Rapid Prototyping, Rapid Tooling, and Time Compression Technologies.

INTRODUCTION

This paper primarily describes an engineering curriculum integration effort that was carried out at SWT with support from NSF. The following summarizes the results of a literature survey that was used to drive our curriculum development efforts.

In a report published by the Society of Manufacturing Engineers (SME) entitled, "Manufacturing Education for the 21st Century: Manufacturing Education Plan" [1], the following competency were identified in current graduate engineers – concurrent engineering, product engineering, CAD/CAM, manufacturability, material selection and application and tooling. A survey conducted by the Mechanical Engineering Department [2] at Seattle University, in which nearly 100 manufacturing companies were asked to comment on current and future manufacturing practices and on curriculum recommendations, revealed that CAD, concurrent engineering and computer simulations were cited amongst the top ten manufacturing technologies. Based on these studies, it was concluded that it was important to teach the applications of rapid tooling and other time-compression technologies that center around RP such as CAD, CAE, CAM, investment casting, and injection molding [3]. Rapid tooling has been defined as tooling constructed from RP machine output and resulting in parts molded from production materials [4]. The concept of rapid tooling is becoming increasingly popular as a method of saving time and money [5].

In their NSF project of 1997 [6], Higley and Kin involved the use of industrial quality equipment to implement integrated design/manufacturing projects in which students could experience the complete product cycle from product inception through recycling. Based on these prior works, it was concluded that SWT's curriculum efforts would focus on:

- inclusion of RP, rapid tooling, CAD, CAM, other computer-based time compression technologies.
- the use of senior-level laboratory projects to provide students the opportunity to experience the entire product cycle. This would be effected by bringing to bear the integrated application of computer tools from several engineering courses to the solution of the senior project.

Once our goals were established, the next stage was the procurement of funds to support this initiative.

OUR APPROACH

The NSF was determined to be a primary funding agency with priorities that were similar to our goals. Therefore, in Fall 1998, a proposal was sent to the NSF that focused on curriculum development and capital equipment.

The project impacted three courses directly. These are TECH 2310 – Machine Drafting, TECH 4330 – Foundry and Heat Treatment, and TECH 4310 – Technical Drafting (now Tool Design).

The lower level machine drafting course was used as a vehicle for introducing the concept of design and rapid prototyping. Other lower level courses such as ENGR 2300 – Materials Engineering and TECH 2332 – Material Selection and Manufacturing Processes provided students background in materials and processing. Once these basics were individually covered in these lower level courses, the upper level classes (TECH 4330 and TECH 4310) permitted students to experience the entire product cycle through the avenue of laboratory projects. Thus, our curriculum development efforts focused on reengineering these existing courses to incorporate the aforesaid innovations.

Curriculum development in turn led to the choice of capital equipment. Accordingly, the following equipment was deemed essential for project implementation:

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- Stratasys FDM 3000 Rapid Prototyping Machine.
- Investment Casting Equipment
- Mini-Jector 45 Injection Molding Machine.

The equipment sought through grant funding was complemented by other equipment and facilities that were already available and on hand. These included:

- CAE laboratory with 16 engineering workstations that were loaded with Pro/ENGINEER (for solid modeling), Algor (for Finite Element Analysis) and AFS Solid (for solidification modeling).
- Helisys LOM 1015 RP machine.
- Foundry and Heat Treatment laboratory with general sand casting capabilities.
- Automated Machining laboratory with a three-axis Bridgeport machining center and a Browne and Sharpe coordinate measuring machine (CMM).

The grant was funded in Fall 1999 and lasted until Summer 2001.

DETAILS OF PROJECT IMPLEMENTATION

For purposes of convenience, this section is detailed through the medium of one of three courses previously cited, i.e. TECH 4330, to explain how curriculum integration was achieved.

One of the areas in which rapid prototyping and time compression technologies have had a major impact on product lead-time is in metal casting. With the advent of CAD, CAE, RP, and common format file transfer (such as the STL format), it has become very easy to take advantage of many manufacturing engineering applications using a single data base. Just 8 or 10 years ago, castings were typically produced using hand made or hand machined patterns. In just a short time however, advancements in computer based technologies have totally redefined the rules for the metal casting industry.

Students who enroll in this course would have typically completed prior courses in CAD, materials science, quality assurance, RP and fundamentals of manufacturing processes. In this course, lecture and laboratory activities include castings design, heat preparation, spectrographic analysis, the relationship between heat chemistry, cooling rate and microstructure and all of the standard tests that are currently used to provide manufacturing engineering with the ASTM traceability for cast products.

Towards the conclusion of the semester, students are assigned a capstone project wherein they design, analyze, optimize and manufacture a cast part. Students use CAD and CAE tools to design and optimize the castings. RP is used to support manufacturability analysis and generate the pattern/tooling. Students have to deal with issues such as recycling of the casting and molding materials. Thus, they have an opportunity to experience all aspects of the product cycle.

CASE STUDY

An example of a senior design project involved re-engineering a brake drum for a forklift (see figure 1). The brake drum was broken and neither spare parts nor engineering drawings were available. Measurements from the old brake drum were used to create a solid model of the same in Pro/ENGINEER (see figure 2). Students selected a material for the brake drum based on functionability, castability, machinability, and cost.

FIGURE. 1
BROKEN BRAKEDRUM

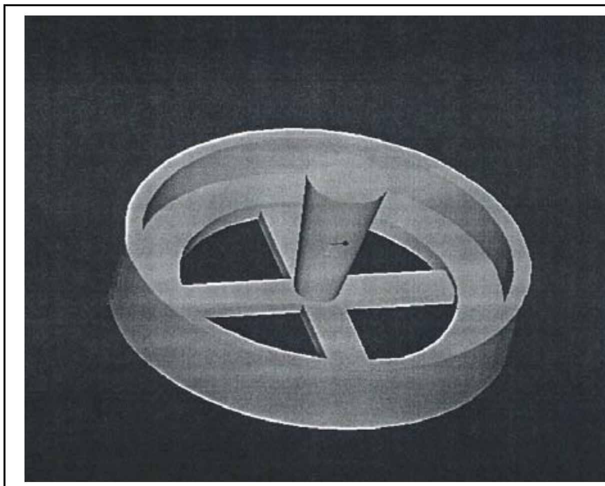

FIGURE. 2
PARAMETRIC SOLID MODEL

Next, a stereolithography (STL) file of the part was generated. This file was used as an input to the RP process (Stratasys FDM machine, see figure 3). Once the prototype was developed, it was evaluated for form, fitness, draft angles, machining allowances and shrinkage allowances.

Subsequently the rigging system was determined, modeled in CAD, and assembled on to the casting. This model was used as an input to AFS Solid to perform a solidification analysis. Upon completion of this analysis, students used outputs such as temperature distribution, solidification time, critical fraction solid, porosity and hot spots to refine the rigging system.

FIGURE. 3
STRATASYS FDM MACHINE

The next step involved creating a match plate model in Pro/ENGINEER for the brake drum (see figure 4). An STL version of this model was input to the Helisys LOM RP machine, so as to produce the appropriate tooling.

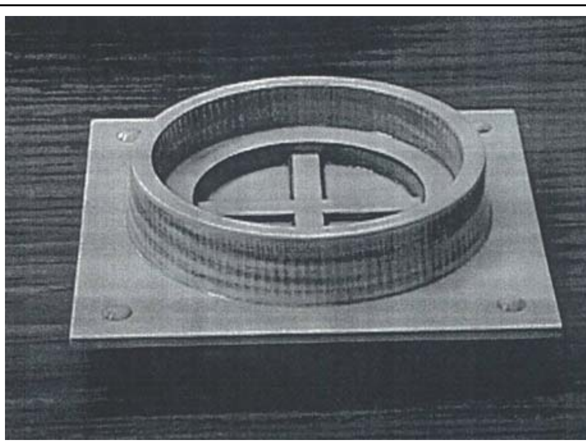
FIGURE. 4
RAPID PROTOTYPE OF TOOLING

Lastly, the match plate was used in the Metal Casting laboratory to make molds in sand. The mold was poured. Upon solidification the cast part was retrieved. The final product was obtained by machining the cast product in the Material Removal laboratory. At this point in time, students assisted the instructor in recycling the molding sand and excess metal.

CONCLUSIONS

Student reactions to the capstone design experience have been very favorable. Many students are able to assemble the pieces of knowledge that they had learned in specific courses towards the solution of a common engineering problem. Thus, a key result of our grant undertaking was that the laboratory project helps students see the "big picture". As engineering and technology knowledge base keeps growing, a significant dilemma confronts engineering educators. On the one hand dedicated courses are required to teach specific bodies of knowledge such as material science, processes, controls, design, etc., while on the other it is important that students "see" the interconnectivity between these specific bodies of knowledge. This paper outlined one such approach to curriculum integration.

ACKNOWLEDGEMENT

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ON THE USE OF NUMERICAL MODELS AS SUPPORT FOR SOLVING ENVIRONMENTAL PROBLEMS IN COASTAL AREAS

Joseph Harari[1] *and Ricardo de Camargo*[2]

Abstract — *Numerical models have been largely used for studying environmental systems – atmosphere, oceans, continents, polar areas, etc. These models solve the differential equations that describe the spatial and temporal variabilities of these systems, allowing simulations, hindcasts and even forecasts Coastal areas are particularly affected by environmental problems related to sea - air interactions and human activities: coastal erosion, water pollution, flooding of flat areas, etc. Numerical models may help engineering solving these problems by giving information on the behavior of the systems. The numerical models commonly used are: atmospheric models (for simulating winds and meteorological systems), wave models (wind generated sea surface waves), hydrodynamic models (ocean currents, sea surface levels and properties of sea water), and dispersion models (distributions of particles, substances or pollutants, in the atmosphere and oceans). Environmental issues and the use of related numerical models are presented, for study cases in the Southeastern Brazilian coastal region.*

Index Terms — *Numerical models, Atmospheric systems, surface waves, ocean currents, dispersion in the air and sea.*

INTRODUCTION

Numerical modeling is the technique that makes use of mathematical and computational methods to represent and analyze physical events. In other words, numerical modeling simply takes the equations that describe a system and use them to simulate the changes in the system. With the right equations and proper mathematical techniques, scientists can use numbers and variables to create rather accurate portrayals of atmospheric and oceanic processes. The equations are solved for specific variables, which can be used in visualizations of how the atmosphere and ocean change with time.

Atmospheric and ocean dynamics are represented in the models by equations of conservation (of mass, momentum, heat, water vapor or salt, etc…), modified according to the spatial and temporal scales involved. Solutions to the equations are found through numerical methods (finite differences, finite elements, etc …).

Models may be used for hindcasts and forecasts, provided the necessary initial and boundary conditions to the equations.

A sequence of numerical models is being implemented by:

- Group of Oceanic Modeling of the Institute of Astronomy, Geophysics and Atmospheric Sciences of Sao Paulo University (Grupo de Modelagem Oceânica – GMOC, do Instituto de Astronomia, Geofísica e Ciências Atmosféricas da Universidade de São Paulo - IAGUSP) and
- Laboratory of Hydrodynamical Numerical Simulations and Predictions of the Institute of Oceanography of Sao Paulo University (Laboratório de Simulação e Previsão Numérica Hidrodinâmica – LABSIP, do Instituto Oceanográfico da Universidade de São Paulo - IOUSP).

The main objective of the models is to represent the most important physical aspects in the South Atlantic Ocean, with emphasis on the Eastern part of the Brazilian coast and continental shelves.

METHODOLOGY

Initially, the results of global meteorological operational models are obtained, as given by the Center of Weather Prediction and Climatic Studies (Centro de Previsão do Tempo e Estudos Climáticos – CPTEC, Brasil) and the National Climate and Environmental Prediction – NCEP, USA; their results for the South Atlantic (every 6 hours, with horizontal resolution between 200 and 250 km) are processed, graphically displayed and subsequently assimilated into a mesoscale meteorological model, the Regional Atmospheric Modeling System - RAMS (Cotton et al., 1982; Pielke et al., 1992); that allows the attainment of details of the surface winds and other variables of interest (with horizontal resolution of 32 Km, at every hour).

The surface winds are then transferred to the WaveWatch-III - WW3 (Tolman, 1991, 1999), a numerical model of third generation that represents the sea state (sea surface waves), with a horizontal resolution of 1/12°. This model solves the equation for wave action spectral density, assuming that the environment (bottom topography, currents) and wave field present variabilities in space and time with scales much larger than the scales of a single wave. The model equations include refraction and straining of the wave field due to mean depth and currents, growing or decay of waves due to

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winds, dissipation and bottom friction. The wave model is valid for ocean depths bigger than 40 – 50 meters.

The sea surface winds are also used as input to ocean circulation models, as the Princeton Ocean Model - POM (Blumberg & Mellor, 1987), in order to evaluate the ocean currents, surface levels and sea water properties of temperature, salinity and density (Harari, Camargo & Cacciari, 2000).

Finally, the ocean currents are used to estimate the dispersion of properties, pollutants and tracers in coastal areas, through the solution of the advection – diffusion – decay equation or, alternatively, through the Lagrangean tracking and random walk of particles (Harari & Gordon, 2001).

The operational predictions regularly performed by GMOC and LABSIP may be acessed in www.surge.iag.usp.br .

RESULTS

A selection of results will be presented, relative to the four kinds of model above cited.

Figure 1 shows *CPTEC* large scale analyzed fields for the period of 13 to 16 July 2000, relative to a frontal situation in the 13th and a new cyclone formation in the 15th and 16th.

A model prediction of sea surface waves is presented on Figure 2, giving the elevations and directions of propagation.

Simulations of the mean sea surface level in the harbor of Santos (Brazil) through a hydrodynamical numerical model of the Southwestern Atlantic (POM) are presented on Figure 3, considering inputs given by a large scale atmospheric model (CPTEC) and a regional one (RAMS); this figure also shows the good agreement between these numerical simulations (with horizontal spacing ranging from 7800 to 9100 m) and observations (which tidal oscillations were filtered out).

Figure 4 shows a prediction of sea surface currents in the oceanic area off the Southeastern Brazilian shelf, with a horizontal resolution of 1/12° in longitude and latitude. In this case, the model was forced by surface winds (predicted by the large scale atmospheric model of NCAR), density effects (with climatological values of temperature and salinity), tides and mean sea level at the open lateral boundaries (given by a global model of tides and climatological values of dynamic depth, respectively).

Simulations of the dispersion of continuous substances and particles are presented on Figure 5, for the coastal area of Santos, under the effects of tides and NE winds.

CONCLUSIONS

This publication presents recent developments in operational and theoretical numerical models which can be useful for practical applications in several human activities, such as navigation, fishing, coastal protection, prediction of severe meteorological conditions and coastal flooding, water quality control, air and sea pollution prevention, among many others.

For future research, coupling of these physical models to biological / geological ones and making available the model results to authorities and policy makers is recommended.

ACKNOWLEDGMENT

The authors are grateful to the Institute of Oceanography of the University of Sao Paulo (Instituto Oceanográfico da Universidade de São Paulo – IOUSP) and Institute of Astronomy, Geophysics and Atmospheric Sciences of the University of Sao Paulo (Instituto de Astronomia, Geofísica e Ciências Atmosféricas da Universidade de São Paulo – IAGUSP) for their support in the modeling researches and operational implementations.

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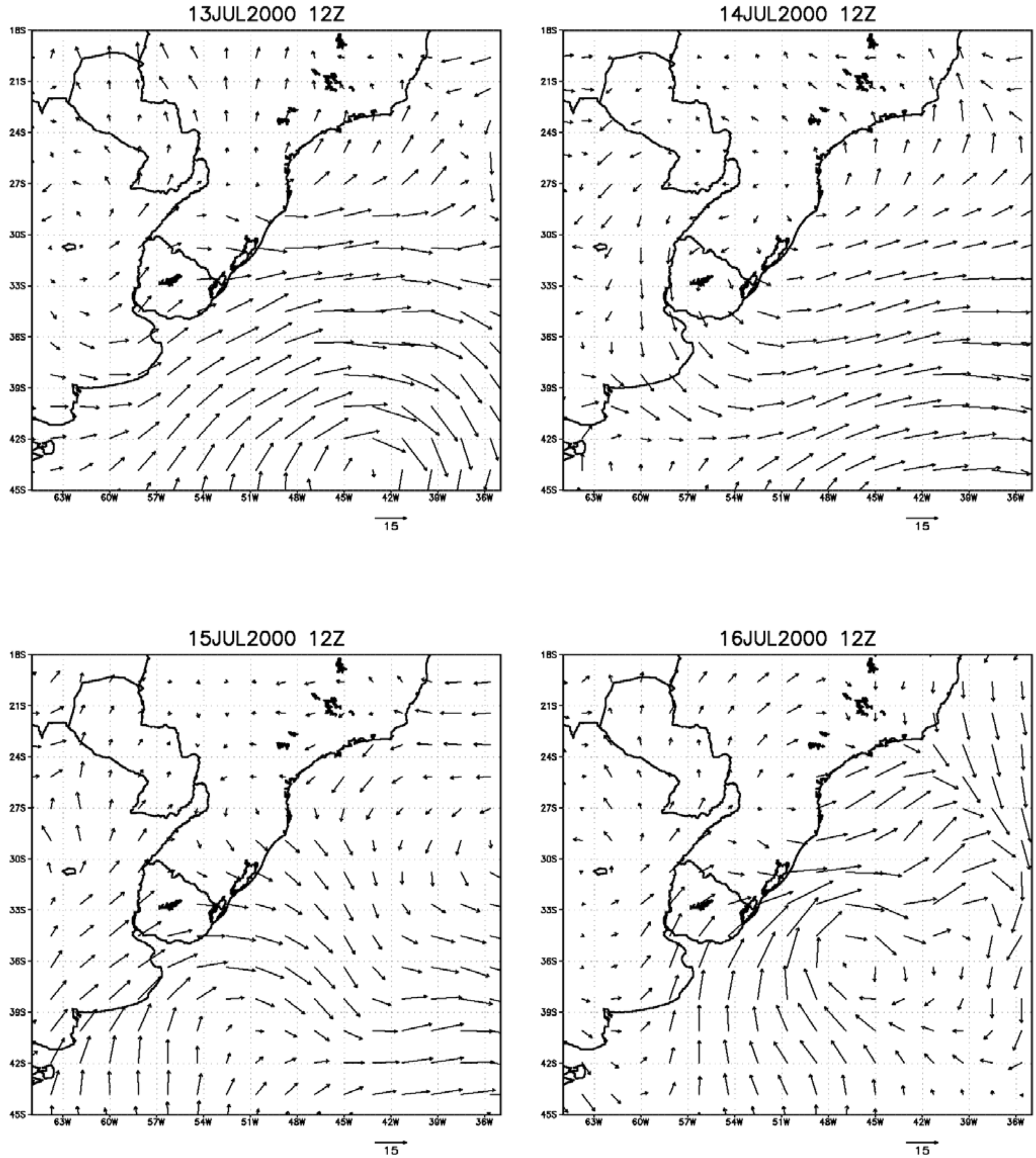

Fig. 1 - Surface winds (m/s) from CPTEC analyzed fields.

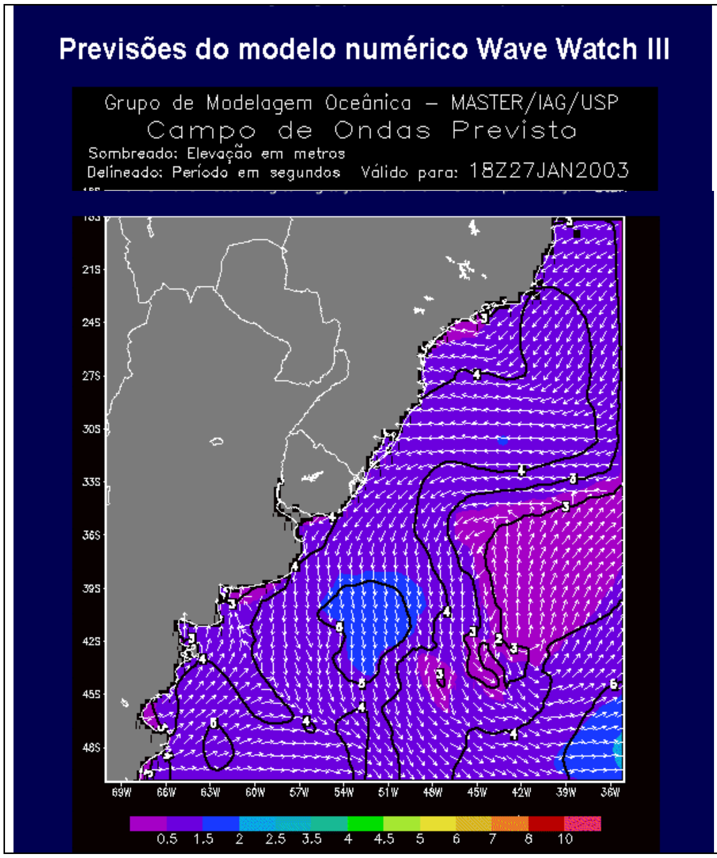

Fig. 2 – Prediction of wind generated surface waves through the model Wave Watch III, for 18 Z 27 January 2003 (heights in meters).

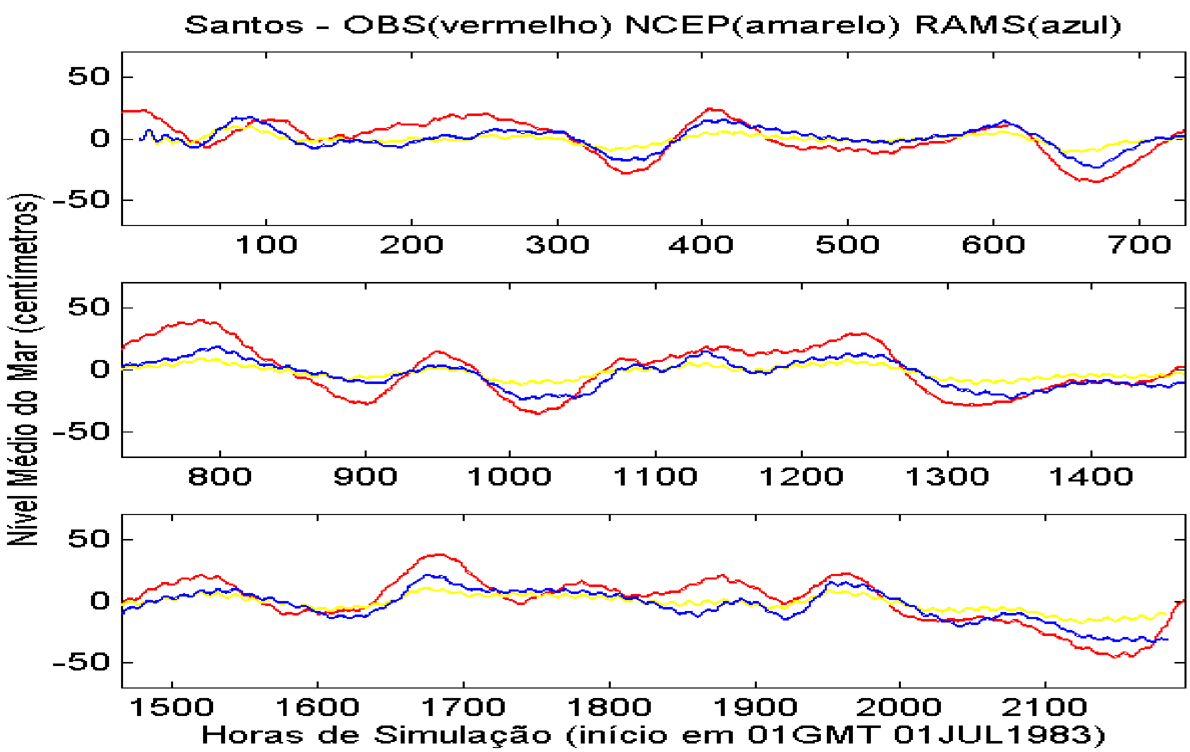

Fig. 3 – Comparing mean sea level oscillations in Santos (SP, Brazil) in the period from July to September 1983: filtered observations (red), results of hydrodynamical model forced by NCEP winds (yellow) and results of the same model forced by RAMS winds (blue)

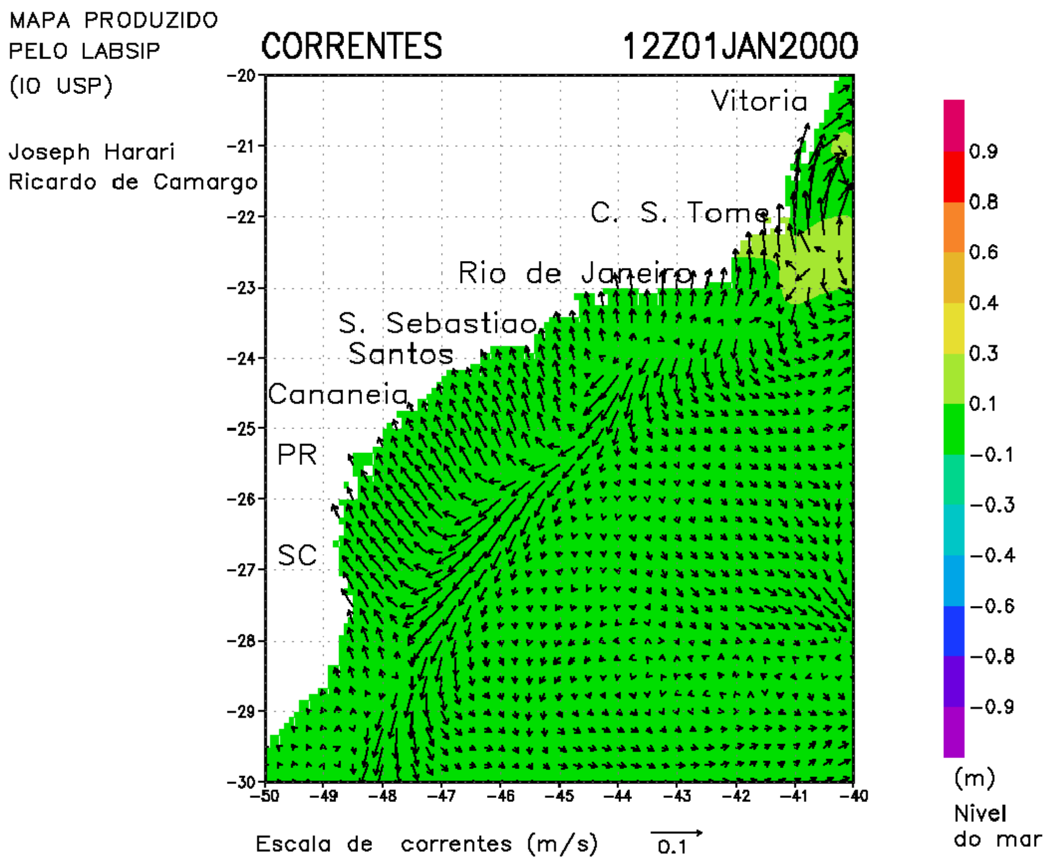

Fig. 4 - Surface currents given by hydrodynamical model forced by winds, density variations, tides and mean sea level oscillations.

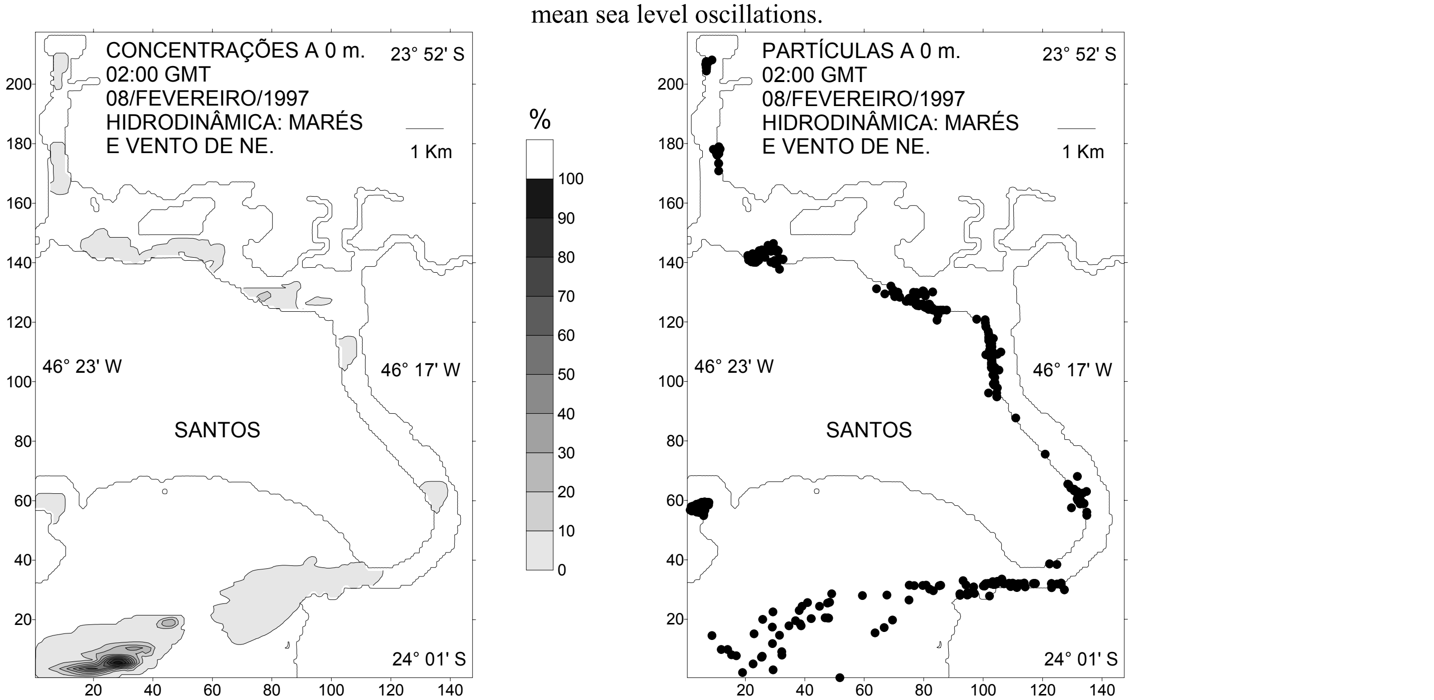

Fig. 5 – Solutions of dispersion models, for continuous substances and particles in the coastal region of Santos (SP, Brazil), subject to tides and NE winds.

ENSINANDO ORGANIZAÇÃO DE COMPUTADORES E SISTEMAS DIGITAIS USANDO HARDWARE RECONFIGURÁVEL DE BAIXO CUSTO

Roberto Medeiros de Faria[1], Elmar Uwe Kurt Melcher[2] e Maria de Fátima Queiroz Vieira Turnell[3]

Abstract — *Often some form of simulation is used in computer science classes in order to demonstrate aspects of computer organization in laboratory experiments. Our experience shows that it is very difficult for a student to grasp how a computer really works from simulation. In electrical engineering classes, sometimes discrete TTL logic devices are connected manually to form more complex digital circuits. However, it is very difficult to build even a very simple processor using this approach because most of the time is lost searching for bad electrical connections.*
This paper presents a low cost FPGA (Field Programmable Gate Array) based kit specifically developed for teaching hardware topics. Starting with a very simple circuit that may use only a flip-flop and an inverter, students may build a finite state machine and finally implement a simplified processor. Based on our experience during 5 semesters we can see that the practical knowledge is acquired more thoroughly using our method.

Index Terms — ensino de tópicos de hardware, arquitetura de computadores, organização de computadores, sistemas digitais, FPGA.

INTRODUÇÃO

É comum encontrar os cursos de arquitetura e organização de computadores ou sistemas digitais utilizando-se de alguma forma de simulação para realizar suas práticas de laboratório. Isto ocorre por diversas razões, que vão desde a facilidade de obtenção de software para este fim até a dificuldade de aquisição do material necessário e específico na montagem de um laboratório hardware, pelos altos custos envolvidos. Esta prática distancia muito o aluno da realidade concreta dos elementos de construção de um computador, impedindo que o mesmo atinja completamente os objetivos previstos para estes cursos. Para vencer este problema, a idéia é colocar nas mãos do aluno componentes de hardware e até um processador real com o qual ele possa experimentar à vontade, dominando assim o funcionamento e os elementos de construção de computadores.

O presente trabalho mostra uma alternativa de baixo custo para a instalação de laboratórios de hardware, para cursos de graduação em computação e engenharia elétrica, a partir de laboratórios de PC's (computadores pessoais), normalmente já existentes, a um baixo custo financeiro adicional. A solução mais barata que se tem no mercado é adicionar a um PC uma placa de expansão construída a partir de um FPGA (*Field Programable Gate Array* – dispositivo de hardware reconfigurável). Porém, mesmo assim, as placas deste tipo disponíveis no mercado são adquiridas a um custo ainda muito alto. Outra dificuldade, também, é que estas placas, via de regra, não foram projetadas para ensino e sim para demonstração de funcionamento de um FPGA ou, ainda, para desenvolvimento e teste de hardware específico, construído sobre um FPGA. Assim, estas placas não apresentam uma interface adequada que dê ao aluno uma visualização simples e efetiva do funcionamento do hardware construído.

A PEAC (Placa para Ensino de Arquitetura de Computadores), aqui descrita, se mostra como uma alternativa de baixo custo para equipar laboratórios de hardware, apresentando também uma interface que traz facilidades efetivas para o domínio, por parte do aluno, do projeto, construção e funcionamento de sistemas digitais modernos.

O ENSINO DE TÓPICOS DE HARDWARE E SEUS OBJETIVOS

Mostra-se a necessidade de ensino de tópicos de hardware de computação preponderantemente nos cursos superiores de computação e engenharia elétrica. Os objetivos do ensino de tópicos de hardware para essas duas áreas do conhecimento diferem principalmente na ênfase maior que é dada ao aprendizado de como projetar e construir computadores em ciência da computação, enquanto, em engenharia elétrica, a ênfase se dá na construção de sistemas digitais em geral. No mais, as disciplinas de tópicos de hardware para os cursos de computação e engenharia elétrica têm objetivos semelhantes.

De modo geral, as disciplinas de hardware de um curso de computação devem mostrar ao aluno a organização e a arquitetura de computadores, suas unidades funcionais e sua estrutura em níveis – os computadores modernos são organizados em camadas onde cada uma funciona como uma máquina virtual.

Também é importante mostrar ao aluno o funcionamento interno detalhado do processador, pois este, dentre os componentes principais do computador, é o que mais concentra funções, controlando os demais componentes e executando efetivamente as instruções.

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Pela natureza funcional do processador, é importante também mostrar ao aluno suas relações com as demais unidades funcionais do computador, evidenciando a distinção entre os caminhos por onde transitam os dados e como se dá a comunicação de controle, possibilitando assim ao aluno distinguir entre bloco de dados e bloco de controle de um computador, analisando os aspectos funcionais de composição e de construção.

Como o computador é na realidade composto de uma parte de hardware e outra parte de software, é muito importante dar ao aluno o conhecimento sobre como funciona a interação direta entre estas duas partes do computador (software e hardware), levando em conta que a fronteira que separa estas partes não é estabelecida de forma definitiva e varia de acordo com a tecnologia de construção empregada.

Vale ressaltar aqui que, quando o objetivo for aprender a projetar e a construir computadores, é fundamental que o aluno tenha condição de conhecer o suficiente para escolher a tecnologia que dará a melhor solução a cada projeto específico. Isto implica ter que experimentar e avaliar os vários modelos de solução disponíveis no mercado.

A experiência com o uso da placa PEAC, que se desenvolveu no Curso de Engenharia Elétrica da Universidade Federal de Campina Grande, foi no âmbito da disciplina Arquitetura de Sistemas Digitais. Esta disciplina tem como objetivo, além de introduzir os fundamentos da arquitetura destes sistemas, dar formação ao aluno em diferentes técnicas de projeto de sistemas digitais. Os conceitos são apresentados a partir do projeto de um computador didático, capaz de realizar cinco instruções, construído a partir de circuitos lógicos simples tais como contadores, registradores e um circuito somador [1].

Ao longo dos semestres em que a disciplina vem sendo lecionada, os alunos realizam experimentos durante os quais esta máquina é montada e testada. O projeto desta máquina permite ao aluno concretizar os conceitos apresentados na disciplina e conectá-los diretamente com os conhecimentos adquiridos na disciplina que lhe é pré-requisito – Circuitos Lógicos.

O Ensino de Tópicos de Hardware Utilizando Componentes Discretos

Construir computadores e sistemas digitais complexos a partir de componentes discretos de hardware é factível, não, porém, quando estes componentes mais simples e elementares são transístores. Tannenbaum, em seu livro sobre organização de computadores [4], escreve que embora o aluno estivesse "... apto a adquirir um saco cheio de transistores para construir o subconjunto da máquina JVM. Os estudantes que conseguirem concluir esta tarefa com sucesso devem receber a nota máxima na matéria e a recomendação de realizar um exame psicológico completo.".

Outra maneira de implementar um processador a partir de componentes discretos seria utilizar tecnologia TTL. Estima-se a necessidade de 50 componentes TTL para implementar todas as práticas de laboratório para um processador deste porte. Esta solução tem algumas dificuldades que devem ser analisadas. Se o circuito for implementado em placa de circuito impresso, em que os componentes são soldados, estes componentes não poderão ser reutilizados e as diferentes práticas laboratoriais exigirão placas específicas de circuito impresso, elevando assim o custo financeiro para a implementação do laboratório de hardware. A solução mais flexível, neste caso, seria a utilização de *protoboard* para a montagem do circuito. Porém, neste tipo de montagem, aparecem muitos problemas de falhas nas conexões elétricas e então, a maior parte do tempo do aluno aplicado nas experiências fica sendo utilizada na eliminação destas falhas.

O Ensino de Tópicos de Hardware com Simulação

É comum as disciplinas que ensinam tópicos de hardware fazerem uso somente de simuladores para ensinar aos alunos os conhecimentos necessários para cumprir os objetivos discutidos anteriormente. Existem várias razões para que a utilização de simulação de hardware seja tão largamente utilizada nestas disciplinas. A razão preponderante é o alto custo do hardware específico necessário em contrapartida com a utilização de laboratórios de computadores pessoais (PC's) utilizando software de simulação. Normalmente, as escolas já possuem seus laboratórios de PC's e os investimentos se restringem à aquisição do software, muitas vezes sem custo por ser de domínio público ou *freeware*. Por exemplo, há autores de livros didáticos sobre arquitetura e organização de computadores que indicam em seus livros o uso de ferramentas de simulação para execução de seus exercícios e práticas [2][3][4].

No seu conhecido livro "*Arquitetura e Organização de Computadores*" [3], Stallings defende o uso da simulação, afirmando que ela é vantajosa, tanto na pesquisa como para fins educacionais, pois "é mais fácil de mudar os vários elementos da organização..." e "...fornece diversas estatísticas detalhadas de desempenho...".

Diante das dificuldades de implementação de um processador, mesmo acadêmico, em hardware e da facilidade sedutora da implementação através de simulação por software, abre-se mão da qualidade do aprendizado, impedindo o aluno de fazer uso de um equipamento de hardware real e concreto em suas experiências laboratoriais.

Existem ainda situações em que a simulação não consegue espelhar a realidade, no caso, por exemplo, de conflito no barramento de dados com a RAM que na prática, eleva o nível da corrente, levando a uma situação de falha elétrica.

Na disciplina Arquitetura de Sistemas Digitais, como parte de uma estratégia que previa a apresentação de outras técnicas de projeto, foi introduzido o conceito de simulação de uma descrição do circuito a nível esquemático. O grupo de alunos, além de montar o protótipo do projeto original, foi solicitado a fazer modificações neste projeto, desta feita através da simulação do comportamento da máquina modificada. Esta etapa do aprendizado permitiu aos alunos experimentar diferentes arquiteturas resultantes de modificações no conjunto de instruções e modos de endereçamento na nova versão da máquina didática.

A possibilidade de modificar o projeto original se mostrou decisiva no processo de aprendizado. Não apenas aumentou a motivação dos alunos, mas acima de tudo facilitou a apreensão dos conceitos abordados na disciplina.

Como etapa subseqüente nesta estratégia de ensino das técnicas de projeto, foi introduzido o conceito de projeto em Linguagens de Descrição de Hardware – HDL. Neste ponto do curso, foram enfatizadas a complexidade do projeto de sistemas digitais e a necessidade de adequar a técnica de projeto.

O Ensino de Tópicos de Hardware Utilizando FPGA

Como já foi dito, a solução apresentada aqui é uma placa de hardware reconfigurável que faz uso da tecnologia de FPGA. O FPGA é um componente programável composto de milhares de portas lógicas que permitem ser configuradas de modo a implementar um circuito lógico qualquer. Melhor ainda, esta configuração pode ser refeita indefinidas vezes, de modo que o mesmo componente FPGA pode funcionar como um circuito lógico diferente a cada reconfiguração. Isto possibilita que uma mesma placa seja reconfigurada para dar suporte às várias experiências que são realizadas no laboratório. O fato de só utilizarmos uma única placa de circuito eletrônico vem contribuir para a redução do custo adicional com hardware específico.

A construção do hardware baseado em FPGA traz consigo as vantagens defendidas por Stallings [3] para o uso da simulação, ou seja, com o FPGA torna-se fácil modificar os vários elementos da organização, e dispositivos para fornecimento de estatísticas de desempenho podem ser inseridos no próprio hardware – vantagem maior.

Descrição da PEAC

A PEAC, placa de hardware de baixo custo, foi projetada para dar suporte às experiências dos alunos em toda a extensão dos cursos de tópicos de hardware, pois, por ser reconfigurável, permite experiências envolvendo apenas *flip-flops* e inversores, como exemplo de experimentos mais elementares, e pode também ser utilizada para implementação em hardware de um processador completo.

A placa tem como componente principal um FPGA EPF10K20RC208-4 da família FLEX de fabricação da Altera, com 20 mil portas lógicas equivalentes. Encontram-se também na placa 2 memórias RAM de 16 Kbytes que trabalham em paralelo para permitir o endereçamento de 16K palavras de 16 bits. Um oscilador de 2,5 kHz foi introduzido na placa para geração de sinal de *clock*.

Além dos componentes já citados, a placa possui alguns outros que são utilizados na interface com o usuário. Para este fim, a placa possui 4 bancos de 16 *leds* que são utilizados para a visualização de conteúdos de registradores e palavras de memória. Adicionalmente, encontramos um banco de 2 *leds* que é utilizado para visualização dos estados e controle da RAM (*write enable* e *output enable*). Por último, 1 *led* adicional permite a visualização do sinal de *clock*. Uma chave de onda com 11 posições foi colocada na placa para possibilitar a mudança da funcionalidade dos bancos de *leds*. Uma chave bipolar, incorporada ao circuito, permite gerar manualmente o sinal de *clock*. Também foram adicionados à placa, para aumentar a possibilidade do usuário interagir com a mesma, 4 bancos de 8 chaves liga-desliga do tipo *DIP-switch* que são utilizadas para configuração de funções de controle. Importante lembrar que, por estarem ligados diretamente aos pinos do FPGA, pode-se, se for necessário, reconfigurar toda a funcionalidade dos *leds*, da chave de onda, das chaves liga-desliga e da chave bipolar.

Um conector de 34 pinos é ligado diretamente ao mesmo número de pinos do FPGA, criando uma interface aberta, totalmente configurável para conexão com dispositivos de entrada ou saída, com outro circuito de expansão, ou ainda, com outra placa semelhante.

A placa funciona com três modos de *clock*: gerado manualmente, gerado diretamente pelo oscilador e gerado pelo oscilador com divisor de freqüência.

Para proteção de sobrecarga e para permitir evidenciar a ocorrência de conflitos no barramento de dados com a RAM, a placa possui um fusível eletrônico que corta sua alimentação, tanto no caso em que a corrente eleva-se a níveis danosos, quanto quando a tensão de alimentação supera 5 volts, protegendo assim todos os componentes do circuito.

Com o apoio do Programa Universitário da Altera (fabricante do FPGA da placa), representada no Brasil pela PI Componentes, em São Paulo, a PEAC pôde ser fabricada ao custo de aproximadamente US$ 80.

PEAC versus Outras Placas Semelhantes

Analisamos alguns aspectos importantes para placas de hardware reconfigurável que se prestariam para ensino. Os aspectos levados em consideração foram: custo, interface com o usuário e memória RAM. Entre 34 placas pesquisadas [5], placas estas que serviriam para o propósito de ensino e que fazem uso de FPGA, nenhuma contém recursos de visualização (*leds*) para mais do que 32 bits, nenhuma contém mais do que 20 chaves para acionamento e nenhuma custa menos do que US$129. No entanto, todas as placas pesquisadas, que possuem memória RAM, têm capacidade igual ou maior que 16 KB.

Comparando a placa PEAC com as placas pesquisadas, se torna evidente que ela é mais adequada para fins de ensino de tópicos de hardware digital a um custo menor.

METODOLOGIAS DE UTILIZAÇÃO DA PEAC

Na disciplina Arquitetura de Sistemas Digitais, o aluno é apresentado a um ambiente de suporte ao desenvolvimento de projetos em HDL e aos recursos oferecidos pela PEAC. O aluno, então, inicia o desenvolvimento de um projeto em equipe, que consiste na definição comportamental de uma versão modificada do computador didático.

No laboratório, a equipe realiza uma aula introdutória ao ambiente de desenvolvimento, e ao uso da placa. Após o término dos projetos, as equipes apresentam os resultados de cada projeto na forma de seminário. Uma vez que os projetos são agrupados em três categorias, durante a apresentação os alunos podem comparar e discutir as soluções adotadas.

Na disciplina Arquitetura e Organização de Computadores, para não sobrecarregar o aluno logo no início, são dadas práticas introdutórias e, em seguida, a construção de um processador é verificada em quatro etapas:

1) Construção de um pisca-pisca (divisor de freqüência) usando componentes TTL;
2) Verificação do funcionamento do pisca-pisca implementado na PEAC;
3) Verificação do funcionamento de banco de registradores e barramento interno;
4) (3) + ULA (Unidade Lógica e Aritmética);
5) (4) + interface com memória RAM;
6) (5) + ROM de microcódigo (processador completo);
7) Implementação, pelos alunos, de novas funcionalidades do processador.

Assim, começa-se com a verificação de um circuito muito simples no primeiro contato com a placa até chegar a modificar o processador Java completo [4].

RESULTADOS COM A UTILIZAÇÃO DA PEAC

A partir destas experiências, foi constatado que além do aprendizado ter sido positivamente influenciado, os alunos tiveram a oportunidade de exercitar conceitos que de outro modo seria inviável, uma vez que a construção de protótipos, em particular, demanda recursos de hardware nem sempre disponíveis. Constatou-se, também, que houve flexibilização para alterações em projetos, rapidez nas modificações introduzidas e redução nos custos de infraestrutura necessários ao ensino dos conceitos das disciplinas.

CONCLUSÕES

A tecnologia de FPGA oferece grandes possibilidades para fazer o ensino de arquitetura, organização de computadores e eletrônica digital mais acessível, mais efetivo e mais empolgante.

O uso da placa PEAC leva a uma metodologia de ensino que possibilita ao aluno iniciante desenvolver suas experiências na medida em que os conceitos teóricos estejam sendo vistos, ou seja, o aluno pode começar construindo elementos mais simples e evoluir para construções de sistemas mais complexos, até chegar à construção de um processador completo. As experiências podem começar analisando o funcionamento de um *flip-flop* e um inversor, passando por uma máquina de estados finitos, de forma que, no final, ele tenha construído um processador integralmente.

Pela nossa experiência com este recurso, podemos afirmar que, quando os conceitos são fixados através das experiências com elementos reais e palpáveis, a aprendizagem se dá de forma muito mais eficiente e que o aluno se sente muito mais seguro na aquisição do conhecimento. Por outro lado, o emprego de um dispositivo lógico programável libera o aluno de dificuldades operacionais de equipamentos antigos, como por exemplo, o citado *protoboard*.

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ENERGY ENGINEERING MANAGEMENT CURRICULUMS FOR ACADEMIA AND INDUSTRIES IN DEVELOPING COUNTRIES

Athula Kulatunga[1]

Abstract — *It is extremely rare to find employees with energy management skills or other required background information within an organization at the start of an energy management program. This paper presents major skills and subordinate skills required by personnel involved in the energy management process. A separate subordinate skill analysis is presented for business managers and energy professionals. These subordinate skill analysis can be used to develop specific learning activities for each group. Energy education does not have to be delivered in a classroom environment. Day to day activities of each of the above group can be modified to teach skills and to enhance energy awareness. Finally, the outcome of an energy management program is subjected to the culture of the country and the organization in which the program is launched. Energy management programs must be tweaked to align with such variations so that the impact of the program is maximized.*

Index Terms — Academia, Curriculum, Energy Management, Industry.

INTRODUCTION

What is energy management? One definition is "the judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions [1]." Definitions may vary from one society to another depending on how the environmental concerns and economic benefits are valued. Regardless, there are many common aspects to all energy management programs. They include: monitoring and reporting energy use; reducing energy consumption through improved efficiency; finding new ways to increase returns from energy investments; improving power quality; reducing brownouts and curtailments; finding new ways to include renewable energy; and enhancing distributed power generation.

For some countries, energy management is a new concept, while others have been doing it for many years. When national or provincial governments subsidize the utility companies, or when there are inadequate metering capabilities, the energy management efforts do not receive proper attention, or are very difficult to implement. On the other hand, it is unwise to pay whatever the utility provider bills a business, due to one's lack of understanding of energy consumption of that business. In some countries, the energy costs of a product may be higher than the labor costs for the same product. Understanding the energy consumptions of an organization by managers, engineers, and all facets of the work force benefits the entire business.

ENERGY MANAGEMENT PROGRAMS

How can businesses initiate energy management programs when there are limited knowledgeable workforces to implement them? This is a challenge faced by many countries. Until colleges and universities start offering course in energy areas, short courses involving specific areas can be developed to help businesses and industries. Energy management always involves a team effort. The team includes the management of an organization, a steering committee with a leader, an energy manager or engineer, who has a comprehensive understanding of the discipline, and many other employees in the organization.

The employees must be well educated, in order to enhance the management system; otherwise, even a very expensive program would do little to conserve energy. Skills required by the employees vary according to their involvement in the process. For example, the upper management needs enough information to make business decisions and future planning. The energy management steering committee also requires education in electrical and mechanical systems. All of the organizations workers should know the objectives of the program, and what their rolls are. Well-trained energy managers are always in great demand, and innovative methods are required to increase the awareness of energy management among each level of the organization.

SKILLS FOR MANAGERS

The commitment of management is essential for making any energy program successful. When the managers have some level of understanding related to terminology and methodology presented in an executive summary of an energy management proposal, the proposals that contain energy management opportunities (EMOs) may receive favorable judgment, and support.

Some EMOs require rescheduling of work hours, production line start-up times, and allocation of new resources. Managers must coordinate and approve such activities. Some EMOs focus on improving air quality, work environment, and safety. Managers should be aware of

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government regulations related to occupational safety and health. In fact, some energy management activities are started in an effort to avoid litigation associated with safety or health related issues. A manager with understanding of the above issues can make informed judgments about proposed EMOs.

Economic analysis and/or lifecycle costs of each proposed EMO is a must. No energy management initiative should start prior to this step. Just because there is little need for new material, retrofits, and equipment for certain energy saving efforts does not mean the effort is without a cost component. Whenever an existing system is changed, there is impact. Workers are involved in any adaptation, automatically adds labor costs. When an EMO needs capital investment, viability of the investment should be clear. Acquisition costs, utilization costs, and disposal costs of new equipment must also be taken in to consideration. Return of investments using simple payback period methods and others such as discounted cash flow, must be examined according to the accepted business practices within the organization.

One of the problems with energy use in commercial sector and industrial sector continues to be poor accountability. Since energy consumption is considered as a fixed cost in most industries, no one person is responsible for the energy use. One solution is to sub-meter each department within the industry, and give responsibility to each. In order to accomplish this, managers should be aware of the benefits and drawbacks of such actions, and instantiate programs to reward departments for improving their own energy efficiency.

In some developing countries, solar energy is abundant. Managers should be aware of such technologies and how they can be exploited or incorporated in to their systems. By organizing conferences and seminars related to specific types of technology, many companies can benefit. For example, an investigation or pilot study in the area of solar thermal collectors may benefit many industries that require hot water for their manufacturing processes. A study investigating the potentials of desiccant cooling may improve the efficiency of commercial buildings that require cooling in the summer or throughout the whole year.

Some countries have a national energy policy; others don't. Most countries do have some form of regulations related to energy use, brownout periods, and environmental protection. One country may have a higher priority for saving energy and preventing environmental pollution, instead of cost effective manufacturing processes. Whatever the focus is, managers should align their energy management efforts with the national priorities, because there may be government incentives and subsidiaries to facilitate those efforts.

Understanding of how energy is billed is another important skill managers should have. In some counties, energy bills are very simple, while in others it can be quite complex. A simple billing structure may include a fixed rate for every kWh of use, and a fixed rate for every kW of demand. A complex bill may include a ratchet clause, where the company has to pay a percentage of the maximum electrical demand for the previous eleven months too even if the facility exceeds an accepted level one time. Energy bills are not always accurate. Such knowledge can help managers decipher mistakes and save money for the organization.

In summary, a list of major skills needed by managers of an energy organization should include the following:

1. Understand energy terminologies, units, and conversions
2. Understand safety and health regulations
3. Understand impact of production rescheduling
4. Understand energy billing
5. Perform economic analysis and life cycle costing
6. Organize seminars and workshops for employees

To master these skills, a series of subordinate skills are required. Figure 1 below depicts the breakdown of those skills into a series of subordinate skills.

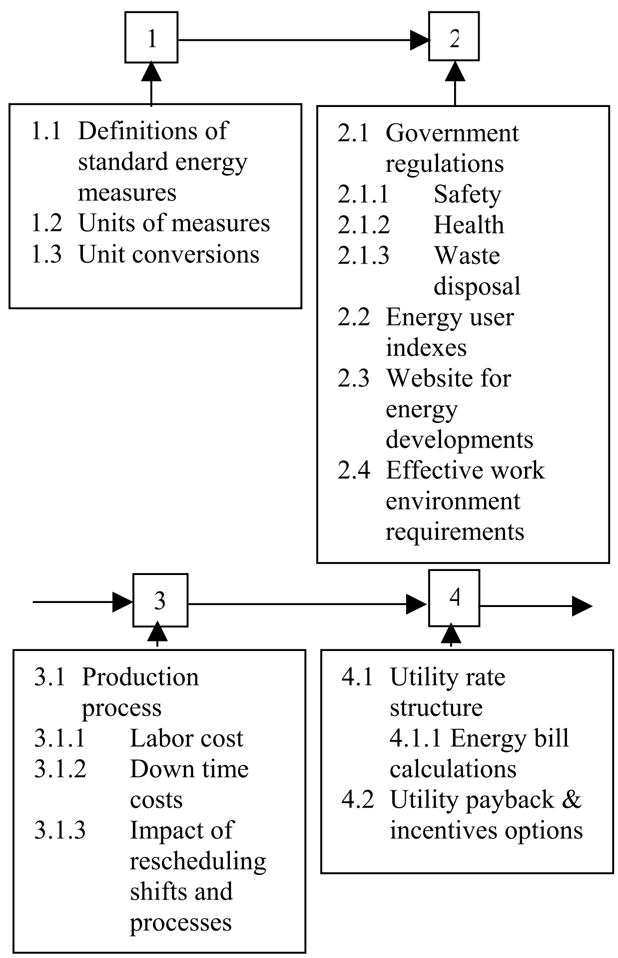

FIGURE. 1
SUBORDINATE SKILL ANALYSIS FOR MANAGEMENT

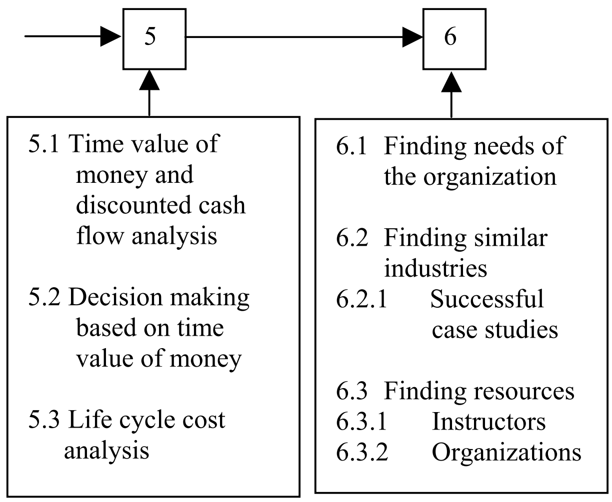

FIGURE. 1 (Continued)
SUBORDINATE SKILL ANALYSIS FOR MANAGEMENT

SKILL FOR ENERGY MANAGER OR ENGINEER

The energy manager is the key figure in all energy management initiatives. The person should have a technical background in the electrical and mechanical systems found in the organization. Those with technical abilities can be trained to become valuable energy manager.

An energy manager should be able to identify the energy-saving opportunities in a commercial or industrial facility. Energy may be purchased or generated locally. Energy may be consumed by lighting systems, a major portion of commercial facilities, air conditioning equipment, electric motors, steam generation, etc. By conducting specific energy audits energy managers finds energy saving opportunities.

An effective energy manager requires the following major skills:

1. Understand energy terminologies, units, and conversions
2. Locate and apply energy statistics
3. Understand energy use in commercial buildings
4. Understand energy use in industry
5. Perform economic analysis and life cycle costing
6. Perform energy audits
7. Integrate renewable energy sources

Each of the above major skill requires a series of subordinate skills. Figure 2 summarizes subordinate skill analysis for energy engineers or mangers [2].

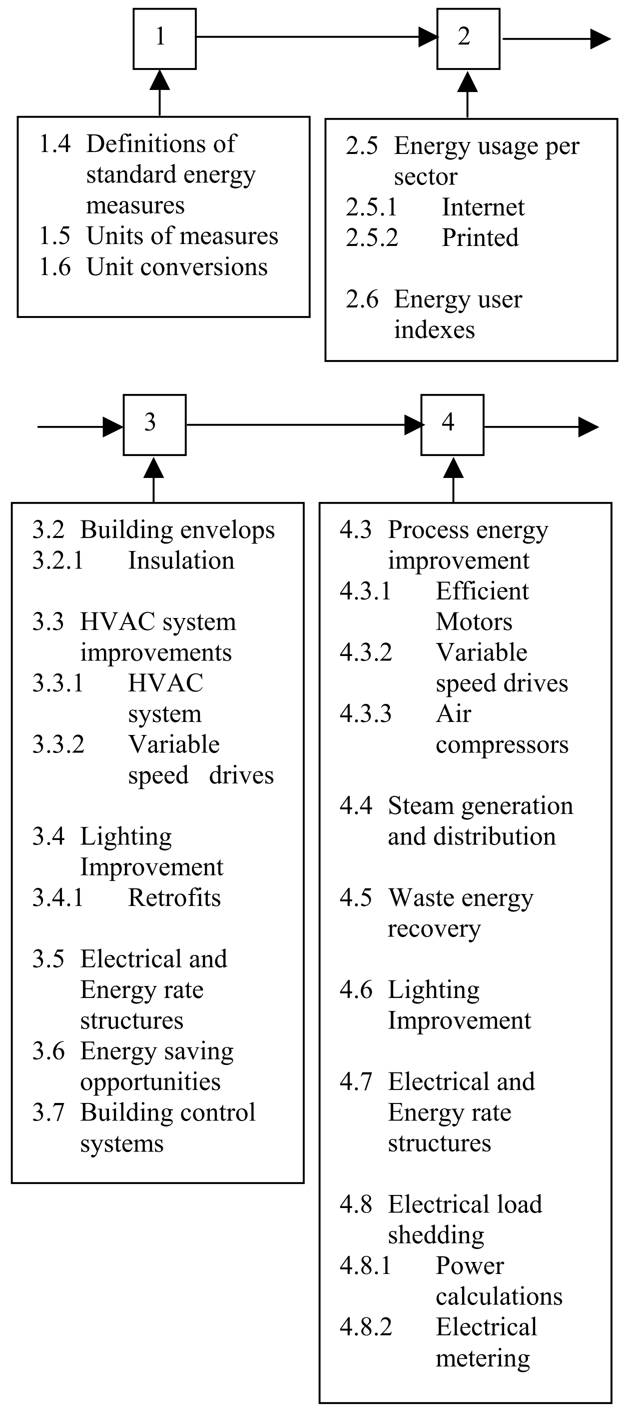

FIGURE. 2
SUBORDINATE SKILL ANALYSIS FOR ENRGY PROFESSIONALS

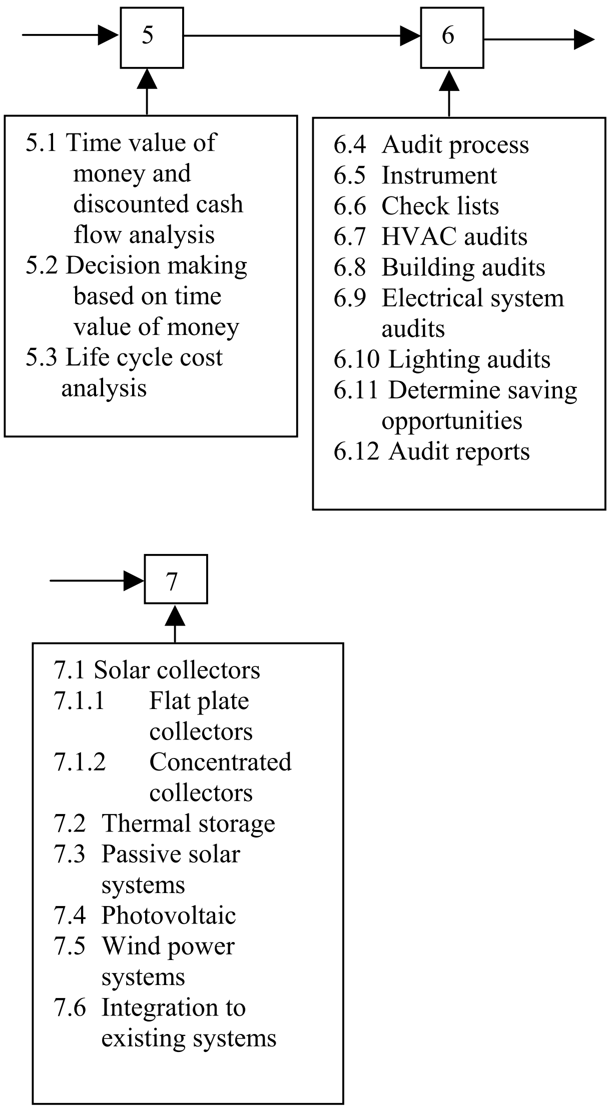

FIGURE. 2 (Continued)
SUBORDINATE SKILL ANALYSIS FOR ENRGY PROFESSIONALS

INFORMATION FOR EMPLOYEES

Employees in general can contribute energy saving efforts if they are well informed. They should know what the goals of their energy management efforts are, how it affects their work environment, and how they can contribute. Management should not wait until the final decisions are made to inform workers. Regular worker input is necessary, especially when energy audits are conducted. If the goal is to change existing lighting in a work area, worker opinion of current lighting and concerns about safety due to poor visibility are essential. Pamphlets describing energy initiatives can be distributed if a meeting of all employees cannot be called. Large posters spread across the facility can also remind the workers of ongoing efforts. It is also crucial to provide feedback to employees about the progress and success of these actions once they are implemented.

Some workers may need more detailed instructions than others. Operators who are in charge of a process of a system should be educated to evaluate and report any unexpected or unsuitable consequences due to changes that were made to accommodate EMOs. These workers should be aware of what the acceptable variations are. For example, if an across-the-line motor starter is replaced by a variable speed drive, the current meter will not indicate the inrush current that is inherited in typical induction motors. Simple efficiency changers such as which light should not be on during specific time of the day should be posted to keep workers informed.

OTHER ISSUES

The management of organizations and the energy managers in developing countries should also pay attention to metering methods and meters employed by their utility companies. Some countries have age-old power distribution system where little or no attention has been given to the metering aspects recently. Some meters are too old. Some meters records power consumption inaccurately when harmonics are present [3]. Certain new retrofit used to replace old ones with the expectation of saving energy may introduce harmonics to the power grid. It is paramount to verify the metering system or install their accurate meters before initiating energy management projects.

Finally, energy management is an applied field. One can learn some of these skills while conducting preliminary energy audits. Required checklists, record sheet, and actions to be taken are well documented and available to public through various organizations in the United States. For example, through US Department of Energy (DOE) and National Lighting Bureau in Washington, DC one can access different types of audit documents.

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Linking Engineering Technology with a Business Administration Program

Raj R. Amireddy[1], Wes Grebski[2], Judith O'Donnell[3] and Lori Singer[4]

Abstract *— The paper describes the curriculum of the individualized option in the baccalaureate Business Administration program. The individualized option is a multidisciplinary curriculum which links the Mechanical Engineering Technology and Electrical Engineering Technology associate degree programs with the baccalaureate Bachelor of Science in Business degree program. Graduates from this program will be prepared for management positions in the manufacturing industry.*

Index Terms — About four, alphabetical order, key words or phrases, separated by commas (for suggestions Preparation of papers, camera-ready, two-column format, ICECE format).

INTRODUCTION

The competitive job market of the 21st century forces college graduates to seek and develop unique and rare skills. The acquisition of these skills is often the deciding factor in achieving employment goals. In a constantly changing work environment, these interdisciplinary skills are more important than ever before. As a result of this situation, professional societies and accrediting bodies encourage and support interdisciplinary projects in the curriculum.

CURRICULAR ISSUES

Penn State Hazleton offers traditional mechanical technology and electrical technology programs. These programs are ABET accredited and are offered in Hazleton at the associate degree level. The graduates of these programs can either seek employment or continue their education at the baccalaureate level. A majority of the students continue their education in the baccalaureate degree programs (Fig. 1).

Unfortunately, those baccalaureate degree options are not available at Penn State Hazleton. Depending on the choice of major, most students continue their education at the Capital College in Harrisburg, the Altoona College, or the Berks-Lehigh Valley College. Penn State Hazleton also offers associate and baccalaureate degree programs in business administration. Similar to the engineering technology students, business administration students who graduate with an associate degree can either enter the job market or continue their education in a baccalaureate degree program. In contrast to engineering technology, however, a baccalaureate degree program in business administration is available in Hazleton.

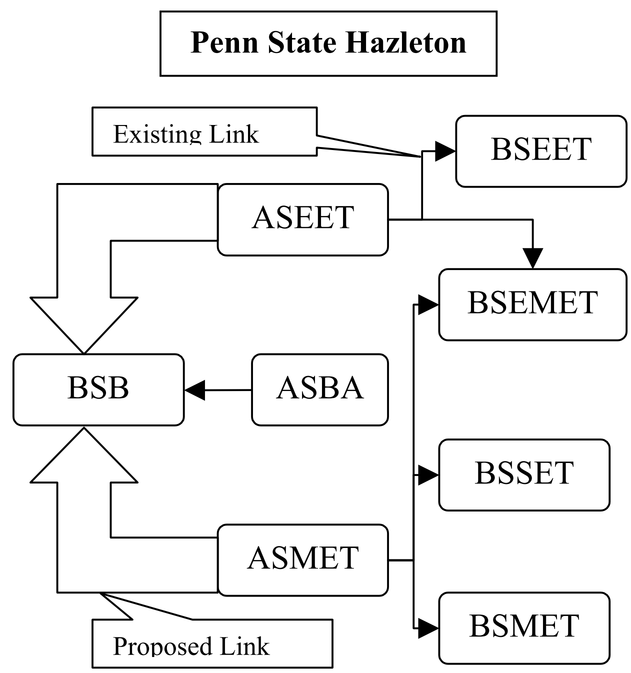

FIGURE 1
EXISTING AND PROPOSED LINKS

By linking these two programs, students at Hazleton in the Engineering Technology programs are afforded the opportunity to complete a baccalaureate degree and remain

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at Hazleton. In this two plus two design, Engineering Technology students complete their associate degree and then reenroll in the baccalaureate degree the following semester. The transition is virtually seamless and allows students to complete both the associate and the baccalaureate degrees in approximately nine semesters.

One might think that a conjunction of business concepts with engineering principles is hugely unlikely. The reality is that engineers may be some of the best resources to market and sell various product lines due to the fact that they have the ability to describe the reliability, functionality and needs for buying parts and/or products.

One of the most basic rules in business is the 80/20 Rule. This basically states that 20 percent of a firm's customers are responsible for generating 80 percent of a firm's revenue. Some experts believe that customer retention has a more powerful impact on profits than market share in terms of competitive position in the market place. Some basics of customer retention include: trust building, personal contact, proper installation and training, and seeking customer feedback by follow-up.

It is in the best interest of firms to employ and grow engineers with solid mechanical and/or electrical backgrounds who could communicate to consumers with a firm understanding of the product design and functionality, as well as an understanding of how the use of the product will impact their businesses. This is why the link between engineering technology and business concepts in education is so crucial.

In the 1999/2000 academic year, an agreement was reached between the engineering technology program and the business administration program. This agreement created an individualized option in the baccalaureate BSB program. This new individualized option allows ET graduates to enter into the BSB program at the junior level. This agreement created a very valuable and attractive option for associate degree ET graduates.

The curriculum developed for those individual options is shown in Fig. 2. During the first two years the students take engineering technology courses. Business related courses are taken by the students during the junior and senior years. Presently, a number of students are successfully pursuing this option. At the end of the 2003 spring semester, a number of engineering technology students will graduate with a BSB degree. The feedback received from the students who are pursuing this individual option is very positive. The Penn State Hazleton Industrial Advisory Committee supports the program.

TABLE I

CURRICULUM CONTENT FOR BSBA/MET OPTION

BACHELOR OF SCIENCE IN BUSINESS / 2MET OPTION			
Semester 1		**Semester 2**	
EET 101/109	4	SpCom 100	3
ET 2	1	* IET 101	3
Math 81	3	EGT 114	2
EGT 101/102	2	Math 82	3
Engl 15	3	AHS	3
AHS	3	* MCHT 111	3
	16		**17**
Semester 3		**Semester 4**	
* MET 206	3	MET 210 W	3
MCHT 213	3	IET 215	2
MCHT 214	1	Phys 151	3
EGT 201	2	AHS	3
Math 83	4	Engl 202D	3
Phys 150	3	NatSci	3
IET 216	2		
	18		**18**
Semester 5		**Semester 6**	
BA 321	3	BA 322	3
* MKTG 301	3	* BLOG 301	3
* MGMT 301	3	ECON 2 or 4	3
MIS 204	2	ACCTG 211	4
* FIN 301	3	BA 243	4
ECON 2 or 4	3		**17**
	17		
Semester 7		**Semester 8**	
BA 421	3	* BA 422W	3
IB 303	3	BA 495	6
MSIS 200	4	Engl 419	3
SpCom 352	3	MIS 103	3
HPE	4	Arts, Humanities	3
	17		**18**
Summer			
Arts, Humanities	3	**BA 495** (Internship)	6
Tech Elective	3	can be completed	
		in summer	
* Course requires a grade of "C" or better			

The graduates from this individualized, interdisciplinary program will have the skills necessary to seek manufacturing management positions in industry. The multidisciplinary background of the graduates will allow them to work and communicate effectively with the engineering and technical staff. The graduates will also be able to work effectively with the marketing and accounting staffs as well as with financial institutions.

Since management styles have changed dramatically over the last few decades, with a team of directors leading organizations rather than one sole leader as was done in the past, it makes perfect sense to include individuals with quantitative abilities as one or more of the team members. Due to this current need in almost all businesses, it has become clear that quantitative thinkers need to understand communication and management styles to be effective and successful. Teams and groups now dominate in most work settings for decision making, whereas individual efforts were once hailed. Since business in general has become more complex, with innovative technology that is constantly changing and firms diversifying product and service lines of business so rapidly to stay competitive, it seems to follow logically that engineers should be an integral part of the upper echelon of individuals who lead an organization. Probabilistically speaking, to make engineers more successful, the event of business concepts and applications (call it Event A) is the perfect complement to the event of engineering talent (Event B). Given that these are the only two events in the sample space, the probability of Event A in union with Event B ($P(A \cup B)$) will be equal to $P(S)$, the probability of the sample space, which is a perfect number 1

CONCLUSIONS

The individualized option of the Bachelor of Science in Business program, which has been described, is expected to increase the enrollment in both that program and the engineering technology programs. Penn State Hazleton will survey graduates and employers after a significant number of graduates enter the workforce.

FUZZY LOGIC APPLIED TO INFORMATION RETRIEVAL SYSTEMS

Dulce Magalhães de Sá[1]

Abstract — *Information retrieval systems can be used in a variety of contexts. For example, these systems can be used to support business or learning environments and digital libraries. Information retrieval systems are a type of resources that allow to obtaining information for decision making. Some reasons for information retrieval problems are data structures issues, efficiency of interfaces, information organization, database management systems absence, quality of information and information systems not suitable for specific process use. As a form to reduce the number of problems in information retrieval, fuzzy applications can be used to detect partial needs of user queries and access information element. It also can be used to organize the system answers by ranking of importance to facilitate the user decision, because in fuzzy logic an information element can reside in more than one set of different degrees of similarity.*

Index Terms — *Digital Libraries, Fuzzy Logic, Information Organization, Information Retrieval Systems, Multimedia Applications, Retrieval Techniques.*

INTRODUCTION

One important topic for design and develop information retrieval systems is the data structure and organization of information contents. Data structure is data grouped by an organization method of simple data collections [1]. Between the possible types of data structures are records, sets or files.

The evolution of the Internet, particularly its Word Wide Web component, has created new opportunities and ways of application and analysis of information retrieval systems. One of the components of information retrieval systems is information itself that, in certain ways, has become a social and economical product.

One of the ways of organising information is by creating databases, developing applications and implementing database management systems [2]. Interactive databases in information retrieval systems are a critical component of the success of the system and, eventually, of the organisation that owns it, because they constitute a decision support tool.

INFORMATION RETRIEVAL ISSUES

Information retrieval is the ability of obtaining answers on information needs expressed to system in a language, usually a query language. Information retrieval systems are developed to provide efficient ways of search. Reference [3] defines information retrieval system as a system used to store items of information that need to be processed, searched, retrieved and disseminated to various user population.

The basic components of retrieval information systems are search formulation, search software, information storage environment and queries process [4]. This involves hardware for information storage and persons (searchers) that executes queries.

- *Searcher* - person who has information or information contents needs and then begins the search process. In a particular case, the searcher can be a mixed entity between any person who elaborates part of the initial search process and a software agent who limits the scope of the search [2]. The human search is mostly oriented by subjective processes. The software agent searcher transmits to system the subjective aspects of the human user through rules previous fixed. Software agents can interfere in other phases of search, such as structures of search formulation [5].
- *Search formulation* - a process that requires some decisions that concern to topics of search, information fonts or contents, design of search formulation and which resources should be used in search process.
- *Resources* - software to search in local mode, private networks or Internet [4].
- *Information storage* - an important aspect of retrieval information systems because it allows search across the data structures.
- *Retrieval items* - aspects to performing the way that the system answers to queries depends of its design and conception.

Retrieval techniques are methods or processes used by systems for extract information topics in a particular way. A classification of retrieval techniques [6] distinguish between exact and partial match techniques. Exact match, for example Boolean retrieval and string matching techniques, requires precise information contents concern to topics of search.

Partial match techniques are used to compare queries with information elements represented as sets of features or index terms. Its include techniques based on formal models of information retrieval as probabilistic model, based on the probabilities of relevance to the query or fuzzy set model.

BOOLEAN INFORMATION RETRIEVAL

Information retrieval systems normally accept Boolean expressions, based on logic operators, as queries. Logic

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operators provide to their subject elements (Boolean data type), operations of conjunction, disjunction and negation. Negation operations are processed as exclusion of particular elements in a set of various elements. Logic operators are AND, OR and NOT [7].

Logic operators are used to clarify search formulation in retrieval systems. Let A, B and C words (strings) of any search formulation [A AND B] provided as answer all records with A and also B.

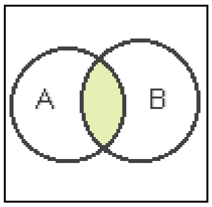

FIGURE 1
BOOLEAN OPERATION: [A AND B]

[A OR B] provided as answer all records whit A, all records with B, and also all records with A and B.

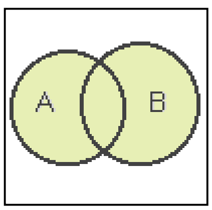

FIGURE 2
BOOLEAN OPERATION: A OR B

And [A AND B AND (NOT C)] provided as answer all records with A and B, but not those with of A and of B but not C.

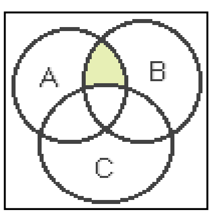

FIGURE 3
BOOLEAN OPERATION: A AND B AND (NOT C)

To obtain efficient results some design aspects must be considered for developing information retrieval systems. They must have a user-friendly search environment, including interfaces and data structures with Boolean type which supports logic operators [8].

However, Boolean information retrieval no ranking answer elements. The way that information contents are treated by retrieval systems and the way that it is presented as an answer to a query or request, are important factors to decision make process.

Difficulty to obtain answers to specific queries and access difficulties to found information contents or valid references to information needed are typical problems on information systems [9] and retrieval systems. A retrieval based on fuzzy set model provide searches with a decision rules to filtered information on databases and can be ranking answer elements to facilitate the decision make process.

FUZZY INFORMATION RETRIEVAL

Fuzzy logic is basically a multi-valued logic that allows intermediate values to be defined between usual valuations like 1/0, yes/no or true/false. It has been used initially in system theory to describe and implement uncertain notions and general concepts [10].

In fuzzy logic an information element can reside in more than one set of different degrees of similarity. Fuzzy relations represent a degree of presence or absence of association, interaction or interconnectedness between the information elements of two or more fuzzy sets.

One of the components of a fuzzy logic system is rules. These rules will be expressed as logic restrictions, in the forms of IF-THEN statements [11]. They are usually of a form similar to the following: *if x is low and y is high then z=medium*.

The area of information retrieval has also benefited from fuzzy logic methodology. Some fuzzy operations like union, intersection or complement can filter information elements with values between absolute true (1) and absolute false (0).

This provides a tool for natural language interfaces in retrieval systems and solution for some information retrieval problems. The software agent searcher that transmits to system the subjective aspects of the human user through rules previous fixed can be based in a fuzzy logic structure [2].

There already exist query systems that provide an ordering among the information items that more or less satisfy the request. The systems may allow for the presence or imprecise, uncertain or vague information in the system database.

One considers a system where the domain of each expression X (word or set of words) is represented as a function of a theme Y. If the expression X is associated to theme Y, X is relevant else X is irrelevant as retrieval item.

The grade of relevance is express for the weight of each X in a Y by numbers: 3 for must relevant, 2 to relevant and 1 to irrelevant. X is must relevant to theme Y if it is associated to weight 3, relevant if the weight is 2 and irrelevant for grade 1.

Weight 3 can be associated to a probability of X is include in Y, for example, between 1 and 0.75; for weight 2, if between 0.75 and 0.5; and for weight 1, from 0.5 to zero. This reduces retrieval items associated to theme Y because only consider "relevant" weights 3 and 2, supposing a rule which determine relevance as a probability of 0.5 as minimum.

CONCLUSION

Where information elements are stored in systems database, they can be classified by one of three weights, but this depends of the subjectivity of person who classified that. This process can be applied in simple and specific systems.

For large and complex systems is more reasonable that decision process depends of searcher. Thus, the retrieval system provides to searcher an optional theme Y for expression X gives by searcher.

System selects in information elements of database or in documents which Xi had weights 3 and 2 on Yi and retrieved them. Xi and Yi are any X and any Y respectively in each record on database or document (file) where X or Y exist.

System can be incremented, for example, by more variables like one second expression Z or more weights for relevance or other elements. This gives more complexity to system processing, but easiness to searcher person that use system and provide more efficient answers.

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OBSTACLES ENCOUNTERED BY UNICAMP ENGINEERING PROFESSORS WHILE DEALING WITH DISTANCE TEACHING PROCESSES

Dilermando Piva Jr.[1], Mauro Sérgio Miskulin[2] Ricardo Luis deFreitas [3], Geraldo Gonçalves Jr. [4] and Rosana Giaretta Sguerra Miskulin. [5]

Abstract — *There is a clear growth in Web use by Universities, with the purpose of spreading online courses. However, online teaching is far from reaching its maximum potential. Several obstacles were pointed out as being the main cause for the deficiencies encountered during studies carried out in a number of countries. The causes for these problems were personal, technological, and institutional. This article has as its main objective, to take these main obstacles that were pointed out during the studies, and see how true they are within the Brazilian reality; specially in the technological area, taking the Engineering courses at State University of Campinas (Unicamp) as the basis, through research done with professors from different courses of this Institution.*

Index Terms — *Distance education, Engineering Education, Obstacles in distance learning, Engineering online courses.*

INTRODUCTION

The increase of Internet use as a way of improving communication means as well as the broadening of computer processing power, have favored the growth of distance learning through the web (online teaching). This has motivated Universities to re-think their practices and teaching policies, and to adopt online teaching programs.

The increases in the learning process quality, the maintenance of competitive advantage, and the improvement in the means of education access, were pointed out as the three main reasons for the set up of online courses according to studies done at the end of the last decade by Universities [1], [6] and [9].

However, the use of online teaching potential is far from reaching its maximum. A number of studies and researches done throughout the world indicate various obstacles, which were pointed out by professors. These obstacles were caused by personal, technological and institutional problems.

This article has as its main objective, to take the main obstacles identified in these studies and researches, and see how true they are within the Brazilian reality, especially in the technological area, taking into a basis the Engineering courses at State University of Campinas (UNICAMP), through researches done with professors at this Institution.

OBSTACLES FOR THE INTRODUCTION OF WEB BASED LEARNING – WORLD CONTEXT

A lot has been written about the importance and the value of the contextualized computer in the teaching/learning process. Glace and Smith [3] wrote about the gap that exists between the expected technological level and the one really used by professors. To obtain success in the integration of technology to teaching, we should not only rely upon the use and acceptance of technology by the students; but also, and on priority bases, rely upon its understanding and mass use by professors.

In the case of online teaching, studies have shown a number of obstacles (barriers) that block the effective use of technology by professors, causing a gap to appear between the expected and the real use of such technology.

Pajo and Wallace [10], based on research results done with Professors at the Business, Science and Education School at Massy University (New Zealand), pointed out as the main obstacles: 1) time required to learn how to use the technology; 2) time associated with the development and implementation of web based courses; and 3) time required to use online teaching environment as well as course monitoring (student feedback).

Aside from this first set of personal obstacles, the same authors point to another group that are imposed upon by the teaching Institutions, which they called organizational obstacles: inadequate technical support, the lack of institutional of recognition/importance of processes involving online teaching and insufficient available funds.

Already in 1995, James and Beattie [7] did a study on graduate education in Australia, which showed a slow evolution of options in his long distance teaching, whereas

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main means of instruction was still written. According to the authors, a major use of online teaching has not yet been reached due to lack of academic pattern consensus, to bad results about other academic work, and the lack of technical support.

Specifically on the item academic work impact, the authors with the help of professors who were interviewed, identified the reasons that influenced this negative impact, and arrived at the three main (obstacles): 1) time required for managing the groups and other chores that go along online teaching (especially feedback to students), 2) a large amount of time required for the production of good quality learning material; 3) long distance teaching is just as rewarding, or less than through traditional teaching methods.

To enhance this hypothesis of problem universalizing, the work of Daugherty and Funke [2] done at Calgary University with students and professors reinforces he existence of obstacles, which are in common to all. The findings obtained by researchers while working with professors as to the obstacles, or changes imposed by online instruction take in were (through order of importance): 1) lack of technical support; 2) lack of equipment as well as adequate software; 3) amount of time required for material preparation and course managing; 4) holding back on the part of students; and 5) lack of institutional support.

Still on this same line of thought, two other studies show that there is usually poor performance on the part of online professors, as to questions pertaining to time and technical support, seeing as how very little or no importance is given to these items [5] and [8]. The later [8], goes as much as to say that the recognition of time involved in the creation of quality products, the development, and its setting up is still not yet agreed upon by the majority of Universities.

Similar results to the ones mentioned above, were also found in other researches done in other contexts, schools and countries [4], [11], [3] and [13].

As we can see, there is harmony in the results of reported researches, and therefore, there is an indication that there is a universalizing of obstacles found by professors in the online teaching process. Our intention is to bring it to accordance with the technological area, specifically in engineering courses.

UTILIZED CONTEXT FOR THE OBSTACLE VALIDATION IN THE ENGINEERING AREA

State University of Campinas (UNICAMP) is a public teaching institution that offers a range of knowledge areas, and levels of undergraduate and graduate courses; preferably through traditional methods. It stands out as one of the largest public universities in Brazil. It has 21 thousand students divided as follows: (55%) undergraduate and (45%) graduate students [12].

UNICAMP does not have clearly defined policies in relation to long distance teaching. Therefore, the observed reality is the existence of individual efforts of a small part of the faculty who is conducting pilot online teaching programs, in its majority, used as support to present teaching.

In the technological area, specifically in the Engineering School at UNICAMP, the scenario is not different.

Only a small percentage of UNICAMP´s school of Engineering faculty (not more then 5%) take or have taken the initiative to use the *Web* channel as teaching means.

Public Consulted

In its context, the encountered obstacle validation process which was found by professors in the long distance teaching process, specifically in the engineering area of UNICAMP, was restricted to a small sample of professors, making this limitation advantageous to the study, because we were able to opt for individual semi-structured interviewing with each one of the faculty members that used or are using the long distance teaching process, wishing to explain with more accuracy the individual perceptions as to obstacles encountered during their online teaching experience.

Table I shows the various schools of engineering at UNICAMP, and the number of professors that were interviewed in each.

TABLE I
SCHOOL OF ENGINEERING AT UNICAMP AND THE NUMBER OF PROFESSORS THAT WERE INTERVIEWED IN EACH LEARNING UNIT.

School of Engineering at Unicamp	Number of professors interviewed
School of Computer and Electric Engineering	4
School of Civil Engineering	2
School of Mechanic Engineering	2
School of Chemical Engineering	2
School of Food Engineering	2

Methodology

The interviews were done during April and May 2002, dates were previously scheduled, and, when authorized they were taped.

Each interview lasted for at least 30 minutes, and in some cases it lasted for as much as 2 hours.

RESULTS FOUND IN THE VALIDATION PROCESS

The interview was guided by the central question: "***what are the obstacles in distance teaching?***" Because of the format of the semi-structured interview, it was done in an open way, without limitations on the part of the professors when answering the questions.

The majority of the professors, who were interviewed, gave as the main obstacle "***time consumption in the***

development of the teaching material, and time spent for the redirection/conduction of the group (feedback) " In the words of one of the professors:

> *"The biggest obstacles are: time and preparation…you spend time to prepare the material, to help the students, and to work with the computer".*

Concerning *feedback* to students, another professor mentioned:

> *" In my attempts (long distance teaching), I used the e-mail as communication means. It was terrible! I wasted all my time doing this, and couldn't do anything else (more important)"*

As to the preparation of teaching material to be used, it was observed that, in the majority of the cases they were already available. They were not, however, in an adequate format or style to be published and or made available for the online teaching. In this sense, one professor points out:

> *"…it is obvious not only to the student as well as to the professor that to do such work (producing teaching material) isn´t an easy task. To write the text, for example, it demands a lot of hard work. I had already written a book on electronics, in which I referred to a course of latex, so I used this material as basis for the Classes. However, it had to be converted into HTML. The Whole conversion process demanded a lot of work."*

In the later report, in common with the set of interviewed people, goes what was identified as the second and biggest impact obstacle in the online set up process and production: "***the technological obstacle: lack of technical abilities in the handling of/ and limitations imposed by such technologies***".

There is an interesting comment made about the second obstacle:

> *"The main obstacle (in long distance teaching) is the lack of effective multidirectional communication. Interaction is jeopardized, thus reducing adaptation space according to the moment and group re-feeding. The tools used for communication nowadays are sufferable, to say the least".*

Besides the communication limitation, also another limitation was pointed out; the one related to the tools aimed at teaching material production. There is a particular aspect pertaining to the technological area, as pointed out during the interviews. In the technical engineering area, there is great need for concept expressing in form of mathematical formulas. These formulas need a tool that facilitates the construction and the publishing process. Therefore, we come upon the third obstacle, which is: "***the lack of specific tools for the technological area which facilitate material publication process***". One of the professors who were interviewed points out:

> *"…when you need to create material, just to think that one has to use equation editor, is hard enough, and there is no point in giving a long distance course unless you have appropriate material. You take twice or three times more time to use an equation editor, as you would if using a text editor or simply did it by hand. It's a great sacrifice".*

The fourth obstacle arises because of the limitations imposed by technology, and it is widely pointed out by the professors who were interviewed: "***the need to (re-learn) a new post as professor/tutor***".

A very pertaining comment came up regarding the fourth obstacle:

> *"The professor has to have it clear in his mind, that long distance teaching is not the same as classroom teaching. There is a difference in standard, and as such, it forces a change in posture in the process of participating agents, especially the professors' ".*

The majority of the professors' manifestation became clear as to the lack of incentives on the part of the institution, to support course transformation projects taught in the traditional way (professor present) to online format. Such manifestation points out another obstacle found: "***lack of clear institutional support to faculty members***".

The professors who adventure into such tasks are the ones who look for innovative processes, not worrying about the return or the institutional support. Here is a comment that emphasizes this obstacle:

> *"… if you can give a professor-present course in which you go there for 2 to 4 hours a week and see from 5 to 6 students because the others don´t look for you anyway, and when it's distance teaching, the ones that never look for you, come and ask questions just to say that they are taking part…and this unmotivates; seeing as how we don´t earn anything extra to do this. Therefore, most professors prefer to stick to professor-present classes only".*

The view that the "institution" does not support such processes can be verified by the views of many professors in the educational format of online teaching:

> *"… so, distance teaching demands a lot more work than professor-present classes, and sometimes this is not very well understood, and when other professors found out that I was teaching online, they asked: what does he do? Do you mean he doesn´t teach? What does he do during his class time? There is a lot of prejudice towards it, but these people are a bit slow, so they don't really*

understand this new way of educating, so I have to explain everything, and show that I spend a lot more time then I would if I were teaching a professor-present class; in which I'd show my ready made transparencies, with nothing new to add; so the teaching task is very small….it´s alright if stay in the classroom for two hours, but I take a lot more then two hours a week to do this online course!"

As for last, other obstacles were pointed out by the professors during the interviews; not in an emphatic way as the ones already mentioned, but that in a way cause a bit of worrying because they touch upon the effectiveness of the long distance teaching set up. Some of them are: lack of support personnel; excessive personal exposure: prejudice on the part of the students: and the fact that communication tools are still deficient.

Table II shows a summary of the main obstacles in order of importance: as they were pointed out by the professors of the engineering courses at Unicamp, while they undertook the long distance teaching process.

TABLE II
MAIN OBSTACLES FOUND BY PROFESSORS IN THE ENGINEERING AREA

Degree of Importance	Obstacles
1	Time used for the development of teaching material and for the conduction and redirecting of students *(feedback*)
2	Technology: Lack of technical handling abilities and limitation imposed by such technologies
3	The lack of specific tools for the technological area which could facilitate the publishing process of technical material.
4	The need to re-learn the new professor/tutor posture
5	Lack of clear institutional support to faculty members

FINAL CONSIDERATIONS

As first proposal, the research done with the faculty members from the Engineering School at UNICAMP, had as a goal, to identify the main difficulties encountered by professors while using the Web for teaching, and to compare them to the results of others researches done in others Universities and countries.

The validation process was successful, for the main obstacles that were pointed out by UNICAMP´s engineering professors, and they were coherent with the ones presented in other papers.

In this comparison, it was possible to validate the use of those papers in future researches in online teaching.

The only point not emphasized in the researche done, but which was highly high lightened by the professors in the technological area, was the lack of tools to facilitate the publishing process of technical contents/mathematical, like formulas, resolution mathematical processes, and technical drawings.

Therefore, we are aware that such obstacles were pointed out as being in conformity with all the professors during the process of setting up online teaching courses; no matter what the geographical location was, or its work area. The great difference in the powering of online teaching is in the bringing out of valid standards, and the construction of a new model, and a new teaching structure, proper for this new context.

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ENTRY LEVEL PROBLEMS DIAGNOSIS, PARTIAL SOLUTIONS, THEIR EVALUATION AND NEW PROPOSALS

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Abstract *— Severe entry level problems are observed in the case of a Mexican school of engineering. Besides problems related to knowledge and skills in basic sciences, students lack study habits; the transit from annual to three month terms demands them to work under pressure and finally, social, economical and psychological aspects are involved. Not all the teachers, despite their scientific level, are concerned with these problems. Several actions have been taken: a program of professor-advisor, updating the curricula, welcome programs, leveling courses, improving the infrastructure and promotion of the SAI (Individual Learning System). Conception, strategies and results of these measures are described. Other actions are to be applied in the near future: promotion of the bachelor programs; study habits workshops; psychological support; increasing non-curricular activities; motivational events; a program of courses for the development of teaching skills and including professional subjects from the beginning of the career.*

Index terms — Advisors, entry leveling, individual learning, welcome programs.

INTRODUCTION

The Division of Basic Sciences and Engineering (CBI) of the Universidad Autónoma Metropolitana – Azcapotzalco (UAM-A) is located in the northern part of Mexico City. As a school of engineering, the CBI Division offers nine engineering bachelor programs, four master and two Ph. D. programs. A tenth bachelor program (Computing Engineering) is about to be opened by Spring 2003. Studies about graduates performance were done and their results are more than satisfactory; a high percentage of graduates are working in their professional field and the institution is increasingly recognized for its results, despite its youth (28 years in November 2002). As a contrast, entry leveling is one of the most concerning problems and its consequences are determinant for students advance. Desertion at the first levels is high and many of the students who stay have significant problems. An effort is being done to revert the situation. First of all, a diagnose was obtained and causes of the situation were identified. As a multivariate problem, it must be attacked from various fronts; strategies must be coordinated and a constant evaluation is needed. Some actions were already taken and others are under planning.

THE DIAGNOSE

The Universidad Autónoma Metropolitana is one of few high education schools in Mexico with three month terms. There are three trimesters per year (Spring, Fall and Winter). A trimester includes eleven class weeks and one more for final exams. Curricula are organized according to this; theoretical subjects normally comprise 49.5 hours and laboratory courses are programmed in eleven sessions of three hours. Bachelor programs consist of 12 trimesters (4 years) and about 70 subjects. There are two admission periods per year: Spring and Fall. Although between 700 and 900 candidates are admitted in a period, not all of them finally register; normally 8 or 9 out of 10 do. In extreme cases, such as Spring 2002, only 7 out of 10 new admitted students effectively registered. The first trimester is critical, because desertion is significant along this term. In some cases, only one half of the initially registered students remain active until the second trimester. In addition, other figures are significant to show the failure of the new admitted students, such as the accreditation rate in some subjects; Calculus I, for instance, has had an average of 35% per period between 1993 and 2001. It is difficult to determine the causes of this situation but some of them may be assumed as a result of studies and inquiries applied to students and teachers.

- Most of the new admitted students are used to semester or yearly terms. The adaptation to trimester terms force them to study under pressure. The advantages of this are evident, because the future professional develops skills and attitudes to work under pressure and adverse conditions. However, adaptation to this should be gradual.
- The students academic entry level is low, specially in mathematics.
- Students lack study habits.
- Students don't feel identified with the institution and their careers at the beginning. The institution organized few and infrequent motivational activities. Students are not organized in an association, although they share cultural and social activities from time to time. Until

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recently, there were no professional contents in the first trimesters; only basic sciences and some social subjects.

- Teachers, despite their scientific level, are not always concerned with the student problems and some of them lack pedagogical skills or training.
- The curricula spent many years without revision and updating.
- Poor promotion of the programs outside the University.
- Social, economical and psychological factors.

Considering this situation, some measures were proposed. Some of them were put in action and others are under planning. They are described and partial results are commented.

Advisors Program

There are three levels of autonomy in the University, with distinctive functions; increasingly: Division, Campus (Academic Unit) and the University itself. The CBI Division started a program of advisors in the trimester Spring 2000, on the basis of assigning a teacher-advisor to every new admitted student. This was difficult at the beginning, specially because advisors practice has little tradition in Mexico. Discussion aroused about whether it was convenient to select advisors whose professional profile was close to the student career or not necessarily; it must be pointed that successful experiences were achieved in both cases, in the U.S. and England, for instance. At the beginning, it was decided to assign advisors regardless of the career but it was noticed that the students wouldn't approach their advisors; so the policy was changed. By Spring 2002, the advisors program was assumed by the Academic Unit, as a consequence of a scholarships programs. It was conceived as an educative service created to follow up the students formation process, as individuals and as a collective, and an opportunity for planning and designing strategies to develop students skills and attitudes. Particular objectives are: to facilitate the students integration to the University; to advise the students for decision taking regarding their studies; to promote criteria and attitudes to contribute to the students' autonomy; to help the students to the early identification of common problems in the studies and to assist them to find solutions; to encourage the rational use of the resources offered by the institution and to contribute to the self evaluation process undertaken by the University. Partial results of this program are not really encouraging; students do not meet their advisors as often as they should, even at the advisor's call. The conclusion is that it's a cultural matter, which only practice and insistence will revert.

Updating the curricula

This is a difficult task in this University for various reasons. The democratic organization of the institution demands that many sectors are to be consulted to take such decisions and the three government bodies (corresponding to the Division, the Academic Unit and the University) have to approve the proposals. Another feature is that the different careers share subjects, not only in the basic level but also in advanced trimesters; this happens for instance with environmental dimension or systems engineering subjects and more emphatically in careers with common interests; thus, the updating of one career necessarily affects others. Finally, regulations demand that only one program must be in force at a time for the same career; so, when a program is updated, the academic record of every student must be converted into the new one. By 2000, the curricula of all nine bachelor programs accumulated a considerable delay in their updating, despite remarkable initiatives; only local and limited revision was registered. A great effort was done in 2001 and 2002; the programs of the nine careers were revised and even a new career was created. Once the programs were updated, all of them applied for accreditation to the CACEI (accreditation board for Mexican engineering programs), a practice of increasing importance and recognition in Mexico. Obviously this kind of actions is very important but, how does it help the first level students? Some elements considered in the changes were directed to this. In some careers the number of credits in the first trimester was lowered, in order to make easier the transition to the university life. The curricula structure was changed into a more flexible one; the prerequisites to take some subjects were suppressed; when the previous programs were in force, students who didn't approve math subjects of the first trimester, weren't allowed to take physics subjects of the second one, with severe consequences for the advance in their studies; this condition was canceled. Some careers introduced professional subjects in early stages. Finally, modern techniques were introduced for evaluation and teaching itself. Updated programs were put in operation in October 2002; a permanent follow up is planned to evaluate the results.

Welcome programs

The Academic Unit has always offered welcome programs to new admitted students, to get them introduced to the university life. The Divisions and Programs Coordinators have also contributed to this activity, although less regularly. An effort was done since 1999, to coordinate the participation of the different institutional branches and even students groups in a program called PIVU (Integration to University Life Program). It is essentially a one day event directed to promote an integral relation between the new admitted students and the University. It is conducted during the first week of the trimesters corresponding to admission periods (Spring and Fall). Its particular objectives are: to offer the new admitted students a global vision of the services offered by the University; to give information about the academic, cultural and sport activities, about the student's rights and duties and where they can get specific information and support; to promote a sense of belonging and identification with the institution. Activities are: information stands about the careers, information stands about institutional services (foreign languages, cultural activities, sports, computer services, library, school administration, educative orientation, graduates, medical services, etc.); an artistic event, such as a concert, is generally included. Again, the students participation in these activities is never as wide as desired; however an opinion poll applied to them showed the following results: They consider that the PIVU is an important event to know the services offered by the institution; they feel important for the University; they believe that more publicity is necessary and that advanced students should cooperate more.

Leveling courses

Most new admitted students have an insufficient background, particularly in mathematics and physics. This has lead to think that leveling courses could be a chance to level them to the basic sciences courses of the first trimester. Opinions vary from dedicating a whole trimester to these courses and make them compulsory for students who are unable to pass a special exam, to those who propose to set them as optional courses for the students, limited to a period of one or two weeks, prior to the formal teaching. A document produced in 2000, for instance, suggests that students with deficiencies in basic sciences should take a set of courses during one trimester, including mathematics, physics and study habits; the student is supposed to dedicate full time to this activity. However, this was never put into practice. Instead, a set of mathematics, physics and induction to the University sessions was offered since Winter 2002; although this is not an admission trimester, the course was initially offered for students who had been admitted in Fall 2001 and, for some reason, decided to inscribe later. This first time only 8 of them attended the sessions but in Spring and the Fall that figure grew to more than 70, about 10 to 15% of the total number of admitted students. The effort was successful, particularly regarding the permanence of the participants in the school. Considering this experience, it is planned to offer a module of support courses for new admitted students, during the first trimester, simultaneously with regular subjects. This will start in Spring 2003.

Improving the infrastructure and promotion of the SAI (Individual Learning System)

This is an alternative to the traditional teaching-learning method. Its most important features are the following: excellence learning, as a possibility for every student; active participation, this requires than the student plays an active roll in the learning process; and positive reinforcement, suppressing every element related to penalties. As an individual learning system, the SAI teacher acts as a guidance and a learning facilitator for the student but must provide him (her) with material enough for the lessons. The SAI allows the student to advance at his (her) own rate; he (she) may even spend two trimesters for a certain subject if necessary; exams are more frequent and with less contents than those ones of conventional courses. That's why this system is suitable for slow progress students as well as for high efficiency ones. Not all subjects are offered through this systems but most of the basic level ones are. Other limitation is the resources dedicated to this program but considering its importance and potential to help students, they were increased in recent years. Promotion of the SAI is sometimes difficult because students are not used to play an active roll in the learning process but students themselves are the best promoters, because those ones who have the experience are generally satisfied and come again. Another important fact is that an extra effort was made to help, through the SAI, students who have failed in their first mathematics courses.

Promotion of the bachelor programs

The University is located in one of the largest urban concentrations in the world, with more than 20 million inhabitants. Despite this impressive market, there are more than 20 schools of engineering in the area, either public or private ones. Some of these institutions include high schools, which are natural providers of candidates to professional programs; the UAM doesn't, as it is established in its Organic Act. Publicity is difficult because it's very expensive to reach to so many people and the budget for this purpose is limited. Thus, the most suitable way to promote the bachelor programs and to get more and better candidates is going to selected high schools; presentations, conferences, brochures, panels and stands are adequate means for this objective. Some Program Coordinators have had initiative enough to follow such kind of activities by themselves. The Metallurgical Engineering Coordinator (co-author of this paper), for instance, has participated in radio programs, visited high schools and secondary schools, conducted guided visits in the University, wrote a manual with a study about the Division promotion and participates in a periodic event called October. Science Month, organized by the CONACYT (National Council of Science and Technology). Other experiences show that the presence of advanced students in visits to high schools is strongly motivating for potential candidates. It's expected that the programs accreditation will increase the prestige of the Division and will become a fine credential for its promotion.

Psychological support

Important help to students is given by the Office of Educative Orientation and Psycho-pedagogic Support, which depends on the Academic Unit. The psychologists team of this office give professional care to students who suffer from addictions, personal or familiar problems and, if necessary, patients are sent to specialized centers, linked to the

University by formal agreements. Another activity of this office consists of giving professional orientation to students, specially through workshops; it must be pointed that many students select their career without a proper orientation and with this kind of help, they have a new chance for their turning point. Several events are organized by this office, such as lectures, workshops and video showings, related to subjects such as VIH-AIDS, addictions and emotional cycles.

Motivational events

It's important for students to feel that their effort is recognized by others, including the institution itself. A program of awards for excellent and very good performance students was established in 2000 in the Division CBI. Standards to define both categories include marks average and number of credits approved in the previous trimester. Awards are granted in a ceremony with the assistance of the President of the University. Other actions in this front are lectures and seminars, conducted by successful graduates; they are organized by the Program Coordinators; the example of the Mechanical Engineering Coordinator is remarkable.

Program of courses for the development of teaching skills

One of the most important elements of the teaching-learning process is the teachers. Although their academic level is high compared to the average schools of engineering in Mexico, not always their pedagogic skills are similarly good. A program of courses for the development of teaching skills was launched in 1999 to contend with this situation. Courses are offered in the periods between trimesters. Fourteen different titles were given, some of them as many as four times. Engineering teachers demand with preference the following courses: Learning Evaluation (the most demanded one), Didactics and Teaching Techniques, Learning to Learn, Educative Multimedia and Group Techniques Applied to Teaching. As a result of this program, teachers get increasingly involved and encouraged to take this kind of training.

Other actions

The Mathematics Club is a space, operating since 2001, where advanced students help their fellows of the first trimesters with their studies. An idea under planning is the organization of a study habits workshop, in order to help students to organize their time and to develop correct study habits and techniques. Information systematization is another task undertaken by the University, to provide teachers, authorities and even students, with enough information in real time to make diagnoses, analysis and to evaluate results. The development and implementation of modern teaching techniques are also important; the University purchased specialized software to promote web based teaching, which is already used by many teachers and a related project was approved in the Division.

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PROGRAM FOR LEARNING STRENGTHENING: EXPERIENCES, RESULTS AND PROSPECTIVE

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Abstract *— Performance and efficiency of an educational institution depend on different factors: academic and administrative policies, curricula, resources and infrastructure, students and also the teachers and their training The analysis and solution of the problems faced by the institution demand an integral focusing of the different sub-systems; in this sense, quality will be the result of the coordinated promotion of all the elements as a whole. Regarding the improvement of the faculty members academic level, the CBI Division of the UAM Azcapotzalco has implemented different strategies; however, they had little influence in teaching-learning indicators. The Program for Learning Strengthening consists of the diagnosis and attention of deficiencies in teaching skills through basic pedagogic training courses. This program is based in modern educative trends and aims to develop, not only skills but also attitudes in the teachers, to promote the students success.*

Index Terms *—Didactics, pedagogy, teaching administration, teaching formation.*

BACKGROUND

The Universidad Autónoma Metropolitana (UAM) is the third university in Mexico, regarding students population; it was founded in the 1970s with an innovative model, in which, the figure of teacher-researcher, the trimestral terms system and the departments organization, have been distinctive features. At present, programs for the effective attention of teaching problems is an institutional concern. This paper describes the Program for Learning Quality Strengthening, promoted in the Academic Unit (Campus) Azcapotzalco of that institution since 1999; depicts a revision of experiences and shows the short and medium term perspective of the program.

THE CHALLENGES OF THE UNIVERSITY FORMATION

Since teaching is one of the main functions in the university system, it faces the challenge of producing human resources with an integral focus. From the point of view of the engineers formation in Mexico, the teaching practice demands the inclusion of new needs, derived from the discipline evolution: the command of pedagogical knowledge and skills; a teacher's attitude which recognizes the education as an essential element of change; the insertion of activities to encourage the students effective learning; as well as other aspects, such as the comprehension of the new information and communication technologies and their use in the educative practice. This context as a whole will help to bring a more professional focus for high education teaching. After three decades of the UAM foundation, period in which its professional programs have been operating, significant changes happened in different aspects of the human life: economy, politics, society, science and technology. This changes have affected production systems, professional work, information management and in general, the way of solving problems. Together with this, the demand of professional abilities such as: team working, decision taking, formal languages knowledge and autonomous learning, reinforce the university commitment to achieve an integral formation for graduates, and to set up a real platform, so that they get a professional development and display their skills. In this sense, the challenge of the high education institutions is to give the students a solid scientific and technical formation, as well as to develop and consolidate skills and attitudes, professionally, personally and intellectually, to cover graduates and employers necessities in a highly competitive, changing and global environment. An integral formation will facilitate the graduates their incorporation to the professional field and to different opportunity areas in the productive sector or to follow their academic formation through postgraduate or permanent education programs.

THE ROLL OF ACADEMICS IN STUDENTS FORMATION

Teachers are the central axis, among different elements in the university, for the educative project, its viability and fulfillment. They are who know, interpret and recreate the curricula; design strategies; apply and adapt educative material, as another way to make academic contents more accessible; moreover they generate a favorable climate within the classroom to get a significant learning and a quality education. However, teachers, at least in this institution, used to face several difficulties, such as insufficient material and infrastructure, the lack of an integral organization for teaching, absence of a program of

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induction to the institutional educative model and absence of a permanent pedagogical program to support their performance. To solve this, it's essential to implement policies and programs to make effective the teaching functions development. There's no doubt that the success of any educative model or improvement program, should become clear in the classroom; that's why it's important to promote programs to improve the teachers performance, under the basis that the more the teachers are trained, the better and more effective will be their results.

TEACHERS STAFF CHARACTERISTICS

The institutional tendency to the strengthening of academic teams, was centered in teacher's disciplinary improvement through postgraduate programs. Although the command and deepening in a discipline is an important factor for teaching practice, a program based essentially in the acquisition of an academic degree, attends just one of the aspects of teaching performance improvement. At present, about 50 % of the teachers in the UAM Azcapotzalco completed postgraduate studies, and this feature is recognized as one of the strengths of this school in the nation. The teaching staff is integrated by part time, half time and full time professors in three categories: assistant, associate and tenured; and also by academic technicians and aides. The Academic Unit Azcapotzalco, as well as the two other units in the UAM, stands out for its high percentage of full time professors (73 %), a less presence of half time professors (13 %) and part time (14 %). These data reveal the institutional concern to conform an academic staff with a professional activity, focused essentially to education. Regarding the postgraduate studies followed by the academics, they have a close relation with a deep and specialized knowledge about a study object related to the professional teacher's discipline; this formation allows him to propose, formulate and develop research projects in a field.But this is not directly related to teaching effectiveness.

TABLE I
DISTRIBUTION OF ACADEMIC DEGREES IN THE TEACHERS STAFF OF THE THREE DIVISIONS OF THE UAM AZCAPOTZALCO

Degree	Basic Sciences & Engineering	Social Sciences & Humanities	Sciences & Arts for Design	Average
Bachelor	40.8 %	48.8 %	66.1 %	51.6 %
Master	37.4 %	30.6 %	24.3 %	30.7 %
Ph. D.	21.8 %	20.6 %	9.6 %	17.7 %

The development of teaching skills is important, as it is the disciplinary improvement. It's necessary to facilitate the teaching formation to academics, through a program identified with the peculiarities of the institution, the curricula, the subjects given by the teacher and their relation to others. Regarding this issue, some unconnected actions were carried out in the Academic Unit and the result was a limited knowledge about techniques, methods, strategies and procedures to contribute to the professionalization of the teachers activity; however it's necessary to promote reflection about the implications of teaching under a focus of integral analysis.

ACTIONS UNDERTAKEN FOR TEACHERS FORMATION

Regarding teaching formation, the institution has passed through diverse experiences along its history; some particular efforts can be remarked. That's the case of the Commission for Academic Support and Development (CADA); this office was created in the early stages of the institutional life and initially focused its activities to the support for the development of the departmental organization and the formation of basic academic groups to satisfy curricular necessities; this lead to carry out a project, which involved a considerable part of the early academic community, for the design of curricular programs following the institutional model. CADA assisted to academic and psycho-pedagogical support to students in the 70's and 80's; this task was later assigned to the Professional Orientation Office. As well, the national educative tendency of those years was supported by CADA, through the organization of different courses and seminars in subjects such as: basic didactics, objective-oriented curricular design, didactic material design and learning evaluation. These courses had a limited and restricted impact, regarding the number and kind of teachers who participated. They didn't conform a permanent program, although solved particular problems and demands of that moment. Another set of actions, carried out by CADA in the 80's and 90's were related to the organization of short courses for teachers, about different subjects, mainly computer skills. In recent years, CADA transformed its structure and at the present offers support to teachers, through: promotion of scholarships program for postgraduate studies in the country and abroad; search of financial support by means of agreements with other institutions; and promotion of academic exchange for the development of scientific and technological research.

ANALYSIS OF THE STUDENT'S INQUIRY.

The opinion of students is important to orientate the strengthening quality teaching program, It was taken from a survey. A survey is regularly applied to students between the 6th and 7th weeks, each trimester. One of the purposes of the instrument is to know the opinion of the students. regarding the acting of their professors. The survey includes three parts, one of them is dedicated to evaluate the students performance in the course, another part shows important elements of the professor's acting and finally it has a part that gives the students the possibility to write free comments to expose opinions or recommendations about the course or the professor's work. An analysis was done on a sample of 1063 free comments extracted from the survey, selected from the three levels of engineering careers: basic level, basic professional and concentration areas. The student's comments were classified in professor's acting, curricula structure and infrastructure. Regarding professor's acting results were classified in function of domain of three aspects: knowledge, command of teaching abilities and capability to transmit values and attitudes. The analyzed information emphasize the follow aspects:

- Most of the students recognize the high academic level of their teachers.
- They value apprenticeship that comes from professors who have professional experience additional to teaching experience.
- They demand an education based in concrete applications besides of theoretical approach to the topics.
- They show the necessity of doing evaluations closely related to the courses objectives.
- Comments show the necessity to reinforce educational skills of the professors; for example: ability to give appropriate rhythm and correct level to different parts of the course, enhancing personal aspects, such as voice management; leading students to learn processes with effective strategies instead of teaching practices based and focused in professor's activities.
- Also the students refer the necessity of improving motivation, equal treatment and achieving better communication and cooperation between students and professors.

RECENT ACTIONS. PROGRAM FOR QUALITY LEARNING STRENGTHENING

In order to attend specifically the teaching formation of the faculty members, as well as other problems related to educational aspects, The Coordination of Teaching (COD), depending on The General Coordination of Academic Development, was created in the UAM Azcapotzalco in April 2001. At the present, the work of this Coordination refers mainly to the *Program for Learning Quality Strengthening*, which in turn is divided into three sub-programs:

- Program for teaching formation and upgrading;
- Program for educative innovation and curricular implementation and
- Program for planning support, follow up and evaluation of teaching.

Prior to the creation of this office, the first of this programs was already put in force; different courses were offered for teachers, with the following titles: Introduction to the teaching process; Planning and formulation of learning objectives; Group techniques applied to teaching; Production of didactic materials with the use of electronic media; Production of multimedia didactic materials; Effective education and micro-teaching; Introduction to the teaching-learning process; Groups dynamics; Didactics and teaching techniques; Learning evaluation; Learning to learn; Learning to think; Development of intuition and perception for learning; Didactic planning and Descriptive chart elaboration.

The courses with highest demand by engineering teachers, in decreasing order, are: Learning evaluation; Didactics and teaching techniques; Learning to learn; Production of multimedia didactic materials and Group techniques applied to teaching.

The average offer of the courses was four per period between trimesters (twelve courses per year); they have been conducted in total in ten periods; they comprise 20 hours; 220 professors of the three divisions have participated; the share of each division is almost equal; it shows that the interest is similar, regardless of the professional field. The criteria for the course selection was to look for a basic proposal to attend practical-methodological aspects, focused mainly to help the teacher in planning, performance and evaluation activities. However, articulation and harmonization of efforts in very important, in order to consider the diverse aspects which lead to a professional teaching function. Thus, it's very important to design and put in force an integral, well defined and permanent program, with the objective of enriching the formation of the academic staff with knowledge, skills and attitudes, to help them to achieve an optimal performance as teachers. So, the integral program for teaching formation and upgrading in the UAM-Azcapotzalco is being defined looking for three particular objectives:

- To get the introduction and incorporation of the teacher to the institutional model, through a project of induction to the teaching function.
- To design a project of basic teaching formation directed to attend different didactic-pedagogical aspects, to improve activities for planning, conduction and evaluation of the teaching-learning process.
- To contribute to the disciplinary formation of teachers, through a project of specific teaching formation, derived from necessities in the divisions.

At the same time, the following activities are suggested, to strengthen the production of didactic materials, reflection about teaching and administration:

- Lectures given by guest experts.
- Courses and seminars with the support of teaching administration experts.
- Cooperation with other branches of the university to incorporate new communication and information technologies in the teaching-learning process.

- Promotion of didactic materials production using new technologies and favoring distance learning.
- Development of evaluation projects to identify and to plan solution to relevant teaching practice problems in the Academic Unit.

PRELIMINARY RESULTS OF THE FORMATION COURSES

As mentioned above, the Program for Quality Learning Strengthening began in 1999. Different courses were offered since that date; the quantitative impact of the program has been approximately 700 inscriptions. At the end of each course, a survey is always applied to identify the participants' opinions, regarding contents, instructors, and the strategy itself. An analysis shows the following results:

- The professors make evident the necessity of offering a more structured program, capable to link and give sequence to the courses' contents.
- They demand an institutional recognized teaching program.
- They suggest more levels for different topics that can be structured either in a wide permanent education program or in a master program in education.
- They mention how they have improved their teaching abilities after they have taken some courses.
- They mind greatly about the importance of their work in education.
- They declare to have achieved critical and reflexive thought about ways to improve their activity.
- They recognize teaching as a collective, interactive and dynamic activity that includes students and teachers.
- They give importance to the search of strategies to allow them to achieve a better knowledge.
- They mention the necessity of programming more practical sessions and linking the topics in the teaching courses with the objectives of the courses they offer.
- They suggest to explore other ways to access teaching courses, for example web and multimedia supported distance education.

FURTHER ACTIONS

The following topics are considered as essential aspects for the basic teaching formation; to be implemented with courses, activities and with projects conducted by teachers collectives:

- Significance of the educative work
- Pedagogic competence
- Design of learning objectives
- Teaching evaluation
- Classroom communication and team work
- Strategies and styles of teaching and learning
- Implementation of educative projects by electronic media

To get from the teachers a different form to give his classes it's necessary that they gets a different formation, answering the following questions:
What's the formation to be encouraged?
What are the characteristics to achieve in the graduates?
What are the mechanisms to get these qualities?

It's very important, for the **specific teaching formation**, to consider the particular necessities for each knowledge field, taking into account that the teacher bases his didactic action on what he has received. In engineering courses, for instance, it's necessary to support the process in the skills and attitudes to be promoted in students, such as: analysis and synthesis abilities, alternatives analysis, searching capacity, team work, identification and application of strategies for problems solution, incorporation of the systemic thought and the relation cause-effect.

CONCLUSIONS

Teachers profile and formative requirements. Analysis of cultural characteristics and emergent demands, allow to depict the required general profile of the XXI century high education teacher:

- Reflective and autonomous person, capable of acquire permanently professional skills, through observation and systemic registration of actions; conscious of his acting and of the effects produced in students.
- Prepared for the design, evaluation and reformulation of strategies and innovative pedagogic programs, with comprehensive knowledge of techniques and methods, which he employs, evaluates and improves, modifies or creates other more efficient methods.
- Capable of systemic research and permanent reflection about his professional practice, basing his decisions on the critical application of upgraded specialized knowledge; which he understands and uses properly in the processes and methodologies of the disciplines or disciplines he teaches.
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CHALLENGES OF THE NEW PARADIGMS IN THE RELATION TEACHER-STUDENT

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Abstract *— Traditionally, the essential element of a good teacher in higher education levels, used to be the command of a field of knowledge. In recent decades, the importance of pedagogic aspects was increasingly recognized. At the present, technological progress and its application to the teaching-learning process, are determinant for the relation teacher-student and demand the former to accomplish a more effective learning and to use new tools and resources. Modern teaching faces important challenges, such as the transition from the paradigm of the teacher-authority to the teacher-promoter of learning and human development; the increasing critical attitude of the students; the development of new skills and the necessity of a more active roll of the student in the process. This paper presents a background, the results of a questionnaire applied to teachers of the institution about this aspects, proposals and conclusions.*

Index terms — *Modern teaching, Relation teacher-student, teaching-learning process*.

INTRODUCTION

One of the essential elements in current education is to improve the communication process among teachers and students. To overcome some problems that the student faces to access to education when he inhabits rural areas or when he lives in large cities, is a difficult task. They have to cover long distances to attend school, with consequences such as: thousands of unproductive hours employed for transportation, less time for personal and professional activities, physical fatigue, stress and other problems as pollution, expense of energy, risks and insecurity. All these elements outline the necessity of looking for alternative models, capable of facilitating the communication among teachers and students.

In this sense various authors point that distance education presents characteristics, such as:

- Good cost/benefit balance to satisfy the necessities of the formation.
- Extension of the formation to organizations and collectives.
- Reinforcement of the inter-regional and international transfer of experiences, conclusions and formative materials.
- Demand of students commitment and high motivation level.
- Responsibility of the student himself in the learning process.

The introduction of new learning methods like the above mentioned ones and others, is modifying the idea of centering the teaching-learning process in the school. This fact, together with the relatively recent incorporation of new communication and information technologies, opens new horizons for the education, offering real possibilities of increasing satisfaction for a growing number of people, interested in institutionalized education but living in distant areas.

With reference to the means, the use of video, audio, television broadcasting and incorporation of the new communication technologies like: electronic mail, virtual spaces, real time communication and satellite connections, among others, generate many expectations regarding education productivity and effectiveness.

ANALYSIS

A. – Net supported teaching and its characteristics

Teaching based on the support of computer nets is a resource which has achieved, and still registers, an impressive development. The interest in this tool type has generated great discussion and controversy, as well as a great deal of literature about the association between technology and its applications to education. In some discussions, qualities that, in fact are not inherent to net based teaching are attributed to it; although they were already observed in other teaching methods, not necessarily associated to computers nets. Distance teaching and individual teaching share some advantages with web based education. The following table shows in brief a chronology of the world development of non-present education.

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TABLE I

Brief chronology of the world development of the non-present education

Date	Place	Observations / Comments
1728	Boston Gazette	Self -instructive material sent to students by mail .
1840-1843	Isaac Pitman. England	The Phonographic Mail Society is created; its objective is to deal with shorthand exercises corrections
XIX century	Thomas Foster and the Mining Herald (Pennsylvania paper).	Attempt to teach mining and prevention of mine accidents.
XIX century	Industrial cities of Western Europe and the U.S.	Effort to help people who didn't attend regular schools, due to various reasons.
1938	Victoria, Canada	The first formal action to promote distance education. The First International Conference on Mail Education is carried out.
1939	France	The National Center of Distance Teaching is created, to assist war refugee children by mail.
1947	School of Letters and Human Sciences, Paris, France	Masterly classes in almost all literary subjects were broadcasted by Radio Sorbonne.
End of 2nd War World	Central European countries and developing nations.	Literacy plans and other popular education programs.
60´s and 70's	Various countries	A broadcasted high school program starts operations in Spain. The University of Delhi creates a department of mail education. The Telesecundaria System is created in Mexico in 1968. The Open University is created in England in 1969.
80´s		Distance education evolves into a truly interactive tool with videoconferences application.
90´s		A new pedagogic attitude places the student in the first line and the institution in second place. Computer nets reach great development.
End of the 90´s and beginning of the XXI century		Offers cover different levels of the education (systematic, non systematic, professional, training and permanent education).

It's interesting to point a fact which can explain the quick spreading of computer nets based teaching, in particular through Internet, as one of many applications of this technology. Since the emergence of the radio, forty years passed until this communication medium reached 50 million receivers in the United States; television reached that number, in the same country, in thirteen years; but only four years were necessary for Internet to get such a number of users in the U.S.

Internet possibilities include the transmission of knowledge, images, texts, sound, animation and even dialogue in real time, to a multitude of users, wherever they are located in the world, at a reasonable and decreasing cost. Consequences in present teaching, as well as in distance teaching, are obvious but it is evident that the impact is observed mainly in the latter. Indeed, distance education registers a deep transformation with Internet tools.

It is necessary to point out that several tools have been developed for the implementation of teaching with the help of computers nets; some of them reached wide acceptance. These tools differ in hardware requirements and training level for their use. Some of the most popular ones are Blackboard, Mentor ware, Learning Space and WebCT. None of them is probably the best for all the approaches and science fields.

Michael Dertouzos, in his book "What Will Be", states that there are still some questions to be answered, regarding learning with the use of computers:

Does it improve the capacity of the students retention?
Does it help to build complex ideas starting from simple basis?
Does it improve the capacity for problems resolution?
Does it provide new perspectives and conceptual horizons?
Does it promote a better cooperation among students?
Does it strengthen the feeling of belonging to a community?

From the point of view of the evaluation, the new technologies present a great challenge for academics and researchers. It is not only necessary to evaluate the academic capacity but also other variables which are extremely difficult to measure; for example: the students emotional learning and the student's identification with the educational community.

The support, not the substitution, of teaching based on nets to present teaching, is an aspect with a very important projection, for it provides the teacher with a set of new teaching means, not to replace, rather to complement conventional ones, such as audiovisual means and even the use of the computers not necessarily associated to nets.

Regarding this aspect, the World Conference on Superior Education, sponsored by the UNESCO, in Paris, October 1998, produced a document which had wide dissemination: "World Declaration on Higher Education for the Twenty First century: Vision and Action" Its article 12 is entitled: "The potential and the challenge of technology"; it declares that "The rapid breakthroughs in new information and communication technologies will further change the way knowledge is developed, acquired and delivered …" and that they…" offer opportunities to innovate on course contents and teaching methods and to widen access to higher learning. However, it should be borne in mind that new information technology does not reduce the need for teachers but changes their role in relation to the learning process and that the continuous dialogue that converts information into knowledge and understanding becomes fundamental."

B. - Prospective trends in education

The revolution in the educative process conception involves different elements; not only Internet, demanding a new role by the teacher, the student and the institution. Flores Ochoa suggests the trends of the education for the next decade:

1. Tendency to decentralize the education, detaching it from the classroom, the schedule, the fixed group of students and the professor's constant look. (non-present, non formal education).
2. Tendency to substitute the technical school for the direct presence of the students in the production centers. These last ones spread to assume the technical training and the professional formation of the employees more and more intensively, considering the growing distance between the technological advance of the companies and the technical backwardness of the schools.
3. Tendency to a less massive education and to emphasize the individualization through two different roads:
   - Allowing such curricular flexibility, so that each student can self-design his own curriculum based on his characteristics, interest and capacity.
   - Increasing the use of more totalizing multimedia, mainly those that present higher versatility and interactive communication.
4. Centers of cultural and scientific-technique information with guides instead of teachers; they will replace little by little the conventional schools.
5. New strategies for the search of information will be promoted beyond the formal logic, the memory and the simple conceptual discrimination; more global, holistic strategies, creative intuition, evaluative synthesis, etc. as an effective answer to the quick explosion of new knowledge.
6. In the intricate and dispersed tangle of ideas, knowledge, theories and ideologies of all type, the contemporary teacher needs to recycle his function of keeping and transmitting information, to become an universal sensor and, at the same time, a fine conceptual selector of the range of his specialty with research capacity in the area. Thus, he will guide, with security and authority, the first steps of those students not included in his specialty, and at the same time fortify the creative abilities of students who are in his specific field.
7. The new teacher's authority shall be supported in his knowledge, and it won't require the imposition of the institutional punishment to be accepted. His task is neither to dictate class, nor to give instruction, nor to transmit formulas, theories or concepts. The student is the main actor of his new knowledge, the teacher is rather a guide at the shade, a slope that the student should discover.

CONCLUSIONS

Today, more than in other times, the prevailing idea of a school is the space in which the individual is linked with other individuals and with his environment; a learning process which goes beyond the classroom walls, in which a communication process is established to drive the student to modify, to enlarge and to enrich his formation outlines.

In this sense, the man's and world's transformation have been achieved through interaction among men, in which individuals and peoples who have not expressed their word were left behind.

As Paulo Freire refers in "The Pedagogy of the Oppressed": " Blocking the communication transforms men into objects"; he also mentions how the more quickly the interaction begins, the more revolution will be got in terms of learning.

These concepts, which go clearly against the traditional practice, were called by Freire "bank education". This is essentially anti-dialogical and non communicative; it continues existing in the environment of the education, in spite of the desire to overcome it.

Leaving the traditional paradigm behind implies for the educator to be removed from the protagonist paper that this model grants him, to open the way to educational models which grants the student's learning the central place in this process and where the means only constitute roads that facilitate the communication.

Therefore, the interactive process with the help of web, which is the professor's responsibility, will promote a climate of trust to encourage the students, freely and without restrictions, to express doubts and questions related with problems of adaptation, learning or advance. These problems represent, among others, causes which interfere with the learning process.

The professor's function, with the support of communication and information technologies, will consist of designing the road to create, to maintain and to promote for the student aspects like: the internalization of knowledge for his learning, the development of his expression capacities, the inquiry capacity, the discrimination and the development of his critical capacity as elements to be selective, regarding the information accessed through various information media; also the modification of outlines, attitudes and values which lead him to achieve an ethical and responsible behavior and which offers him the real possibility to share experiences, as well as the feedback and evaluation, as inherent aspects to the teaching-learning process.

A new paradigm arises in this context; the formation with be supported in the communication and information technologies, which gather those forms of information susceptible of being digitized, such as: text, sound, graphics, fixed image and in movement, etc.

A mixed methodology with a present-virtual outline, where the student attends classes and carries out other academic activities with support of the electronic means of information, would allow him to contact the school regardless of the schedule, encouraging the possibility of an almost permanent contact. Examples of those academic activities are: consulting, problems delivery, work in group, search of information, gathering, handling and analysis of data and other administrative services, such as inscriptions, studies revision, administrative steps and records.

Communication through these means, using email or teleconference, would allow to promote analysis and discussion on diverse topics, the formation of small groups to comment with their advisor or their equals the revised contents, for feedback or to exchange experiences with other groups of other countries that are studying the same matter.

Therefore, the challenge of the current education, consists of how to take advantage of the technology; since independently of the selected methodology, it will promote an effective communication among students and teachers, in the same way that incorporation of computer science and the use of various technological means supporting the education, imply a paradigm change in the relationships among teachers and students.

As Litwin refers, "The new information technologies have created new communication forms, new work styles, new ways to access and to produce knowledge". It could be added to that... "and the acting of a new relationship teacher-student".

Finally, it should be pointed out that not all the virtues attributed to the computer nets based teaching are exclusive. By no means they arose with it. The truth is that distance education doesn't begin with Internet, neither the systems of individualized or tutorial learning, in which the student can study at his own rate and play a more active role in the process that the one he takes in the present teaching.

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USE OF VIRTUAL MANUFACTURING CONCEPTS IN ENGINEERING EDUCATION

R. Radharamanan[1]

Abstract — *In this paper, Virtual Manufacturing (VM), an emerging technology, that provides the capability to "Manufacture in the Computer", and the modeling approaches necessary to realize VM are presented and discussed. VM has the ability to interchange models between their use in simulation and control environments. The use of VM concepts improves decision-making and quickly achieves products with high performance and quality at a low cost. VM can provide accurate and realistic means to predict schedule, cost, and quality; address affordability as an iterative solution; and bridge the gap between engineering (design) and manufacturing in an interactive fashion. The benefits, costs, limitations, and risks associated with adopting VM are highlighted and discussed. The use of VM tools and concepts such as Virtual Reality, and Web-based learning in engineering education are presented and discussed.*

Index Terms — *Virtual manufacturing, virtual organization, agile manufacturing, virtual reality, web-based learning in engineering education.*

INTRODUCTION

It is known that acquisition strategies require the capability to prove the manufacturability and affordability of new products/systems prior to the commitment of large production resources and/or to shelving the system for restart in the future. Loosing the manufacturing capability and experience in production is a major risk in the current manufacturing environment [6, 8]. Maintaining the state-of-the art manufacturing proficiency without actually building/ manufacturing the products is a major challenge. Virtual Manufacturing meets the above challenges by providing the capability, in essence, to continue manufacturing in the virtual world of the computer. Through the use of distributed manufacturing modeling and simulation, VM enables the enterprises to evaluate the producibility and affordability of new product and/or process concepts with respect to risks, their impacts on manufacturing capabilities, production capacity, and cost.

Virtual Manufacturing is one of the key technologies that allow going beyond the assumptions driving the old acquisition strategies. It provides the following fundamental changes: VM can be used to *"prove out"* the production processes, resulting in *"pre-production hardened systems"* - i.e., the systems which are developed and verified but never actually undergo actual production runs; VM can significantly improve production flexibility, and hence, reduce the fixed costs; and VM can substantially improve the decision making process of acquisition managers by reliably predicting schedule, risks, and costs.

BACKGROUND

According to the Air Force Man Tech *"Virtual Manufacturing is an integrated, synthetic manufacturing environment exercised to enhance all levels of decision and control"* in a manufacturing enterprise [6, 10].

It is clear from the results of the Virtual Manufacturing Workshops organized by Air Force Man Tech [11, 12] that a single definition of VM is inappropriate. A definition of VM is proposed to capture design, production, and control aspects of manufacturing: The Design-Centered VM adds manufacturing information to the Integrated Product and Process Design (IPPD) process with the intent of allowing simulation of many manufacturing alternatives and the creation of many *"soft"* prototypes by *"Manufacturing in the Computer"*. The Production-Centered VM adds simulation capability to manufacturing process models with the purpose of allowing inexpensive, fast evaluation of many processing alternatives. The Control-Centered VM uses machine control models in simulations, the goal of which is process optimization during actual production.

Vision of VM: The vision of Virtual Manufacturing is to provide a capability to *Manufacture in the Computer*. VM will ultimately provide a modeling and simulation environment so powerful that the design, fabrication/assembly of any product including the associated manufacturing processes, can be simulated in the computer. A comparison between the physical and virtual manufacturing is shown in Figure 1.

VM Concepts: VM supports implementation of lean/agile manufacturing to achieve improvements in enterprise flexibility and economy. The use of simulation results in manufacturing systems those are less risky to change. Computer assisted model-based planning and control systems require less coordinating communications.

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The models provide a basis for sharing knowledge between organizations. VM based systems are expected to enhance operations by providing timely answers to the questions: Can we make the product? What are the alternatives? What is the best way to produce the product? When can we deliver the product? How much will it cost?

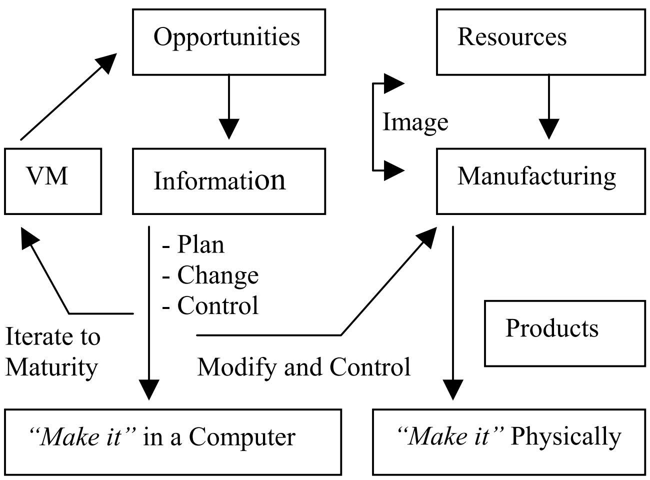


FIGURE. 1
COMPARISON BETWEEN PHYSICAL AND VIRTUAL MANUFACTURING

The relation between the existing enterprise and the market force in creating a new product, the needed changes, the bottlenecks, and the requirements for the new product development are highlighted in Figure 2.

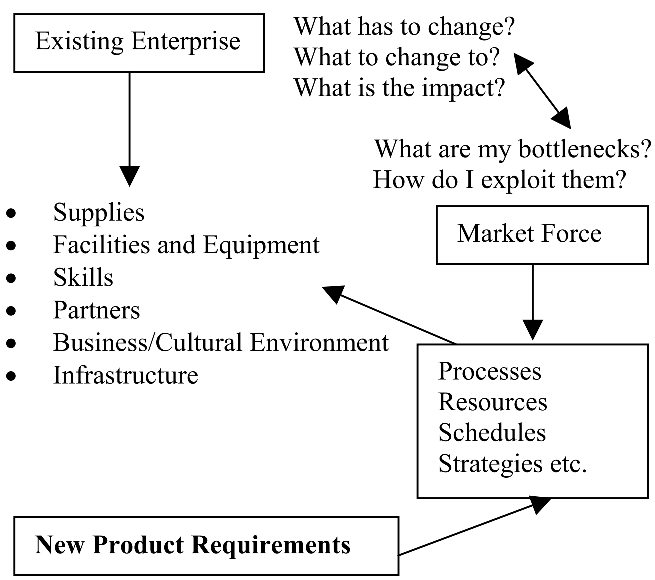


FIGURE. 2
REQUIREMENTS FOR NEW PRODUCT DEVELOPMENT

VM relies on modeling and simulation technology to simulate the production process and to enable us *"make it virtually."* It is an application of modeling and simulation, but extends that discipline beyond the conventional use. VM supplements the IPPD process since it provides a pathway for the manufacturing knowledge to be migrated to the early phases in the life cycle. VM also adds simulation to the Virtual Enterprise (VE) concept and Virtual Prototyping. VM must be integrated with all the relevant enterprise functional areas via a trade-off mechanism (IPPD process) as shown in Figure 3.

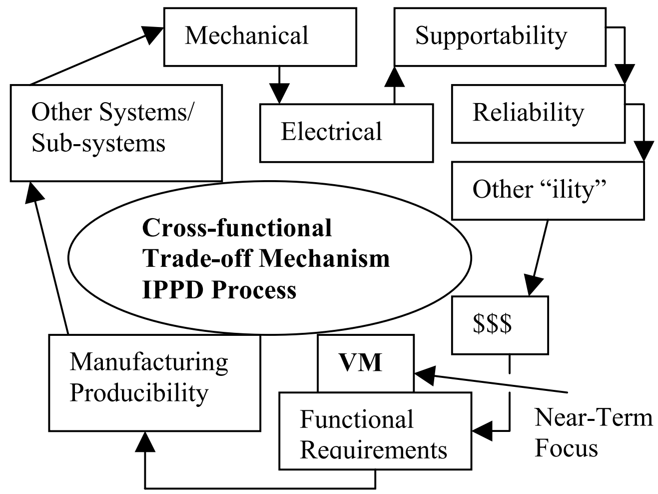


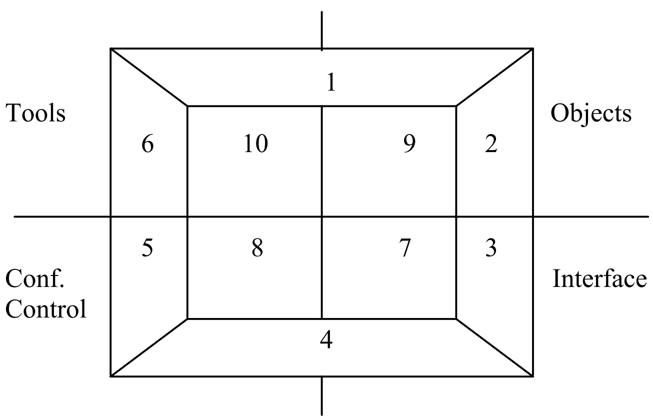
FIGURE. 3
THE INTEGRATION OF VM WITH ENTERPRISE FUNCTIONS

The expected benefits of VM are summarized below: preparedness for market trend, affordability, shorter cycle times, producible prototypes, flexibility, quality, responsiveness, and customer. Virtual Manufacturing as an emerging technology looks for the development of appropriate new tools and techniques for its successful implementation and realization.

Some of the existing tools that can be effectively incorporated for realizing VM include [9]: Design tools, production tools, quality tools, artificial intelligence (AI) tools, computer science tools, management tools and mathematical tools.

The Technical Workshop results indicated that the technologies critical to VM could be organized into the following major categories [12]: Visualization; Environment construction technologies; Modeling technologies; Representation; Meta-modeling; Integrating infrastructure and architecture; Simulation; Methodology; Integration of legacy data; Manufacturing characterization; Verification, validation, and measurement; Workflow; and Cross-functional trades.

VM environment enables a shortening and simplification of the life cycle, by improving the reliability of analyses and accelerating decisions through the use of modeling and simulation. VM helps to evaluate product making using simulation and supports operations to provide timely response to the Integrated Product and Process Design (IPPD) functions in the development of new products and/or processes. Collections of objects in a VM environment may also simulate the entire manufacturing enterprise to provide rapid response to customer requirements. Customers with multiple VM-based supplier organizations can use models of their suppliers' enterprises to provide knowledge to an Enterprise Capabilities Expert. Vertical partners can contribute to capabilities models for use in the knowledge-based computer programs that will evaluate customer requirements and supplier capabilities to establish the organizations desirous of responding to specific customer needs. VM also will support rapid technology transfer by enabling the sharing of the advanced manufacturing capabilities between cooperating organizations. VM applications and VM tools of one organization may be shared by means of the National Information Highway to the operations of manufacturing partners. Some of the specific areas of applications are: corporate memory, capital investment, supplier management, product design, cost estimation, risk management, customer interface, functional interface, and shop floor. The components of VM architecture are shown in Figure 4.



1. Product performance; 2. Process simulation;
3. Producibility simulation; 4. Production control;
5. Supportability, Maintainability, Disposability;
6. Assembly Visualization; 7. Unit & Component Models;
8. Assembly Models; 9. Factory Models; and
10. Enterprise Models.

FIGURE. 4
ARCHITECTURE OF VIRTUAL MANUFACTURING TECHNOLOGY.

RESULTS AND DISCUSSIONS

Based on the literature search to identify the key issues for realizing VM, it can be summarized that new integration technologies and philosophies are emerging. Visualization hardware and software is becoming more affordable and widespread. New modeling and model abstraction techniques are appearing. The most important set of technologies center on modeling and simulation. Some of the key areas that require attention in modeling and simulation are: model object selection (what to model); degree of abstraction; level of depth; flexibility and maintenance of models; integration of different models; and model validation. The results are discussed under the following headings:

Flexible Manufacturing: The discussion with a National Research Group from Oak Ridge National Laboratory, Sandia National Laboratories, and Los Alamos National Laboratories indicated that the research in telerobotics and flexible manufacturing systems though showed progress, it would be practically impossible to totally replace human with robots. Maturity in existing and emerging technologies (both hardware and software) is needed to see potential success in this area.

Lean Manufacturing: Womack et al. [13] in their book on *"The Machine that Changed the World"* addressed the future of the automobile and extensively discussed the importance of lean production. A team spent five years exploring the differences between mass production and lean production in one enormous industry. They have been both insiders with access to vast amounts of proprietary information and daily contact with industry leaders, and outsiders with a broad perspective, often very critical, on existing practices. In this process they have become convinced that the principles of lean production can be applied equally in every industry across the globe and that the conversion to lean production will have profound effect on human society - it will truly change the world.

Virtual Prototyping: The discussion with a rapid prototyping user group revealed that the customers have difficulty is accepting *"Virtual Prototyping"* as one of the means of acquisition for the following reasons: There exists a significant difference in the prototype they see *"virtually in the computer"* and the real product they receive; One can show a colorful, attractive, and high quality products *"virtually in the computer"*; however, the real product may differ in various aspects - including functional and aesthetic aspects - of what was seen in the computer. Virtual Prototyping is still in the experimental stage and it will take a few more years to mature in terms of technology (visualization, representation, abstraction, and appropriate hardware and software) and be used by vendors and consumers.

Virtual Quality: The discussion with the users of TQM, and ISO/QS 9000 showed that virtual manufacturing concepts will aid significantly the way business will be done in the future for the following reasons: Once the VM technologies mature, the concept of building quality in the product is much easier even before the product is made and hence the concept of *"Right First Time"* will have much more meaning in term of Quality Standards. Quality is defined as *"Fitness for Purpose"*, and the VM technologies will make it happen since the customers can make *"changes virtually"* in the product and make it fit for the intended purpose even before the product is made. In terms of quality, VM can go beyond the customer satisfaction and help in achieving Quality Function Deployment (QFD).

Virtual Reality: Despite the enthusiasm surrounding virtual reality (VR), there is a substantial gap between current technology and that needed to bring virtual environments closer to reality. That is the conclusion of a National Research Council committee report on 3D computer-generated worlds with which people can interact. According to the committee, certain areas hold the most promise for practical uses of VR: training, hazardous operations, medicine and health care, design, manufacturing, and marketing. Using VR and telerobotics, one can or will be able to explore the ocean floor and outer space, dig up a 10-ton container of hazardous waste, take a submarine trip through the human circulatory system, and try out products not yet manufactured, for example.

Virtual Organization and Agile Manufacturing: In the search for agility, companies will rely increasingly on virtual enterprises, virtual manufacturing, and virtual reality. Goals of virtual manufacturing include analyzing design, product, and process alternatives for viability, cost and risk; integrating product and process development; improving customer response time and cost estimates; and retaining corporate knowledge. The Society of Manufacturing Engineering developed a videotape on *"Agile Manufacturing: Moving to the Next Level"* [1]. The video addressed *"agility"* as the new survival concept for global manufacturing competitiveness and indicated that the emerging concept of agility is based on the factors: markets of all nations are combining into a single global economy; rapid change in the global market place is inevitable; the explosion of technology makes every country a potential competitor; customers are demanding customized products with short lead times. Goldman et al., [3] in their book on *"Agile Competitors and Virtual Organization: Strategies for Enriching the Customer"* addressed how to confront and thrive on change and uncertainty.

Realization of VM: The STEP standard [5] is intended for long-term development and uses a widely available language called Express to describe the complexities of solid geometry. STEP, also referred to as ISO-10303, is an international standard for the exchange of product model data. Designers and engineers should be aware of its capabilities, how it might be used, and what developers have planned for it. The super-model database, in progress, will be Web compatible and it can be accessed by the entire supply chain. The Web based languages such as SGML (Standard Generalized Markup Language), HTML (Hyper Text Markup Language), and XML (eXtensible Markup Language) are helpful in implementing VM. SMMS software [4] developed by RTSe (USA), Inc., is an ideal product for creating, managing, and publishing metadata to improve overall management of large data archives. SMMS can also be used in the realization of VM.

Research Relevant to VM: The Virtual Manufacturing Technical Workshop [12] identified technologies that are critical to virtual manufacturing. The technologies were classified under Core Technology, Enabling Technology, Show Stopper Technology, and Common Technology. The Core Technologies identified and reported are: VM methodology for process characterization; technologies to simulate assembly operations; declarative representation of product and processes; natural language for VM meta-model; cost database and integration; VM user interface (communication between VM knowledge base and user); VM verification & validation methods, algorithms & tools; process model and simulation validation; methodology for using a VM system; VM framework (guidelines, integration standards, etc.); methodology for design abstraction; tools to relate conceptual design with possible manufacturing methods and processes and cost estimates based on manufacturing features; manufacturing engineering automation (knowledge-based computer applications to perform manufacturing engineering decision making); and simulation architecture.

It is seen that some of the technologies listed above and other related technologies are being studied by government agencies, academia, and industry in the U.S. and other nations. It is necessary to coordinate and bridge the gaps in randomly emerging technologies related to VM and mature them. Some of the technologies that need immediate attention are: selective addition to animation, shop floor based generic models, metrics, representation, and integration.

VM CONCEPTS IN ENGINEERING EDUCATION

The increasing access to Internet and the World Wide Web has expanded the variety of media by which universities are able to offer distance learning opportunities. Most recently courses and whole degree programs are being developed for delivery via the Internet.

Online students have many advantages as well as disadvantages compared to traditional and other forms of distance education. The advantages include: More accessible to mature students; Gteater flexibility to control the time, pace and order in which to study the course materials. The disadvantages are: Removes the structure providesd by weekly class meetings; Less disciplined students can easily fall behind in the class work; No motivation, support and encouragement from the instructor; No help and mentoring from the faculty; Do not allow students to see the instructor deliver the lecture and respond to students' questions like in televised or video formats; and Possibility of higher dropout rate. These disadvantage are likely to have adverse effect on student performance.

The collaborative learning environment enhances student learning and performance by taking advantages of Web-based technologies. Web-based materials can be classified in different categories: course administration, reference textbooks, lectures, laboratory simulation and experiments, and recitation/assignments/grading. Common information provided consists of items such as teaching schedules, the syllabi, instructor's contact information, list of assignments, grades, links to other sites, and basic lecture notes. These sites do not take advantage of the interactive capabilities of the delivery medium, as the Web is only used as an efficient repository of information. An important component in the collaborative learning paradigm is the use of Virtual Portfolios. The major difference between the virtual portfolios and traditional ones are that virtual portfolios are on-line for anyone to evaluate and that they remain on-line for years to come, allowing students to take advantage of these resources and marketing tools during their job searching activities. Inter-group peer evaluations transfer some of the responsibility of the assessment process to the students, thus, promoting critical learning by requiring students to compare, evaluate and reflect upon their own work and that of others. Students can also be tested through web-based readiness assessment quizzes.

Virtual reality concepts are to redesign the introductory mechanical engineering course in an effort to incorporate the learner as designer strategy, and positively impact the students' conceptual understanding. To achieve these objectives, the courses were designed to use virtual reality as a tool that integrates the fundamental concepts of design, analysis, and manufacturing. Further, virtual reality is used to create an arena for constructivism, interactive learning and experimentation with design [7]. Dessouky et al [2] proposed a Virtual Factory Teaching System (VFTS) in support of manufacturing education – i.e., a multimedia collaborative learning network that illustrates the concepts of factory management and design in a realistic setting. To assess the viability of a VFTS for manufacturing education, a prototype was developed that aids the students in learning a specific manufacturing topic, factory scheduling.

CONCLUSIONS

The potential scope of VM is very large. What is important is that a time phased, realizable scope for VM be defined. VM should be implemented incrementally starting at unit product/process level, then at subsystem level, and finally at system level. The manufacturing process and the scope of VM products should be improved in the *"big M"* manufacturing domain: concept through production including marketing, sales, and service. Disagreement remains on what VM is and the key issues for realizing VM - there is a need to define VM more precisely. VM concepts and web-based tools are effectively being used in engineering education for training, distance learning, laboratory education, and testing of students. Some of the other VM concepts/tools such as virtual prototyping, virtual quality, virtual laboratory, virtual factory system, and modeling and simulation technology are being tested for effective use in engineering education.

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ESTILO DE APRENDIZAGEM: UM INSTRUMENTO NO ENSINO DE ENGENHARIA

Anna Cristina B. D. de Carvalho[1] and Arthur José Vieira Porto [2]

Abstract — *The engineering students are not different from other students. Each one of them learns in a different way. That heterogeneity can harm the learning in a classroom, because depending in the way as the teacher leads your classroom. To know the style of learning of the students help the teacher to plan your classes in a more appropriate way and more it holds.*

The use of the inventory of learning styles is a tool developed by David Kolb that identifies the style of the individuals' learning. She can be used to help the teacher to understand better as your students they learn and to plan the form of developing the contents in classroom.

The present work has as objective presents a study on the use of the inventory of styles in the planning of the engineering teaching.

Index Terms: Learning, Engineering, Style

INTRODUÇÃO

A nova Lei de Diretrizes e Bases publicada em 1996 orienta o ensino superior no Brasil. Ela define que o profissional de engenharia deve ter formação técnico científica sólida capaz de aprender e desenvolver novas tecnologias, ter uma atuação criativa e crítica na identificação e resolução de problemas de diversas naturezas.

Essa formação citada pela nova LDB[1] sugere que os cursos de engenharia precisam passar por um processo de mudanças em suas estruturas, pois não se desenvolve criatividade e atuação crítica apenas com a formação seqüencial de disciplinas que ensinam regras de cálculo para os alunos. Além disso, existem os problemas de aprendizado que envolve professores e alunos. Os professores são responsáveis pela mediação do conhecimento e os alunos pela busca de novos saberes.

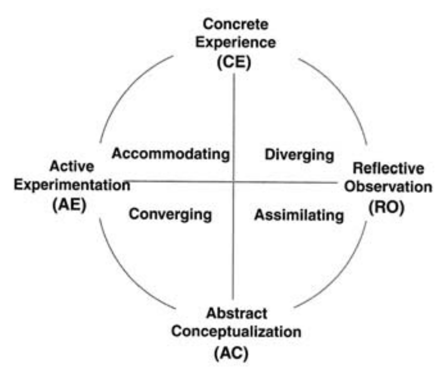
A identificação do estilo de aprendizagem do aluno é um dos requisitos para a melhoria do processo ensino/aprendizagem. O estilo de aprendizagem é a forma como o aluno aprende melhor. Identificado o perfil da turma o professor poderá preparar atividades adequadas ao conteúdo que vai ser desenvolvido.

O objetivo desse trabalho é apresentar um instrumento fácil de ser utilizado pelo professor em seu planejamento de sala de aula privilegiando o uso de tecnologias, discussões, estudos de casos e outras ferramentas importantes do desempenho do aluno.

INVENTÁRIO DE ESTILOS

O inventário de estilos foi desenvolvido por David Kolb com a finalidade de identificar os estilos de aprendizagem de seus alunos. As indagações de como se aprende melhor, por que existem ritmos diferentes de aprendizado, motivaram Kolb a estudar e desenvolver um instrumento de auxílio a identificação do estilo de aprendizagem.Ele observou que existiam formas de perceber o conhecimento e de processar o conhecimento. As formas observadas por Kolb inicialmente foram: Experiências concretas, observação reflexiva, conceituação abstrata e a experimentação ativa.

O inventario de estilos de aprendizagem consiste na



identificação das preferências do indivíduo no processo de aprendizagem. Essa identificação é feita de duas formas, através da percepção dos fatos e do processamento desses fatos. A figura 1 mostra os quadrantes contendo os estilos de aprendizagem.

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FIGURA 1
Estilos de Aprendizagem (Kolb,[2])

Os estilos podem são caracterizados a seguir:

- **Divergente** – se encontra no primeiro quadrante, tendo como preferência de percepção as habilidades ligadas a experiências já observadas e processam o conhecimento através da reflexão das observações feitas. Pessoas com este estilo não concordam com soluções convencionais, buscam sempre novas alternativas. Eles aprendem melhor em situações que possuem generalização de idéias. São pessoas com imaginação fértil, se preocupam como bem estar dos outros, utilizam seus sentimentos para tomar decisões, gostam de cultura e arte, são chamados divergentes por serem individualistas e buscam sempre alternativas pessoais de melhoria;
- **Assimilador** – Eles associam observações feitas de situações com conhecimentos que já adquiriram. São muito teóricos, necessitam de conceitos teóricos para embasar as observações feitas. Não são muito intuitivos, são lógicos e não tem interesse em desenvolver relacionamento interpessoais. Não aceitam fatos que não podem ser provados teoricamente. Esse estilo é chamado de assimilador por estar sempre em busca de novos conhecimentos;
- **Convergentes** – São aqueles que integram a teoria e a prática. Utilizam tanto a teoria como o senso comum. Gostam de resolver problemas práticos. Utilizam as hipóteses para definir solução de problemas. São chamados de convergentes por buscarem soluções ótimas para problemas práticos. São muito práticos;
- **Adaptáveis** (no original seria accommodating**)** – são muito interessados em fazer coisas, levar planos a frente, fazer experiências, viver o novo. Não tem medo de riscos. Normalmente resolvem problemas na forma de tentativa e erro. Utilizam outras pessoas para encontrar a teoria que possa ajuda-lo na situação que precisa resolver. São pessoas muito criativas e inquietas. Descobrem novas teorias sem precisar de uma orientação padronizada. São naturalmente lideres. São chamados de adaptável por se adaptarem muito fácil a novas experiências e situações;

Para identificar o estilo de aprendizagem, o professor aplica um questionário contendo perguntas que se relacionam com a forma como aluno aprende melhor. O aluno responderá conforme seu grau de preferência. Depois de respondido são somados os pontos das questões correspondentes a cada estilo e colocado no gráfico apresentado na figura 1. Nesse gráfico é visualizado qual o estilo é mais marcante no aluno.

Com esses dados o professor pode perceber a preferência dos alunos e fazer seu planejamento de aula com ferramentas que auxiliem o aluno a aprender melhor.

CICLO DA APRENDIZAGEM

Podemos definir o ciclo da aprendizagem como o processo pelo qual passa o indivíduo para consolidar os conhecimentos novos que serão acrescentados a sua estrutura cognitiva.Existem vários autores que estudam o ciclo da aprendizagem o que foi utilizado como base teoria foi o ciclo de Belhot, que possui as mesmas características dos outros ciclos, mas tem uma influência construtivista. A figura 2 representa todas as etapas do ciclo de aprendizagem de Belhot.

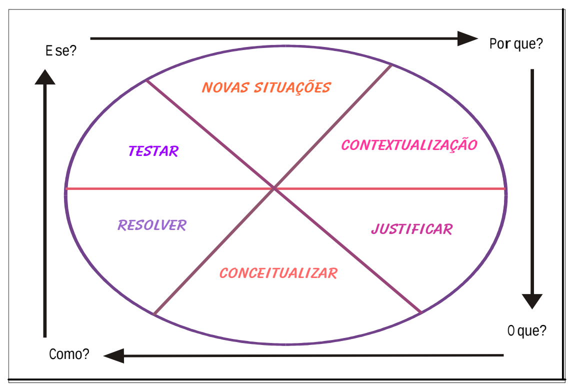

FIGURA 2
Ciclo adaptado de Belhot [3]

A primeira etapa desse ciclo é o questionamento, a busca dos por que? E da busca de relações com o que se pretende entender. Essa fase é muito importante, pois o indivíduo é despertado para um novo conhecimento. Ele começa a se envolver com as dúvidas e as questões não resolvidas sobre o assunto. È uma fase de observação.

Segundo Belhot [3], é nessa fase que ocorre a descoberta do sentido do assunto e a motivação para aprender. Todas as atividades que envolvam o desafio da descoberta são bem vinda. O aluno tem a oportunidade de expor aquilo que não sabe e levantar questões que se relacionam com o assunto, mas que ele não conhece.

A segunda fase faz parte do processo de observação. È nela que se levanta o que é mais importante ser aprendido. O que realmente interessa para aquele assunto. Nessa fase o professor começa a expor o conhecimento. A dividir com os alunos os pontos importantes do assunto e chamar a atenção dos mesmos a partir de suas dúvidas listadas na fase anterior. A grande motivação dessa fase deve ser a necessidade de resolver as dúvidas anteriores e aprender coisas novas sobre o assunto. Inicia-se uma fase onde o aluno vai começar a assimilar novos conceitos e ancorar esses novos conceitos a conceitos pré-existentes.

A terceira fase do ciclo que também faz parte da assimilação é como aplicar esses conceitos nas atividades reais. Como tornar esse conceito utilizável no dia-a-dia. Essa é a etapa em que o professor vai apresentar exemplos, exercícios, estudos de casos para que o aluno sinta-se seguro para aplicar o conceito novo e ampliar ainda mais o universo que se iniciou com a apresentação de dúvidas sobre um determinado assunto. Nessa etapa o aluno entra em contato com ferramentas e técnicas que podem facilitar seu processo de desenvolvimento. O computador é uma excelente ferramenta nessa etapa. (Belhot, [3]).

A partir da fase anterior começa a etapa do fazer, onde os alunos começam a levantar novas hipóteses de uso do conhecimento. Com mais maturidade fica tranqüila levantar situações diferentes e tentar resolver essas situações. Aqui não existe mais regra fixa para facilitar a execução de uma atividade que envolva o conceito aprendido. O aluno começa a aprimorar o conhecimento e a levantar alternativas diferentes para resolver os obstáculos que vão aparecendo ao longo da nova situação.

Para que esse processo gere novos conhecimentos é necessário que o assunto esteja bem dividido e hierquizado, evitando assim, erros na formação da estrutura cognitiva do aluno. Além de ajudar o aluno a formar sua própria estrutura de conceito, facilitando a busca de novos conceitos. Para se obter um resultado positivo é necessário que o aluno seja motivado, sinta-se seguro e outros aspectos apresentados anteriormente na teoria cognitivista.

PROCESSO DE PLANEJAMENTO

O planejamento de aula é necessário para que o professor identifique os objetivos as serem atingidos, os conceitos importantes, as atividades complementares e a tecnologia educacional que deve ser utilizada. As etapas para desenvolvimento desse planejamento são(Carvalho[4]):

1. Definição das competências a serem desenvolvidas na disciplina;
2. Definir os conhecimentos necessários para o desenvolvimento dessas competências;
3. Aplicar os conteúdos no ciclo da aprendizagem para identificar as tecnologias que poderiam ajudar em cada item;
4. Identificação do estilo de aprendizagem dos alunos e fazer adaptação das técnicas planejadas se necessário;
5. Fazer avaliações periódicas para verificação dos alvos estabelecidos;

A primeira e a segunda etapa do planejamento é a identificação das competências que serão desenvolvidas através dos conteúdos que serão apresentados aos alunos. Segundo Perrenoud [5] a noção de competência remete a situações nas quais é preciso tomar decisões e resolver problemas. A competência utiliza conhecimentos e capacidades, mas só consegue ser desenvolvida quando a ação se realiza. Não são somente conteúdos que serão apresentado aos alunos, mas situações reais ou que simulem a realidade para ajuda-los a desenvolver essas competências.

A terceira etapa do planejamento é adequar tecnologias educacionais ou atividades complementares a cada um dos conteúdos que serão desenvolvidos. Para isso o professor precisa conhecer o ciclo da aprendizagem e os estilos de aprendizagem para entender qual o melhor instrumento em cada conteúdo a ser apresentado. A figura 3 mostra o ciclo da aprendizagem com os estilos de aprendizagem e as possíveis tecnologias que poderão ser utilizadas pelos professores.

A quarta etapa o professor verifica o estilo de aprendizagem dos alunos no início do curso e verifica se as atividades planejadas estão adequadas, caso não estejam pode ser feito uma adaptação para que o resultado do aprendizado possa ser o esperado.

A quinta etapa é avaliações com os alunos, não somente avaliações de conteúdo, mas qualitativas para verificar a eficiência das atividades planejadas. Os alunos são um ótimo termômetro para verificação da eficiência de atividades em sala de aula.

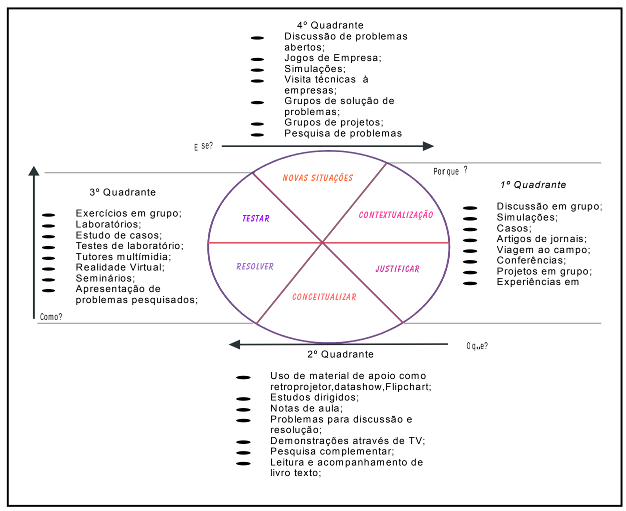

FIGURA 3
Ciclo de Belhot modificado por Carvalho [4]

CONSIDERAÇÕES FINAIS

Os professores de engenharia podem utilizar a metodologia acima, sem dificuldades. Ela é simples de ser entendida e de ser utilizada.

Os conhecimentos sobre ciclo da aprendizagem, novas tecnologias, estilo de ensino ajudam o professor a preparar um planejamento de aula mais rico e consistente. Esse procedimento necessita que o professor esteja sempre atento as reações dos alunos em sala, pois qualquer tendência de falha no processo de aprendizagem pode ser verificado o problema e corrigido.

Os professores de engenharia estão passando por atualizações e modificações em seus comportamentos diante da função de educador. É importante não somente formar profissionais aptos ao desenvolvimento de cálculos complexos, mas aptos à análise e modificações de situações problemas.

O desenvolvimento desse trabalho teve por finalidade auxiliar os professores na melhoria de suas atividades em sala de aula.

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A TEACHING AND LEARNING ENVIRONMENT FOR INTEGRATING VIRTUAL LABORATORIES

José Manoel de Seixas[1], Carmen Maidantchik[2], Rômulo Cunha Monteiro[3] and Gustavo Luis Almeida de Carvalho[4]

Abstract — *In this work, a teaching and learning environment to support different virtual engineering laboratories is described, allowing remote access via Internet. Such environment integrates virtual laboratories on linear systems, signal processing, control engineering, and neural processing and it is designed to be used in continuous learning and regular undergraduate courses, both in the frameworks of presential and distance learning programmes. As the laboratories are designed in a modular structure and using accessing layers of different depths of the didactic material, extensions to accommodate other virtual laboratories can be easily accomplished. The environment also supports implementation in firmware, using digital signal processor technology. A set of tools integrated to the environment also supports the automatic introduction of new modules by the teachers and communication among students and between students and instructors.*

Index Terms — *Distance learning, engineering education, remote and virtual laboratories.*

INTRODUCTION

The Internet and recent computing resources offer many possibilities for disseminating educational material to students, both locally and as part of remote programmes. Traditional courses offer classes driven by professors, and supported by libraries, exercising lists and hours dedicated to the clarification of misunderstandings and doubts. Uncertainties of previous years can reamain the same for new students. Therefore, the answers of earlier doubts can be helpful for novices as well and accomplished projects can serve as a base for new developments. Failed experiences can be analyzed and understood to avoid undesired outcomes. Graduated students can access stored materials to improve the way a task is planned, designed, implemented, tested, adapted, expanded and so on. Furthermore, one working team can make use of all information and acquired knowledge of other groups, not necessarily in the same domain area.

Within a worldwide scenario, the Internet is a powerful tool to provide access to any data independently of its location and of person's background. So, knowledge databases are becoming increasingly popular as a method to catalog the best practices of several categories of projects and keeping, in this way, the main resource that an enterprise has, it means, its experience.

Engineering projects are becoming more and more complex because they are involving interdisciplinary and cooperative activities and some working group members are geographically distributed, placed at different locations. Another arising necessity is that laboratory experiments are a vital part of engineering education [1]. Recent advances in Internet/Web technologies and computer-controlled instrumentation presently permit net-based techniques to be utilized for setting up environments that respect the previous requirements. In this context, teaching and learning activities have been requesting urgent reviews on traditional educational systems, in order to match the needs of modern communication models [2].

In this paper, we present an Internet teaching and learning environment to support different engineering virtual laboratories. It integrates hypertext pages on linear systems, signal processing, control engineering, and neural processing. The laboratories are designed for either continuous learning or regular undergraduate courses. Their modularity facilitates the integration of diverse virtual building blocks and allows the aggregation of new material. The environment also supports implementation in firmware, using digital signal processor (DSP) technology. A set of tools integrated to the environment also supports the various aspects of engineering classes and learning processes, such as, for instance, the communication among students and between students and teachers.

VIRTUAL ENGINEERING LABORATORIES

The Federal University of Rio de Janeiro has been developing the Papoula Project, envisaging the interconnectiont of virtual laboratories. The project aims at furnishing a learning environment that integrates a set of virtual hypertext labs, in a way to explore new teaching approaches and to introduce sophisticated technologies. One of the fundamentals of the proposed environment is the hardware and software amalgamation, which is in fact a strong observed tendency in engineering nowadays. It is important to realize that such concept of fuzzy limits between hardware and software emphasizes how broad is the knowledge required in the conception and elaboration of modern engineering projects.

More specifically, the integration of virtual laboratories is achieved by hypertext links that are set among the contents of each individual module belonging to the interconnection net. Three development layers

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compose the elaboration method of the contents of each module of each virtual lab. The first layer aims at facilitating the knowledge acquisition by the student of fundamental topics of each module. The second layer is dedicated to the simulation of the topics that will be further codified into hardware (firmware), in a way that the student can explore a practical implementation. Thus, the last layer, provides the virtual access to hardware implementation over programmable devices, in this case, using the digital signal processing (DSP) technology. The layers are implemented through commercial and widely used software packages, which allows students to easily enter into the lab environment.

The implementation of the hardware layer is performed by experiments built over a computer net, using testbench equipments (generators, power-supplies, oscilloscopes, multimeters), which are remotely commanded through the Web. The equipments are interconnected by a GPIB interface, which allows the communication with the server computer of the environment. A virtual instrument for each piece of equipment is thus available to the users for control and display of the experiments. In the server, a DSP development layer is installed, which makes it remotely accessible. This proposal gives priority to a fast, easy and dynamical communication through a suitable language at each interaction level in order to stimulate the students [3].

This model for the learning and teaching environment can support both regular and distance learning programs. It also integrates available information technology in order to facilitate not only who accesses the didactic material but also who creates the virtual laboratories. The distinction of the Papoula Project, comparing it to other distance learning developing environments, is the grouping of diverse engineering subjects and tools within a cooperative environment, offering a remote execution of resources and allowing their sharing. It is interesting to notice that this model can also be applied in other contexts, such as cooperative work, resources training and experiments through virtual instruments.

Before initiating the construction of a distance learning environment, as the initial investment is quite high, even when having the supporting tools available, it is important to validate its real need, since a traditional class or a presential training can be less expensive. The first step is to validate whether the content will have some stability. Evidently, the content of a distance learning course can be updated, but it is necessary to consider the costs of its maintenance. A remote course can be synchronous with a specific date to start with and predefined length, offering discussion means, hardware access (the technical responsible or even a sort of robot has to turn it on and off) and cooperative tasks. A registering tool is essential in such cases. On the other hand, a distance learning course can also be asynchronous and, in these cases, the students must to have in mind that arising doubts sent by email may not be answered immediately [4].

In order to make the developing process of distance learning environments easier, some steps must be respected: define who are the main users, study the need of different access form for all types of users, define the fundamental requirements to provide ways of using the learning tool, inform the whole contents of the material to alert users before initiating the course, define a plan of a suitable navigation to avoid that wrong choices influence the learning process.

The development of a Web-based learning tool must give priority to the interactivity and to the communication among students and between an educator and students. Pointing towards this goal, the environment should dispose some services such as forums, notes about the course, main topics and bibliographic references used. The user registration tool is a powerful tool, since it enables the information exchange among users and serves as a base for the environment that can provide a suitable configuration according to students' background. A student register helps on determining the user profile through an analysis of his/her data stored into a database. In conjunction with other tools, a distance learning course may personalize the page navigation, automatically switching the contents to the needs or to the skills of its users. It is important to take into consideration that everybody, including those with no Web experience, has to be able to use the tools and the learning environment itself. In this way, the environment could offer Web tutorials in order that more complex functionalities could be used in the advanced modules.

DISTANCE LEARNING TOOLS

At the beginning of the developing process of a supporting tool for a distance learning environment, some steps should be followed as describing its goal, defining the input and output data, classifying its functionalities, identifying the development strategy, restrictions and improvements for a next version. This specification guides programmers as it delineates the tool scope and target.

Within the Papoula Project, the tool organization follows the classification proposed by Malluhi [5]:

- **System administration tools:** belong to this group the tools that make the user interface to work, including its facilities such as password protection, user's files access, user profile characterization, dynamic menu automatically generated, contents listing in a linear format (not in a hypertext format), user registration including access levels based on the student knowledge, mechanisms that allow access level change, localization in the hypertext map, specialization, map of the site, automatically update of the references, and verification of not existing hypertext links.
- **Authorizing supporting tools:** any implementation that supports the structuring of a distance learning course can be classified in this category: selection of course components from a complete list, contents publishing based on certain criteria, multimedia contents, test and examination creation, graphical page design, personalized icons, course outline elaboration support, last updates, glossary access, mechanism for searching and inserting hypertext

links, sensitive figure generation, cooperative authoring, references list, working team (titles, background and positions) and general information about the course.

- **Collaboration and communication tools:** belong to this group the tools that assist the instructors on controlling ongoing courses as visualization of the entire course by instructors, visit counting, statistics of the time spent in each module, activities registry, frequency control, examination and listing databases, test generators, automatic correction of tests, creation of groups, advertisements, and administration of users.
- **Students tools:** implementations that support users to visualize the contents and to obtain information about its performance such as grade visualization, comparison between a certain grade and the class average, creation of lesson guides, abstract database, searching for a specific data within a course, presentation of the latest modifications, and glossary of terms.
- **Virtual and remote laboratory tools:** this category groups all tools that support simulations (virtual labs) or the remote execution of resources as software and hardware supporting mechanisms and mathematical function programs.

In the context of the proposed environment, the tool development is directly related to the technological needs of the virtual laboratories.

PAPOULA: AN IMPLEMENTATION OF THE PROPOSED MODEL

The PAPOULA[5] environment corresponds to a practical accomplishment of the proposed model. It runs on the Web and its main goal is the delivery of a set of laboratories on the Internet that supports the learning of some of the main subjects in electronics engineering. PAPOULA offers to the users three levels of contents and exercises, both theoretical and practical, as well as a virtual practice of experiments with the support of a specific software for either a simulation of a device or a real hardware test through remote mechanisms. The current laboratories already implemented and linked are:

- **PATROL:** supporting pages to the learning of control systems, including aspects of both classical and modern control engineering.
- **PAPROS:** supporting pages to the learning of signal processing, presenting the main topics in signal processing, discrete and continuous.
- **PANN:** supporting pages to the learning of neural networks under supervised and unsupervised learning.
- **PALAS:** supporting pages to the learning of linear systems, including both time and frequency analysis.

[5] The acronym comes from the original in Portuguese, which translation means "supporting pages to presential and distance learning courses".

Besides the contents of the above pages, the Web environment also integrates some of the tools cited in the previous section with the assistance of the "Tools Module", which contains pages to support the technical development of learning systems in the Internet. This module also provides mechanisms to help on the construction of virtual and remote experiences, linked to devices that are shared among several users. In addition, two labs are under development, linking engineering and basic science:

- **PACUS:** supporting pages to the learning of Calculus.
- **PALIN:** supporting pages to the learning of linear algebra.

Figure 1 presents the HomePage of the PAPOULA Web environment. The right frame provides access to the laboratories. The left frame presents the menu, where the main functionality and links are. All pages follow this design, in order to provide the same navigation structure among the accessible laboratories.

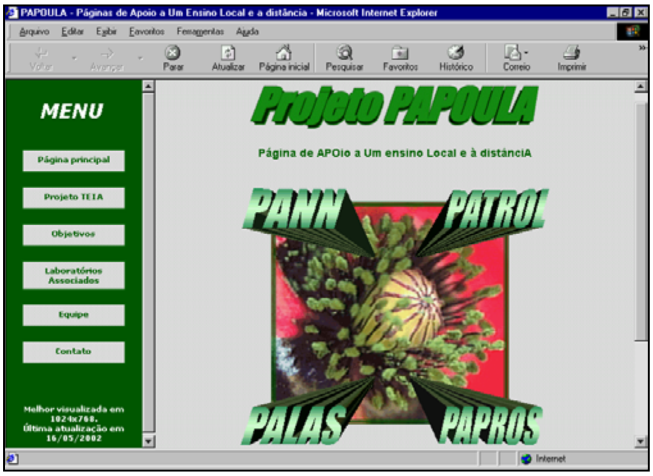

FIGURE. 1

THE PAPOULA HOMEPAGE.

The linked pages through the PAPOULA HomePage have the objective of providing information, via a simple and informal way, of the subjects discussed inside a classroom. In order to achieve the target of presenting a colloquial text, the students themselves read, understand a specific topic and write the contents with the orientation and supervision of full professors.

The laboratories have to work mainly as an extra helping source to clarify eventual doubts. The practical examples evolve through three stages. In the first stage, exercises are suggested to practice the theory. Succeeding, simulated experiences are proposed. Finally, real experiments are remotely performed with the support of instructors and current technologies. For example, regarding the linear systems theory, the PALAS laboratory integrates simulation techniques of circuits and systems with simple hardware modules. Besides simulation, students can experimentally practice through experimental kits located in one physical laboratory.

As part of the theoretical material, supporting tools to the learning process are accessible by the environment. On each module of a given laboratory, students are invited to face a challenge. A complex problem referred to the current module is presented and, in this way, the subject can be deeper discussed based on the student ability. The challenging section is also useful to test the contents assimilation by students and the creative capacity of a student, as the problem is not directly argued within the module. Obviously, electronic mail supports the communication among students and offers an efficient way to clarify eventual doubts with the assistance of instructors.

Within this environment, the students can access several static data related to the subject (as reading a book) and also interactive contents. The importance of the Web technology in the learning process is the possibility to offer a high degree of interactivity to an user, independently of the working place. It is not demanded to install software or to have a specific hardware. A browser and an Internet connection are enough to start acquiring knowledge and expertise. Though an environment like this, it is possible to perform experiences on numeric simulation through the Web and get the results immediately afterwards. Moreover, the student can choose the parameters that will be used in the simulation.

The pages run over an HTTP Apache server in a Linux platform. The HTML language is used on the static parts of the laboratories and CGI programs, implemented in C or C++ language, correspond to the dynamic part. Graphical results as well as all kinds of images are presented together with the text, contributing to a better understanding of the users through multimedia facilities.

Respecting the informal way of learning, a laboratory can provide "tips" on how using the features, devices and software packages. Another feature is the reference page with hypertext links to other Web sites related to the main subject of the module.

FUTURE IMPROVEMENTS

The working group is developing a Web environment to support the automatic creation of distance learning sites. This feature integrates the contents with only some of the distance learning tools as registry, search by keyword, communication features, latest updates, self-scoring, multiple-choice tests. The Web environment also guides instructors on the requirements of a distance learning environment. It means that the environment asks for important data to be displayed as the author background, the summary of the whole contents, terminology, creation date, objective of the course, an email for contact and so on. Contents and tools are automatically integrated through a database without requiring from instructors knowledge about HTML, JavaScript or Web programming.

Our next step is to develop more pages within PAPOULA by using the Web environment and, in this way, guaranteeing standard interfaces. We also plan to construct other distance learning tools according to the classification presented in this paper. Other important feature is related to evaluative criteria for Web sites that would check aspects related to authority, accuracy, currency, navigation, design, quality of writing and so one [6]. At last, we notice that it is very important to produce a variety of mechanisms to facilitate the creation of virtual and remote experiences.

Regarding the concepts of the proposed model, it is necessary to improve the connectivity method that links the laboratories. Nowadays, the authors have to set each link between two pages. Nevertheless, a certain level of procedure automatizing can be achieved by, for example, the glossary tool, where the terminology of all modules is placed. It could also be very useful to provide a database of content links among various pages and, moreover, a database of experience links among different laboratories.

The idea is to offer a technological "factory" of distance learning pages and to make the construction the most automatic as possible. Professors would concentrate on the contents while the Web environment automatically publishes an already integrated learning material of software, hardware, theory and practice in the Internet.

CONCLUSIONS

The information technology and the intense use of the Internet are becoming very interesting for educators in several knowledge areas. Different conceptions of learning environment on the Web were developed. Nevertheless, the need of creating educational tools that facilitates a fast and easy access to a stored knowledge is increasing, maily due to the necessity of a constant intellectual update.

Generally, the available time that professionals can dedicate to the update of new methods and techniques is quite restricting. Thus, offering conditions to acquire information through a fast and efficient way is essential to either enterprises that need to keep themselves market competitive or qualified peope that constantly need to keep informed.

Recent researches pointed out the potentiality of distance learning through computational support. That is the main reason a specialized distance learning model can contribute to the increasingly grow of new learning methods based on modern technologies applied to engineering courses.

The research project presented in this article intends to construct a multidisciplinary network of virtual laboratories. The network integrates hardware and software to support students in the learning process of different subjects from electronics engineering and basic sciences.

The hypertext pages aim at presenting, through a clear and objective way, material and mechanisms for an effective learning. The Web environment assists instructors within classrooms and not only, as the learning process can be continued out of teaching hours and anywhere. The focus of our proposal is on interconnectivity of data from several domain areas, high interactivity and stimulating the cooperation among users. The PAPOULA environment demonstrates that the proposed model for the interconnection network of virtual laboratories feasible and that students can get more involved with interactive and dynamic learning material.

The integration of tools, contents and devices to connect different virtual laboratories aims at enlarging the navigability about the didactical material gathered by hypertext links constructing a huge net of knowledge.

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BASIC AND TECHNICAL SCIENCES INTEGRATION IN TERMS OF THE LECTURES COURSE "ENGINEERING CREATIVENESS BASE"

Tatiana M. Tkacheva, Zoya S. Sazonova and Nina V. Chechetkina

Abstract — **Lectures course "Engineering Creativeness Base" is one of very important fundamental disciplines for engineer's training in the State Technical University MADI. This course appears to be syntheses of basic (Physics, Chemistry, Mathematics) and technical disciplines (Material Science, Strength of Materials, Engineering Graphics) and makes students to learn them more and allows students to grasp deeper the significance of their future job and it allows them to feel creative work satisfaction. Learning the course "Engineering Creativeness Base" After learning of this discipline students can better perceive other disciplines necessary to become a real ENGINEER.**

Index Terms — **Philosophy, history, Natural Science, classic Physics, quantum Physics, Chemistry, Biology, Synergy, Ecology, Evolution**

I. INTRODUCTION

In the 20th Century the basic feature of our own period were formed and they can be determined as following: snowballing increase of information, vigorous growth of computer science and using it everywhere, a competition increase of intellectual labor, formation and development of new branches of science, technics and technology. That is why the engineer's background changes and new requirements are necessary. The main aim of engineer's background now is innovative thinking cultivation and creative work ability formation instead of traditional skill development which is not enough for successful engineering activities. An engineer of 21st Century must be a creative personality, who can reveal and propound himself a creative problem in all situations and surely solve this problem.

New ways of engineering education all over the world depends on the development of the human society in a whole and on the development of science, technics, technology and culture in particularly. Contemporary intensive processes of new pedagogical technologies formation and development can be considered as a part of new informational technologies speedy elaboration. High level of Russian engineers qualification is supported by innovative pedagogical technologies and by special programs of the engineering education.

Russia was famous earlier and is famous now for its theoretical developments in different branches of science.

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Engineering education is not an exclusion. You know well the name of P.K. Engelmeier who was not only engineer but one of the philosophy of technics founders [1]. It is necessary to mention the name of G. Altschuler [2] and M. Zinovkina [3] who search and contrive creative methods for children and adults, for students in particular. Now Russia need to use all its theoretical experience and try to implement it in the tutorial process.

Departments of the engineering education are organized now in several Russian technical universities. They are charged not only to use but to search, to find and to implement new pedagogical ideas in the background of engineers. Their activities can be carried out within the framework of fundamental disciplines complex i.e. disciplines of natural science, humanitarian disciplines and technical disciplines. The Department of the Engineering Education of the State Technical University MADI correlates its tutorial programs with programs of the general education departments such as departments of Physics, Mathematics, Chemistry.

The best way to get students to understand the importance of basic sciences learning is a real example. The most demonstrative example of basic sciences and technics integration is PC production process and its history. The first step was done in the 19th Century by M. Faraday and H. Becquerel who began to study properties of semiconductors. Then in 20-40 years of the 20th Century the fundamental theoretical items were proposed together with some prognoses of future practical semiconductor application. In 1923 Schottky was published the theory of solid state amplifier. In this theory the necessity of quantum-mechanical methods was highlighted. In 1940 during the Second World war the first crystal detectors for waves of centimeters in length was built. In 1947 Shockly, Bruttein and Bardin proposed and done the first semiconductor bipolar transistor. This year became a new era birthyear.

It is well known that more that 90% of electronic devices and systems are made using silicon as a basic material. On the Earth silicon can exist only as silicon dioxide or silica and as a part of different compounds. The transformation of the raw material into pure silicon single crystal can be considered as the purification from the case when silicon content is equal to 98-99 % (raw material) to the case when siliocn content is equal to 99.9999999 % (silicon single crystal or wafer). This kind of the transformation is possible only by using fundamental scientific knowledge and Hi-Tech tecnologies.

The way of silicon raw material into electronic devices demand knowledge and skills of different sciences and engineering:

raw material search and mining – Geology, Chemistry, Physics, engineering; silicon dioxide rectification – Physics, Chemistry, Material Science, Metallurgy, engineering; matrix and then devices production – again and again Physics, Chemistry, Material Science and engineering. The last step of some electronic devices, i.e. PC, demands to use mathematics and information science. During all steps of semiconductor devices production it is necessary to keep in mind the ecological problems which can follow these manufactures. Before manufacturing of devices and during this process it necessary to follow the market demands. Now it is well known that the every dollar invested in silicon wafer production will return multiplied by 18-20 after matrix manufacturing and multiplied by 100 at least when electronic system was produced.

It is necessary to note that sequences of engineering activities can play double-natured role: from one side we have some material objects i.e. machines, new materials, buildings, bridges, roads, etc. and from other side we notice a change in a human way of thinking and its social behavior. So, we can underline that social sequences of engineering activities to increase the engineer responsibility.

From our point of view the base of engineering creative work consist of high fundamental education, comprehensive imagination and patriotism. The latter can be strengthen if a student knows the ways of engineering development in Russia, if he knows the biographies of the great Russian engineers and scientists. One of the practical task for students is writing of reports on great people biographies. In its practical work the professors of the Department of Engineering Education use to visit Moscow Museums devoted to the great Russian Scientists and Engineers as well as Museums of Art and History. State Technical University MADI has its own museum where students can acquaint themselves with MADI formation and development and with biography of its graduates.

Fundamental education appears to be a result of mutual efforts of departments of general education such as Departments of Physics, of Chemistry, of Mathematics and by Departments of humanitarian sciences. Scientific cognition's methods used by different branches of natural science enrich a future engineer, give him an opportunity to make himself master of successful application of these methods. Learning humanitarian disciplines a future student receive a possibility to reach figurative selfrealization. One of the founder of quantum mechanics E.Heisenberg wrote that his breakthrough in Physics were based on his speculation arose during Platon's "Dialogues" reading.

One of courses developed by professors of the Department of the Engineering Education of the State Technical University MADI is the course "Engineering Creativeness Base". This discipline includes several world outlook sections but in a whole this discipline is directed to practical training. A future engineer must understand that the Universe can be cognized. Every engineer's project must be realized according the Nature laws which are under research infinitely. That is why the engineering education must not stay but it are developing too.

There are several stages of engineering activity that we can select. They are:

- problem searching and propounding
- invention creating
- project designing
- engineering research fulfilling
- project developing
- technology and industrial engineering
- an exploitation and evaluation of mechanisms and means of production
- a liquidation of dated or disused construction and machines.

An engineer of the 21st Century must also know the rules of marketing, advertisement and he can evaluate his commitment (including evaluation of production cost) and future profit.

An engineer of the 21st Century can work in an individual manner and as a member or a leader of a team. So, he must know how to organize his own work when he is alone and when his work is a part of cooperative work. That means that he must know some Psychology information.

All of these stages can be successfully carried out on the base of knowledge received during learning the course "Engineering Creativeness Base". Students of the second year learn it during two semesters. This discipline includes:

- a natural-science Universe pattern and a historical view on science formation and development from ancient civilization till nowadays;
- a historical view on technics creation and development;
- dynamics of science and technics interaction, a historical view on technical science formation and technical education origination;
- a consideration and using interdiscipline synthesis for development of a creative work skill
- an integration of knowledge in the area of natural science and using of natural science methods and techniques in an engineering activities
- characteristics of engineering activities and a structure of an engineering project;
- methods of different technical problems propounding and methods of scientific and technical creative work;
- ways of modern information technologies using in everyday engineering activities;
- an initial information from Psychology and using its imagination in an engineer activities;
- an engineer's responsibility, interaction of engineering activities and ecology problems;
- specific features of engineering thinking and innovation thinking cultivation;
- an element's, function's and structure's analysis as a part of a system analysis;
- an initial information about value analysis and value engineering;
- an initial information about marketing and advertisement;
- presentations of successful scientific and technical careers

By learning the course "Engineering Creativeness Base" students will adopted the ways of fundamental sciences using in their future creative work, will understand their own creative potential, will study the principles of a creative work in a team. A student obtains an opportunity to become a creative personality who possesses knowledge in rather wide frame from different sciences. After learning the course "Engineering Creativeness Base" students can generate new creative idea, or even create new technical objects.

During Centuries science and technics were as twins: i.e. Archimedes was one of the first engineer-scientist or vice versa scientist-engineer. The same words we can say about Leonardo da Vinchi, Galileo, Huygens, Gilbert or others. It is well known that every great scientist or engineer is a creative personality. This conclusion push us again to great importance of a creative work in engineering activities too.

The main goal of creative engineering activities is "a technical object". Every time the preliminary idea of any technical object promises a perfect product. During speculations and then during producing of this new item there are two types of work (this division is rather rough, of course): creative work which sometimes is very close to irrational thinking, and routine work the other name of which can be "rational thinking". More irrational in your work means the fact that you are closer to creative thinking and work. Father you from irrational thinking means the fact that you fulfilled now only rational work and your thinking now is rational thinking (Fig.1). You can see that "technical object" contains basic sides of a human activity – material, scientific, artistic – which can not birth and exist without creative work. It should be noted that every new creative idea based on the previous knowledge. You can follow the changing of any technical object i.e. ships, and you can

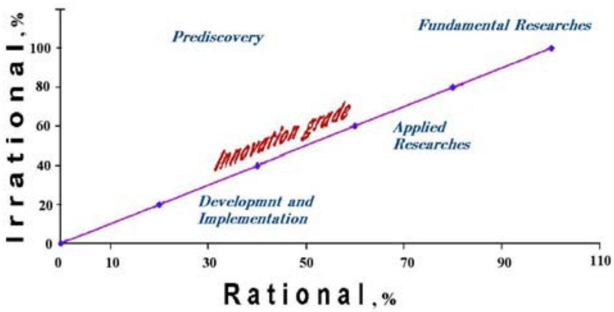

Fig. 1. The relationship of irrational and rational thinking and an innovative grade dependence for different types of engineering activitis.

see that every following exemplar has some feature of a previous one (Fig.2). This figure shows us one of a rule of an application for patent creation: every following step consists of the previous one.

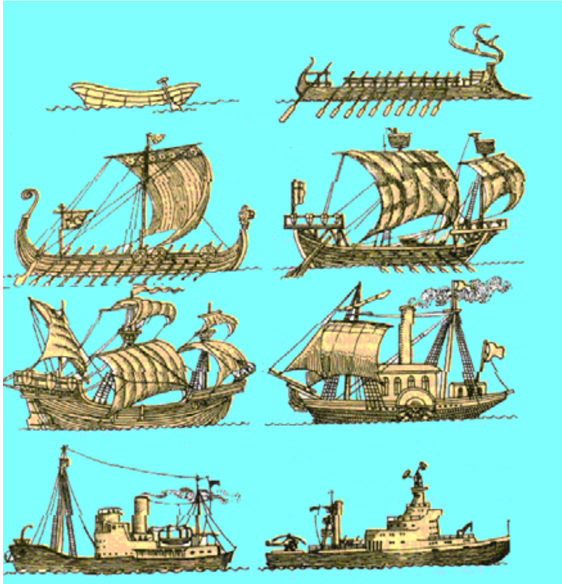

Fig.2 An example of more and more sophisticated models of ships as a result of a human creative work.

Looking at these ships we can follow the process of well-known idea transformation: oars plus clothing – quicker sailing… vapor plus clothing – quicker and more margin of safe… nuclear energy instead of electricity – more power, more time for sailing, more interval for velocity etc.

At present a man lives in the artificial environment. The logic of this environment development and evaluation depends only on intellect, knowledge and high moral principles of the human society.

To receive new perfect technical decision or to create new technical product is possible only if you know some methods. In application to engineering activities such method or methods are the methods of a creative work.

As a rule every stage of engineering activities consist of three creative acts. They are:

1. "a guessing act" (an idea) which results in clear propose or intention;
2. "a knowledge act" (a plan) which results in clear scheme;
3. "a skill act" (an implementation) which results in final technical project creation or pilot construction formation.

So, at first it is necessary to understand what methods can be considered as methods of a creative work. The second step is learning of this methods through using them as an individual person, then as a member of a team , and it is necessary to try to reach the leader place in a team. During learning of methods of a creative work all modern technical devices and tools must be used. For example, database of physical, chemical effects, database of some constructional elements, database of known technologies etc.

The method of learning can be transformed by using interactive self-instruction technology. From our point of view this technology is generalized one. Then cognitive, instructional and training activities are the main and leading activities for a student. A professor will play role of a consultant. One way of dialogues between a student and a professor is a formation of interactive web-site (www.ipmadi.narod.ru). The Department of the Engineering Education of the State Technical University MADI has its own interactive web-site, where an information which is necessary for students is situated and where its professors can find students questions and demands. So, professors and students can better get to know each other.

It is necessary to note that the most active students after learning several courses of the Department of the Engineering Education use their new knowledge in practice. For example, during methods of a creative work learning namely "brain storm" or "value analysis" ("Engineering Creativeness Base") several students used rules of work in a team ("Psychology of Business Interaction"). The best student value analysis carried out when they received as a task "automobile system of gas waste getting off" bellowed to that students who learnt the both above mentioned disciplines. These student found necessary information about several systems, analyzed them, they found necessary constructional-technological documentation and made a creative analytical work to propose their own modernization steps to increase ecology safeness of this system. Naturally because of their small practical experience and knowledge these proposition are not real for implementation in the production But the main thing is that they begin their creative work, enjoy it and want to know more and do better.

It should note that every time when it was necessary to use some information from any fundamental discipline (i.e. room heater modernization require using of physical effects: Ohm's law, Joule-Lenz' law, Stefan-Boltzman law etc.) the best propose and the most literate propose came from students who had good knowledge in this concrete discipline. Contrarily after learning of "Engineering Creativeness Base" we can notice the motivation increasing to learn basic fundamental discipline and we can note some increase of marks level that students receive later (Fig.3).

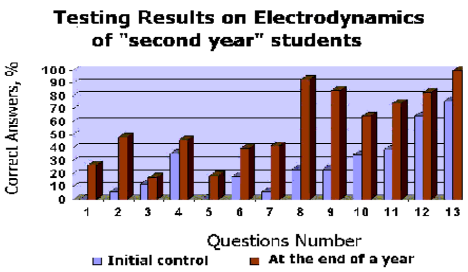

Fig. 3 The comparison of " the second year" students testing results on "Electrodynamics" fulfilled before and after "Engineering Creativeness Base" learning.

It is necessary to mention very interesting students projects carried out during learning methods of "brain storm" (increasing of walker safe in the street), of "focal objects" (it was several unexpected application of TV in the northern parts of the Earth) and "morphological analysis" (room heater modernization). Propounding of a technical problem was a task for students when the leakage of oil in 70th years of 20 Century was done as an example of global difficulty. Some students proposed their original decisions.

The analysis of correct answers shows that we receive approximately the expected Gaussian distribution. The initial questions (1-5) represents new material that students learned just before testing (brown raws). n the middle of diagram there are that questions which our students studied in school and then repeated them during their student life (blue raws)y see that after "Engineering Creativeness Base" learning the pattern of correct answers distribution is approximately the same one but correct answers percent increase (Fig.4)

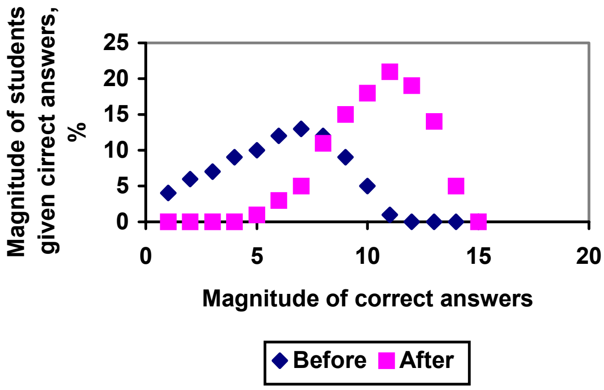

Fig. 4. The comparison of correct answers patterns before and after "Engineering Creativeness Base" learning for "the second year" students.

Practical tasks for students, their questions and demands, testing results allow the o professors of the Department of the Engineering Education correlates tutorial programs to teach talented and creative engineers.

It should be note that humanities in engineering education, the role of natural sciences in engineering education appear to attract a dramatic attention of the professors worked in engineering education all over the world. It is enough to read the papers presented on the 31st International Symposium "Engineer of the 21st Century"[ ]. The most of papers highlight the importance of basic sciences as well as humanities and creative work for teaching the real engineers of the Future.

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DESIGNING IN MIND: CREATIVITY

Secil Satir[1], Elmira Sener[2]

Abstract — *Creativity as an hypothetical aptness, can be found in each and every person. This inclination exposes a creative idea as a result of a multi dimensional thinking system, and the idea motivates the designer in order to be materialized.*

The properties of creative thinking, the understanding of "four p" principles; "product", "process", "personality" and "press" in creativity, are the important creativity concepts that takes place in the continuity of this announcement.

Mentioning the experiments of creativity process in computer environment and their results, points out the differences between the creativity process in mind and in artificial mind. The presence of multi dimensional psychological factors effect the synthesis of thoughts in many aspects, whereas the images obtained from computers are insensitive and are varied in one dimension.

Therefore the fact that designing in mind is special to human and apart of human personality can not to denied.

Index Terms — *Creativity, human mind, creativity process, creativity process in computer .*

INTRODUCTION

Creativity is an impulse believed to be in every individual, an inner reaction that motivates the individual to think, act or to produce differently from the known.

Derived from the latin verb "creare", in german "kreativiat", the word creativity, is a perfection that brings out an independent idea, an action or a product as a result. However, this talent that can be improved with exact and hard working can be defined as talent for designing. Because to design means to form in mind, to organize and to sketch. It can also be explained as to prepare in mind, to perform, to organize ideas, to fantasize in mind etc. The meaning of the word "human thought" is a process of a multi dimensional thinking and materializing, giving a meaning to life.

CREATIVE THINKING

Creativity, just like design, includes a multi dimensional thinking process and the case of this process to be materialized. However, producing an original creative idea is not sufficient. It's required that this idea to be seen by the others. The materialisation of a creative idea can occur in an act; in the mimics, jests or words of a comedian; in a caricature, a picture, a statue or architecture; in a song, poem or an article; in a design object; in the solution of a daily problem; in a scientific discovery; in a plan or system analysis; in the process of overcoming an economical difficulty; in creating solutions for a business or engineering problem etc. Briefly it can occur in finding positive solutions for all kinds of difficulties.

As seen, creative thinking covers almost the whole life. And in environments that no difficulty exists, it is significant to individuals who know life and whose creativity improved in order to feed their motivation to search, find and present the beauties of life.

To improve creativity one may not need to know how it forms in ideas, yet the knowledge of how an idea forms in mind may arise desire to feed the memory. For this reason, the knowledge of how and where an idea forms in the brain, how information is stored and how the communication is established in brain cells.

According to the studies of F. Vester, in the physiologic structure of thinking the stimuli that come to the brain are transferred between the cells to be evaluated, and 500 billion synapses work to transfer the stimulus between the brain cells [1]. With the help of these synapses, one can think, learn and remember systematically. The stimuli, also known as the information models that turn into substance as protein balls between the 15 billion brain cells, are continuously in communication with themselves and the new coming stimuli. These information models are always in a cycle of changing from substance to energy and energy to substance. The more the memory is fed, the denser the communication network would be, as long as there is not an obstractive reason.

These researches in creativity, lasting since 1950's, improve much with the studies of Guilford. Correl and Preiser define creative thinking extensively with the properties stated below [2] [3] ;

Properties of creative thinking:

* fluency
* flexibility
* originality
* problem sensitivity
* re-structurability
* materialization
* activation with every detail

These properties show different concentration in every individual's idea. For some people fluency of the idea is in the first place, while for some others the most important property shifts to flexible thinking or to problem sensitivity.

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Dimensions of Creativity

According to American creativity researches, the "four p" principles defines the dimensions of creativity [3].

The "four p"'s are;

1 - “product”
2 - “process”
3 - “person”
4 - “press”

Product

It is the materialization of an original idea formed by creative thinking into something that can be seen, touched, heard etc. Creative product leads to an exciting conclusion in scientific and art studies. It may also put forward solutions to the daily problems of private and business life. Above all, creative product is original and unique. Creative product is something that a person is not accustomed to; something surprising, logical, useful, exciting; an existing product that is changed, altered or entirely transformed; it brings out feelings such as joy, enthusiasm and relief.

Process

The formation of creativity in brain is not a mysterious process as many people believe, but a solution of a tiring work, effort and struggle.

Linneweh classified thinking into two groups as "visual thinking" and "intellectual thinking". It is seen that visual thinking can be continously used in every situation. The transformation, alteration and re-organisation of the problem elements are in the coverage of visual thinking. It is an idea that has a strong perception capability. For that reason the formation of new connections and the increase of sensibility in visual thinking, develop creative talent and imagination, in other words the inner eye. It is an important fact for invention. On the other hand, intellectual thinking is based on logic, succeeding in understanding, comprehension, perception, presentation of what is learned and making use of them. Visual and intellectual thinking must not be separated, keeping in mind that creativity can be found in each and every person and it may build on an intermediate intelligence base. However, it is considered that intellectual thinking develops in intelligent people while visual thinking develops in creative people.

The stages of creativity process starts with the perception and analysis of problems by the inner reaction of the individual. It is followed by gathering information. The information stored in individual’s memory, try or force to find ways of communication with the intervention of the synapses and they either enter an incubation phase or go in hypothesis formation.

As a result of these stages that can be named “black box” and “transparent box”, creative idea comes out as “a sudden thought flare” or “an idea synthesis”. For creativity process to be completed, the born idea should be examined, scrutinized, readied to be materialized and finally materialized.

The problem that needs solution should be constructed first, in order to materialize the creativity process. No matter the sort of existing problem, the construction should be simplified. The simplification means the purifying of the problem from all complexities. The problem may be easier to understand by classifying, may be defined as one by separating from the others, or may be defined again by analyzing the roots keeping the saying “the solution of a problem lies down in its roots” in mind.

Person

It is known that creativity lies on at least an intermediate level of intelligence basis. For this reason creativity exposes the intellectual aspects of the individual. However, creativity is also concerned with the motivation field of the person, because the creative idea that forms in the subconscious and arises as a sudden thought, comes to life depending on the drives, in other words motivation.

Creative person overcomes complexities and conflicts, has self-confidence, resists obstacles and judges independently. He/she has characteristics such as curiosity and ability to provoke imagination. Creative person usually does not suppress his/her personal feelings and is determined on his/her way to the conclusion. He/she is sensitive to the unique and beautiful. Attaches importance to diversities. He/she is suspicious and notices the negative and absent parts of the existent with this suspicion. He/she is interested in mental studies. Differentiates ideas and objects. May have extreme excitement reactions. Knows himself/herself well.

Press

Press may either create or exterminate creativity. Creativity can not exist without a physical or social environment. Above all, attractive, exciting and independent press motivates creative thinking. On the other hand, lack of confidence, constrained behavior and senses, intolerance and various social and cultural obstacles barricade the creativity.

CREATIVITY PROCESSES IN COMPUTERS AND THEIR COMPARISON

In the century we live in, human brain is being studied in many aspects and its structural properties are being modeled in means of artificial intelligence. This improvement exposes the development of electronic machines that can compete with human intelligence. Despite the fact that the user spends less effort, it seems that machines with artificial intelligence will become more capable as their technology develops.

As known, designing in computer environment, presents efficient improvements in finding practical solutions, creating virtual reality, visualizing the design, designing interfaces and creating artificial intelligence. This field, where the recent technologies are utilized, reaching a synthesis with words and numbers in theoretical dimension and with geometric shapes in visual dimension, may help the creativity studies. New patterns may be exposed by putting forward multiple possibilities from the geometric patterns which are recommended by the computer programmers and appreciated by the users.

"Harold Cohen designed a computer program which can generate drawings without the requirement of human interaction and produce an infinite number of variations within certain rules" [4]. However, such programs are limited with the thinking style of the individuals designing the computer program and they can not include all the users.

While it was easier to draw the planar and sharp contoured geometric structures in the beginning, with the developing technologies, designing with organic lines (alias wave front) and using the advantage of flexibility offers a wide range of design possibilities to the user. The designer uses this infinite opportunities as a tool for his creativity. Utilization of the visual abilities of the designer is important in developing computer programs, providing alternative production methods and presenting an easier use.

The programming which was "process oriented" before, has now turned into "object oriented" programming in realization of synthesis related to end user requests and analysis [4].

The Importance and the Difference of Designing in Mind

Searching alternative forms in design is useful with the use of computers in order to gain time and to produce multiple alternatives. Computer programs may present the form study in ways of step by step mutations. For example, designs of furniture back supports drawn in computer environment or alternative designs of some abstract forms improved by means of mutation, can vary only in their own limits in means of geometric forms. But in this variation, how can sensitive ideas, that effect the design and feed the human senses by taking place in permanent memory, be projected to the program itself ?

In contents of object oriented programs; tool, machine, objects, jewelry, environment, building etc. in all fields of design, except the assisting role of computers in speeding up the process, the first and sudden creative idea of the place or object design is particular to the individual. With the use of advanced computer technologies, exposing the idea using a touch pad and realization of creativity process by transferring organic forms to an electronic interface, is useful in presenting the idea as fast as possible.

On the other hand, the effect of the cultural structure which does not exist in computer programs, the psychological status of the individual and images on creative senses can not be denied. The most important property of creative intelligence, also defined as emotional intelligence, and its main difference from designing in mind, is the reflection of this emotionality on creative thinking.

CONCLUSION

The age we live in is the information age. Science and technology aim a better, healthier, longer and happier life for us. A happier life is equivalent to the usage of a wider range of creativity. If the designer can design a product that suits his sensibility, using the available programs directly or with the use a few key strokes and still continues to enjoy drawing with his hand, then science and technology would succeed in their task.

While the new disciplines introduced by computers such as "virtual reality", "interface or interaction design", "design for visualization" and "artificial intelligence" replace the design disciplines, they also should remain within certain limits leaving the design process to the designers themselves.

If the computers aim to replace the human brain, then the individuals would have to record all their daily incidents, perceptions, senses both in verbal and figurative and schematic ways to their computers. Regarding the informations and perceptions that the human brain finds necessary to forget, solving the problem would be more complex.

Computer technologies can make the work easier, exalting the creative personalities, instead of depriving the person of his joy to design and create.

Given all these information and ideas, creativity can be defined as a source of happiness that gives meaning to life and confidence to deal with the obstacles in every stage of our lives.

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INTEGRATING LIBERAL EDUCATION INTO ENGINEERING TECHNOLOGY SENIOR DESIGN COURSE AT MIAMI UNIVERSITY

Suguna Bommaraju[1], Ron Earley[1] Dave Hergert [1]

Abstract *—At Miami University, the senior design course in the baccalaureate Electromechanical Engineering Technology (EMET) Concentration takes the form of a yearlong liberal education capstone course. In addition to conducting engineering analysis, students are encouraged to integrate ethics, environmental issues, cost/benefit analysis, safety, and aesthetics into their project. Miami emphasizes critical thinking, sharing of ideas, synthesis, and informed reflection as significant precursors to action while focusing on student initiative to define and investigate the problems or projects.*

The inclusion of the liberal education component has proven to be an exciting challenge to the students. Alongside the project design work, the students have to reflect on personal and societal benefits while considering the reality of costing of the projects and the impact in terms of safety, environmental, or ethical issues related to producing the item. The integration of liberal education into the curriculum has generated an implicit understanding of the role of humanities and social science courses in enhancing engineering education.

Index Terms — *Miami University, Liberal Education, Senior Design Course*

INTRODUCTION

In 1996, the department of Engineering Technology at Miami University, OH, developed a capstone course 'Senior Design Project' in its Electromechanical Engineering Technology degree program. This capstone course is required in the final year for all students graduating with electrical/computer concentration or mechanical concentration[1]. The primary objective of this course is to make the students work in teams to conduct major open-ended research and design projects. This allows the students to be striong team player, utilize their knowledge and skills acquired in earlier course work, and incorporate engineering standards and real world constraints such as economical and social factors, marketability, ergonomics, safety, aesthetics and ethics.

To date, the senior design course has been successful as a Capstone course, meeting the requirements of Liberal Education component. After a brief backgtound on Liberal Education at Miami, the paper outlines the senior design course. The philosophy of embedding the liberal education component in the course is presented later. Finally, the paper shows the assessment techniques employed for continuous improvement of the course.

LIBERAL EDUCATION

Unambiguously a well-rounded education of engineering graduates must include a considerable liberal education component[2]-[9]. Although an engineer's job is to make things better, more efficient, and cheaper, other non-engineering skills such as writing, speaking and effective communication, as well as social and societal awareness, environmental consciousness are involved. It is important that engineering curriculum is comprised of considerations of the appropriateness of various technical solutions and resolution of conflicts that extend beyond classical engineering optimization. Such conflicts involve humanistic considerations that a technical solution must address conscientiously with careful thought.

Albeit the idea to plant the seeds of a social conscience in every graduate is an old one, its implementation at universities is complex and is subject several constraints. In order to estimate the current thinking among academia, a question was posted on the ENT Listserv with regard to if and how liberal education is incorporated in enginnering technology curriculum. The data collecetd from that inquiry indicated a strong support for including Liberal Education component. It appears that most of the engineering students are engaged in takling communication, history,math and science courses in their freshmen to senior level. Some of the postings on the listserv suggest that liberal education concepts should be introduced early on at grade school level (K-12).

The reluctance to add liberal education courses to engineering curriculam stems from the concern that there may be little room left for engineering courses. There is no doubt that introducing liberal education component by including liberal arts in an engineering can be only minimal at best to maximize the time to teach engineering subjects.

One of the ways to overcome this limitation is to embed liberal arts components in one or many senior design courses, in particular, any Capstone engineering design or project course.

THE MIAMI PLAN

At Miami University, all students must complete courses identified as parts of the Miami Plan as well as courses in Major[1],[8]. The Miami Plan for liberal education is an ambitious and complex plan. Based on some of the best thinking at the time of its development, the plan emphasizes four foundation principles. In addition, the plan aims to provide breadth through foundation courses, engagement through seminars, depth through the thematic sequence, integration through the capstone experience, and options for all disciplines to create courses based on the principles of the plan[4]. These are not novel ideas in liberal education program design. What makes the Miami plan unique, and also complex, is that it includes all of these ideas, emphasizing forms of inquiry and pedagogy, allowing overlap among requirements, and operating in an unresolved alliance with college and major requirements.

The Miami plan has two parts; Foundation and Focus. The 'Foundation' requirement is met by taking 36 semester hours of courses (Table-I). The 'Focus' requirement, is met by taking a minimum of 9 hours in a Thematic Sequence outside the major and a minimum of 3 hours in a senior Capstone Experience taken in the final year of study (Table-I).

Typically, a student registered at Miami University would fulfill 28% Foundation requirement, 9% Focus requirement and 63% in the field requirement as shown in the Pie chart.

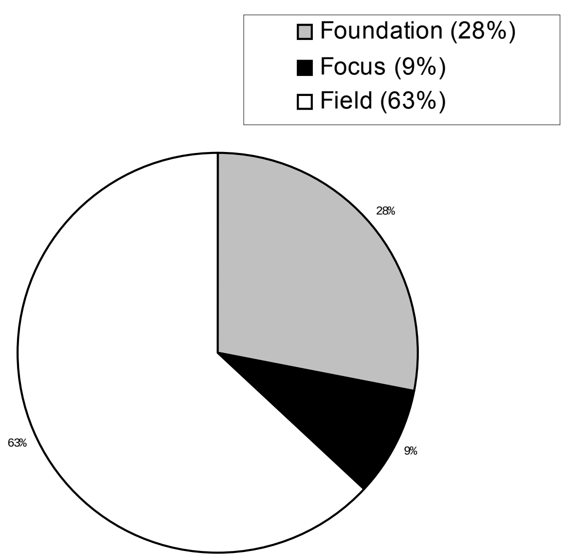

FIGURE. 1
DISTRIBUTION OF COURSE WORK

The Capstone presents an excellent opportunity to bring together the student's entire undergraduate program. The Capstone Experience, usually completed near the end of baccalaureate studies, integrates liberal learning with specialized knowledge. Each Capstone emphasizes sharing of ideas, synthesis, and critical, informed reflection as significant precursors to action, and each includes student initiative in defining and investigating problems or projects.

Capstones may be completed in or outside the major; in some departments, the Capstone Experience will be a requirement of the major. For students not majoring in the department where a Capstone is offered, prerequisites often may be met by completing a related thematic sequence. All Capstones presume a significant scholarly background of specialized study in a major as well as in liberal education course work.

At Miami University, the senior design project assimilates engineering design, analysis, and liberal education concepts such as cost/benefit analysis, environmental issues, and ethics. The Department of Engineering Technology developed the Senior Design Course in 1996. The Liberal Education Council later approved this sequence as a Capstone course. The department has seen the liberal education component in ENT 497/498 as a valuable asset. By focusing on the principles of liberal education at Miami, students learn to ask why they are designing a project, not just how to design it.[1],[9],[10].

TABLE-I
FOUNDATION AND FOCUS SEMESTER HOURS

Foundation Courses (36 Sem. Hrs.)		
English	Fine Arts	Humanities
Social Sciences	US cultures	World Cultures
Biological Sciences	Physical Sciences	Mathematics/Technology/ Reasoning
Focus (9+3 = 12 Seem. Hrs.)		
THEMATIC SEQUENCE: 9 hours Typically a Three Course Sequence outside the department of major		CAPSTONE EXPERIENCE: Integrates Liberal Learning with specialized knowledge

BASIC ELEMENTS OF SENIOR DESIGN COURSE

The senior design course is divided into two semesters: ENT 497 and ENT 498. The course addresses the application of the knowledge of senior Engineering Technology students to perform a major open-ended design project. This allows students to work in design teams that utilize their combined expertise and skills to achieve a successful design. Each group of students has a faculty mentor.

The fundamental elements of the design process are considered in this course through continuous interaction with faculty and bi-weekly seminars by outside professionals. In this course, a variety of methods is offered to the students to enable them to develop their designs. As appropriate, seminars on topics relevant to the projects and design are conducted by the faculty, students, and guest speakers from industry and other institutions. These topics include Miami Plan, Ethics, Cost Analysis, Liberal Education Component, U.S. Patents, Engineering Design Project, and Design Alternatives.

Along with Guest speaker's seminars, the students and the faculty meet regularly. In each of these meetings, students generate minutes that describe the discussions, activities to be conducted in the future, progress to date, and persons responsible for future tasks.

The design projects include the establishment of objectives and criteria, synthesis, analysis, and evaluation. In all designs, students will consider realistic constraints, such as economic factors, marketability, human factors, safety, reliability, aesthetics, ethics, and social impacts.

The projects offered in this course are chosen from real-world problems. This is intended to enable students to recognize current needs and trends in industry and society. The first part of the project (ENT 497) deals with feasibility studies or proposals. The second part (ENT 498) is the actual implementation, testing, and production or simulation of the prototype. Because design is an iterative process, the students may find it necessary to adjust their proposals from that in ENT 497.

At the end of the second part (ENT 498), the students are required to give a demonstration of their developed design. This is done by using computer simulation or by physical testing. The format for the final report is similar to that of ENT 497 but contains more information about the final design: analysis, mathematical model, cost, and operational procedures.

In general, students are graded (Table-II) and evaluated according to their performance in four areas: 1) finishing the proposed design, 2) reports, which include final report, minutes, and other progress reports; 3) participation, which includes meeting attendance, discussions, active involvement, and leadership in carrying on one's responsibility; and 4) midterm and final presentations.

It should be noted that the students are working in groups to emphasize the importance of teamwork in real life situations. Each group is responsible for dividing the different tasks among its members, writing reports, and presentations. Individuals within a group may receive different grades. Grades are determined by regular evaluations taken during the semester by the instructor and by the students for each individual. While the student input will be given considerable consideration, in the event of conflicting opinions or other such problems, the ultimate grade determination will be by the instructor.

Students submit written assignments in ENT 497/498.

- Mid-Term Report
- Final Report
- Weekly Journal Entries
- Reflective Essay (Appendix-A)
- Presentations

TABLE-II
ENT 497 COURSE GRADE SHEET

Date: ______________

Maximum Points Possible	Graded Item		Points Earned
(15 points)	Project Proposal		
(45 Points)	Final report		
	(2 points)	Title	
	(2 points)	Statement of Purpose	
	(10 points)	Scope & Methodology	
	(10 points)	Expected Findings	
	(10 points)	Conclusions & Rec.	
	(2 points)	References	
	(7 points)	Appendices	
(15 points)	Quality of Participation		
(30 points)	Presentation		
(15 points)	Use of Engineering Analysis		
(30 points)	Weekly Journal & Reflective Essay		
		150 points Total	

The following assessment tools are used in the course.

- Presentation Evaluation (a panel of judges evaluate student projects and presentation at the end of each semester) (Appendix-B)
- Liberal Education Survey (Appendix-C)
- Student Evaluation (divisional student evaluation done at the end of the course)
- Two Minute Survey (usually done after each guest speaker)

EMBEDDING LIBERAL EDUCATION CONCEPTS

All engineering colleges require engineering design from their Senior Design students. In order to foster the consideration of social context and other non-technical issues when designing, building, and implanting engineering projects, liberal education concepts are introduced into the senior design course. These are 'critical thinking', 'understanding contexts', 'engaging with other learners' and 'reflecting and acting'.[1]

- Critical thinking: Critical thinking is to involve imagination, intuition, reasoning, and evaluation in such a way to analyze systematically and solve complex problems. [1]
- Understanding Contexts: The relevance of the problem and the solutions to the society, environment, and the well being of people is as important as the problem and the proposed solution.

Knowledge of the conceptual framework and character of the society are essential inputs. [1]

- Engaging with Others: Only through open and honest exchange of ideas with piers and teachers and colleagues does one accomplish a balanced solution. Active listening, exchange of ideas, reevaluation of established views and critique through actively seeking other's opinions are corner stones to achieve a proper result. [1]
- Reflecting And Acting: Practice decision-making and evaluation of the repercussions thoughtfully. The idea is to enhance personal moral commitment, enrich ethical understanding, and strengthen civic participation. [1]

Students in ENT 497 are required to first establish who is in their group, and then choose a project. Often students have more than one alternative, so they can choose a project that best fits their ability and interest. Groups are altered if there is little diversity in terms of background.

Next is the planning stage, where students discuss the design, establish objectives, prepare a Gantt chart, and assign tasks. Literature research and preliminary reports make up the rest of the semester. All areas of critical thinking (analyzing, formulating alternatives, implementation, and documentation) are done in this class. The mid-term report gives the instructor a clear understanding of the progress of the group.

Following is an analysis of how the department meets the four principles of liberal education at Miami.

Critical Thinking In Liberal Education

All senior design projects require a component of engineering analysis. Critical thinking in engineering technology is most often is centered on analysis and design. The principles learned in prior courses are used as a guide for conceptualizing a complex project, designing the system using engineering analysis to mathematically model the system, then building it. Critical thinking skills are used in analyzing problems, formulating alternative solutions, implementing solutions, and documenting the results. [10]

Here are a few examples:

- A group of students designed a fiber optic multiplexer that allowed a computer to be connected to a matrix of cables. The project was complex and yet quite successful. The company that sponsored this project later patented the final system. To design the mechanical part of the system, students used principles of Statics, Strength of Materials, and Machine Design learned in their engineering technology courses. The accuracy and repeatability of the alignment was crucial to communication being established. Students spent most of the year determining the type of electrical control to be used (i.e. open or closed loop) and designing the mechanical apparatus. They also evaluated a wide variety of designs to best move the platform for proper alignment of the cables. The final decision was that the control system had to be closed loop because of the precision involved. The students designed the control system using differential equations and other modeling techniques taught in their control course.
- A group of students designed a PCB electrical board etching system that allowed schematics to be drawn on a computer, and then downloaded to a robotic arm that etched the board. All aspects of the system (including the robot) were designed and built by students. The students used the knowledge they gained from their mechanical courses, digital design, and programming courses to build this system. The software was written in Visual C++; I/O ports were used to control the machine. The machine entirely built by the students required a tolerance better than a thousandth of an inch. This would normally take months to design and build. Owing to the time spent in planning and preliminary design, the team was able to successfully build, program, and test this complex machine in one weekend.

Engaging With Other Learners

All groups have two or three students in them. Students are required to meet at least once a week outside of class, and keep the minutes in a journal. The instructor regularly reviews the journal to see how well the students are working together. If there is a communication problem, the instructor resolves it quickly, rather than let it fester throughout the course. [10]

An example of engaging with other learners follows:

- For two different years, a group of ENT 497/498 students served as advisors for the F.I.R.S.T. Robotics competition. This national competition has students design a robot in a 6-week period to perform a task. Over 800 colleges and high schools participate in the national event. Our group advised Northwest High School students on all aspects of the robot design. They were also involved in raising funds for the national competition in Florida. In 2000-2001, Miami/Northwest placed first in the region and runner up nationally. In 2001-2002 our students placed first in the region and third nationally. This project had a combination of high school students, college students, and engineers from industry working together to produce the final design. The ability to work so well together in a short time frame is tribute to the communication skills of Miami students.

Not all students communicate well though. Sometimes one student will control the project while others watch. This becomes obvious from the journal entries, and students are informed that group responsibilities must change. All students should contribute equally, depending on their interest and talents. Limiting the maximum number of students to three has also helped with this problem.

Understanding Contexts

Understanding Contexts includes adding a conceptual framework, cost/benefit, and cultural implication to a student's knowledge base. [10]

Rather than rush to build the project, students planning are the focus in the early part of ENT 497. Later, literature research and brainstorming sessions help the student to consider all aspects of the project. Feasibility studies help students envision the effect their product will have once it is designed and produced.

The central focus of the projects is engineering design; so all projects are required to have a significant component of engineering analysis. Students generally find an industry sponsor to fund and mentor the project. This way, students gain a perspective outside the classroom.

Understanding contexts includes other factors besides mathematical analysis. Students are required to include in their design such topics as cost/benefit analysis, safety, ethics, environmental issues, and aesthetics. The company sponsoring the project also mandates these components. Students see the context that the project will be used in, not just engineering analysis.

During ENT 497, guest speakers visit often. Attendance is mandatory on these evenings. A list of subjects presented by guest speakers for Fall 2002 is:

- Miami Plan – August 29
- Ethics – September 12
- Cost Analysis – September 26
- Liberal Education Component – October 10
- U.S. Patents – October 24
- Engineering Design Project – November 7
- Design Alternatives – November 21

Speaker topics are partly determined from student and industrial feedback in previous years. These topics help students step back and look at the project as a whole, rather than designing for the sake of design. A couple of examples of understanding contexts are given below:

- A group of students had a preliminary design for a robotic system that sprayed a fiberglass coating evenly on a tank. They took into account cost/benefit analysis, but not safety. After the instructor required them to look at all aspects of the design, they discovered that the project, if built, would not meet OSHA standards. They redesigned it, and the company is now using the robotic system.
- A group of students designed on paper a brake caliper for an automotive manufacturing plant. They did six different designs. They determined that some of the designs, even though more cost effective, could lead to carpal tunnel syndrome in the company employees. They chose not to go with this type of design when building the final project.

Reflecting And Acting

Reflecting and Acting is demonstrated by requiring students to think what they are designing before building it. The Reflective Essay is due at the end of each semester. It encourages students to evaluate their Senior Design experience with regard to the four goals of liberal education. The report guidelines are in Appendix A. Shown below are student comments from selected Reflective Essays. [10]

- "The goals of the Miami Plan for Liberal Education, in particular the goals of critical thinking and reflecting and acting have been instrumental in the preparation of this project."
- "Communication was one of the most important aspects of this project…because we had clear and concise communication, everyone felt they had a part in the final design."
- "In closing I would like to say that ENT 498 was the most difficult course to date. Not the project itself, but trying to complete the project in such a short amount of time. If I had to do it all over again, I would have insisted on a project that could be completed in a third of the time. By not speaking up, I allowed us to take on a project as complex and involved as this, and open ourselves for potential failure."
- "The communication that Tim and I had… was critical in the development of the project as a whole."

This essay has helped students observe their performance in the course. It helps them see how the breadth and depth of subjects they learned at Miami, including engineering technology, speech, English, philosophy, etc., helped shape their talents as they prepare to work in industry.

EVALUATION OF THE COURSE

At the end of ENT 497, students judge each other's projects and presentations (Appendix-B). While one group is giving the presentation, the remaining students observe and evaluate. The same evaluation form is given to outside judges in ENT 498. The outside judges consist of industrial representatives and faculty from other universities. For the past two years, some of the Miami faculty judge University of Cincinnati (UC) senior design projects and professors from UC evaluate ENT 498 presentations. Input from other colleges has helped us see areas for improvement in the sequence.

For example, in 2000-2001 the presentation day was somewhat disorganized because students wanted to change the time of their presentation at the last minute.

This confused the judges. Now, all students agree to a presentation time weeks in advance. This time schedule is strictly followed.

Students performing the presentation evaluation in ENT 497 tend to be quite honest in their critique. This helps students revise their presentation for ENT 498 the following semester.

The department also uses presentation evaluations to help evaluate the course. For example, the judges from ENT 498 last year made note that some groups had trouble with their speaking ability. They seemed unsure of themselves. To help correct this problem, the faculty is now requiring students to do more practice presentations before being must first create a timetable for completion. Creating objectives and judged. The presentation evaluations will be checked this year to see if the oral presentation is improving.

As stated earlier, the Reflective Essay and weekly journal entries help students observe their contribution to the course.

EVALUATION OF LIBERAL EDUCATION COMPONENTS

The assessment tools used in the course are an aid to the faculty and students. Student evaluations help ensure that ENT 497/498 is meeting the needs of the department and Liberal Education. The Liberal Education survey helps the faculty determine if students understand and appreciate this component of the course.

The Liberal Education Survey began in the 2000-2001 school year. Appendix-C contains the questions asked and a summary of the responses. As can be seen, students in general understand and appreciate the liberal education component of the course.

At the beginning of the school year, faculty meet to discuss ways of implementing improvements based on the survey results from the previous year. For example, Question 7 on the survey asks if the course has helped the student understand ethical issues related to engineering technology. In 2001-2000, the response was 2.97, but in 2001-2002, the response was 3.31. In the 2000, we showed a film on ethics relating to the Challenger disaster. This film generated much discussion in the class. Last year, we had only a short discussion on ethics. To improve on the 2.97 score from last year, we invited an engineer to discuss ethics both from both a moral and legal aspect. The survey will again be used to see if this helped the score.

As for the writing assignments, both years show that while students complain about the amount of written assignments, they do understand the value of journaling, reflecting, and reporting on their project.

CONCLUSION

All engineering colleges require engineering design from their Senior Design students. Most also require cost/benefit analysis, environmental issues, ethics, etc, although these topics are often seen as a minor component of the course. In the Engineering Technology department, these issues cannot be pushed to the background. By focusing on the four principles of liberal education at Miami, students learn to ask why they are designing a project, not just how to design it.

Some of the faculty in the department was initially skeptical of including liberal education in the course. Students take a number of engineering technology courses before enrolling in ENT 497/498, so why not focus on assimilating engineering design and analysis into their project? The thinking was that including liberal education provided little value to engineering analysis and design. Indeed, the quantity of liberal education in the required foundation courses was sometimes seen as a handicap, rather than strength.

Partly by co-teaching ENT 497/498 with other instructors, partly from seeing the effects of including liberal education on the final projects, and partly from listening to guest lecturers, most of the faculty have come to see the value of including all aspects of student learning in the course.

The department, while initially skeptical, has made a valiant attempt to integrate liberal education into the ENT 497/498 sequence. It has been a challenge for most of the faculty, because the engineering programs they were in included few, if any, liberal education courses. Their senior design experience focused purely on mathematical design and analysis.

In the beginning, at times the faculty felt unsure of what they were doing. Communicating with other departments that have a senior design course (such as Manufacturing Engineering) has helped the department develop the course. Having more guidance from the Liberal Education Council would have helped the ENT department understand what was expected. Input from LEC was especially necessary because the department has no other Miami Plan courses to use as a guideline. Overall, the department believes it has successfully integrated the Miami Plan for Liberal Education in the course, but is not sure if this is what the council is looking for.

Some of the faculty believe that ENT 497/498 is the strongest course in our department. The course is being reviewed for continuous improvement. The faculty is contemplating to utilize the course across varied disciplines to supply liberal education component in their curriculaum at senior level..

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APPENDIX A

INDIVIDUAL REFLECTIVE ESSAY

Write a 2-3-page essay on your experience in the senior design project. In your essay, address the issues discussed below. Please remember that a reflective essay is more about self-assessment, performance, and lessons learned than just giving oneself a letter grade.

The objective of the individual reflective essay is to allow you to reflect on your experience in conducting your senior design projects. One way to define reflection is to self-assess one's performance in achieving a certain task. The question is how well did you perform in this course? How did you arrive at this conclusion? Another way to define reflection is to compare and contrast the course objectives to what actually happened. For example, the main objective of the course is to *utilize the application of the senior students' knowledge in science, mathematics, and engineering to perform a major open-ended design project.* The question now is: were you able to do that? Why or why not?

Another course objective is integrating liberal education goals (i.e. critical thinking, understanding contexts, and engaging with other learners) and professional engineering goals. These may be found in the principles of engineering science, manufacturing process and methods, and engineering design. See the text for more information. Again, how do you evaluate your experience with regard to this objective? In your opinion, did the course achieve the Miami Plan' requirement for a capstone experience? Why or why not?

Thus, one thing we would like you to do is to read the course syllabus, one more time, and reflect on your experience in the course. Other aspects of the course and the whole experience that you should to reflect on are:

A group of students had a preliminary design for a robotic system that sprayed a fiberglass coating

- Team work: you and your partners' ability to perform in a team.
- Communication: your ability to document your research, to present your results, and to communicate with your advisor, team members, and customer.
- Design: your ability to perform an open-ended design problem. How do you evaluate this experience versus other engineering courses? Explain.
- General skills and knowledge, such as AutoCAD, computers, theory, electronics, machining, etc. How do you evaluate your abilities to apply such skills in your project?
- Learning to learn on your own: how do evaluate this aspect of your performance in this course?
- Your performance, in general: how do you evaluate your own performance? What did you do well and what can be improved? What are the lessons you learned in this experience?

APPENDIX B

TABLE-III

ENT 497 Presentation Evaluation

Group Name _________________

Objective of Project Clearly Stated	Very Good	Good	Fair	Poor
This includes problem statement, customer, and given constraints.				
Synthesis of Group	Very Good	Good	Fair	Poor
This includes brainstorming ideas, using constraints to bring together different components, ideation, and creating schematics and graphical representation of ideas.				
Quality of Analysis:	Very Good	Good	Fair	Poor
Did the group demonstrate the use of engineering science, science, mathematics, statistics, and other modeling techniques to evaluate their solution?				
Testing and evaluation:	Very Good	Good	Fair	Poor
They discussed the approach they used to test and evaluate their hypothesis, model, or solution. Explained clearly the constraints used to achieve that.				
Literature Research	Very Good	Good	Fair	Poor
Includes library research as well as company literature, web surfing, etc.				
Progress of Project	Very Good	Good	Fair	Poor
They used schematics, Gantt chart, narrative, cost, and advantages and disadvantages each approach to the design.				
Future Work	Very Good	Good	Fair	Poor
They discussed their plans for the future, including after the year is over.				
Vocal Quality	Very Good	Good	Fair	Poor
This includes speaking to the audience, holding a level of interest, using connective sentences.				
Appearance of Group Members	Very Good	Good	Fair	Poor
Equal Time for Each Member of Team	Very Good	Good	Fair	Poor

Time of Presentation (minutes) ___________________________

APPENDIX C

TABLE-IV

ENT 497/498 Survey Results, 2000-2001 & 2001-2002

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, and SD = Strongly Disagree.
Critical Thinking
1. I believe my critical thinking skills have been enhanced by this course. **SA A N D SD**
2. I believe that my critical thinking skills have been enhanced the work. I have done on my project. **SA A N D SD**
3. I believe this course stressed thinking and not memorizing. **SA A N D SD**
4. I believe this course provided many opportunities for critical thinking about problem solving, program design, and solutions **SA A N D SD**
5. I believe my critical thinking skills have been enhanced by the writing **SA A N D SD**
Understanding Contexts
6. I believe this course helped me understand the positive and negative consequences of the design process. **SA A N D SD**
7. I believe this course helped me understand some of the ethical issues related to engineering technology. **SA A N D SD**
8. I believe this course helped me understand the cost/benefit to a design project. **SA A N D SD**
9. I believe this course helped me understand the manner is which design engineers think and act. **SA A N D SD**
10. I believe this course helped me become sensitive to the consequences of implementing a design. **SA A N D SD**
Engaging With Other Learners
11. I believe the class activities have allowed me to engage with other learners in an effective way. **SA A N D SD**
12. I believe this course has improved my ability to work and solve problems with others. **SA A N D SD**
13. I understand the importance of group work for engineering technology professionals. **SA A N D SD**
14. I learned some things I did not know by working with others. **SA A N D SD**
15. Working with others has helped improve my communication and listening skills. **SA A N D SD**
Reflecting and Acting
16. I believe that the structure of the course has provided opportunities for me to reflect upon the concepts I have learned and apply them in an effective way. **SA A N D SD**
17. I believe that my design will help me reflect upon the concepts I have learned and apply them in an effective way. **SA A N D SD**
18. I believe this course helped me understand the need to reflect before implementing an engineering design. **SA A N D SD**
19. I believe this course helped me to take into account all aspects of an engineering design **SA A N D SD**
20. I believe this course helped me to reflect before acting in other area of my life **SA A N D SD**
Characteristic Ways of Knowing
21. I believe this course helped me to understand the importance of understanding a problem before trying to solve it. **SA A N D SD**
22. I believe this course helped me to understand the importance of designing a solution before trying to solve a problem. **SA A N D SD**
23. I believe this course helped me understand the importance of meeting a users needs when designing a project. **SA A N D SD**
24. I believe this course helped me understand the importance of safety in design practice. **SA A N D SD**
25. I believe this course helped me understand the importance of logic when solving a problem. **SA A N D SD**

The questions are summarized based on the following numerical assignments:

Opinion	Number
Strongly Agree	4
Agree	3
Neutral	2
Disagree	1
Strongly Disagree	0

The survey results for the past two years are shown below:

Question	2000-01 Average	2000-01 Standard Deviation	2001-02 Average	2001-02 Standard Deviation
1	3.47	0.52	3.38	0.62
2	3.33	0.72	3.50	0.63
3	3.80	0.41	3.81	0.40
4	3.80	0.41	3.71	0.60
5	3.13	1.13	3.15	0.93
6	3.53	0.52	3.50	0.52
7	3.31	1.13	2.97	0.87
8	3.53	0.52	3.35	0.48
9	3.67	0.49	3.67	0.50
10	3.40	0.83	3.00	0.63
11	3.60	0.51	3.69	0.48
12	3.53	0.99	3.50	0.73
13	3.47	0.83	3.69	0.48
14	3.40	0.83	3.50	0.52
15	3.47	0.92	3.63	0.62
16	3.60	0.83	3.81	0.40
17	3.33	0.90	3.56	0.63
18	3.60	0.51	3.56	0.51
19	3.27	0.96	3.44	0.73
20	3.40	0.83	3.56	0.51
21	3.57	0.85	3.80	0.41
22	3.57	0.85	3.73	0.46
23	3.36	1.01	3.47	0.74
24	3.43	0.85	3.67	0.49
25	3.29	0.91	3.53	0.64

STATISTICAL INFORMATION DATABASES DEVELOPMENT SUPPORT GUIDE

Maria Helena C. Guerra[1] and Ana Cristina M. Costa[2]

Abstract *— The main objective of the Development Support Guide is to establish procedures to help statistic technicians to construct the Production Database (PDB) and the User Database (UDB) for Portugal's data on the European Community Household Panel (ECHP). These databases are constructed through several steps. The Development Support Guide concerns the imputation and weighting procedures steps as well as the final production of the PDB and the UDB. The PDB and UDB development process is based on specific programs developed by the Statistical Office of the European Communities (Eurostat) with the Statistical Analysis System software (SAS) and C++ programming language applications developed by the University of Michigan. The SAS programs require adjustments every time a new wave (annual survey) is carried out. As a result, with the Development Support Guide it is intended to describe and characterize the SAS programs modifications and the structure of the data files engaged on this process.*

Index Terms — European Community Household Panel, SAS programming, Statistical Information Databases, Statistics Technicians Guide.

INTRODUCTION

Information on income and social indicators is getting more and more relevance to support economic and social policies within the European Union. Consequently, the Statistical Office of the European Communities (Eurostat) decided to implement a longitudinal survey called European Community Household Panel (ECHP).

A panel design allows following up and interviewing the same private households and persons over several consecutive years. The questionnaire of the ECHP gathers information on income, labour, health and other social indicators concerning living conditions of private households and persons.

This information is processed through several steps such as data checking, imputation and weighting. Afterwards, the data is stored in the Production Database (PDB). Based on the PDB a process of anonymisation is carried through and a user-friendly longitudinal User Database (UDB) is constructed.

The purpose of the Development Support Guide is to establish procedures to help statistic technicians to construct the Production and the User Databases for Portugal's data on the ECHP [1]. This document concerns all the mentioned steps to create the PDB and the UDB except data checking.

The next section describes the ECHP and the several stages that lead to the statistical databases construction. After referring the most relevant databases technical issues, the structure and content of the Development Support Guide is presented in detail. The last section points out the main conclusions.

THE EUROPEAN COMMUNITY HOUSEHOLD PANEL

The ECHP is a longitudinal annual survey conducted by Eurostat in cooperation with the National Data Collection Units, witch are National Statistics Institutes or Research Centres from each country. The annual surveys will be referred to as waves. The first wave was implemented in 1994.

The questionnaire development was carried out by Eurostat and a standard version was established. Although a few modifications to the questionnaire were made for each country, the information gathered allows the development of comparable social statistics across Member States on income, labour, poverty and social exclusion, housing, health and other social indicators.

Portugal's National Statistic Institute collects the data by means of the national questionnaire. The raw data is compiled and processed through several stages (Figure 1). In the first stage, data checking, data cleaning and cross wave consistency checks are made. By providing multiple observations on the same individuals, panel data makes possible to reveal some inconsistencies that may damage the quality of the results.

After the data checking, there is the imputation stage where several techniques are employed for a number of crucial variables to minimize the amount of missing data. The imputation is more difficult in panels than in cross-sectional surveys since plausible cross-sectional imputations of a given variable in successive waves may produce a highly implausible measure of change [2]. Then, in the weighting stage, several sample weights are constructed

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taking into account the cross-sectional and the longitudinal weights and adjusting the sample distribution to agree with the known distribution of population totals.

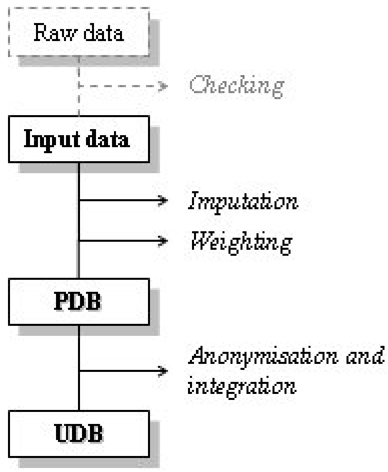

FIGURE. 1
PDB AND UDB DEVELOPMENT STAGES.

After these various stages, the data is stored in the Production Database (PDB). For each wave, this cross-sectional database is composed of four files containing *household register records*, *membership roster records*, *household questionnaire records* and *personal questionnaire records*.

Besides of the complex structure of the PDB files, the information stored is considered confidential. Therefore, a process of anonymisation takes place and a user-friendly longitudinal database is created (UDB).

DATABASES TECHNICAL ISSUES

File Management

The PDB and UDB development process is based on specific programs developed by Eurostat with the Statistical Analysis System software (SAS) and C++ programming language applications developed by the University of Michigan.

Physically, the data files and the SAS programs files are organized in six directories for each wave and three directories common to all waves. There are also SAS programs, C++ applications and other files stored in SAS software directories (for example: *c:\sas*, *c:\sas\sasuser* and *c:\sas\srclib*). The physical organization of all files was setup by Eurostat and any change to the directories structure or file names implies extra modifications to all programs involved.

The approximate number of files involved in the databases development and their functional organization is illustrated in Figures 2 and 3. It is important to point out that as the number of waves increases the file management becomes more complex.

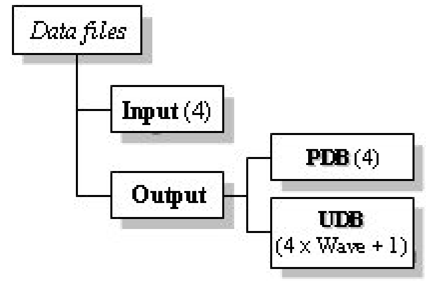

FIGURE. 2
APPROXIMATE NUMBER OF DATA FILES INVOLVED IN THE DATABASES DEVELOPMENT AND THEIR FUNCTIONAL ORGANIZATION.

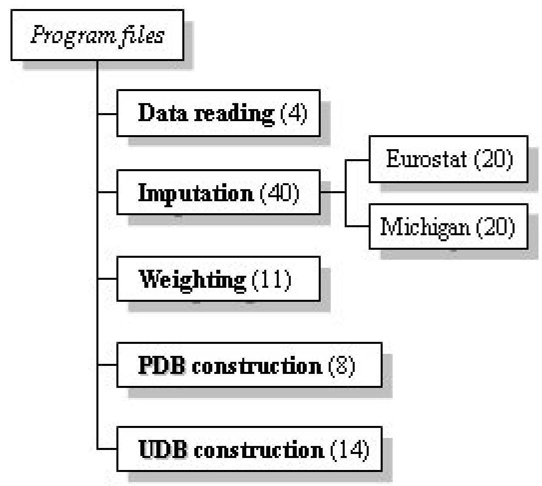

FIGURE. 3
APPROXIMATE NUMBER OF PROGRAM FILES INVOLVED IN THE DATABASES DEVELOPMENT AND THEIR FUNCTIONAL ORGANIZATION.

Program Execution

The program execution sequence follows, in general, the steps described by Figure 1. The way that SAS code was produced does not allow any deviation to this sequence and therefore the running order is extremely important. For example, some programs are run more than once over the process and, during the imputation stage, Eurostat programs are executed alternately with Michigan programs.

THE DEVELOPMENT SUPPORT GUIDE

The main objective of the Development Support Guide is to establish procedures to help statistic technicians on the process of construction of the statistical databases, PDB and UDB, for each new wave. This document describes and characterizes the SAS programs modifications and the structure of the files engaged on that process.

As a complement to Eurostat documentation, this guide constitutes a very useful support for any experienced SAS programmer to make the necessary adjustments to the programs every time a new wave is carried out.

Document Structure

The Development Support Guide is organized in two major sections: *Programs, data files and requirements* and *Program modifications*.

The first one includes:

- Hardware and software requirements
- Software configuration
- Files organization
- Data files description
- Program files description
- External information
- Programs execution sequence

On the second section, all the modifications to the SAS programs are described by program execution sequence. In this part of the document, every time a more complex program adjustment takes place, the text is illustrated with SAS code examples for the fifth wave. Finally, at the end of the document, the most important bibliographic references are listed.

The main sections of the Development Support Guide referred before will be analysed in detail.

Document Content

On the first section, the *Hardware and software requirements* subsection describes the software specifications and the minimum requirements of free disk space, RAM memory and computer processor. The Development Support Guide users must take into account these restrictions in order to construct the statistical databases successfully.

All the software configurations are clearly specified and, for example, when it concerns to the *config.sas* file the necessary changes are explicitly presented on the guide.

In the *Files organization* subsection the information concerning the path and the description of each file is illustrated through a table format and follows the fifth wave situation. The decision of making this kind presentation was due to the fact that there are a great number of files engaged on the databases construction process and because this number increases every time a new wave is implemented. Figure 4 shows a fraction of that tabular form.

The fourth subsection, *Data files description*, summarises the contents of the PDB and UDB files whereas a full description is available on the *ECHP UDB Manual – Waves 1, 2 and 3* [3].

The *Program files description* subsection is organized by program execution sequence:

- SAS programs that convert the input data files in ASCII format to SAS Data Set format
- SAS programs of the imputation stage
- SAS programs of the weighting stage
- SAS programs for PDB construction
- SAS programs for UDB construction
- SAS programs that convert the UDB data files to ASCII format

Directory	Files		Description
. . .			
c:\painel\wav5_imp	capself.sas comprev.sas etape1.sas etape2.sas etape3.sas etape4.sas hhdinp.sas indep.sas nbmonhh.sas nbmontp.sas	netgros1.sas netgros2.sas neth.sas netp.sas persinp.sas rent.sas revinp.sas sample.sas verifh.sas	Imputation SAS programs
c:\painel\wav5_wgh	alweight.sas controle.sas logcatmo.sas newbirt3.sas newbirth.sas newhhd.sas	step1.sas step2.sas step3.sas step4.sas step5.sas	Weighting SAS programs
. . .			

FIGURE. 4
FILES ORGANIZATION.

The description of each file includes the program purpose and its subprograms (program executed by other program). Figure 5 illustrates the document text regarding the second program to be executed during the imputation stage (Michigan program *etape1.sas*).

> **<u>Step 2</u> – program ETAPE1.SAS (Michigan)**
>
> The purpose of this program is to impute income variables at individual and household levels.
>
> The ETAPE1.SAS (Michigan) program executes several programs:
>
> ▪ YIMPUTE.SAS – performs the imputation of *Net Monthly Household Income*.
>
> ▪ YIMPUTE1.SAS – performs the imputation of *Self-Employment Income*.
>
> ▪ YIMPUTE2.SAS – performs the imputation of *Capital Income*.
>
> ▪ YIMPUTE3.SAS – performs the imputation of *Rental Income*.

FIGURE. 5
DESCRIPTION OF THE PROGRAM FILE ETAPE1.SAS.

The *External information* subsection specifies which auxiliary information must be provided by the National Data

Collection Units for each wave and also details the structure of the external information control file.

The *Programs execution sequence* subsection presents thoroughly and step by step, the running order procedure of the databases construction. At this point, and for each step, the programs names, their location and a short technical description are indicated. Since the execution sequence is quite complex, it is important to point out that all the information presented in this stage is brief and very precise.

On the second major section, *Program modifications*, the changes to the SAS programs are examined in detail.

All the programs and subprograms are analysed by execution sequence and, for each one, it is mentioned the exact position in the program code where the modification takes place and the exact description of that adaptation. It is important to refer that, at this point, it is also explained the logic process of the modifications. Along the text, SAS code examples for the fifth wave are used to illustrate more complex program adjustments.

The Development Support Guide also draws attention to some efficiency issues. To create the SAS programs for the current wave it is advisable to use as reference the last implemented wave programs to perform the necessary changes. Thus, this process becomes more efficient and the occurrence of programming errors is minimized. Moreover, it is important to write descriptive comments along the SAS code every time an adaptation occurs. This makes easier the program modifications for the next wave.

CONCLUSION

The main objective of the Development Support Guide is to establish procedures to help statistic technicians to construct the Production and the User Databases for Portugal's data on the ECHP. The feedback to this document was positive since it turned out to be very useful for the statistical databases development for the sixth and following waves.

However, the users would like the SAS code to be presented more thoroughly in order to simplify the modification process. Unfortunately, the programs complexity does not allow an exhaustive description of the SAS code. Nevertheless, this guide is intended to be used by experienced SAS programmers and a previous analysis of all programs is advisable.

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THE EFFECTS OF DESIGN STUDIO'S PHYSICAL ENVIRONMENT ON ARCHITECTURAL EDUCATION

Elmira Sener[1], Sinan M. Sener[2]

Abstract *— The basis of the architectural education is "architectural design studio" class. In Istanbul Technical University Faculty of Architecture, architectural design studios take place in two kinds of design studios: "single room design studio" and "separated design studio groups in a large classroom".*

The aim of this paper is to investigate the physical characteristics of these two kinds of design studios in terms of learning environment, in which "design process" takes place; to question the relationship between the physical characteristics of the design studio and the interaction of student / tutor; to research about the different consequences of the different physical characteristics of the "single room design studio" and "separated design studio groups in a large classroom" on positive or negative behavior among the students.

In this structure, the study is enriched by a questionnaire, which investigates the experiences of about usage the design studios; conclusions, which can be useful for designing the architectural design studios, are recorded.

Index Terms — Architectural design education, design studio education, design studio's physical environment, student/tutor interaction.

INTRODUCTION

The "architectural design studio course" which is fundamental for architectural education is an applied course where architectural design process is realized artificially. This environment is an educational element in terms of the importance given by the academicians, educational institutions and the time reserved for the course. The architectural design studio in the Istanbul Technical University lasts for four years, which make eight complementary semesters following each other. The "design studio" where the students may choose a different tutor every semester and the tutor educates an average number of 10-15 students is also the name of the classroom.

SCOPE OF THE RESEARCH

The architectural design studio in the Faculty of Architecture of Istanbul Technical University is a period in which the architecture candidate works on a subject on a pre-defined project plot for fourteen weeks and for eight hours a week, in each semester.

The learning process can be driven by the concept of working in teams or groups. Because, creativity can be enhanced by collaboration and cooperation [1]. Thus, collaborative and cooperative works, establish the design studio education.

In I.T.U. Faculty of Architecture, the studio courses take place in two types of physical studio environment: "single room design studio"(Figure-1) and "separated design studio groups in a large classroom"(Figure-2). One or two architectural project groups continue their courses in "the single room design studios" while approximately ten project groups are in the same space in "separated design studio groups in a large classroom".

FIGURE-1 GENERAL VIEW TO "SINGLE ROOM STUDIO"

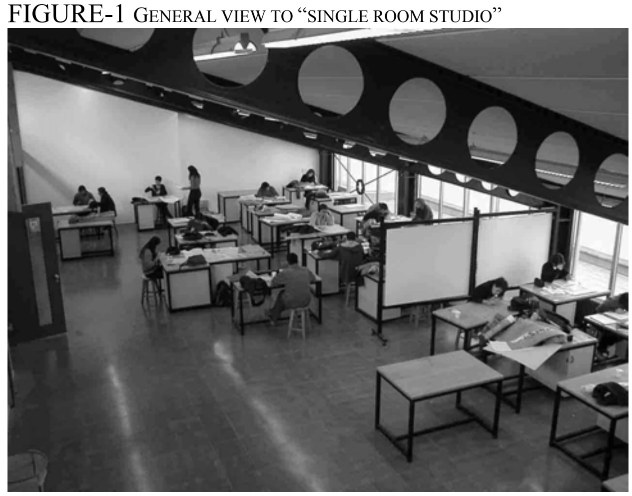

FIGURE-2 GENERAL VIEW TO "SEPARATED STUDIO"

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Thus, it is very important to arrange the spatial and physical capabilities of the project studio in a way to contribute to the project education period, considering that the academic semesters are limited.

RESEARCH OBJECTIVES

In the architectural design, creativity has a very important role like in all the other design educations. The indirect link between design and creativity is established in the studio environment throughout the time in which the first ideas starts to appear. As Candy and Edmonds stresses, it is important to gain experience from past examples, to produce possible methods and strategies out of collected information, to synthesize the visual perceptions and to experience various information in this studio is important [2].

Cuff, evaluates the studio education not only as a "work place" but also as a "home" and a" work place" together, similarly to the contemporary concept of a home-office. The reason of this approach is the fact that the studio education is spread through a long period of time in the education process. Students should perceive the studio as somewhere, which they can work in enthusiastically both in and out of the class hours [3].

The objective is first to observe the physical properties of the above mentioned studio types, the studio space and the sub-compounds of it where the activity of "architectural design" takes place, and second, to cross-examine the relation between the results of communication and interaction of student-tutor depending on the physical properties of the architectural studio space. In existence of a relation, it shall be searched in which way the two studios, by which properties cause which kind of behaviors, and whether they create a discontent. The reason for a trend in spatial choices and the advantages/disadvantages shall also be compared.

RESEARCH METHOD

Within this study, in terms of the above-mentioned educational necessities and spatial properties, a survey design has been conducted among the students who use different types of physical environments. The survey instrument used in the study was a self-designed standardized questionnaire. By analyzing the effect of studio space on the design education, it was tried to reveal their preferences about the studio environment and the physical environment of the space.

In this process, the questionnaire is tested with 174 students. 71 of them were students who use single room design studio, and 103 of them were from separated design studio groups in a large classroom. Information, which can be data for the design of architectural design studios and about the experiences and desires of the students about the studios, has been gathered.

EVALUATION OF THE SURVEY DESIGN

The survey included two groups of students. These were either from a studio where one or two tutors shared the same space, or from a single large studio where up to ten studio groups are divided by separator panels.

Same questions were asked to all the students and their responses and positions were displayed in the graphics below.

It became clear that students from 3-4th semesters mostly study in "single room studios" (35% 6-7th semesters, 65% 3-4th semesters), while in "separated studios", the student ratio of 3-4th semesters to 6-7th semesters is equal (50% 3-4th semesters, 50% 6-7th semesters).

71% of the students who study in "separated studios" are pleased with their physical studio environment and 29% are not pleased, while only 38% of the students who study in "single room studios" are pleased and 62% are not pleased with their environment (figure-3,4).

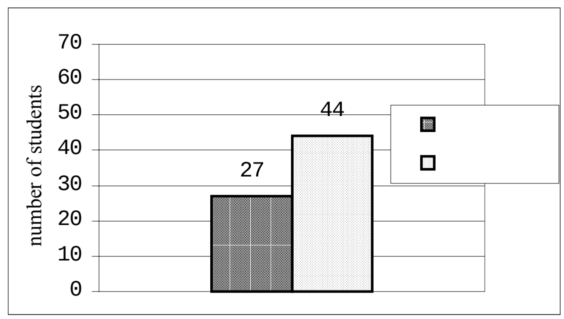

FIGURE-3 PLEASED / NOT PLEASED STUDENTS IN"SINGLE ROOM STUDIOS"

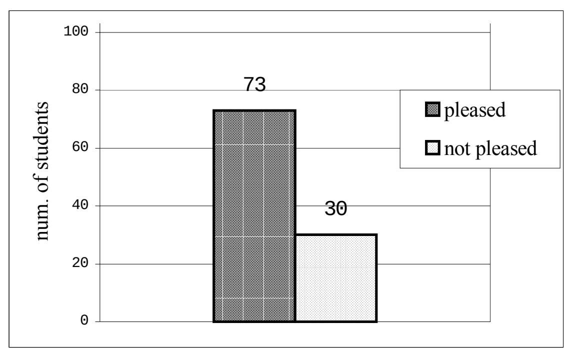

FIGURE-4 PLEASED / NOT PLEASED STUDENTS IN "SEPARATED STUDIOS"

Student Preferences on Studio Environment

When the students of "single room studio" group were asked in what type of a studio they would like to attend their courses, 27% preferred "single room studio", 30% preferred "separated studio", 33% preferred "personalized space in separated design studio", 7% preferred virtual (reality) studio and %3 answered the choice as "other".

For the students of "separated studio" group, 13% preferred "single room studio", 60% preferred "separated studio", 14% preferred "personalized space in separated design studio”, 10% preferred virtual (reality) studio, and 3% answered the choice as “other”.

Studio Environment Effects on Tutor-Student Relation

When it is questioned what affect the studio space has on the tutor-student relationship, it drew our attention that the output of the survey was the same for two groups. 47% of the students suggested that the studio space did not have any contribution to their interaction with the tutors while %29 suggested that the space was a positive factor and 24% suggested just the opposite.

The Existence of Separators in the Studio Environment

In case the separator panels between different project groups inside the large classroom were removed, %7 of the single studio’s students thought it would be positive, 66% said it would be negative, 12% suggested it would not make any difference, 12% expressed that it would confuse them and 3% told they would feel more relieved (figure-5).

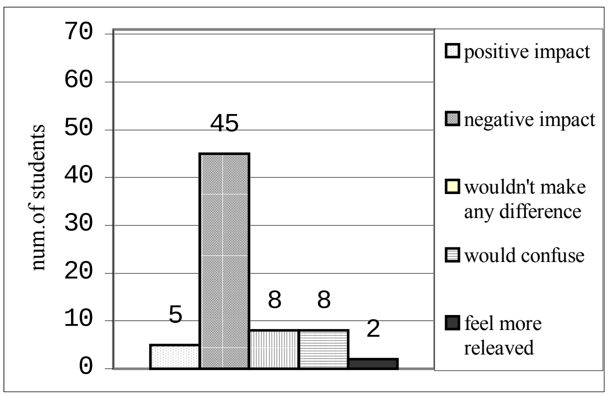

FIGURE-5 IMPACTS OF SEPARATORS ON SINGLE ROOM STUDIO STUDENTS’

On the other hand when the students of separated studio were asked the same question, 4% of the students thought it would be positive, 73% said it would be negative, 9% suggested it would not make any difference, 12% expressed that it would confuse them and 2% told they would feel more relieved (figure-6).

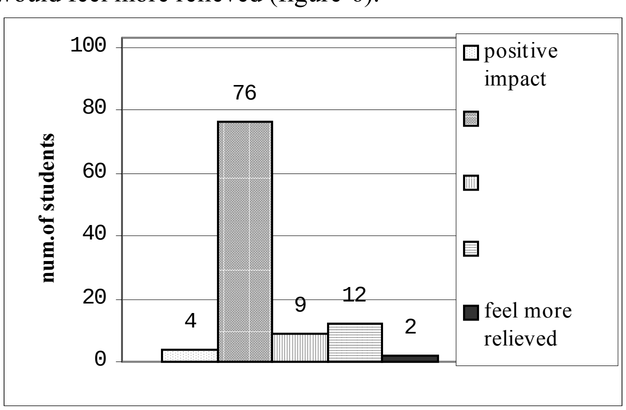

FIGURE-6 IMPACTS OF SEPARATORS ON SEPARATED STUDIO STUDENTS’

Single Room Design Studio’s Advantages and Disadvantages

According to the survey, when the students of a single room studio were asked about the advantages of single room studio, 29% of them chose sincerity, 23% chose individualization of the space, 23% chose quietness, 2% chose prevention of distraction, 2% chose benefits of separator panels and 1% chose “other”(figure-7).

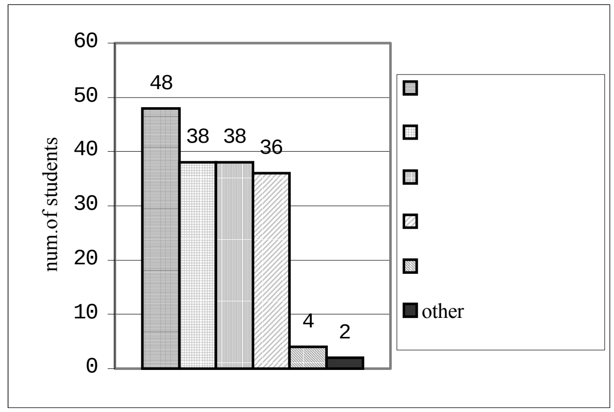

FIGURE-7 ADVANTAGES OF “SINGLE ROOM STUDIOS” ACCORDING TO STUDENTS OF “SINGLE ROOM STUDIOS “

When the students of separated studios evaluated the advantages of single room studios, 24% of them chose sincerity, 21% chose individualization of the space, 24% chose quietness, 26% chose prevention of distraction, 4.5% chose benefits of separator panels and 0.5% chose “other” (figure-8).

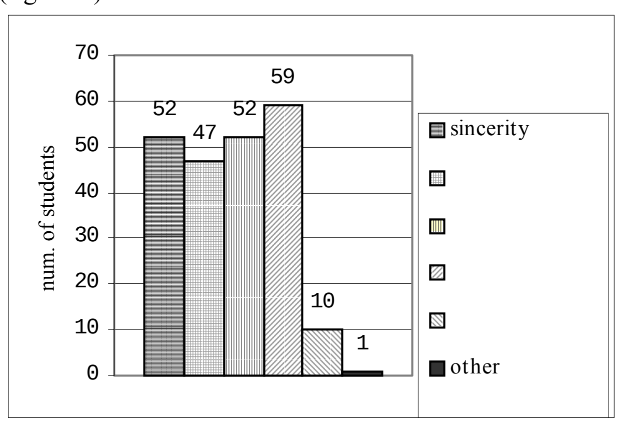

FIGURE-8 ADVANTAGES OF “SINGLE ROOM STUDIOS” ACCORDING TO STUDENTS OF “SEPARATED STUDIOS”

On the other hand, when the students of a single room studio were asked about the disadvantages of the single studio, 25% chose unawareness of other groups works, 2% chose quietness of the space, 20% chose lack of communication with friends in other groups, 21% chose inconvenience or distress due to small space, 19% chose negative effect of insufficient air, 12% chose feeling too much control of the tutor and %1 chose as “other”.

For the students of a separated studio, 23% chose unawareness of other groups works, 4% chose quietness of the space, 19% chose lack of communication with friends in other groups, 20% chose inconvenience or distress due to small space, 19% chose negative effect of insufficient air, 14% chose feeling too much control of the tutor and 1% chose as "other".

Separated Design Studio's Advantages and Disadvantages

The size of the studio space was also questioned within the survey study. Assuming that their studio type was separated studio, first the students of single room studios chose the advantages of largeness in an order. According to the results, 34% chose awareness of other groups works, 30% chose visual communication with other groups, 27% chose flexibility of space reserved for any group, 7% chose less control of the tutor and 2% chose as "other"(figure-9).

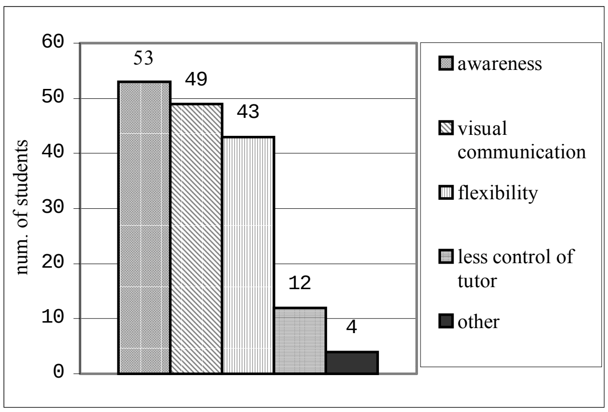

FIGURE-9 ADVANTAGES OF "SEPARATED STUDIOS" ACCORDING TO STUDENTS OF "SINGLE ROOM STUDIOS"

When the students of separated studios were asked to choose the advantages, 31% chose awareness of other groups works, 32% chose visual communication with other groups, %26 chose flexibility of space reserved for any group, 9% chose less control of the tutor and 2% chose as "other"(figure-10).

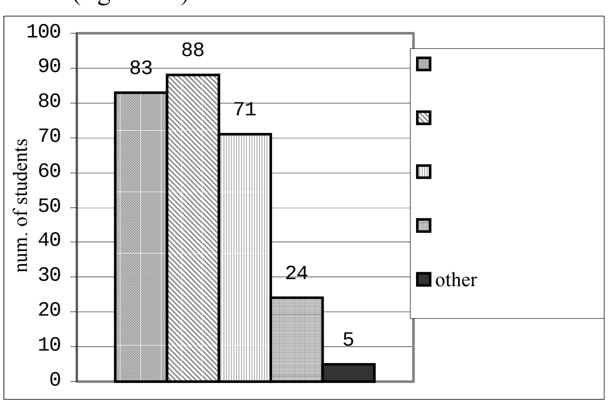

FIGURE-8 ADVANTAGES OF "SEPARATED STUDIOS" ACCORDING TO STUDENTS OF "SEPARATED STUDIOS"

When it came to thinking the disadvantages of a separated studio, 32% of the students of single room studios chose distraction of attention while 38% chose noise, 4% chose low temperature in studio, 6% chose interior breeze or wind, 19% chose distraction of tutor and %1 chose as "other"(figure-11).

For the disadvantages of separated studios, 27% of the students of separated studios chose distraction of attention, 40% chose noise, 7% chose low temperature in studio, 7% chose interior breeze or wind, 17% chose distraction of tutor and 2% chose as "other"(figeure-12).

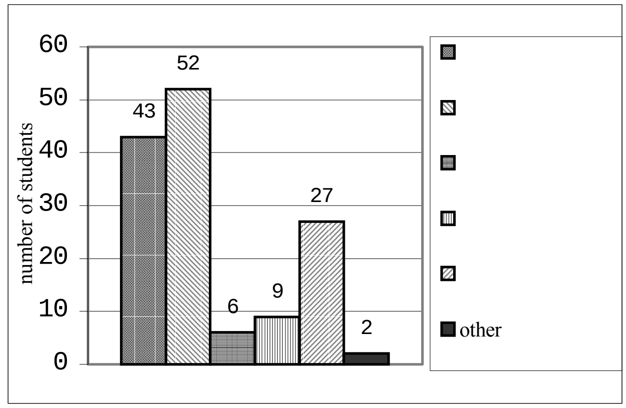

FIGURE-11 DISADVANTAGES OF "SEPARATED STUDIOS" ACCORDING TO STUDENTS OF "SINGLE ROOM STUDIOS"

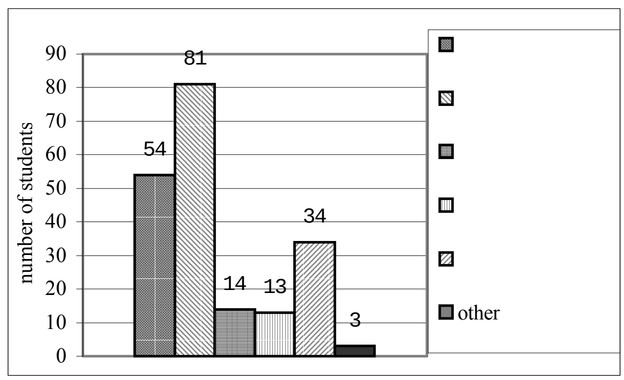

FIGURE-12 DISADVANTAGES OF "SEPARATED STUDIOS" ACCORDING TO STUDENTS OF "SEPARATED STUDIOS"

GENERAL EVALUATION

While the students of separated studios are pleased with their spaces on a high percentage, this percentage is lower for the students of single room studios.

Another general result is that, the students of separated studios mostly prefer studying in the same type of studio, but the students of single room studios desire individualized space inside a separate studio at the first place. Their second and third choices were a separated studio and their own – single room studio-, respectively.

All test subjects thought that the physical environment in their studio did not contribute to the interaction between the students and the tutors.

All test subjects agree that the separator panels are important and positive elements.

The common view of both student groups is that "a separated design studio group in a large classroom with individualized spaces" is the best for them. But it was also seen that a flexible arrangement of space inside single room design studios would enhance their satisfaction with the studio.

While the most important aspect of a design studio for the students of separated studios is "visual communication with other groups", this choice leaves its place to "awareness of other groups" in a single room studio group. As a matter of fact, the students of single room studios have grown to ignore the importance of visual communication, which they already lack. In order to increase creativity inside the studio, the students prefer a freedom of perception at their own will and timing, instead of visual and cognitive isolation.

Although the separated design studio groups in a large classroom is mostly preferred by students, this model is also blamed for poor acoustics and distraction of attention of both students and the tutors.

The preferred aspects of the single room studios are spatial sincerity, individualization, quietness and prevention of distraction. On the contrary, both group of students state that distressing or boring size of space and unawareness and lack of communication with other groups is important disadvantages.

CONCLUSION

The contribution of design studio, which is a touchstone for architectural education, is obvious. This survey, which searches effect of "single room design studio" and "separated design studio groups in a large classroom" type of studios and their spatial organization, on the student-tutor behaviors, depicts the positive and negative aspects of these spaces. The likes and dislikes of the students about a studio appears more clearly. Consequently, as the results have shown the dilemma or duality on this matter with both advantages and disadvantages, it was evaluated that both types of studios should exist in terms of variety in architectural education. As a general comment, it is natural that students who have not used the possibilities of a flexible type of studio may require other spaces, which belong to themselves or small groups.

It would not be wrong to say that the students' choice agrees with the "separated large design studio groups in a large classroom" type of studio provided that; acoustical comfort is maintained, individualization and belonging is easily created via mobile panels, it is always possible to interact with other groups depending on their choice and flexible use is supported.

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ANÁLISE DAS INTERFACES DOS SIMULADORES DIGITAIS E SUAS APLICAÇÕES

Alisson Moisés Moreira de Souza[1]*, Ana Cristina C. Lyra*[2]

Resumo *— A simulação digital mostra-se como importante ferramenta para desenvolvimentos e para aprendizagem. Trata-se de análise de diferentes interfaces homem-máquina usadas nos simuladores digitais e suas aplicações. É simulada a partida da máquina de indução. São consideradas três ambientes de simulação: o "prompt" de comandos do Mat Lab; o Simulink usando diagramas de simulação analógica; e modelos padronizados na biblioteca Power System , MatLab 6.12/Simulink*

O ambiente de "baixo nível" (prompt) exige familiaridade com modelos matemáticos, indicado ao ensino de modelagem e integração numérica, ou ao desenvolvimento de modelos inéditos, exigindo poucos recursos computacionais. A linguagem de simulação analógica permite estruturar e personalizar os modelos, o que é útil no processo pedagógico. Finalmente, o uso de modelos padronizados (Tool Box) exige pouca habilidade com modelagem, substituída pela familiaridade com a implementação de bancada, aplicando-se, geralmente, à exploração de propriedades macroscópicas dos modelos. Por outro lado, exige abundantes recursos computacionais.

Índice—Simulação digital, interfaces homem-máquina, máquina de indução, Mat Lab

INTRODUÇÃO

O uso de simuladores digitais é hoje uma realidade para os engenheiros. Seja na construção de máquinas elétricas , na indústria automobilística, nas faculdades e até na economia, a simulação digital mostra-se como importante ferramenta nos processos de desenvolvimento e de aprendizagem. Torna-se possível prever situações indesejadas, antecipar decisões, dimensionar parâmetros ou, simplesmente, explorar propriedades dos sistemas em simulação, garantindo economia de tempo e dinheiro.

Análisam-se três diferentes interfaces homem-máquina usadas nos simuladores digitais e suas aplicações na engenharia, em especial na elétrica.

A historia dos simuladores digitais quase se mistura com a historia da programação. A simulação digital apareceu dentro das grandes universidades como ferramenta aplicada ao estudo de sistemas físicos ou matemáticos, para explorar propriedades e validar teorias, geralmente em situações associadas à pesquisa ou ao desenvolvimento, que exigiam número elevado de cálculos, inviáveis até então. Com poucos, e caros, recursos computacionais, a simulação digital possuiu uma infância bem difícil, com interfaces bastante desconfortáveis ao usuário, próximas ao nível de abstração da máquina. Rapidamente, grandes laboratórios e grandes empresas vislumbraram o potencial da simulação digital para o desenvolvimento e para a pesquisa.

Com o desenvolvimento das linguagens de programação e a expansão dos recursos computacionais, a simulação digital também se desenvolveu, aumentando a proximidade com o usuário e o grau de especialização.

Hoje, com o mercado de software consolidado, existem inúmeros simuladores digitais voltados a cada área especifica, em diferentes níveis de proximidade com o usuário e de acordo com cada aplicação.

METODOLOGIA

A metodologia adotada foi a simulação do modelo matemático da máquina elétrica de indução trifásica em diferentes interfaces de simulação em três níveis de proximidade com o usuário, usando, para isto, o software MatLab 6.12 e seus pacotes.

A primeira interface, ou linguagem, de baixo nível de proximidade com o usuário, refere-se ao "prompt de comandos" do MatLab 6.12. A segunda interface refere-se a diagramas de simulação analógica usando o pacote *Simulink,* também no MatLab 6.12, em ambiente gráfico.

A última interface análiseada, de alto nível de proximidade com o usuário, refere-se ao ToolBox

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da biblioteca Power System, também no *Simulink*, MatLab 6.12, onde a modelagem é implementada em ambiente gráfico com modelos padronizados ou pré-formatados.

MODELAMENTO MATEMÁTICO

O modelo matemático utilizado é o modelo da máquina de indução trifásica alimentada via estator, escrito na referência síncrona através de eixos ortogonais conhecidos por dq. As simulações consideram uma máquina de indução de 3hp.

O conjunto de equações diferenciais que sintetiza o modelo é listado a seguir. As equações de (1) a (4) são as equações elétricas de estator e rotor, compostas pelas parcelas ôhmicas e indutivas nos enrolamentos.

A equação (5) representa o acoplamento entre as correntes e os fluxos magnéticos da máquina de indução. Finalmente, as equações (6) e (7) representam o torque eletromagnético gerado, juntamente com acoplamento mecânico do momento de inércia e a carga mecânica aplicadas ao eixo.

Embora haja sete equações, matematicamente, tem-se um sistema diferencial não-linear de 5ª ordem: duas equações de estator, duas equações de rotor e uma equação mecânica.

$$estator\begin{cases} v_{qs} = \frac{1}{\omega_b}\cdot\frac{d\varphi_{qs}}{dt} + \frac{\omega}{\omega_b}\cdot\varphi_{ds} + r_s\cdot i_{qs} & (1)\\ v_{ds} = \frac{1}{\omega_b}\cdot\frac{d\varphi_{ds}}{dt} - \frac{\omega}{\omega_b}\cdot\varphi_{qs} + r_s\cdot i_{ds} & (2)\end{cases}$$

$$rotor\begin{cases} v'_{qr} = \frac{1}{\omega_b}\cdot\frac{d\varphi'_{qr}}{dt} + \frac{(\omega-\omega_r)}{\omega_b}\cdot\varphi'_{dr} + r'_r\cdot i'_{qr} & (3)\\ v'_{dr} = \frac{1}{\omega_b}\cdot\frac{d\varphi'_{dr}}{dt} - \frac{(\omega-\omega_r)}{\omega_b}\cdot\varphi'_{qr} + r'_r\cdot i'_{dr} & (4)\end{cases}$$

Matrizfluxo-corrente

$$\begin{bmatrix} i_{qs}\\ i_{ds}\\ i'_{qr}\\ i'_{dr}\end{bmatrix} = \begin{bmatrix} a & 0 & b & 0\\ 0 & a & 0 & b\\ b & 0 & a & 0\\ 0 & b & 0 & a\end{bmatrix}\cdot\begin{bmatrix}\varphi_{qs}\\ \varphi_{ds}\\ \varphi'_{qr}\\ \varphi'_{dr}\end{bmatrix} \qquad (5)$$

$$\begin{cases} \textit{Equação}\text{ do Torque Eletromagnético}\\ \tau_{ele} = \frac{3}{2}\cdot\frac{X_m}{\omega_b}\cdot\left(i_{qs}\cdot i'_{dr} - i_{ds}\cdot i'_{qr}\right) & (6)\\ \textit{Equação}\text{ mecânica}\\ \frac{d\omega_r}{dt} = \frac{1}{J}\left(\tau_{ele} - T_c\right) & (7)\end{cases}$$

LEGENDA DAS VARIÁVEIS DAS EQUAÇÕES

v_{qs}	tensão do eixo q do estator;
v_{ds}	tensão do eixo d do estator;
v'_{qr}	tensão eixo q de rotor refletida no estator;
v'_{dr}	tensão eixo d de rotor refletida no estator;
r_{qs}	resistência do eixo q do estator;
r_{ds}	resistência do eixo d do estator;
r'_{qr}	resistência eixo q de rotor refletida no estator;
r'_{dr}	resistência eixo d de rotor refletida no estator;
i'_{qr}	corrente eixo q rotor refletida no estator;
i'_{dr}	corrente eixo d rotor refletida no estator;
i_{qs}	corrente do eixo q do estator;
i_{ds}	corrente do eixo d do estator;
Ψ_{qs}	fluxo por segundo do eixo q do estator;
Ψ_{ds}	fluxo por segundo do eixo d do estator;
Ψ'_{qr}	fluxo por segundo do eixo q do rotor refletido no estator;
Ψ'_{dr}	fluxo por segundo do eixo d do rotor refletido no estator;
ϖ_b	freqüência base da rede de alimentação do estator;
ϖ	freqüência da referência genérica utilizada no modelo, no caso a freqüência síncrona;
ϖ_r	freqüência mecânica do rotor;
J	momento de inércia do eixo do rotor;
T_c	torque de carga.
X_m	reatância mútua entre estator e rotor;

$$b = \frac{X_m^{\ 3} - X_{lm}^{\ 2}\cdot X_m}{X_{lm}^{\ 4} - 2\cdot X_{lm}^{\ 2}\cdot X_m + X_m^{\ 4}}$$

$$a = \frac{X_{lm}^{\ 3} - X_{lm}\cdot X_m^{\ 2}}{X_{lm}^{\ 4} - 2\cdot X_{lm}^{\ 2}\cdot X_m + X_m^{\ 4}}$$

O modelo matemático é aplicado às diferentes interfaces de simulação. A variável de saída análiseada é a velocidade durante a partida.

INTERFACE DE BAIXO NÍVEL: "PROMPT" DE COMANDOS DO MATLAB 6.12

Nesta interface, a programação do modelo é feita reescrevendo as equações diferenciais em forma de equações de estado, para permitir a utilização de métodos numéricos de integração. O método numérico de integração utilizado é o método de Euler Modificado.

A linguagem de programação é composta de uma seqüência de comandos estruturados no "prompt" do MatLab 6.12. Trata-se de linguagem semelhante à linguagem C, permitindo estruturas de programação do tipo *for , if, while*, entre outras.

Em primeiro lugar definem-se os parâmetros da máquina elétrica: resistências, indutâncias, momento de inércia, carga nominal, freqüência base, etc. A seguir, inicializam-se as variáveis do programa, como as correntes, a velocidade, torque, fluxos magnéticos, tempo e outras variáveis auxiliares.

Então, entra-se no loop das iterações, uma estrutura do tipo *for*, começando com t=0 até o tempo final de simulação, onde o sistema diferencial é resolvido passo a passo.

Dentro do *for*, calcula-se cada derivada das variáveis de estado, no caso, os fluxos magnéticos e a velocidade. Então, integra-se cada variável de estado, usando uma aproximação linear (Euler Modificado). A seguir calculam-se as correntes e, a partir destas, o torque. Finalmente, consegue-se a velocidade. Isto é feito para cada incremento da variável tempo, cujo passo é 1ms. A cada passo, a velocidade e outras variáveis de interesse (torque, tensões e correntes) são armazenadas em estruturas do tipo vetor de dados, conhecidas como *Array*.

Segue, abaixo, o conjunto de comandos responsável pela simulação do modelo, nesta interface.

INTERFACE DE BAXIO NÍVEL DE PROXIMIDADE COM O USUÁRIO

```
%%Interface de baixo nível de proximidade com o usuário
clear all
%%Parametros-simulação
passo=0.001;
tfinal=5;
wref=377;
%%Parametros-máquina
wb=377;
rs=0.435;
rr=0.816;
xm=26.13;
xls=0.754;
xlm=xm+xls;
J=0.089;
a=((xlm^3-xlm*xm^2)/(xlm^4-2*(xlm*xm)^2 +xm^4))
b=((-xm*xlm^2+xm^3)/(xlm^4-2*(xlm*xm)^2 +xm^4))
vsmax=1.22*220;
vrotor=1.22*0;
tc=11.9;
%%INICIALIZACAO
fiqs=0;
fids=0;
fidr=0;
fiqr=0;
ids=0;
iqs=0;
idr=0;
iqr=0;
wr=0;
triangular=0;
%% Loop
for t=0:passo:tfinal;
%%Define vds, vqs,vdr,vqr e tcarga;
vds=vsmax*cos((wb-wref)*t);
vqs=vsmax*sin((wb-wref)*t);
%
vdr=0;
vqr=0;

if t<3
   tcarga=0;
elseif t>4
   tcarga=2*tc;
else t>1
   tcarga=tc;
end;
%
%%DERIVADAS
dfiqs_dt=vqs*wb-wref*fidse-rs*iqse*wb;
dfids_dt=vds*wb+wref*fiqse-rs*idse*wb;
dfiqr_dt=vqr*wb-(wref-wre)*fidre-rr*iqre*wb;
dfidr_dt=vdr*wb+(wref-wre)*fiqre-rr*idre*wb;
%%FLUXOS
fiqs=fiqs+(dfiqs_dte+dfiqs_dt)/2*passo;
fids=fids+(dfids_dte+dfids_dt)/2*passo;
fiqr=fiqr+(dfiqr_dte+dfiqr_dt)/2*passo;
fidr=fidr+(dfidr_dte+dfidr_dt)/2*passo;
%%CORRENTES e TORQUE ELETROMANETICO
iqs=a*fiqs+b*fiqr;
ids=a*fids+b*fidr;
iqr=b*fiqs+a*fiqr;
idr=b*fids+a*fidr;
tele=3/2*xm/wb*(iqs*idr-ids*iqr)-tcarga;
dwr_dt=1/J*(tele);
wr=wr+(dwr_dte+dwr_dt)/2*passo;
%
plot(tempo,velo)

velo(t/passo+1)=wr;
tempo(t/passo+1)=t;
tele_(t/passo+1)=tele;
ids_(t/passo+1)=ids;
iqs_(t/passo+1)=iqs;
is_(t/passo+1)=sqrt(ids^2+iqs^2);
triangular_(t/passo+1)=triangular;
vdr_(t/passo+1)=vdr;
vqr_(t/passo+1)=vqr;
end;
```

INTERFACE : DIAGRAMAS DE SIMULAÇÃO ANALÓGICA (MATLAB 6.12/SIMULINK)

Este tipo de interface foi muito consagrado entre as aplicações de controle de sistemas, dada sua proximidade com a implementação dos sistemas de controle através de elementos analógicos e sua capacidade de sintetizar propriedades do sistema de maneira visual.

Nesta interface também é preciso reescrever as equações diferenciais na forma de equações de estado. A seguir iniciou-se a construção dos diagramas de simulação analógica a partir dos elementos do pacote Matlab 6.12/Simulink. São utilizados blocos que representam as operações matemáticas das equações de forma visual. Nestes diagramas, pode-se representar operações lineares como soma, ganho, integração, diferenciação; operações não-lineares como o produto entre duas variáveis de estado; ou mesmo os termos não-homogênenos das equações como fontes e o torque de carga, através de entradas senoidais ou degraus no domínio do tempo.

Cada equação de estado é montada e transformada em um bloco fechado, formando um sub-diagrama. Existem quatro blocos, um para as equações de estator, um para as equações de rotor, um para a equação mecânica e um para matriz corrente-fluxo.Pode-se visualizar a seguir o bloco da equação mecânica.

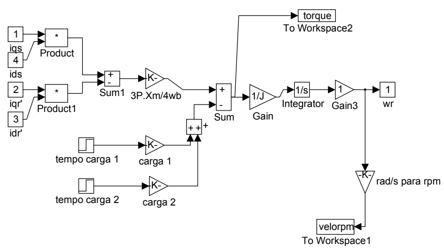

FIGURA.1
EQUAÇÃO MECÂNICA

Então, cria-se um modelo de simulação estruturado e sintetizado através do agrupamento destes sub-diagramas, formando o diagrama de simulação principal, o produto final.

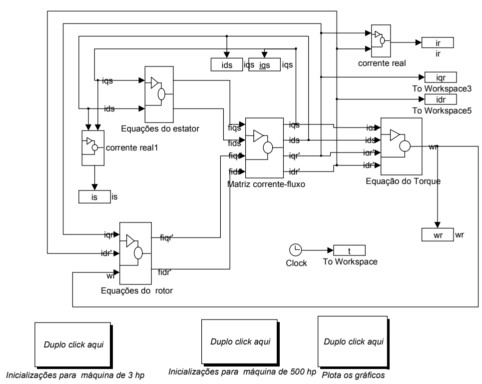

FIGURA.2
DIAGRAMA DE SIMULAÇÃO PRINCIPAL

INTERFACE DE ALTO NÍVEL : BLOCOS PRÉ-FORMATADOS (BIBLIOTECA POWER SYSTEM, MATLAB 6.12/SIMULINK)

Este tipo de interface, de alto nível de proximidade com o usuario, torna o processamento praticamente transparente e, portanto, não é preciso reescrever as equações. Na verdade, neste caso, não é preciso nem mesmo conhecê-las, já que o modelo da máquina de indução é padronizado pelo software.A construção do modelo é iniciada utilizando os elementos oferecidos pela biblioteca Power System do Simulink. Os blocos utilizados são os elementos que seriam utilizados para implementação pratica em um laboratório: a máquina de indução, uma fonte trifásica, a carga mecânica e, finalmente, o osciloscópio.

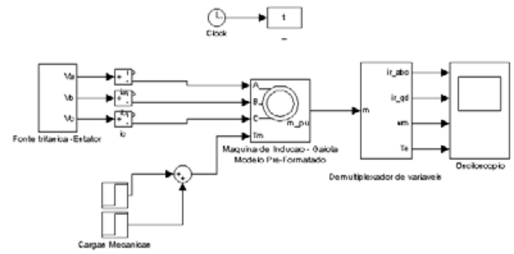

FIGURA.3
DIAGRAMA DE SIMULAÇÃO DE ALTO NÍVEL

RESULTADOS

A seguir, o modelo da máquina de indução trifásica é simulado a partir das três interfaces, fornecendo, como variável de análisee, a velocidade. É simulada a partida da máquina nas seguintes condições: a máquina, de 3hp, é partida em vazio, nas condições de tensão e freqüência nominais até que a velocidade de regime seja atingida. Então, é adicionada ao eixo carga mecânica de valor nominal, aguardando a nova velocidade de regime. Finalmente, adiciona-se uma segunda carga mecânica, também de valor nominal. Como havia de se esperar, todos os modelos forneceram os mesmos resultados de saida.

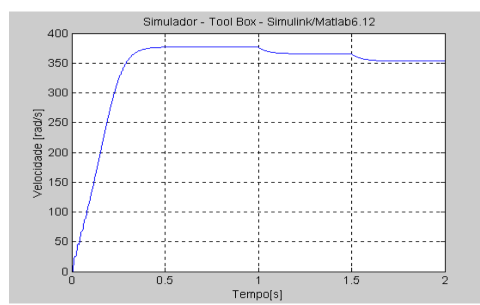

FIGURA.4
SIMULAÇÃO 1 – ALTO NÍVEL

FIGURA.5
SIMULAÇÃO 2 – DIAGRAMA SIM.ANALÓGICA

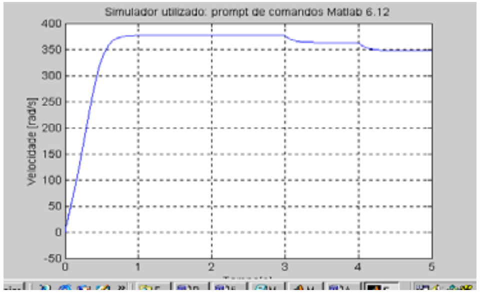

FIGURA.6
SIMULAÇÃO 3 - BAIXO NÍVEL

CONCLUSÕES

Conclui-se que o ambiente de "baixo nível" (prompt do MatLab) exige familiaridade com os modelos matemáticos, sendo indicado ao ensino de modelagem matemática e métodos numéricos de integração. Aplica-se, ainda, à pesquisa de modelos inéditos, onde a padronização não é bem vinda.

A linguagem de simulação analógica exige também habilidades com os modelos matemáticos, permitindo personalizá-los e estruturá-los, o que é útil no processo pedagógico.

Já o uso de simuladores de alto nível de proximidade com o usuário (no caso, Tool Box, MatLab 6.12/Simulink) exige pouca habilidade com modelagem, que deve ser substituída pela familiaridade com a implementação de bancada e aplica-se, geralmente, à pesquisa com elementos clássicos, disponíveis no programa.

Aplica-se também à exploração de propriedades macroscópicas dos modelos. Por outro lado, exige abundantes recursos computacionais e permite pouco domínio do processamento dos modelos em sim4ulação.

Nota-se grande tendência ao uso de simuladores de alto nível, especialmente em aplicações comerciais e nos processos produtivos, onde a padronização e o tempo de desenvolvimento são fatores cruciais. Por outro lado, a padronização aplicada à modelagem pode prejudicar o processo criativo aplicado ao desenvolvimento cientifico, na medida em que não permite mudanças matemáticas estruturais, presentes nos simuladores digitais de baixo nível.

Deste modo, o uso de simuladores digitais no processo pedagógico deve ponderar o nível de proximidade com o usuário aplicado ao modelamento a fim de permitir uma formação ampla, preparando fundamentos necessários aos futuros cientistas, importantes para o desenvolvimento cientifico e, ao mesmo tempo, profissionais que serão absorvidos pelo mercado produtivo.

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TABELA 1
SÍNTESE DAS ANÁLISES

Nível de proximidade com o usuário	Baixo nível	Médio nível	Alto nível
Interface	Prompt de comandos	Diagramas de Simulação analógica	Modelos pré-formatados
Linguagem	Próximo à linguagem C	Simulação Analógica (visual)	Blocos prontos (visual)
Modelos Matemáticos	Equações de estado	Blocos e sub-blocos estruturados	Modelos invisíveis ao usuário
Hardware suporte	Pouca capacidade de processamento Plataforma usada: 486 – 66Mhz	Capacidade razoável: Plataforma usada: Pentium 233 Mhz	Grande capacidade de processamento: Plataforma usada: Duron 1100 Mhz
Construção do Modelo	Demorada; trabalhosa; Permite domínio do processamento interno;	Permite estruturação dos blocos; Pouco domínio do processamento interno;	Fácil; Prática; Pouco domínio do processamento interno;
Familiaridades exigidas	Modelagem; programação;	Simulação Analógica;	Implementação de bancada;
Interpretação dos resultados	Depende da implementação;	Depende da implementação;	Padronizada;
Finalidade Principal	Estudos teóricos de modelagem, métodos de integração; Pesquisa com modelos inéditos;	Ensino; Pesquisa;	Estudo de propriedades macroscópicas dos modelos; Exploração de modelos já bem consolidados na literatura; Laboratórios virtuais; Ensino à distancia;

THE PRINCIPLES OF DOCTRINE FORMATION OF ENGENEERING EDUCATION IN RUSSIA

Yuri Pokholkov[1], Boris Agranovich[2]

***Abstract**: In the report the systems analysis of the causes is conducted and the objective necessity of radical changes in higher engineering education is shown, the main principles for elaboration of national doctrine of engineering education are formed.*
The principles examined in the report include the following groups:
***general-system** principles of formation of the doctrine of engineering education;*
***the principles of formation** of the requirements to engineering activity of the future;*
***principles** of formation of the contents of engineering education; principles of transition on new educational technologies in engineers training;*
***support principles** of quality of engineering education on the socially important level.*
In the report the mentioned above principles are in detail parsed and the concrete examples of their implementation in engineering high schools of Russia are given.

Introduction: Russian Association of Engineering Education (RAEE) and Russian leading technical universities design the principles of formation of the national doctrine of engineering education.

RAEE represents the all-Russian public affiliation of the teachers, engineers and specialists of engineering higher educational establishments, research entities, firms, industry, technical exhibitions, and other organizations interested in development and perfecting of engineering education. For implementation of mission, achievement of object in views and the solution of authorized problems the Association has the departments in 57 regions of Russia and is one of the leading public formations determining the policy of engineering education, ensuring cooperation, with the domestic and foreign partners, state and public organizations.

The contents of the national doctrine of engineering education is determined by a number of the steady tendencies in the world development, change of the social and economic basis of the country, as well as by establishment of new educational values.

To major factors of the world development essentially influencing technical-engineering education, one should attribute the formed imperative "of «survival rate" of mankind and transition to « the model of steady development » of a civilization, globalization of economics and its transition on a technological way of development with the dominance of science and education intensive technologies, and also formation on this basis of a new way of life whose economics and society are based on knowledge. The scale of the mentioned above current economical and social changes in the world demands absolutely new approaches to education and specialist training. The national doctrine of engineering education in these conditions should imply formation in a country of distributed multicultural scientific - educational medium on the international level; openness of the students towards realities of the interdependent world; creation of labor force, competitive at a global level; dilating of understanding of own and other cultures, religions, political systems; development of students' global vision of the world, and also skills indispensable for formation of grounded and weighting judgments on the problems of the contemporary world.

The change of social and economic basis and admission (acknowledgement) of Russia as a country with market economy, realization of [1]necessity of transition to antropoeconomics have generated in Russia and the former union republics complex political, social and economic, social and cultural processes, connected with structural rearrangement of production, development of regional economicses and providing them with specialists for the vital areas of industry, social life, science, culture and education. The economical growth that has begun in Russia and integration of national economy into global economical processes has resulted in formation of the market of intellectual labor and intellectual production. Intellectual labor and production competition in the regional, national and global market faces engineering education with the number of specific problems concerning both satisfaction of the market demand for the specialists in the field of science and engineering, and establishment and development of university of corresponding scientific - educational medium. The strategy of university development should be in this respect directed at training of competitive specialists who are socially protected by the quality and professional opportunities of their education, and also completely personally prepared to work in permanently changeable conditions, which is the essential characteristic of the XXI century.

The new educational paradigm as the basic mechanism of maintenance "of «survival rate" of mankind and steady development of a civilization should be strategically oriented at development of personal features and faces us with the necessity of person-oriented

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professional education whereby personal aspects of professional activity are deliberately pointed out as meaningful and essential for engineer's work and engineering as a whole; demands strengthening of links between education and culture, drastic increase of the specialists' creative potential , strengthening of fundamental specialist training, determines priority development of the university type of the higher technical education, which fully meets the new tasks of civilization development and personal features formation.

Analytical study conducted by the experts of the above reviewed conditions and factors essentially influencing engineering education, and also public expertise of strategies and development directions of engineering education allow forming the main principles of the national doctrine.

General-system principles of formation of the doctrine of engineering education

The doctrine of Russian engineering education represents the system strategic solution determining the purposes and values, policies and main directions of rearrangement and further development of Russian engineering education in response to social,economic, technological and other challenges of the XXI century. The doctrine should provide the basis for elaboration of the contents of engineering education, selection of new educational technologies, permanent support on socially important level of quality of engineering education, maintenance of measures of social and state security of the country and competitiveness in the global market, and a number of other factors. The analysis of the factors determining development of engineering education, demonstrates, that the doctrine elaboration should base on:

analysis of cardinal reformist shifts in the technological and social and economic sphere on the threshold of XXI century (steady development, imperative "of «survival rate" of mankind, antropoeconomics, technological development, formation of educational society,development of complex multidisciplinary sciences, informatisation and mediatisation of all spheres of activity, cross-cultural activity, etc).

prognosis of substantial and structural changes in production, science and culture of the country and educational demands of the population;

research of the processes of transition from raw economy to intellectual, the formation of multistructural economy of the country, the development of regional economies and the problems of globalization of economy;

the systematic conception of the goals and values of the engineering activities of the future;

taking into account the **changes** in the meaningful content and new philosophy of the professional education;

analysis of the condition and dynamics of the market of engineering labor and intellectual products on the regional, interregional, national and international levels.

Taking into account the role of the personal organization of the professional engineer in forming the engineer's mind, in his personal way of entering the engineering culture, his desire for self-improvement and development of his professional skills.

It is vital that the doctrine of engineering education should show the realization of the ideas, written in the National Doctrine of education of the Russian Federation, which aim is to make education the means of public development and of forming the contemporary type of economical relations and State organization.

The fact that in the conditions of awareness of the need to make scientific and intellectual technologies of first priority the engineers are becoming the main figures in the social and economical sphere of society, is of great importance for the formation of the doctrine of engineering education. This puts special responsibility for the definition of the existing and coming problematic situations in engineering education, for the complete formation of the problem-oriented purposes of the doctrine, for the efficiency and quality of the proposed ways of development and for the content of the measures, aimed to implement these goals. It is known that inaccurate or mistaken determination of the problematic situations on the first stages of the social project may lead towards the number of measures, which will not provide the solving of the real problems and which may be fraught with serious consequences in the future.

The content of the doctrine is formed taking into account the fact that education refers to the sphere of national strategical interests of Russia.

The principles of forming of the requirements to the engineering activity

The above-mentioned general principles of the forming of the national doctrine of the engineering education determine the system (planning sphere), which pose the strong requirements towards the end products of the engineering activity. The end product of the engineering activity is represented by the complex of the engineering-technical, engineering-economic, administrative, ecological, etc. project decisions on creating the artificial environments, correspondent to the requirements of the system of planning. The determination of the content of end products of engineering activity and system of planning allow to form the global net of engineering activity and to decompose it into the system of sub-goals, using the well-developed heuristic procedures and models.

The forming of such systematic description of the engineering activity is provided by the experts, using the methods of systematic projecting, the advanced procedures of working with experts and information processing.

Further decomposition of the main goals according to the requirements of the planning system, structure of the engineering activity, and the work of the experts on assessment of futility, completeness, the importance of determined purposes and values, functions of engineering activities, their ranking and aggregation should allow to form a normative variant of goals, functions and structures of engineering activities in the future, which will form a basis of engineer's training.

Usually such structures contain several thousands of elements that are why generation, storage, actualization, and navigation along such a structure, together with the analysis and forming of the project decisions require the use of special informational and program provision.

We assume that this system of requirements, described as a tree of goals of engineering activities, should be transformed into the requirements for the level of efficiency of those, who have finished the program of education of the specialty, and should be included into the Russian state educational standard.

The principles of forming the content of engineering education

The analysis of the requirements towards the engineering activities of the future, presented in the form "Tree of Goals", allows developing the principles of forming the content of engineering education.

The content of engineering education should include the fallowing fractally organized combination [1,2]:

training, which provides mastering of the humanitarian and social-economical, mathematical and natural science, general and vocational knowledge of the required level;

education, which provides, together with training, the forming of methodological culture of the graduate, mastering of the methods and ways of cognitive and professional, communicative and axiological activities on the required level;

habilitation, which provides, together with training and education, the complex preparation of the graduate for the professional activity, and also his professional self-actualization.

For the graduate to become a real professional engineer he needs to leave the educational environment for the real life. Knowledge and methods of his activity should be united into the system, where certain key values serve as the systematizing factor.

The peculiarity of the system of knowledge of engineers training is based on the knowledge of natural-science, mathematics and world outlook, on the breadth of interdisciplinary systematically integrated knowledge of nature, society, thinking, and the high level of general and special vocational knowledge, that provide the ability to act in the problematic situations and solve the problem of training of the specialists with high creative potential.

The bases of engineering education should contain not only the subjects, but also the ways of thinking and acting, in other words the reflective procedures. Knowledge and methods of learning and acting should be joined into the one unity. All these factors arouse the need to include the questions of forming the methodological culture, together with the methods of cognitive, professional, communicative and axiological activity into the requirements for the content and level of engineers training.

The distinguishing feature of the engineering education should involve a high level of methodological culture and a superb creative possession of cognition and activity.

The specialists' training experience shows the success of the engineers' activity which is mostly determined not only by the high level of knowledge and fruitful possession of methods of cognition and activity but also by the integrated preparation for professional work. Not only the preparation for professional activity in normal life conditions and exquisite manufacturing should be taken into account but also ordeals, change of lifestyle, repeated change of one's ideas, viewpoints and philosophy of life may play a vital role. Thus, successful professional activity implies not only a high level of teaching and education but also a mental, psychological and physical culture of a man. An institute of higher education in this respect should become not only the scientific and the educational center, but also the center for one's habilitation, one's professional formation and self-actualization.

Planning the concept of education and the demands for engineering training level, it is crucial to find space for the system of knowledge and methods designed to solve the issues of self-cognition and self-actualization of an individual.

It is very important that the engineering education should be more humanitarian, fundamental and professional.

The meaningful feature of engineering education humanitarization is the provision of harmonious unity of natural-scientific and humanitarian culture of cognition and activity, the unity based on mutual understanding and dialogue.

The most important task of the engineering education system in this respect implies creating the conditions of the revival of a united natural-scientific and humanitarian culture of cognition and activity.

The educational concept could become more fundamental by means of broadening and deepening of specialist's interdisciplinary knowledge oriented towards problematic situations being solved in scientific, designing and business activity; increase of the level of methodological integrity of cognitive, professional, and communicative activity; provision of natural-scientific and humanitarian knowledge and transition to complex criteria of productivity, effectiveness and quality of activity; ability for widening the scientific bases of social and professional activity at the expense of its methods, generalization and various designing types.

The important components of educational concept in this respect should become learning material and educational technologies, which create the conditions to form innovative mentality: multicriterial problem setting and solving, original thinking, stable skills of informational culture possession etc.

The inevitable element of the concept implies special training on technology transfer, including digestion of knowledge and formation of methods of systems engineering and programming of growth and development, strategic management and business activity marketing, formation of scientific base of technology transfer, mastering the methods of cross-cultural communication.

It is necessary to include the system of knowledge on forming the methods of innovative business activity in the sphere of technique and technology.

The determined methods of reorganization of educational concept should provide the basis for creation and development of innovative education in Russian high school, which presents one of the most important tasks of the doctrine.

Educational professionalization is directed at training the new type of scientific-technical professional specialist, who possesses global thinking, encyclopedic knowledge, and refined mind, able to work creatively at all stages of life circle beginning from research and constructing up to technology development and business activity.

Professionalization in the real educational practice is achieved by the mastering of engineering and engineering culture and practical training (system methodology, conceptual designing and programming of development).

One of the main sides of engineering education should become practical knowledge of foreign languages as the means of cross-cultural communication.

On the threshold of the third millennium creation of the high level of informational culture seems to be an important demand of engineering productivity provision.

Informational intellectual technologies, accumulated informational resources in the form of databases and knowledge, informational logical models, huge computational capability and means of global telecommunications create the basis for the denial from functional division of labor in scientific technical activity and for the first time in the history of mankind provide opportunities for creation of the complex systems in the creative laboratory of a certain person.

The principle of transition to the new educational technologies

The development and creation of alternative technological, social and pedagogical decisions, the usage of ideas and new high technologies providing multiple increase of effectiveness of pedagogical work, the creation mass “production of talents”, the usage of open education are of great importance for the implementation of the engineering education doctrine.

The fact that the system of engineering education becomes the sphere of mastering the methods of cognitive and engineering activity, communicative and engineering culture, cardinally changes the idea of the institute with its teaching and educational process. The most important guideline of the engineering education development in this respect is the special organization of a student’s work during the whole period of studying at the institute in complex multidisciplinary practically oriented groups, the creation of the purposeful forms of education with students actively involving themselves in creative work and participating in research projects. All this should create the premises for step-by-step transition in the engineering education from teaching and educational (memory training) process to the scientific and educational one. The scientific and educational process can be presented as a system of creative workshops of famous scientists, leading engineers, where permanently renewing community of students searching for bachelor’s, master's and engineering degrees forms a creative group, a scientific school where succession is fulfilled in the methodology of cognitive activity, development of the idea of world and the place of a human in it, of the ideals, values, and aims of scientific and engineering work; where traditions of the art of research and engineering activity are reinforced and transferred with the help of the very research process.

Modern educational technologies in the system of engineering education naturally include wide academic mobility.

Nowadays the just criticism is leveled against self-sufficiency of an institute of higher education in any country to train a professional engineer competitive on the world market of intellectual activity. The necessity of broadening the academic mobility of students for the increase of training quality is obvious.

The export of educational service to the foreign countries on the basis of the integrated internal and extra-mural teaching using the technologies of distant learning will contribute to the development of Russian engineering education.

As our practice shows that the professional educational programs of scientific and technical specialists training are in popular demand and meet the international requirements.

The support of the engineering education quality on the socially significant level

It is of vital importance to elaborate in the doctrine the integrated system of engineering education quality support on the socially significant level. The system must contain the following elements:

- a new generation of **state** educational standards and educational standards of university level based on them;
- the **system** of social and state attestation of educational institutions in the area of engineering;
- the **system** and technology of professional educational programs accreditation;
- the **system** of certification of engineering specialists and granting the engineering certificates of various levels;
- the **system** of social and economic stimuli of the professional growth and the increase of the social status of an engineer;
- the **system** of the permanent raising the level of one's skill and post-university engineering training.

Conclusion

In conclusion I would like to point out the necessity of development of engineering education national doctrine as a document entirely reflecting the viewpoints of scientific and technical community, person and state on the future of engineering education in Russia.

The national doctrine of engineering education must be laid as a basis for the Russian Federal program for the development of professional education; legislative acts and governmental decrees should be adjusted with its regulations; professional engineering ethics should be formed in accordance with it.

The national doctrine of engineering education will become a useful and necessary document only in case the mechanisms are created and its permanent conducting, actualization and development in compliance with the changing conditions; factors and new requirements to the engineering activity are provided.

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AN INTERACTIVE ENVIRONMENT FOR FUZZY AND SUPERVISORY FUZZY CONTROLLERS DESIGN FOR INDUSTRIAL PROCESS CONTROL

Francisco José Gomes[1], Clayton Guimarães da Mata[2]

Abstract *— The work is related with a graphic environment for designing and tuning of feedback control systems loops, utilizing PID controllers, PID -like - Fuzzy Controllers and Fuzzy Supervisory Gain Scheduling PID controllers. The environment, totally based on GUI techniques, deals with the more common models of systems utilized in control daily practice. The user may select the desired controller structure and, in a interactive process, to follow a step-by-step procedure for getting the desired final configuration. To facilitate the fuzzy controller design, the environment allows, through "click and drag" techniques, the implementation and tuning of the membership functions in the fuzzyfication and defuzzyfication stages. The environment also incorporates a supervisory fuzzy configuration that adapts the PID parameters, according to the information given by the user. The work is directed to the students in a formal graduate course, as well for operators in a technical training in the control and automation area.*

PALAVRAS CHAVE - . Estrutura de controle nebulosa, controlador nebuloso, supervisório nebuloso, PID adaptativo

INTRODUÇÃO

Atualmente, o computador exerce função essencial na área de ensino de engenharia. Esta exigência, justificada pelo avanço tecnológico, leva a uma busca constante por métodos de dinâmicos ensino correlacionados com o aprendizado auxiliado pelo computador. Este artigo apresenta uma ferramenta computacional útil para estudantes e profissional em treinamento na área de controle e automação de processos, com enfoque nos controladores nebulosos.

Os controladores mais difundidos e largamente utilizados na prática industrial são os com estrutura de três modos, Proporcional + Integral + Derivativo [1], mais comumente referidos como controlador PID, devido à sua estrutura simples e desempenho robusto. Sua configuração e sintonia requer o ajuste de três parâmetros: constante do ganho proporcional, constante de tempo integral e constante do ganho derivativo. Ultimamente, grandes esforços têm sido empregados no desenvolvimento de técnicas e procedimentos para sintonia destes parâmetros visando à otimização das dinâmicas em malha fechada de estruturas contendo estes controladores.

Os controladores PID, grosso modo, podem ser divididos em duas classes principais. Na primeira categoria, seus parâmetros de sintonia permanecem fixos, uma vez que tenham sido sintonizados em algum ponto, considerado ótimo segundo algum critério particular adotado. Existem vários métodos para esta sintonia, sendo o mais tradicional e difundido o procedimento de Ziegler-Nichols [2]. Os controladores da segunda categoria possuem estrutura similar ao PID clássico, mas seus parâmetros de sintonia são adaptados "*on-line",* baseados em informações adquiridas da dinâmica do processo sob controle, o que pode requer algum conhecimento preliminar do processo, ou seja, do modelo da planta, a ser controlada. Estes controladores são geralmente denominados *Controladores PID Adaptativos*.

A utilização dos sistemas baseados em experiência, na área de controle de processos industriais, vem crescendo, especialmente no campo do *Controle Nebuloso* [3], [4]. Neste controlador, descrições lingüísticas de experiências humanas, representadas por regras e implicações fornecidas pela lógica nebulosa, formam uma base de conhecimentos usada pelo mecanismo de inferência, que gera uma ação final de controle. Esta ação pode ser baseada, por exemplo, no sinal de erro e em sua derivada (ou diferença) no tempo, expressa pela diferença entre a variável controlada e o sinal de refer6encia.

O ambiente digital desenvolvido, apresentado neste artigo, explora a aplicabilidade e diversidade dos controladores para automação, mais especificamente em modelos de processos mais freqüentes no meio industrial. Para esta análise foram selecionados três concepções distintas de controladores: o controlador nebuloso com estrutura PI, o controlador PID clássico e um controlador PID adaptativo com estrutura supervisória nebulosa [5]. As estruturas desenvolvidas, bem como as telas principais do ambiente, com exemplos de simulações comparativas, são apresentadas na sequência. As conclusões finais encerram o trabalho.

CONSIDERAÇÕES PRELIMINARES

O objetivo pretendido, ao se desenvolver o ambiente do *Controlador de Processos Industriais*, ***CPI***, foi possibilitar um interface entre o graduando de engenharia da área elétrica/automação, com modelos de processos rotineiros e comuns no meio industrial, com as respectivas estruturas de

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controle, disponibilizando para o mesmo uma importante ferramenta para simulações. As simulações e análises são efetuadas em "tempo real", utilizando as estruturas já mencionadas dos controladores PID clássico, PI nebuloso e supervisórios nebulosos para sintonia PID. O programa foi desenvolvido em linguagem de programação DELPHI [6].

A exigência de se construir um ambiente digital para simulações surgiu como uma resposta frente às necessidade da área de controle do curso de Engenharia Elétrica da Faculdade de Engenharia/UFJF, pois tal ferramenta funcionaria como um passo intermediário entre os estudos conceituais na área de controle e as práticas de laboratórios, facilitando o entendimento e consolidação dos fundamentos teóricos trabalhados nas disciplinas.

Entre as principais características do *CPI*, quando comparado a outros ambientes atualmente existentes, pode-se destacar:

- Geração dos sinal de saída do sistema em "tempo real".
- Possibilidade de mudança de referência, perturbação e parâmetros da planta durante a simulação, com visualização da resposta do sinal de saída em "tempo real".
- Sintonia do controlador PID, PI nebuloso e PID com supervisório nebuloso em um processo interativo simples, de fácil manuseio.
- Alternativa de mudança de velocidade de amostragem para a plotagem do sinal de saída, possibilitando uma melhor visualização de respostas em processos de baixas constantes de tempo.
- Fácil manuseio, com uma interface auto-didática.

ESTRUTURA COM CONTROLADOR PI NEBULOSO

A figura 1, a seguir, mostra a tela de entrada do *CPI*. Nela, o usuário pode escolher um dentre os seis modelos disponíveis, bem como o tipo de controlador aplicado à planta. Serão apresentados, nesta seção, procedimentos para utilização de uma estrutura de controle do tipo PI nebuloso.

A escolha dos modelos é efetuada através dos botões ao lado esquerdo da janela, que, quando acionado, acende um contorno verde e mostra o modelo no painel central à tela. Os desenhos nos botões estão conforme a representação de malhas por Mason [7] [8].

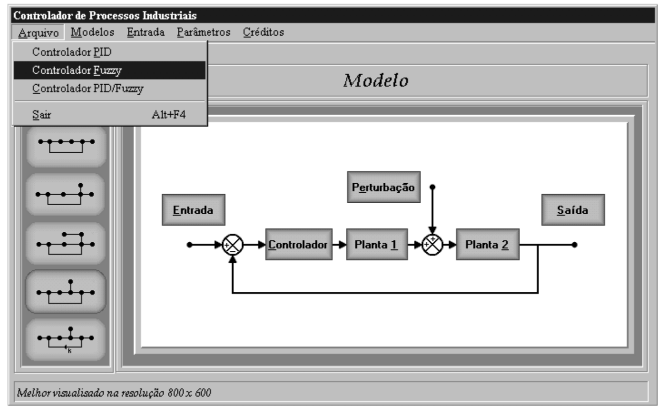
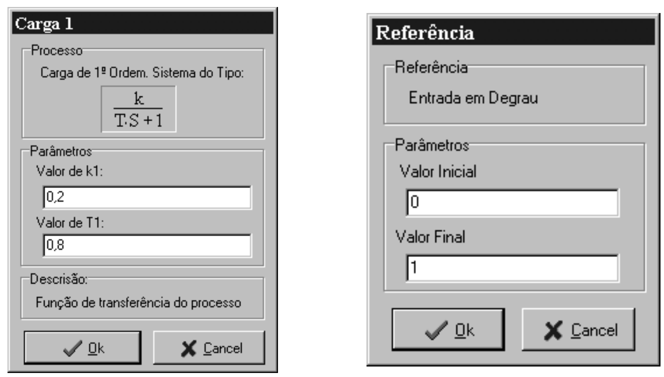


FIGURA. 1
TELA DE APRESENTAÇÃO.

Os valores de entrada do sistema são definidos pressionando-se o botão do mouse sobre os blocos correspondentes. As figuras 2(a) e 2(b) descrevem a inicialização das constantes das plantas e da perturbação em degrau (referência e rejeição de carga) respectivamente:



(a) (b)

FIGURA. 2
JANELAS DE ENTRADA DE DADOS.

A sintonia do controlador PI nebuloso é pré-ajustada pela janela mostrada na figura 3, utilizando-se para isto as funções de pertinência para a nebulização dos dados de entrada para o controlador. Nesta tela, o usuário escolhe o limite máximo positivo (ponto *e*), sendo que os demais limites se ajustam automaticamente. Este ajuste automático torna-se possível pelo fato do controlador utilizar, por opção de projeto, funções de pertinência triangulares simétricas. Esta opção não tira o caráter de generalidade do sistema, haja vista que esta opção é, de forma geral, a mais utilizada nos diversos projetos de controladores nebulosos.

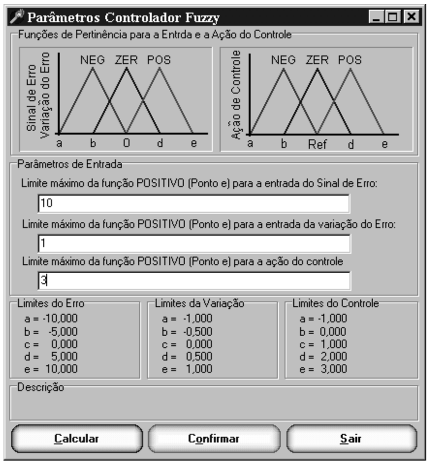


FIGURA. 3
TELA DE SINTONIA PARA O CONTROLADOR PI NEBULOSO.

Com um "*click"* do mouse sobre o botão de saída, começam automaticamente as simulações para o sistema escolhido. Observar que o ambiente disponibiliza, em uma tela única, quatro campos de plotagem que mostram as dinâmicas da variável controlada, da lei de controle, do sinal do erro e da variação deste último no tempo, informações estas últimas utilizadas diretamente pelo controlador.

Na delimitação dos "*Parâmetros"* estão os valores de entradas escolhidos anteriormente e sujeitos a qualquer alteração dinâmica, como ruptura de modelo, mudança de referência, perturbação de carga ou mudança de sintonia do controlador, que serão introduzidas em tempo real ou após um tempo determinado, de acordo com a escolha do usuário (Figura 4).

Observar que, a qualquer momento, o usuário pode efetuar nova alteração dos parâmetros já selecionados, com o ambiente efetuando nova simulação a partir deste momento, funcionando, desta forma, com características de "tempo real".

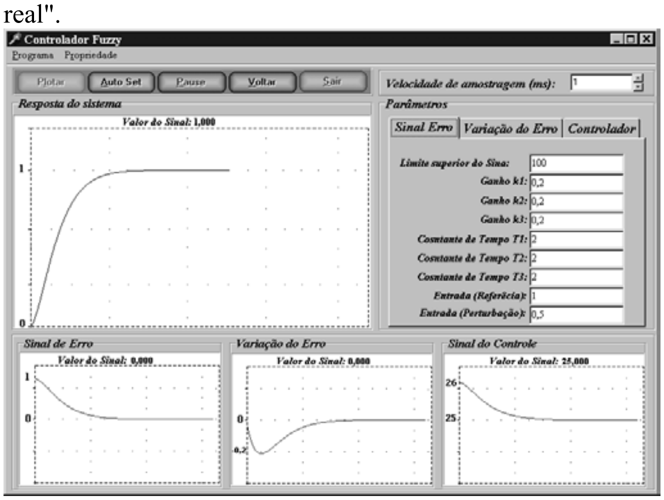


FIGURE. 4
TELA DE SIMULAÇÕES.

ESTRUTURA COM CONTROLADOR PID CLÁSSICO

Para a inclusão do controlador PID clássico à malha de controle, em substituição ao PI Nebuloso, basta efetuar sua seleção no menu *Arquivo* da tela principal, conforme mostra a figura 1. As telas para a entrada dos valores em degrau referência, rejeição e carga e ruptura de modelo são as mesmas descritas em 2 (a) e (b).

A sintonia do controlador PID é pré-ajustada pela janela mostrada figura 5. Nesta, o usuário escolhe os valores das bandas Proporcional, Integral e Derivativo

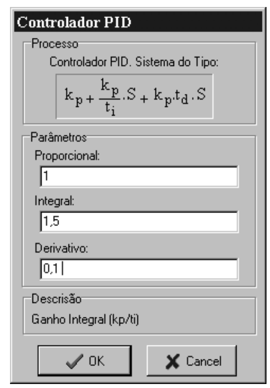


FIGURE. 5
CAIXA DE ENTRADA DOS PARÂMETROS DE SINTONIA DO PID.

A tela de simulação é mostrada na figura 6**.** Nos quatros campos de plotagem estão dispostos os sinais da resposta do sistema ao controlador PID, (podendo atuar ainda como PI ou PD), e a resposta ao P, I e D, atuando isoladamente.

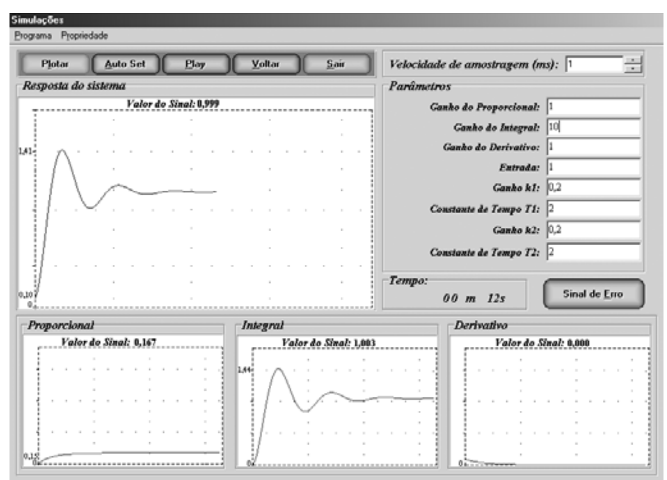


FIGURE. 6
TELA DE SAÍDA DE SIMULAÇÕES.

O *CPI* também oferece a visualização do sinal de erro, como mostrado na figura 7:

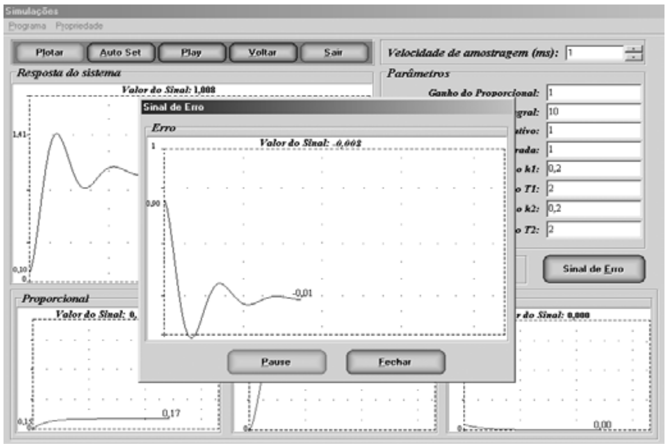


FIGURE. 7
TELA DE SIMULAÇÃO DO SINAL DE ERRO.

Observar que os valores numéricos sobre as curvas são mostrados quando habilitados no menu "*Propriedade – Cursor*", acompanhando a dinâmica das curvas durante todo o processo de simulação.

ESTRUTURA COM O CONTROLADOR SUPERVISÓRIO NEBULOSO

A escolha da estrutura de controle PID com supervisório nebuloso é apresentada na tela inicial do *CPI*, conforme mostrado na figura 1. A escolha é feita através do menu "*Arquivo - Controlador PID/Fuzzy*". Para esta opção de controlador é seguido o padrão de entrada de valores dos anteriores, como para a perturbação de referência, rejeição de carga e para as plantas, sendo estas entradas efetuadas pelas "*janelas*" da figura 2(a) e (b). A tela de simulações é apresentada na figura 6. A sintonia do Controlador supervisório é pré-ajustada pela janela mostrada na figura 8. Nesta, o usuário entra com o valor de k_u e T_u, Ganho Limite da Estabilidade e Período de oscilação limite da estabilidade [2], que estão intimamente relacionadas com o projeto do supervisório utilizado [5].

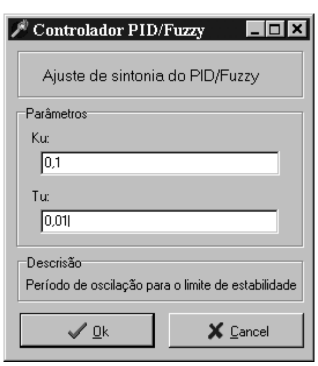


FIGURE. 8
TELA DE SINTONIA DO CONTROLADOR PID/FUZZY.

CONCLUSÃO

O presente trabalho consistiu no desenvolvimento e implementação de estruturas de controle do tipo PID, PI nebuloso e supervisório nebuloso para sintonia PID. As motivações que deram suporte a esta decisão foram:

– Estudar e desenvolver estruturas de controle para processos comuns no meio industrial, com ênfase na estrutura supervisória para sintonia do controlador PID, a qual foi dedicado maior parcela de pesquisas.

– Criar uma um ambiente de simulações em tempo real para estudos de controladores aplicados em plantas industriais, fornecendo uma ferramenta útil para estudantes de engenharia elétrica/automação, podendo ser utilizado como ferramenta didática nas disciplinas de Controle.

O processo de desenvolvimento foi efetuado utilizando os conceitos subjacentes à lógica nebulosa, baseado na proposição de Viot e Zhao-Tomizuka-Isaka [5] na qual foram introduzidas modificações buscando maior eficácia na otimização do processo de controle.

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CONTROL AND AUTOMATION TEACHING: AN UNIFIED APPROACH IN A GUI DIGITAL ENVIRONMENT

Breno Scopinho[1], Clayton G. Mata[2], Francisco J. Gomes[3], João C. Netto[4] and Leonardo A. M. Moraes[5]

Abstract — *The work deals with a graphic environment that allows the user to plan, tune and analyze feedback control systems loops, involving he more common models of systems utilized in control daily practice. These models include PID controllers in the feedback loop and, in all cases, controllers' gains tuning are possible by changing the electronic circuit of a PID structure. The process models are of first and second order, in the s domain, but working also with their associated electronic circuits. All the parameters of the models and controllers can be changed in "real time", allowing the user to analyze their effects on the final dynamics. Besides, the environment includes a "step-by-step" procedure for designing a control system based on the pole placement technique, in the state-space, for an inverted pendulum. The importance of this work is mainly in giving to the student a strong relationship between theoretical models and its physical implementations through electronic circuits, embedded in a friendship environment.*

Index Terms — *Engineering Education, Control and Automation Education, Digital Environment, PID Controllers.*

INTRODUCTION

The computer is becoming an essential tool in teaching and training of projects and analysis of control systems. This fact relays on its capacity to determine the systems dynamics under analysis, in a closed or open loop, to help in the tuning of controllers and analyze its performance, prior to the construction of the physical systems. Through several situations simulated, dynamics with desirable characteristics can be obtained, taking in account parameters like dumping, settling time, stability, overshoots, and others.

In the teaching process of control and automation, however, some difficulties generally arises when trying to conciliate theoretical concepts, like the conceptual analysis of the systems, with their ordinary physical implementations. Excellent simulators, like Simulink, use basically mathematical tools, while practical aspects of implementation of these systems can be analyzed only with others environments like PSpice. The difficulties grow up when the training imposes the necessity of physical modules, that are, in general, imported and with expensive prices.

Analyzing this situation, the present work – a graphical simulation environment – was implemented based on conventional mathematical tools, basically transfer functions and state-space equations, allowing the user to define and tune the parameters of control systems (plants and controllers), verifying the associated dynamics in "real-time". The most important environment characteristic is the fact that the systems – plants and controllers – can be analyzed and worked not only as mathematical functions, but also as electronic circuits, allowing the user to operate with mathematical models and/or physical implementations.

The next section deals with the module based on Proportional-Integral-Derivative (PID) controllers. Its electronic circuit is accessible to the user, allowing its tuning through alteration of capacitors and resistors values. With this environment is possible to have, graphically, answers of, to references changes, load rejection and models rupture, in "real-time". This open the possibility of using the "PID Controller" in a very extensive range of applications, involving academical applications and even industrial operators training.

The following section illustrates the state-space project module. Elaborated as a step-by-step project manual, based on the classical inverted pendulum system, it allows the user to analyze its relative and absolute stability, trough poles placement. The final conclusion ends the work. All the sections, additionally to the conceptual contents of each module, display some environment screenshots and the possibilities they offer to the user.

PID CONTROLLER

This section deals with the PID Controller module, that simulates in closed-loop the most common models utilized in practical control configurations that embraces the majority

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of the common industrial area control situations. The selected systems, in their several configurations, are presented in closed-loop, with unitary or first-order dynamic feedback, and with a PID controller.

Models

The developed environment allows the simulation of six classical systems in closed-loop configurations:

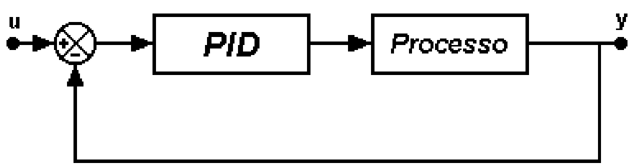

FIGURE. 1
MODEL 1.

Figure 1 shows the first simulation model, with first- or second-order dynamics, according to the user's choice, and unitary feedback.

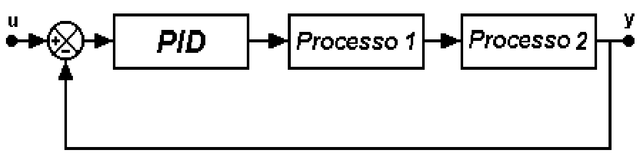

FIGURE. 2
MODEL 2.

The second model, as displayed in Figure 2, consists of two first- or second-order processes, cascade configuration and unitary feedback gain, allowing simulation of third or fourth orders dynamics.

For these two first models is possible to define reference alterations and model rupture. The third option, presented in the Figure 3, has first- or second-order dynamics, unitary feedback gain and allows reference alterations, load rejection and model rupture.

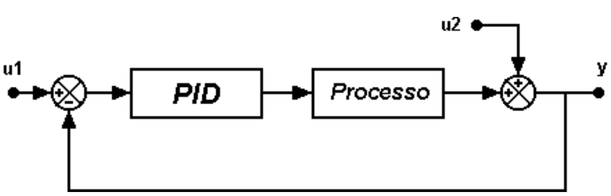

FIGURE. 3
MODEL 3.

The fourth model selected, shown in the Figure 4, simulates dynamics of first- or second-order, unitary feedback gain and allows reference alterations, load rejection and model rupture, in a different configuration.

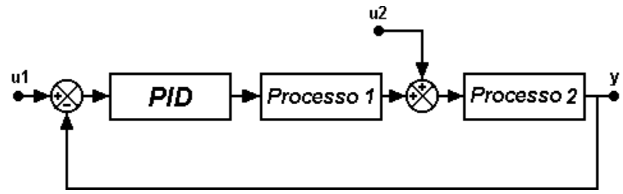

FIGURE. 4
MODEL 4.

The fifth model opens the possibility of selecting the load perturbation dynamics, according to the user's selection.

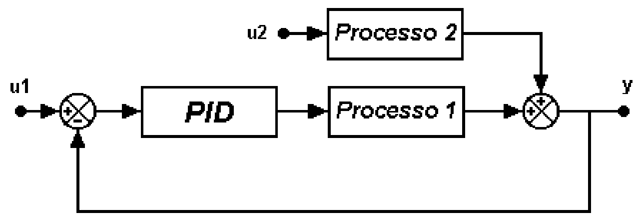

FIGURE. 5
MODEL 5.

The last model, shown in the Figure 6, offers additional characteristics to the fourth model, by including not-unitary feedback gain, selected by the user.

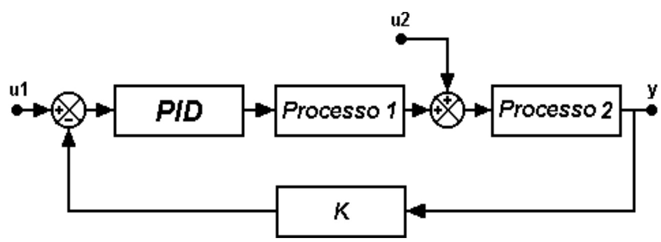

FIGURE. 6
MODEL 6.

All the presented options, like perturbations and alterations introduced in the systems, are selected through a friendly graphical environment.

The Program

The initial screen of the environment allows the user to select the models for simulation, available with its characteristics, just scrolling over the mouse on the icons. Figure 7 shows, as an example, the choice of the first model.

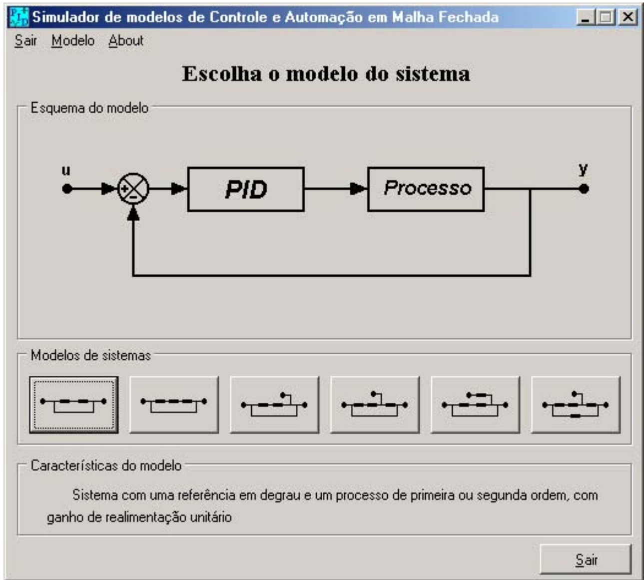

FIGURE. 7
INITIAL SCREEN OF THE PID SIMULATOR.

Figure 8 shows the simulator screen, after selection of the model, "waiting" for the simulation start. The PID controller tuning is possible trough "clicking" on the PID block, on the closed-loop block diagram. In doing so, the window containing the schematics of the analog electronic circuit of the controller is opened, as shown in Figure 9.

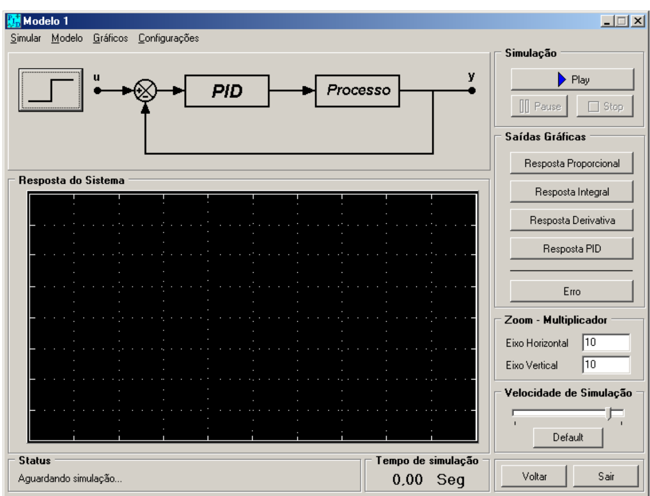

FIGURE. 8
"WAITING" SIMULATION OF THE MODEL 1.

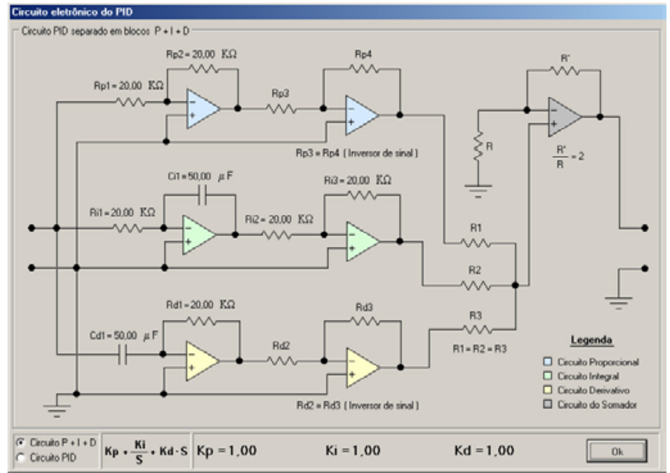

FIGURE. 9
SCREEN OF THE ELECTRONIC CIRCUIT OF THE PID CONTROLLER.

Figure 10 shows the input screens for reference alterations, allowing analysis of the servo behavior, and the plant parameters, which allows model rupture.

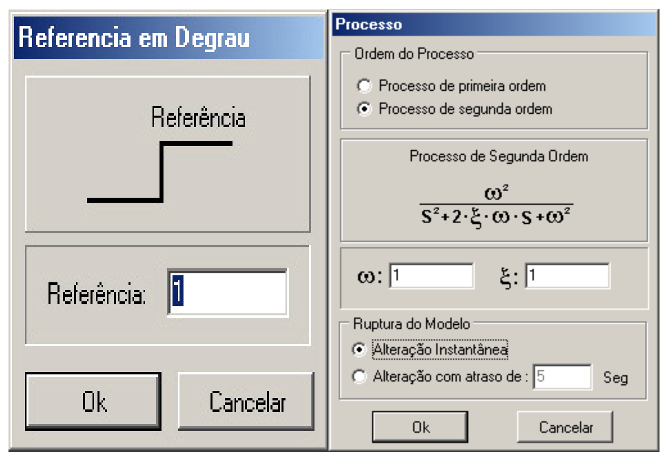

FIGURE. 10
INPUT SCREEN FOR THE REFERENCE AND PROCESS VALUES.

In a similar way, the models can also be analyzed through its electronic circuits, allowing selection of the parameters (gain and time constant) directly in the hardware or through numerical values.

The several systems are modeled by their differential equations and solved with the 4th order Runge-Kutta method.

While the simulations are running, all the values (controller tuning, plant and perturbation constants) can be changed in "real-time". The alterations influences on system dynamics can be analyzed by the user either graphically or numerically. As the environment was designed for teaching and training purposes in the process control area, the following screens are available to the user:

- **Controlled variable**: the user can follow the evolution of the perturbations on the final dynamic of the controlled variable.
- **Separated PID Controller modules actions**: aiming a better user understanding of the PID controller modules, the environment displays, simultaneously, separated windows for the proportional, integral and derivative modes, allowing the user to analyze each one's influence on the final control law.
- **Control Law**: the environment also displays, graphically and numerically, the final control law corresponding to the three PID modes sum, allowing the user to verify its final composing.
- **System Error**: finally, is also showed the deviation between the controlled variable and the reference allowing the user to verify, numerically, the error dynamics for the selected perturbation.

The controlled variable graphical is displayed on the simulated model window and the others ones are shown in separated windows, opened according to the user's need. Figure 11 is an example of the controlled variable graphic, with the proportional answer displayed on a separated window (right).

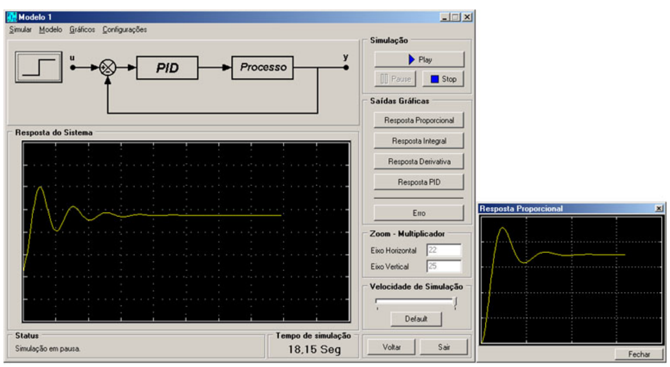

FIGURE. 11
GRAPHICAL OF THE CONTROLLED VARIABLE WITH THE PROPORTIONAL ANSWER IN ANOTHER WINDOW.

INVERTED PENDULUM SIMULATOR

As mentioned, the implemented environment incorporates a case of state variables controller design, based on poles placement methodology applied to a classical control problem: the inverted pendulum. The user has the possibility of implementing, step-by-step, with the help of the simulator, the poles placement controller, checking the system behavior for alterations on its closed-loop poles.

The Inverted Pendulum

The system consists of an inverted pendulum constructed on a cart commanded by a motor, generating a unstable system, falling laterally, at any time, unless an adequate force is applied on the car, driving the pendulum to a vertical position.

The selected model, state-space equations based, can be obtained on the specific bibliography and has the form:

$$\begin{bmatrix}\dot\theta\\ \ddot\theta\\ \dot x\\ \ddot x\end{bmatrix} = \begin{bmatrix}0 & 1 & 0 & 0\\ \frac{M+m}{Ml}g & 0 & 0 & 0\\ 0 & 0 & 0 & 1\\ -\frac{m}{M}g & 0 & 0 & 0\end{bmatrix} \cdot \begin{bmatrix}\theta\\ \dot\theta\\ x\\ \dot x\end{bmatrix} + \begin{bmatrix}0\\ -\frac{1}{Ml}\\ 0\\ \frac{1}{M}\end{bmatrix} u \qquad (1)$$

$$\begin{bmatrix}\theta\\ x\end{bmatrix} = \begin{bmatrix}1 & 0 & 0 & 0\\ 0 & 0 & 1 & 0\end{bmatrix} \cdot \begin{bmatrix}\theta\\ \dot\theta\\ x\\ \dot x\end{bmatrix}$$

The model used in the majority of current applications, and also in the developed environment, is a linearized one. Supposing the angle θ (angle between the bar and the vertical axis) is small, the sin θ can be approximated to θ, cos θ = 1 and $\theta^2 = 0$.

Poles Placement

Mathematically, is possible to prove that if a closed-loop system is completely controlled by the state, then its poles can be put anywhere in the complex plan, using the state feedback, through an appropriated feedback gain matrix. Specifically in this case, the system is completely controllable if its controllability matrix M has a rank equal to 4.

This matrix M for the system of the inverted pendulum is given by:

$$M = \begin{bmatrix}0 & c & 0 & a\cdot c\\ c & 0 & a\cdot c & 0\\ 0 & d & 0 & b\cdot c\\ d & 0 & b\cdot c & 0\end{bmatrix} \qquad (2)$$

where

$$a = \frac{M+m}{Ml}g \qquad b = -\frac{m}{M}g \qquad c = -\frac{1}{Ml} \qquad d = \frac{1}{M} \qquad (3)$$

If the system is completely controllable by the state, a state feedback matrix can be calculated, just like its respective equations.

The Simulator

Considering the inverted pendulum as a system with one input (the force u acting over the cart) and two outputs (the position x and the angle θ between the bar and the vertical axis) and using its model equations, the environment displays its dynamics through graphics or animated frames. Using this option, one can see the sketch of the inverted pendulum moving according to the answer of the system.

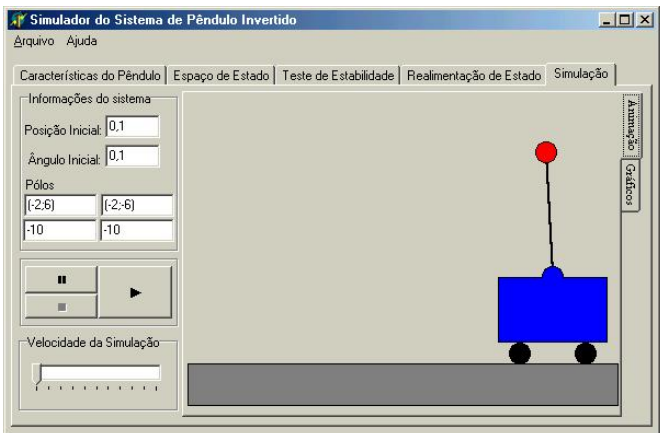

FIGURE. 12
SCREEN OF INVERTED PENDULUM SIMULATION AT ITS INITIAL POSITION.

FIGURE. 13
SIMULATION OF THE INVERTED PENDULUM SYSTEM OCCURRING.

The simulator also offers the option of varying the system parameters (pendulum mass and length and car mass), the initial position and angle and the closed-loop poles, which determine its final dynamics.

Step-by-step, the user analyses what happens during the process of designing the control system. When the simulation starts, the simulator takes on stability tests to verify the possibility of doing the poles placement, indicating to the user, step-by-step, the procedures for getting the final controller design. During this process, it is built the system feedback matrix, asking for the user to determine the closed-loop poles positions. The system then determines the answer corresponding to the variation of the position x and θ. At the end, these variables are exhibited in a graphic form, where parameters like the output of the system, as well factors like accommodation time and dumping factors can be analyzed.

Figure 13 shows the inverted pendulum simulation screen with the characteristics imposed by the user, for the pendulum and the composition of the graphical outputs.

CONCLUSIONS

This work is extremely useful in the study of control and automation procedures due to its user-friendly interface. With a differential characteristic of having mathematical models linked directly to their physical implementation, the environment allows and facilitates the understanding and operationally of the control laws and procedures by the users. Based on common models that can be utilized for representing the dynamics of most industrial processes, this work is very important for academical studies and training of industrial systems operators.

ACKNOWLEDGMENT

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THE ART, SCIENCE, AND PSYCHOLOGY (ASP) OF DEBUGGING

Russell E. McMahon[1],

***Abstract** -- As any computer language teacher knows it doesn't take long before a student produces his/her first bug. Therefore, it is not only important to teach students good programming techniques, but also, how to debug. In a lecture it is important that debugging is addressed early and in a lab situation it is imperative that an instructor can quickly debug a student's program. A student who has no concept of debugging will likely have a difficult time completely homework assignments on time. A student's failure to successfully debug a program can also results in the failure of the concept being adequately learned and a lot of frustration on both the learner's part and the teacher's part. Students need to understand that their own perception of their code is as important as knowing how to code. Ideas on how to conduct lectures, labs, homework, and tests will be given.*

Index Terms -- computer programming, debugging, problem solving, programming

1. Introduction

Ever since Grace Hopper "debugged" the Mark II in the 1940s this term has been an integral part of computer programming. Debugging skills are important and its mastery is necessary for anyone who plans on a career in the Information Technology (IT) field. Debugging is a form of problem solving that has three aspects to it: an art, a science, and a psychology. Grace Hopper popularized the term "debugging" in the computing field on that fateful day in 1945 when Howard Aiken (her boss) asked her what she was doing. Her bug was a real one, a moth to be exact[1].

If you want your students to both enjoy coding and be successful at programming, it is important that they learn how to debug quickly and thus, be able to concentrate on the concept that is currently being taught. Often times, it is not the concept that is the problem, but those "darn bugs." I even put together a bemusing PowerPoint slide show entitled "Bugs come in all shapes and sizes" to try and get students to think about what kinds of bugs they create and how to find them.

In many ways you are a coach preparing your students for that day when they will indeed have to debug a system that a client needs and all eyes are focused on them. This comes only with practice, patience, and a lot of hard work on the teacher's part and the students' part.

2. Types of Bugs

Basically, there are four kinds of programming bugs: syntactic, run-time, logic, and design. The first three need to be taught in detail to beginning programming students. Design bugs come later during a systems analysis and design course.

Syntactic errors are failures to use the correct grammar of your language and are caught immediately by the compiler (or interpreter) or even beforehand by a "background" syntactic checker of many modern Integrated Development Environments (IDEs). They are usually easy to fix and in general present the least amount of problems for students (provided they are paying attention).

Run-time errors can be either syntactic errors not identified by the compiler ahead of time or errors that result in the program crashing. Performing an "illegal" operation like division by zero or moving string data into a numeric field are example of these. The compiler is unable to catch these kinds of errors because the values of the variables are unknown until run-time. These errors cause your program to throw an exception, which a programmer may want to handle programmatically.

Most beginning students spend their time here when it comes to debugging. Part of the problem is that students tend to write too much code before they test it especially, if it compiles clean. Therefore, the instructor should also spend more time teaching how to deal with these kinds of bugs.

Logic errors can be from problems with the design of the application to assumptions being made about what is acceptable output. The algorithm used may be the wrong one or something as simple as not testing for all the possible values of a variable. These kinds of bugs required a good testing plan to be put in place and are the hardest to detect and find. Often times these are created as a result of poor design.

Logic errors can lie dormant for a long time before they are detected and if they are not discovered soon enough, their output becomes they may become the accepted answer. This is why companies need to spend a lot of time testing an application before it goes to production (and retesting it after it goes to production).

Logic errors are hard for many students because they don't take the time to verifying the results. As with the run-time error mentality, if students get a program to run and it looks pretty good then it is OK to turn in for credit. The best

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way to teach this is to give students a completed program and have them develop and implement a testing plan.

Design errors occur at the start of the development cycle and a poorly designed program is doomed to failure. However, this topic is more suited for a systems analysis course, advanced programming techniques course, or software engineering course. A good design does not mean logic errors won't exist. Testing is still a very important aspect of enterprise development. In a beginning programming course, design errors are not as big since most programs written are fairly short. As a student progresses, both testing and good design become a key aspects of the system development life cycle.

3. Research

Recent studies indicate that programmers spend between 50 – 80% of their time on debugging. If these numbers are only half right this would still reflect an enormous amount of time and energy being spent on something that is obviously a major problem with application development[2]-[3]. In a recent study by the National Institute for Standards and Technology (NIST) it was found that software errors cost the US economy roughly $59.9 USD annually. This report estimates that more than half the bugs are not found until well into the development cycle or after the product has been sold or put into production[4].

In his book Code Complete, Steve McConnell points out that the industry average for code production is 8-20 lines of correct code per day. He further points out that there are 15-50 errors per 1000 lines of delivered code. Mr. McConnell recommends that programmers learn how to code more defensively[5]. Since most applications go into the millions lines of code these bugs can become an enormous drain on the programmers supporting them and the companies using them

Marc Eisenstadt of the Open University wrote a paper entitled "My hairiest bug war stories." He collected antidotal information from programmers who related their worse bug nightmares. What is especially interesting is the number of programmers who inherited code from someone else and then were expected to complete the project. Many of these programmers complained that the bugs were there when they got the code.[6]

In a paper entitled "The Debugging Scandal and What to Do About It", Henry Lieberman from MIT states "debugging is still, as it was thirty years ago, largely a matter of trial and error." Part of the problem, Lieberman contents is the "lack of attention to improving the tools for debugging programs."[7] There is also a lack of attention on the instructors' part of teaching students how to use a state-of-the art debugging tool. Debugging is a skill that is not normally taught instead, many students learn it on their own (through "osmosis").

There is currently a lot of excitement about Agile or Extreme Programming with its approach to producing nearly bugless production code. Emphasis is placed on shorter development cycles and lots of ongoing testing and debugging as the system progresses not just after the system is finished[9].

The concepts of debugging and testing need to be taught. Testing is not the same as debugging, but it can show the presence of errors in the code and both skills go hand-in-hand. Knowing one has a bug in his/her program is a start, but it still remains for the programmer to find the bug and correct it. At the beginning level of programming courses, students need to be taught how test and debug their programs and they need to understand that this is an art, a science, and most importantly a frame of mind (psychology) in terms of what one thinks the problem is and how one views their own code.

A special kind of logic error is called the "Heisenbug" name after the Heisenberg Uncertainty Principle. This kind of bug appears in an actual test run of the program, but disappears when run within the debugger. Sometimes it seems to magically appear and then just as quickly disappears. In general, if you don't know what causes, it you have a possible Heisenbug.

4. Art

Debugging is described as a black art or a secret art. It is more of a creative art, which requires the practitioner to use that creative, non-logical part of the brain to track down the bug. The more creative part of our mind is sometimes needed to know where to look for the bug and the willingness to look in the exact opposite place. This form of debugging is where hunches are sometimes the way a programmer finally finds the bug[8].

Debugging will always be an art because of the constant changes in computer languages prevents someone from thoroughly knowing a language. (Many programmers joke that if you know the language intimately, then you are three releases behind.) When switching from one language to a new one there is a new syntax to learn, a new set of compiler rules, a new set of bugs, and sometimes a new paradigm about which to learn (like going from procedure programming to object-oriented programming). All computer languages are different and all have a different set of problems associated with them. Debugging SQL is different from debugging HTML which is different from debugging C# but, it is possible to use all three in the same application.

Debugging is a creative art because even the best programmer knows that sometimes what appears as the obvious location of the bug is really just where it manifests itself and the real bug lays somewhere else. It may even be in the design of the application itself.

Debugging is a learned art. This means learning how to use available tools to see what's going on in your code. This leads to the science of debugging.

5. Science

Debugging is a science. There is a set of rules for general debugging that follows the scientific method. A hypothesis is formed on what the caused the error and is then tested. If the assertion is true then the bug can be fixed quickly and the student is able to move forward with the program. Otherwise, the student must reformulate his/her hypothesis and test again.

There is a methodology that can be applied in tracking down the bug and fixing it. Back in the older days of programming (where punched cards and GOTOs ruled the world) there were no real easy ways to debug programs except to use some sort of "print" method to display the values of the variables you were interested in seeing and doing a lot of desk-checking. Desk-checking is still a good method to use when all else fails as it requires you to "play" computer and really think about what it is your code is doing.

Debugging requires good analytical skills. Students who are good in math and science tend to be good in debugging. Knowing where to start debugging is the challenge. This can, however, be taught and modeled by the teacher. Code isolation and verification is a good technique to use when presented with a large program that does not work. Comment out sections of code until you are able to narrow the bug down to the offending line of code.

Teach program develop through the use of an IDE. They are very rich in tools that make it quicker and easier to debug. Plus, it is very likely that students would be using such a tool on the job. You can set breakpoints, step through your code, watch the values of your variables, and switch over to the assembled code if you need a closer look at what is going on.

Finally, the science of debugging requires students to read the documentation on any errors they receive. The documentation does not always help in explaining what the programmer did wrong but, it can serve as a guide by telling you what areas of your code you should check. If this is the first time a student of mine has seen this particular error, I expect him/her to use the help facility.

6. Psychology

Sometimes you convince yourself that what was written cannot be wrong and therefore, the error is either elsewhere in the code or in the system outside of your code. The error is staring you right in the face, but you refuse to accept it. Hence the saying: "Programmer know thy self and your compiler." Students need to understand that sometimes they will make mistakes and not be able to "see" them because they have convinced themselves that the code in question is correct. Compilers are constantly being updated and sometimes code that compiled cleanly under an older version fails to recompile in the newer one.

There are three basic questions all coders should ask themselves when they encounter a bug. What sort of errors have I made in the past? What kinds of habits have I picked up that lead to this bug? How can I change these habits? Sometimes the only difference between my students and myself is that I know what kinds of errors I can make and the habits that lead up to this error and they don't.

Students need to understand the psychology of debugging because the mind can be the roadblock in the way of successfully finishing an assigned program in a timely manner or frustrating oneself for hours on end. Getting students to catch their errors sooner instead of later is important. Most of my students agree that some of the errors they have made are because they convinced themselves that the line of code in question or algorithm is correct and therefore the bug must be somewhere else in the code or that the OS, network, IDE, compiler, or some other fluke of nature is the cause of their problem.

One needs to adjust his/her mindset when debugging. First and foremost all programmers need to accept that they will create bugs. This sounds simple enough, but many people have trouble with this. Second, one must feel comfortable enough in his/her programming skills such that bugs can and will be found and appropriately handled. Instilling confidence in your students is very important. They must feel that the bugs they encounter are not insurmountable and that with a little more persistence and work they will solve the problem. Students can become so convinced that something else was the cause of the error that even when it was shown, they still wanted to defend their invalid code. (This has happened to me a number of times.)

Remember what's in the book is not always correct. Most programming books are one release behind the actual product and often times the sample code has not been thoroughly tested. What may have worked before may not work with a newer release of the product. Teach your students to treat all information with caution. This is difficult for beginning programming students because they expect the author and instructor to be infallible experts and they really have no way of knowing what is correct or incorrect.

Another problem is switching to new version of a language or to a whole new language (such as going from Visual Basic 6 to Visual Basic.NET). Although the same errors like dividing by zero will generate an error, the error messages do change (sometimes for the better). (In C# it is possible to execute unchecked code that would normally cause an overflow error. This does not stop the code from executing or from returning results back.)

7. Lecture

In a lecture it is important that good coding techniques be taught. Code that is well designed, written, and structured is less prone to bugs to begin with and is easier to debug later. Students learn early on that I will not help them with a programming problem if their code does not follow good coding standards. Debugging is addressed early in my programming courses with students being introduced to the more common errors of the language they are learning.

Introduce bugs in small doses and give students the opportunity to create their own bugs so they become familiar with the error messages and what they really mean. Teach students to fix bugs before continuing and to test their code every step of the way. Good programming habits will carry a student far. This includes showing them how to use the available help facilities.

Start with an explanation on debugging by asking students if they all know what ASSUME means. Most know what is meant here (don't make an ASS out of yoU and ME). Next tell your students to stop making preconceived ideas about what the caused the error. Many times it is this notion that the error can't be where it appears that causes them problems.

Teach students how to write stub program code and then how to enhance the various stubs as they go alone checking each step before proceeding to the next. Have students identify the important parts of the program and start out small. Teach student how to desk-check. Although, this is not as necessary as in the past, it still is useful and teaches the students how to "think like a computer."

Writing clean code is not so much a problem when students have plenty of time to design/write/test/debug their code as much as it is during a test. Many students believe that writing pseudo-code on a test is better than nothing at all. By pseudo-code I mean the program did not compile, but instead of fixing the problem (because the student could not do so) the student continues to write code pass the problem area. (Damn the torpedoes, full speed ahead) In some cases students do not even compile their code until they are all done with the problem. These habits can be hard to break, but if the rule of "no compile -- no points" is applied, it tends to stop most students from handing in incomplete code.

Although an IDE usually has a debugger built in it and will help a student find the errors, this does no good if the student fails to understand how the program is functioning in the first place. This goes back to the psychology of debugging. The data given back by a debugger is interpreted by a student who may not really understand what the true meaning of the information returned. It is critical that students learn how to decipher the meaning correctly or else they could easily spend more time than needed to solve the problem.

Before sophisticated IDEs and debuggers the standard way of checking what a piece of code does was to insert "print" statements into the code and watch the values as the program ran. Nowadays you can insert a breakpoint in your code and a variable "watch" window will show the variables you are interested in.

8. Lab

Most of our computer-related courses have an associated lab. We feel that a lab is vital to our students' success. Students need practice debugging under a control environment. They need to be shown how programming is done in lecture and practice it in lab. This is the time where I assess a student's ability level. A student who is not very successful in lab is likely to have a hard time with any homework and subsequent tests.

Just as thought of eating an insect makes most people squirm. I like to give my students a set of programs with bugs and watch them "squirm." I have built up a library of "interesting" code for use in my labs. I give them a document with code on it and they have to find the bugs first via desk-checking and later verify their results on the computer. Other times I have students work as teams and create bugs in a program and then have another team debug it. A little competition goes a long way.

I also like to have another student to debug someone else's code. This helps both students. Many times I have seen my errors as soon as a colleague of mine came to my cubicle to help me debug. If those two students can't solve the problem, I may assign a third or fourth student to the bug before I get involved.

During lab time I walk around observing students' work on the computer. Occasionally, I observe a bug that a student has created. However, I do not immediately rush to aid the student instead, I choose to let him/her find it and fix it. If that student later needs my help, I am often times able to look like a magician for the speed in which I found their bug. Of course, this doesn't happen like this all the time so my students know I am fallible.

A programming course without a formal lab makes teaching a language difficult but, not impossible. Treat your labs like a typical science lab. This is the time for students to learn, interact with one another, and discover new things. Students are expected to be there and do the work assigned during that time period. Also, use the lab time to work with individual students. At the University of Cincinnati, we use Blackboard as a means in which students can communicate with their classmates and post their answers.

At the College of Applied Science we have a Programming Learning Center (PLC) where students can go for additional help. This program was started in January 2002 and has a goal of allowing our more advanced students to work with our any of our students who are having problems. Our PLC techs are paid so there is an incentive for them to delve into the problems given to them. The PLC techs can be link with a struggling student for more one-on-one help.

In a lab situation it is imperative that an instructor can quickly debug a student's program. In a beginning course a student can become too frustrated and is then unable to move forward. Even in an advanced programming course it is important that the instructor can debug the program or at least point the student in the right direction. Failure to do this can result in the failure of the concept being adequately learned and a lot of frustration on the student's part.

9. Homework

A professor has less control in this situation so it becomes even more imperative that students learn how to design, write, debug, and test their code. A student hitting a roadblock here can be bogged down for a long time and frustration sets in sooner or later. Keep the list of programming assignments reasonable and add one or two that are very easy to write. Spend time going over possible solutions and buggy solutions.

There are students who are very good programmers and some who can hack their way through most any problem you give them. By in large however, most students are not natural born programmers and need a good foundation before they can successfully build large applications. Both homework and labs are the perfect time for students to practice what they have learned.

Homework should also give the students the opportunity to learn something new about the capabilities of the language they are using. C# for example has extension date/time functions, sort capability, data structures and other functionality already built-into its extensive class libraries. Give assignments that will allow students to learn more about these and expand beyond what you teach or what is in the book.

10. Testing

I generally give three tests a quarter (10-week, 3-quarter system). The first two have a debugging part to it. I test less on debugging as the quarter progresses, but students realize they are responsible for being able to debug their programs. You may need to occasionally help a student debug his/her program during a test. Do this when the bug is something that may not have encountered before or is too obscure to let it impede a student's progress. When you assist a student, speak loud enough so other students are made aware of this problem and can adjust accordingly.

11. Conclusion

There are plenty of articles and books on debugging in a particular computer language and these make excellent resources for learning language specific debugging techniques. Debugging is a form of problem-solving. I enjoy debugging and always have learned something new when presented by what sometimes looks like the simplest bug and it's this life-long learning, that I want to impart to my students.

Teach students how to limit their bugs by testing as they go along. Do not reward students for coding additional code beyond the initial bug. Give students programs with bugs for lab and homework. Not only discuss debugging and how it can be best achieved, but also discuss the psychology of debugging. Students will miss bugs because they are convinced that the area in question was correct and therefore the bug has to exist elsewhere. Be patience with your students. Once they become successful at debugging many of the advance programming concepts become easier to teach because students are now able to concentrate on them and they no longer have to worry about the incidental bug.

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CAMPFIRES NOT REQUIRED

Diana K Stewart[1], Clark A. Cory[2] and Mark W. Bannatyne[3]

Abstract — *The question parents have asked over the last couple of decades is "Where can I send the children during the summer?" Summer camps bring thoughts of sitting around a campfire in the great outdoors hundreds of miles away from civilization, but some campers and parents are seeking alternative summer experiences. During the last five summers, the Computer Graphics Technology faculty at Purdue University has hosted a Computer Graphics Camp for high school students. Approximately 100 students travel each year from around the United States to West Lafayette, Indiana, for a weeklong stay on the campus of Purdue University. Throughout the week the students explore a variety of computer graphics software in the laboratories, take tours of companies that produce or use graphic works, and participate in some fun and educational activities in the evenings. This paper will discuss the goals of the camp, the weekly schedule and most importantly, some of the trials and tribulations that occur when working with high school students.*

Index Terms — *Computer Graphics, High School Students, Summer Camp, Technology.*

INTRODUCTION

The Purdue University - Computer Graphics Technology Department prepares visually oriented students who are interested in creating and managing the production of computer graphics for a wide range of industry. Students enrolled in the Computer Graphics program can select from the following disciplines: Construction Graphics Communication, Interactive Multimedia development, Computer-Aided Design, or Computer Animation. The department consists of nineteen faculty members at West Lafayette, the main campus, and five more faculty at the Purdue Statewide Technology Programs throughout the state (see Figure 1). There are approximately 500 undergraduate students enrolled at West Lafayette, 45 graduate students, and 175 undergraduates in the statewide system. The Department of Computer Graphics strives to prepare students to be the nation's best practitioners, managers and leaders of applied computer graphics. The department is also recognized as a national leader through its diverse faculty, staff, and students, and its excellence in learning, discovery and engagement.

FIGURE. 1
PURDUE UNIVERSITY, WEST LAFAYETTE (CIRCLED) AND THE STATEWIDE TECHNOLOGY PROGRAMS.

One of the activities that the department engages in is a Computer Graphics Summer Camp for high school age students. This camp provides students with hands-on sessions in fields such as Computer Animation, 3D Solid and Surface Modeling, Web Development, Digital Publishing, Computer Game Development, Technical Illustration, Engineering Graphics and many other aspects of computer graphics.

COMPUTER GRAPHICS SUMMER CAMP

The question parents have asked over the last couple of decades is "Where can I send the children during the summer?" Summer camps bring thoughts of sitting around a campfire in the great outdoors hundreds of miles away from civilization, but some campers and parents are seeking alternative summer experiences. During the last five summers, the Computer Graphics Technology faculty at Purdue University has hosted a Computer Graphics Camp for high school students. Approximately 100 students travel each year from around the United States to West Lafayette, Indiana for a weeklong stay on the campus of Purdue University.

The goal of the camp is to attract students who are interested in Computer Graphics and expose them to the Computer Graphics Department at Purdue University. During the week, the students are introduced in a stress-free,

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non-competitive environment to software such as Photoshop, FreeHand, Flash, Rhinoceros, 3D Studio MAX, as well as a variety of other tools. Finally, the students are challenged in each classroom to create projects that are outlined either by their instructor or themselves.

The Computer Graphics Camp is geared towards high school sophomores or juniors, but freshman and seniors have attended. High school students should be thinking about future career options that will be available upon graduation. What better way to get the students interested in their future than to jump start their professional education with a general introduction to all areas of computer graphics?

The general demographics of the students are extremely diverse. Most are based in the United States with the majority coming from Indiana and its neighboring states, Kentucky, Ohio, Michigan and Illinois. (See FIGURE 2) There have been several students from as far away as Hawaii, Puerto Rico and Alaska. There were even a couple of French foreign exchange students from a high school in Chicago. From north to south and east to west, the students bring to Purdue their diverse background knowledge of graphics.

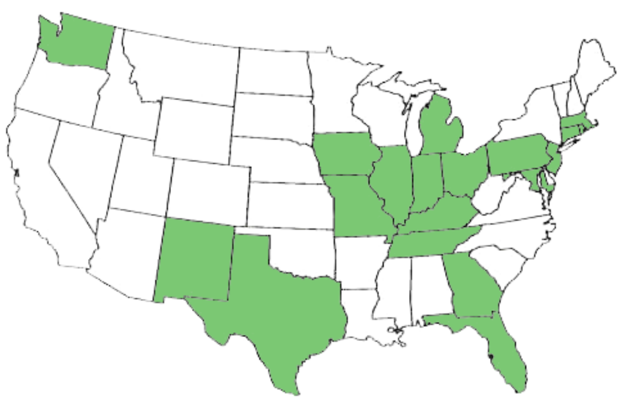

FIGURE. 2
STATES IN WHICH STUDENTS HAVE PARTICIPATED IN THE CAMP.

SCHEDULE

The camp, which is scheduled for mid June, runs from Sunday to the following Friday. The students are divided into groups of twenty-two, the number of computers in the Purdue computer lab. There are either four or five groups in a typical summer camp. Each group has two graphics session a day lasting three hours with a noon lunch break and an evening activity. (See FIGURE 3) The designated lunch break gives the student time to eat and either explore campus or go back into the computer lab for some independent work time. After supper, the group is walked to an evening activity.

Monday, June 17, 2002		**White Team**
7:00 am	Walk-up Call	
7:30-8:00 am	Breakfast	
9:00-Noon	Session 1	FreeHand
Noon-1:30 pm	Lunch	
1:30 pm-4:45 pm	Session 2	T-Shirt Design
5:00 pm-6:00 pm	Dinner	
6:30 pm-9:30 pm	Evening Activity	Physics Show & Campus Tour

FIGURE. 3
OVERVIEW OF ACTIVITIES FOR ONE TEAM

During the week at camp, students participate in computer sessions in the morning and afternoon, rotating through a series of seven computer graphics topics:

1. Vector Graphics – Software utlized: FreeHand
2. Raster Graphics – Software utlized: Photoshop
3. 3D Modeling – Software utlized: Rhinoceros
4. Aniamtion – Software utlized: 3D Studio MAX
5. World Wide Web – Introduced to HTML coding
6. Animation for the Web – Software utlized: Flash
7. T-Shirt Design

Each session takes place in a computer laboratory setting with all the necessary software and hardware to complete projects presented by their instructor. All of the students are provided with disks, binders, copies of projects, and other miscellaneous items that are needed in the classroom.

The seven areas give the students a general introduction to various areas of computer graphics. This curriculum design works effectively with most students, although some demonstrate less enthusiasm about the multiple areas. Some students come to the summer camp with the simple goal of concentrating on one component of computer graphics, and that goal is usually the expansion of their knowledge of animation. It seems that most students attend the camp for a general introduction to computer graphics, but a few just want to expand their knowledge of specific software products. Based on the student evaluations the animation, web, and 3D modeling sessions were selected as the favorites this year.

The following is a sample graphics session in the 3D Modeling. The instructor introduces a software package called Rhinoceros (Rhino). Rhino is a 3-D NURBS modeling program for Windows that is extremely easy to learn and use (www.rhino3d.com). First on the agenda is to introduce the interface and the transformation tools. A file containing a few primitives is given to the students. Using this file the students are asked to move, copy, rotate, and scale the objects. This task allows them to become acclimated to an interface containing a top, front, side and perspective view of the objects in the scene. After a quick introduction to the interface and the transformation tools, the students start working with solid geometric figures like spheres, cubes and cones. They are encouraged to use the primitives to create a rough shape of simple objects like castles, trains, robots, and spaceships. Once they become comfortable with the interface, transformations and primitives, they are introduced to Spline based modeling using revolve and extrude to create 3D geometry. The students are then asked to construct objects such as goblets and decorative vases. The final task of the session is to create some type of building, toy, or character using some of the modeling methods introduced. (See Figure 4)

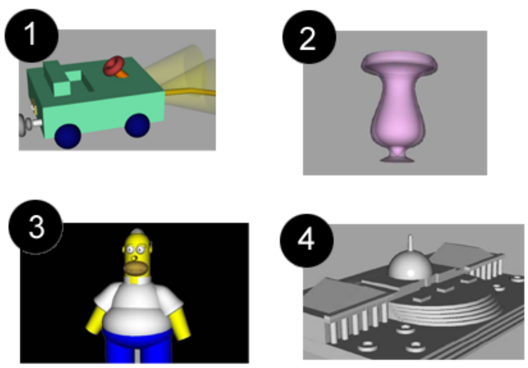

FIGURE. 4
3D MODELSCREATED BY THE STUDENTS IN THE 3D MODELING SESSION.
1. TOY CAR CREATED WITH PRIMITIVES
2. VASE CREATED WITH SPLINES
3. HOMER SIMPSON CHARACTER CREATED WITH PRIMITIVES
4. STATE HOUSE CREATED WITH PRIMITIVES

In addition to the classroom sessions the campers enjoy recreational activites in the evening. Some of the activities that the students take part in or attend are listed below:

1. Purdue Campus Tour
2. Animation Festival
3. Chemistry and Physics Show
4. Swimming Party
5. Billiards and Bowling

The Chemistry and Physics Departments entertain the students with explosive shows highlighting some of the Laws of Chemistry and Physics. Purdue also has many recreational areas including their Olympic Swimming Facility and a Billards and Bowling Hall in which the students can relax and socialize with their fellow-campers. In fact, the billards and bowling evening activity ranked on the student survey as one of the favorites during the camp. The bowling and swimming allow them to release some of the constrained energy. The movie allows them to see computer animations created by past and present Computer Graphics Technology students and animators from around the world. It also gives the students an insight as to what they might accomplish.

One day during the week the campers are taken on a day-trip to Indianapolis, Indiana or Chicago, Illinois to tour industrial and business sites specializing in computer graphics. On these tours the students see first hand the cutting edge of computer graphics and the technology associated with it. The last couple of years the students have toured the Indianapolis Children's Museum which houses the IMAX movie theater. The staff at the Children's Museum also gives the students a tour of their in-house sign shop where all of the exhibit graphics are taken from concept to reality. From there the students visit the Indianapolis 500 Speedway Museum so they can view technology at its best. Finally the day is ended with a visit to the Holcomb Observatory in order to see the stars and the universe. The organizers of the camp have packed this day with tours of sensational places in addition to introducing the campers to businesses that use computer graphics.

Finally, the week is wrapped up with an Awards Banquet that the students' parents, friends, and family are invited to attend. After dinner the camp staff shows a slide presentation of photos that were taken throughout the week to give the attendees a chance to see activites in which the campers participated. Each student that successfully completes the week at camp receives a certificate of completion and is entered into a drawing for free computer related items ranging from mouse pads to printers.

ROLL CALL & CAMP GUIDELINES

Keeping track of 100 campers is not an easy task. All students must attend each and every session and activity at the camp. In order to ensure that all campers are in attendance, roll call is taken in the morning after breakfast, at each computer graphics work session, after dinner before the evening activity, and then once again before the students are dismissed to their floors for the night. Although the students are responsible for getting to every activity, for security reasons roll call is done in every class. If a student does not report for roll call and is not located immediately, the Purdue Police Department is notified that a camper is missing. At this time a search team is sent out to find the missing camper. Once the camper is found the student is dismissed from the camp and their parents are called and asked to make the appropriate travel arrangements for the student to return back home. It is the camp organizers' responsibility to safeguard the students for the week, and they take that responsibility very seriously.

During the five years that the camp has been offered at Purdue there have been very few discipline problems. The first night of the camp the Director reviews the rules and safety regulations for the camp. The main rules are:

1. All campers must attend each and every session at the camp. In an effort to ensure that any camper who does not report to an event is safe, the Purdue

Police Department will be notified immediately it is discovered that the camper is missing.
2. Smoking is not allowed in any building on the campus or at any camp events.
3. Alcohol and illegal drugs in any form are prohibited on the Purdue campus. Violations must, by university bylaw, be reported to the Purdue Police Department.
4. Misconduct toward another member of the camp, or a faculty member, (such as physical or verbal abuse) will not be tolerated. Violators will be excused immediately from the camp for the remainder of the week.
5. Campers who are discovered to be in restricted areas of the dorm or other areas designated as "Off Limits" by university officials and/or camp faculty members will be dismissed immediately from the camp.

After the rules of the camp are reviewed with the students, there is no hesitation by the couselors to take appropriate action if a dicipline problem arises.

RAMPING UP FOR THE CAMP

The coordinators of the camp start preparing about nine months in advance. The camp is advertised in a number of different venues. A letter of invitation is sent to every High School Counselor in Indiana, Ohio, Illinois, Michigan, and Tennessee. An advertisement is also placed on the Computer Graphics Technology website. The other means of advertisement is by word of mouth. Most professors pass along the word at every conference they attend; so the camp is broadcast fairly well. Applications go out to high school counselors in January and are accepted to within two weeks of the start of camp. During this time, other planning occurs.

The planning for the camp is as complex as any conference function. There are scheduled meetings with organizers of food preparation, housing, swimming, bus transportation, field trip organization, and evening activities administrators. Each administrator must adhere to the guidelines Purdue has set for them, and the Computer Graphics Campers must follow those rules. The planning takes approximately two hours per day starting in January right up to the start of the camp.

The camp requires a large commitment from the Computer Graphics faculty and staff. Each graphics session must obviously have an instructor that knows the software and technology that is being introduced as well as chaperones for the evening activities and the day trip. The dormitories at Purdue are staffed with counselors, but the camp is also required to have supervision in the dorms for the campers at night. There are also the little things that can require extra help; for example, most days sack lunches are provided outside of the technology building instead of requiring the students to walk back to the dining room at the dormitory. Having someone who is willing to drive to pick up and deliver the lunches saves quite a bit of time. The organizers of the camp have also recruited undergraduate and graduate students who are attending summer classes or that are on campus for the summer to help out when extra supervision is required.

ASSESSMENT

The last two years of the camp the coordinators decided that the students should have an opportunity to voice their opinions about the camp and the activities in which they participated. The students were asked during the Friday morning's final graphics session to fill out a survey of approximately twenty questions. The questions basically cover the living facilities and dining services, the graphics sessions, the evening activities and the day trip. Each student was asked to rank these areas on a scale from one to ten – ten being excellent and above expectations. A few short answer questions were included at the end of the survey:

1. What other subjects or software would you like to see taught at the camp?
2. What was your favorite activity?
3. If you could change one thing at the camp, it would be...

Other comments were also included by the students on the back of the evaluation sheet. This past year 82 of the 90 campers returned their evaluations. The campers ranked the camp slightly above average on all aspects that were surveyed. In 2001 the results were similar – all slightly above average. The coordinators agree that the camp is meeting the expectations of the students.

Based on the student's comments, there are some areas that could be considered when developing next year's lab sessions. Some students would like to see an introduction to computer programming. Others would like a session on graphic freeware, for example GIMP, which can be downloaded from the internet. This would give them a chance to use graphics software at home without spending the high dollar value for the software that we use in the laboratory. One of the other comments that was included in the written section concerned the amount of roll calls – the coordinators agree that there is no way that the number of roll calls can be decreased. Basically the students want their freedom, but some control must be kept by the adults and supervisors of the camp.

CONCLUSION

The Purdue University Computer Graphics Department has taken the initative to introduce computer graphic to high school students in a structured but stimulating atmosphere. The mix of education, evening activities, social interaction, and promotion of computer graphics works extemely well in capturing the minds of this age group. During the week the campers do not get bored with one aspect of the schedule because there is a variety of technologies to learn. The summer camp gives everyone a chance, instructors included, to learn and grow from the experience. Some of the students come to the camp with refined skills in a particular graphics area, but they quickly discover a lack of general overall graphics knowledge. The camps diverse opportunities allow the students a flexible learning environment to develop additional innovative graphic skills. The camp organizers know that most parents are concerned about their children's welfare, education and future success. It is logical that they should select a summer activity that promotes social interaction and an interest in higher education.

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DISTANCE LEARNING OF CAMAC HARDWARE

Sergey E. Gavrilov [1], Sergey A. Kiprushkin [2], Sergey Yu. Kurskov [3], Eugene D. Zhiganov [4]

Abstract *— The idea of extending client-server technology to the types of services other than manipulating various files on a storage media and transferring files over a network is discussed. Special purpose protocol (CAMAC protocol) and server program (CAMAC server) are described and the possibilities of using the server in multi-user training systems are illustrated. Also, different approaches to teaching CAMAC programming are compared with each other. Description of usage CAMAC server in remote training system for organizing laboratory studies on various topics, including, for example, 'Studying CAMAC modules' and 'Remote control of data acquisition system' is presented as an example of our approach. According to this approach students use CAMAC server in conjunction with client programs, which are appeared to be helpful in acquiring basic skills in CAMAC hardware programming.*

Index Terms — CAMAC hardware, client-server technology, distance education, teaching system.

INTRODUCTION

Client-server technology is widely used for building various software systems nowadays. This technology is based on the idea of dividing data processing task between a server program and a client program or programs. Client programs and server program can run on different machines, connected either through local or global network, such as Internet. The role of a server is to provide clients with the possibility to use some resource of arbitrary nature in accordance with the set of rules comprising protocol, whereas clients, using this resource by means of requests to server, perform their specific tasks. Usually, resources are of 'file' nature: file system in FTP, HTML and other files in HTTP, mail messages in SMTP and POP3, data base files in SQL, etc.

Obviously, it is easy to provide clients with resources of some other nature by developing special protocols and writing special server programs.

A number of software systems designed within the client-server model exist, in which the resource supplied to clients has the nature other than files on discs or another storage media. As examples one can mention well known X Window system, which is de-facto standard for graphical output in Unix-like operating systems (resource is graphical display), various remote administration tools for Windows family operating systems (resource is entire machine and tasks run on it), an assortment of print servers in various operating systems (resource is remote printer or printers). Finally, we would like to mention MIDAS data acquisition system [1], designed in Paul Scherrer Institute (Switzerland), which provides for remote access to event-based experiments in nuclear and particle physics (resource are data taken from data acquisition hardware and also the experiment data base).

Particularly, we are interested in extending client-server paradigm to such sorts of resources as experimental setups or data acquisition equipment. We believe that this approach not only allows organizing effective experiment management but also may give the possibility to work several remote users with different constituents of experimental setup simultaneously. The last property can be used for establishing a multi-user remote training system on the base of such setup.

Although MIDAS system contains a part similar to CAMAC server described in this work, we considered it not quite relevant for our goals, since MIDAS itself is designed for use in nuclear and particle physics experiments; the CAMAC server part is deeply integrated into MIDAS and there was no need to use the entire MIDAS for us. Besides, we used to some extent different approach when implementing CAMAC server: namely, we designed our CAMAC protocol directly over the top of TCP/IP protocol family, whereas MIDAS designers used built-in HTTP protocol combined with the remote procedure call (RPC) mechanism.

CAMAC SERVER AND CLIENTS

We used the idea above when implementing special-purpose server program (CAMAC server), which operates in TCP/IP networks and allows remote users to access CAMAC crates. CAMAC is a program-control system of modular electronics created for communication of measuring devices with digital equipment of data processing. We also have developed corresponding application level protocol (CAMAC protocol) and several client programs demonstrating the possibilities of our approach.

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The remote access to experimental equipment in the scheme we used can be described as follows: dedicated computer running Linux operating system is used to control experimental setup which is connected to this computer through CAMAC crate (Figure 1). CAMAC server running on this computer is responsible for providing remote access to CAMAC crates for several clients concurrently. The sequence of operations to be performed over crates (experiment management) is determined by clients. Clients issue commands to server, which performs the operations requested and returns data obtained from crates as well as the information about CAMAC dataway state (for example, the presence of the X-reply from some slot) to the clients.

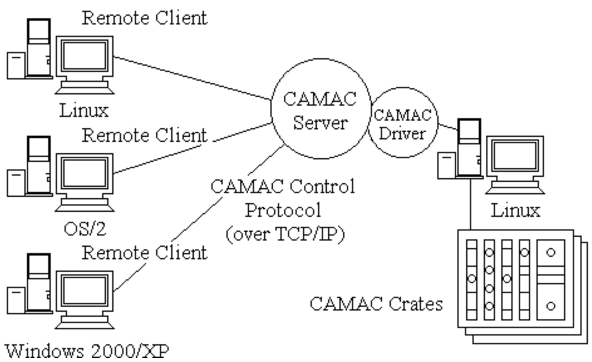

FIGURE 1
CLIENT-SERVER ARCHITECTURE.

CAMAC server is implemented for the Linux operating system in C programming language with the use of TCP sockets technology and is based on the CAMAC protocol developed with the purpose to provide a way for server and client to speak with each other [2]. According to this protocol server is a passive part of the system and the clients are active (client-driven scheme). After client establishes a connection, server sends a textual 'greeting' string, which can be used by the client for the purpose of server identification. Further the data exchange in query-answer mode between the client and the server occurs. Both query from client to server and answer from server to client are six bytes long. The former contains crate number, slot number, address within a module, command code and three bytes of data. Reply from the server includes contents of the control and status register of crate controller, error code and data. Among the commands available in the protocol one can mention 'capture slot', 'release slot' and 'execute standard CAMAC operation' commands.

Typical CAMAC session looks like this: client establishes connection with the server, captures a set of slots needed for it's work, performs data acquisition and then closes the connection. Slot capturing and releasing can occur at any moment of the session. In order to be able to serve several clients simultaneously server is made parallel: each client is served by a separate server process, which is forked by CAMAC daemon after establishing connection. Server processes communicate and synchronize with each other through the System V shared memory and semaphores IPC mechanisms, available in various Unix clones and, particularly, in Linux. CAMAC hardware is accessible for server processes through calls to CAMAC interface card driver.

It should be noted, that CAMAC protocol is designed in such way that users can perform CAMAC operations not earlier than they reserve a slot or set of slots for their purposes. It is especially important in multi-user training system. Only one client can exploit particular slot, until this client wishes to release the slot when it is not needed for the client anymore. This prevents users from disturbing each other.

We also implemented several simple client programs, which are used for various purposes, for example, testing CAMAC server. Among these one can mention client for Linux operating system (CAMAC shell) with a command line user interface and client with a GUI interface for Windows family operating systems. Both these programs allow users (for example, students) to connect to CAMAC server, capture and release CAMAC slots and perform low level CAMAC operations, both addressable, such as reading data from modules and writing data to modules, and nonaddressable, such as Z (initialize) and C (clear) commands.

USING THE SOFTWARE IN TEACHING TASKS

In order to familiarize students with basic principles of CAMAC hardware programming one can use several approaches. First, manual crate controller combined with dataway display and word generator can be used. When using such a controller, teachable persons program CAMAC modules by pressing buttons on the front panel of the controller and word generator. This method has the advantage that such a way of programming provides the closest possible contact with hardware. The main disadvantage of this method is that it is not quite convenient: in order to set, e.g. the value of data word to be written to a CAMAC module, one have to press corresponding buttons on the word generator, which is not very convenient in case when binary code is used. Second, one can use the program library, which allow interacting with CAMAC hardware. In this case students program CAMAC modules using this library and some high level programming language, such as C or Pascal. This way of teaching has the drawback, that students must be familiar well with the language. If this is not the case, they sometimes have to pay too much attention to programming itself and cannot focus on programming CAMAC. Third way to teach CAMAC programming is to use ready software, which allow to perform low-level CAMAC operations. The CAMAC clients mentioned above and CAMAC server can be classified as such sort of software. Using this approach has several advantages by comparison with the previous two methods. First, it is quite close to the hardware, almost as the using manual controller, except that in this case CAMAC cycle cannot be performed in step-by-step mode. At the same time it is much more convenient and faster. Second, it does not require knowledge in programming languages (this does not mean, of course, that students should not know any programming languages at all, but if the goal is to make students acquainted with CAMAC, such a way of teaching seems to be quite reasonable and relevant for this purpose). Third, it provides for remote access to CAMAC hardware.

Using the last approach, we have elaborated training system on the base of the CAMAC server whose purpose is to introduce students to the basics of management of the CAMAC equipment as well as to the methods of organization of remote access to automatic experimental setup.

A short description of the lab work 'Studying CAMAC modules' is used here as an example of usage of this system. This lab study is fulfilled with the help of Windows CAMAC client program, which acts almost as manual CAMAC crate controller. This work is designed for the 3rd year students of the Physical Faculty studying the 'Automated systems for scientific researches' course. CAMAC modules used in the remote training system are connected to the automatic experimental setup, which is used for studying processes of atom-atom collisions by methods of optical spectroscopy.

The goal of this laboratory study is to get introduced to the principles of CAMAC system architecture and to gain some practical skills in working with CAMAC modules.

In order to be able to complete this lab study, students have to go through their lecture materials on data exchange on CAMAC bus, including timing diagram of bus signals during CAMAC cycle. In addition to that they also have to study the structure of crate controller, instructions on how to operate it, and also technical characteristics and commands of CAMAC modules according to the variants of the lab study given to every student.

The assignment includes a number of tasks, which differ in a set of functional modules. Binary-decimal counter and synchronizing timer, for example, is used in one of the tasks, ADC and DAC converters – in another and so on.

Having studied principles of module operation as well as it’s functional purpose and commands by which it can be controlled, students then have to develop an algorithm of how to perform the task and then, using the Windows client program, which simulates the crate controller, get done an assignment, making sure that all of the commands are being executed by particular module properly.

When accomplishing their tasks students connect to the CAMAC server from their personal computers. Having established connection each user with a special command reserves CAMAC modules assigned for him that allows to avoid an access to those modules by other users.

It has been mentioned before that client, which is used to accomplish the lab study, allows a student to generate Z, C and NAF CAMAC commands. Most of the work is done by manipulating well-known controls such as buttons, menus, combo boxes, etc. For example, sending commands to modules include choosing slot and crate numbers, internal module address and function to be executed from a set of combo boxes and pressing 'EXECUTE' button with a mouse click. After each command server returns the content of the control and status register of create controller to the user and, in case of the read command, three bytes of data. If a user acts incorrectly server returns error code. Analyzing contents of the control and status register, a student is able to determine values (active/nonactive) of X, Q and I signals, and also to determine bits' states set by the previous command. As a result users receive the same information as they would when using dataway display.

At the end of the work students have to answer to a number of additional test questions concerning CAMAC system. Also students are suggested to plan some physical experiment automated on the base of CAMAC system and think of what sort of CAMAC modules one would use in this experiment.

We have discussed one of the most simple laboratory studies. Senior students have to do more complicated assignments. Students with Masters degrees studying the 'Technologies of remote access to physical equipment' course have to develop protocol by themselves and to write both server and client program that would manage some experiment.

We would like to stress that the distinctive feature of the system described is that it allows active interaction of the student with real equipment. That helps not only to acquire a certain amount of knowledge as when reading books, no matter, printed or electronic, but also to verify whether knowledge acquired were deep and correct. To be able to reach the goals of the assignments it is necessary to have knowledge of both syntax of commands (system will refuse to perform illegal commands and return error message) and principles of structure and operation of the modular automated system (functioning set of modules will output true data only under proper usage). Automatic control of knowledge can be enriched with the help of communication of different electronic forms between students and a teacher, such as e-mail or ICQ. As long as the help of the teacher is needed only in very difficult cases live communication can be substituted by modern means of communication that can easily be integrated with the system described. Practice showed that written narration of the problem helps students to deeper understand the assignment and even to find a correct answer themselves.

CONCLUSION

In a conclusion we would like to say that CAMAC server developed by authors was successfully utilized for building training system, which in turn was used for organizing laboratory studies on various topics, including 'Studying CAMAC modules' and 'Remote control of data acquisition system'. In conjunction with the client programs, the server is used to help students in acquiring basic skills in CAMAC hardware programming. Notice that combination of the server with similar client programs may be useful for lecture demonstration of ideas of how to work with CAMAC based data acquisition system.

Finally, the approach discussed in this work can easily be extended to other types of modular data acquisition hardware.

ACKNOWLEDGMENTS

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AS NOVAS DIRETRIZES CURRICULARES NO BRASIL: DESAFIOS

Antônio Cláudio Gómez de Sousa[1]

Abstract *— The new directives for engineering education in Brazil was recently approved and published. These new directives define the subjects of the engineering courses, the competencies and skills that we desire for engineers. They allow diversity of curriculum and flexibility of curriculum structure. This paper analyzes the improvements of the new directives, issues discussed but not included, and the challenges put by the new directives: how to qualify the engineers to develop new technologies, actuate critical and creatively, have ethical and humanistic vision to satisfy the social demands, and identify and solve the problems considering the political, economical, social, environmental and cultural aspects. Finally examines the new directives and the tendencies of the engineering in the world.*

Index Terms — currículo, diretrizes, educação, ensino

INTRODUÇÃO

No dia 25 de fevereiro deste ano foi publicado no Diário Oficial da União o Parecer CNE/CES 1.362/2001 [9], que estabeleceu as "Diretrizes Curriculares Nacionais dos Cursos de Engenharia". No dia 9 de abril, também deste ano, foi publicada a Resolução CNE/CES 11 [10], que instituiu as "Diretrizes Curriculares Nacionais do Curso de Graduação em Engenharia". Estes dois documentos definiram as novas diretrizes curriculares para os cursos de graduação em engenharia. Foram produzidos a partir de discussões na comunidade interessada no assunto, e traduzem, em boa medida, o que se discutiu em vários fóruns de debate, como se pode ver consultando os anais dos últimos Cobenge [7] [8], de outros congressos, como os "Encontros de Educação em Engenharia", fóruns de reitores, congressos de educação de variadas áreas do conhecimento, e documentos produzidos por várias universidades ou escolas de engenharia. As novas diretrizes colocaram novos desafios que devemos enfrentar. Este trabalho pretende destacar a evolução das diretrizes, os desafios e as formas de superá-los. Para isso iniciamos apresentando a legislação anterior; depois discutimos os princípios sobre os quais devem se basear as diretrizes curriculares; a seguir apresentamos as novas diretrizes; depois suas falhas; na parte mais importante discutimos os desafios colocados pelas novas diretrizes curriculares; finalmente na última seção apresentamos as principais conclusões deste trabalho.

A LEGISLAÇÃO ANTERIOR

A legislação anterior era baseada na Resolução 48/76 [1] de 1976 do Conselho Nacional de Educação. Ela estabelecia o currículo mínimo para as várias modalidades de engenharia quanto ao conteúdo, e estabelecia certos mínimos quantitativos, como a quantidade mínima de horas dos cursos, e o tempo mínimo de integralização curricular. Definia os conteúdos como matérias, e as Instituições de Ensino Superior deveriam incluir essas matérias em suas disciplinas, o que conferia certa flexibilidade para a organização dos currículos. Sua concepção de currículo era portanto de grade curricular.

As modalidades em engenharia eram divididas em um conjunto pequeno e fixo de habilitações, e as novas modalidades, ou variações, eram definidas como ênfases das habilitações. Essa estrutura, e sua nomenclatura, recebiam forte influência do exercício profissional, com prejuízo para a flexibilidade curricular.

A LDB

Em 20 de dezembro de 1996 foi publicada no Diário Oficial da União a lei 9.394 [5], conhecida como LDB, que estabelecia as Diretrizes e Bases da Educação. Essa lei desacopla o diploma de curso superior do exercício profissional, ao estabelecer em seu artigo 48 que *"os diplomas de cursos superiores tem validade como prova de formação recebida"*.

Ela estabelece também diretivas gerais para a educação que devem ser consideradas, pois tem relação imediata com nossa discussão sobre as diretrizes curriculares para os cursos de graduação em engenharia. Em seu início está posto que a educação deve ser "*inspirada nos princípios de liberdade e nos ideais de solidariedade humana, tem por finalidade o pleno desenvolvimento do educando, seu preparo para o exercício da cidadania e sua qualificação para o trabalho*". A seguir apresenta vários princípios básicos para o ensino, entre os quais a "*liberdade de aprender, ensinar, pesquisar e divulgar a cultura, o pensamento, a arte e o saber, o pluralismo de idéias e de concepções pedagógicas, a garantia de padrão de qualidade, a valorização da experiência extra-escolar, e a vinculação da educação escolar com o trabalho e as práticas sociais*". Com esses princípios a LDB estabelece uma visão da educação para a cidadania, que retomaremos mais adiante ao discutir as novas diretrizes curriculares.

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PRINCÍPIOS PARA A ELABORAÇÃO DE CURRÍCULOS

Uma discussão mais completa deste item pode ser encontrada em [8] e [12]. Vamos aqui começar por uma questão sempre colocada: a formação de engenheiros "adaptados" ao mercado de trabalho. Concordamos com essa questão, mas temos de discutir como se dá essa adaptação. Não de deve submeter os recém formados ao mercado profissional, de forma a terem sucesso em sua inserção nesse mercado, numa visão imediatista e individualista de sucesso. Em primeiro lugar porque se prepararmos, hoje, um currículo para o mercado atual, quando os alunos saírem, daqui a cinco anos, o mercado terá mudado e a adaptação terá sido destruída. Em segundo lugar porque a visão de sucesso deve ser social. Formamos engenheiros para utilizar os conhecimentos científicos e tecnológicos para melhorar o bem estar das pessoas, e fazer avançar a sociedade para outra sociedade mais solidária, humanista e em equilíbrio com a natureza. Em terceiro lugar porque o mercado evolui, e o engenheiro deve acompanhar ou estar à frente dessa evolução, portanto preparado para a evolução. Lopes [6] e Sousa [2] [3] propõem formar profissionais vinculados ao mercado de trabalho de uma forma crítica, de maneira que eles sejam fatores de inovação, uma massa crítica necessária para se chegar a uma nova sociedade.

Uma segunda questão é como preparar nossos egressos para que acompanhem a evolução dos conhecimentos tecnológicos, e sejam criativos nesse processo de produção de novos conhecimentos. Como a tecnologia está apoiada em algumas ciências, como a matemática, a física, a química e a biologia, entre outras, os currículos devem ter um forte embasamento nessas ciências, de maneira a dar aos egressos condições para dominarem as tecnologias e seus porquês, assim como sua evolução. Ao lado desse embasamento, é importante formar os engenheiros com uma atitude pró-ativa, renovadora, compromissada com a evolução dos conhecimentos e apta a produzi-los. Para atingir essa formação, desde o início o projeto pedagógico definido no currículo deve colocar a iniciativa do aprendizado no aluno, e em suas relações com o professor e os demais alunos. Um currículo pode ter lacunas no conteúdo, mas se o engenheiro for formado com iniciativa e forte base científica, poderá sanar essas lacunas. No entanto com falhas no embasamento ou na atitude pró-ativa, será um engenheiro estagnado.

Uma terceira questão refere-se aos desafios colocados atualmente para os que trabalham em tecnologia. Temos hoje conhecimentos tecnológicos para resolver os problemas básicos da sociedade, no entanto eles estão sendo agravados e está aumentando o fosso entre os indivíduos. A fome e a miséria nunca foram tão grandes, apesar de termos avanços espetaculares na bioengenharia, na nanotecnologia, na informática, nas telecomunicações, etc. Em reforma realizada em 1992 no "Worcester Polythechnic Institute", de Massachussets, EUA, foi considerado que o desafio central da engenharia americana era dominar o impacto da mesma sobre a sociedade americana [4]; por isso resolveram que na grade curricular, em todos os períodos do curso, pelo menos um terço do tempo seria dedicado a disciplinas da área de ciências humanas, exatamente para discutir com os alunos o impacto da tecnologia sobre a sociedade americana, e prepará-los para uma atuação socialmente inserida.

Uma quarta questão é a integração dos conhecimentos. Por uma questão de organização do currículo em disciplinas, o conhecimento necessário a um engenheiro é dividido entre as disciplinas. Na análise de sistemas sabemos que se dividirmos um sistema complexo em muitas partes, a agregação dessas partes não recupera todo o sistema original, pois algumas características do sistema poderiam estar apenas no todo. Com as disciplinas acontece algo similar. Cada disciplina é lecionada como algo estanque, com seus objetivos próprios, não está integrada em um processo orientado pelo perfil de engenheiro que se deseja formar. Ao "passar pelas disciplinas" os alunos muitas vezes não conseguem ver seus inter-relacionamentos, pois foram quebrados no particionamento do conhecimento em disciplinas. É necessário organizar atividades explícitas no currículo para a integração do mesmo, visando recuperar a visão global do conhecimento do engenheiro.

Uma quinta questão é a disputa entre formação especializada e formação generalista. Considerando a constante evolução da tecnologia e a necessidade de se ver a engenharia dentro de um contexto mais amplo, como está analisado em [2] e [3], deve-se optar por uma formação generalista que permita ao engenheiro trabalhar em novas áreas, em áreas interdisciplinares, desenvolver conhecimentos e se relacionar com outras áreas do conhecimento. A opção pela formação generalista não significa que não poderemos ter modalidades na engenharia. Elas podem existir, mas em toda modalidade deve-se trabalhar com uma visão generalista de engenharia, mesmo que isso provoque muitas sobreposições de conteúdos, principalmente dos conteúdos básicos.

Uma sexta questão retoma a visão crítica da engenharia. Algumas vezes os conhecimentos tecnológicos ou científicos são vistos e postos como verdadeiros, independentes da sociedade e neutros. O conhecimento em si não é bom ou mau, mas seu uso pode ser bom ou mau. Ao tomar uma decisão tecnológica, o engenheiro deve ter uma visão crítica que lhe permita ver a quem essa opção beneficia, a quem prejudica. Decisões podem ter fortes impactos positivos ou negativos sobre a sociedade ou sobre a natureza. Recentemente um navio petroleiro afundou nas costas da Espanha, vazando óleo e provocando novo desastre ecológico. Não foi a primeira vez, e sempre o desastre ambiental foi provocado pelo fato de serem navios sem duplo casco. A tecnologia do duplo casco permite que o óleo fique confinado nos tanques dos cascos internos, mesmo no caso de rompimento do casco externo. Portanto essa tecnologia já é conhecida, e esse novo acidente ambiental poderia ter sido evitado. Não o foi porque, por pressão dos grandes armadores, a exigência do duplo casco para navios petroleiros só será efetiva a partir de 2015. Sob o ponto de vista tecnológico podemos fazer navios com ou sem duplo casco, mas sob o ponto de vista ecológico está evidente que deve se optar pelo duplo casco. Se isso não é feito, é por interesses comerciais que se sobrepõem aos interesses ambientais.

AS NOVAS DIRETRIZES CURRICULARES

As novas "Diretrizes Curriculares Nacionais dos Cursos de Engenharia" [9], definem que "*o perfil dos egressos dos cursos de engenharia compreenderá uma sólida formação técnico científica e profissional geral que o capacite a absorver e desenvolver novas tecnologias, estimulando a sua atuação crítica e criativa na identificação e resolução de problemas, considerando os seus aspectos políticos, econômicos, sociais, ambientais e culturais, com visão ética e humanística, em atendimento às demandas da sociedade*". Definem também que os currículos deverão dar condições a seus egressos para adquirir competências e habilidades para:

- aplicar conhecimentos matemáticos, científicos, tecnológicos e instrumentais à engenharia;
- projetar e conduzir experimentos e interpretar resultados;
- conceber, projetar e analisar sistemas, produtos e processos;
- planejar, supervisionar, elaborar e coordenar projetos e serviços de engenharia;
- identificar, formular e resolver problemas de engenharia;
- desenvolver ou utilizar novas ferramentas e técnicas;
- supervisionar a operação e a manutenção de sistemas;
- avaliar criticamente a operação e a manutenção de sistemas;
- comunicar-se eficientemente na forma escrita, oral e gráfica;
- atuar em equipes multidisciplinares;
- compreender e aplicar a ética e responsabilidade profissional;
- avaliar o impacto das atividades da engenharia no contexto social e ambiental;
- avaliar a viabilidade econômica de projetos de engenharia;
- assumir a postura de permanente busca de atualização profissional.

Na estrutura do curso, as diretrizes exigem que cada instituição defina seu projeto pedagógico especificando como garantirá o perfil desejado dos egressos. Apontam para uma redução do tempo em sala de aula, para trabalhos de síntese e integração do conhecimento e para trabalhos complementares extras-classes como iniciação científica, estágios, visitas, projetos multidisciplinares, desenvolvimento de protótipos, monitorias, etc.

Quanto ao conteúdo, definem um "*conteúdo básico*", com cerca de 30% da carga horária, que deve versar sobre um conjunto enumerado de tópicos. Definem "*um núcleo de conteúdos profissionalizantes*" com cerca de 15% da carga horária mínima, que deve versar sobre um subconjunto de um conjunto de tópicos enumerados. Finalmente definem um "*núcleo de conteúdos específicos*" que devem caracterizar a respectiva modalidade, de livre escolha por parte das IES. O estágio curricular já previsto na Resolução 48/76 [1] é mantido, mas sua duração passa de 30 para 160 horas. Torna obrigatório o trabalho final de curso como atividade de síntese e integração de conhecimento.

A Resolução CNE/CES 11/2002 [10], publicada no Diário Oficial de 9/4/2002, regulamentou as diretrizes na forma de uma resolução, com seus artigos repetindo o que está definido nas diretrizes. Seu artigo 8o, no entanto, acrescenta a exigência de avaliação dos alunos por parte das IES baseada nas habilidades, competências e conteúdos curriculares definidos pelas diretrizes, assim como exige a avaliação dos cursos baseada nos mesmos princípios curriculares. Introduz portanto uma novidade em relação à avaliação dos alunos e dos cursos.

O documento que foi publicado divulgando as novas diretrizes é antecedido de um relatório que tem três trechos que vale a pena repetir.

O primeiro trecho define o novo engenheiro: "*O novo engenheiro deve ser capaz de propor soluções que sejam não apenas tecnicamente corretas, ele deve ter a ambição de considerar os problemas em sua totalidade, em sua inserção numa cadeia de causas e efeitos de múltiplas dimensões*".

O segundo trecho se refere à estrutura dos cursos de engenharia: "*As tendências atuais vêm indicando na direção de cursos de graduação com estruturas flexíveis, permitindo que o futuro profissional a ser formado tenha opções de áreas de conhecimento e atuação, articulação permanente com o campo de atuação profissional, base filosófica com enfoque na competência, abordagem pedagógica centrada no aluno, ênfase na síntese e na transdisciplinaridade, preocupação com a valorização do ser humano e preservação do meio ambiente, integração social e política do profissional, possibilidade de articulação direta com a pós-graduação e forte vinculação entre teoria e prática*".

Finalmente o terceiro trecho se refere ao Projeto Curricular: "*Na nova definição de currículo, destacam-se três elementos fundamentais para o entendimento da proposta aqui apresentada. Em primeiro lugar, enfatiza-se o conjunto de experiências de aprendizado. Entende-se, portanto, que Currículo vai muito além das atividades convencionais de sala de aula e deve considerar atividades complementares, tais como iniciação científica e tecnológica, programas acadêmicos amplos, a exemplo do Programa de Treinamento Especial da CAPES (PET), programas de extensão universitária, visitas técnicas, eventos científicos, além de atividades culturais, políticas e sociais, dentre outras, desenvolvidas pelos alunos durante o curso de graduação. Essas atividades complementares* *visam ampliar os horizontes de uma formação profissional, proporcionando uma formação sociocultural mais abrangente. Em segundo lugar, explicitando o conceito de processo participativo, entende-se que o aprendizado só se consolida se o estudante desempenhar um papel ativo de construir o seu próprio conhecimento e experiência, com orientação e participação do professor. Finalmente, o conceito de programa de estudos coerentemente integrado se fundamenta na necessidade de facilitar a compreensão totalizante do conhecimento pelo estudante. Nesta proposta de Diretrizes Curriculares, abre-se a possibilidade de novas formas de estruturação dos cursos. Ao lado da tradicional estrutura de disciplinas organizadas através de grade curricular, abre-se a possibilidade da implantação de experiências inovadoras de organização curricular, como por exemplo, o sistema modular, as quais permitirão a renovação do sistema nacional de ensino*".

FALHAS DAS NOVAS DIRETRIZES

Nas várias discussões sobre as diretrizes, além das competências e habilidades que definiam o novo perfil do engenheiro, foram incluídas também as atitudes esperadas desse novo profissional. Essas atitudes apresentadas nas propostas da Abenge, foram descritas em [8] como compromissos com:

- A socialização do conhecimento e a pluralidade de concepções;
- As necessidades sociais da maioria da população e a luta contra toda forma de exploração, opressão ou discriminação dos seres humanos;
- A ética profissional e a responsabilidade social e ambiental;
- A inovação e a atualização profissional permanente;
- Uma postura pró-ativa e empreendedora;
- A defesa das culturas e da sociedade brasileira.

Destes itens o único mantido foi o da atualização permanente. Alguns podem ser lidos nas entrelinhas do relatório, mas não permaneceram explicitamente nas diretrizes. Esta foi uma perda que muito prejudicou as diretrizes, pois definia o perfil de um profissional integrado a seu ambiente social, e com compromissos bem claros.

As diretrizes não quantificaram também a carga horária mínima do currículo, assim como seu tempo de integralização mínimo. Essa nos parece uma outra falha, pois o estudo de engenharia tem um tempo de maturação que deve ser respeitado. A própria lei ao se referir aos conteúdos, fixa percentuais para esses conteúdos, porém ao não estabelecer um tempo mínimo, deixa esses percentuais sem referências, podendo variar muito em valores absolutos, dependendo da carga horária total de cada curso.

No terceiro trecho do relatório, apresentado na seção quatro deste trabalho, foi colocado como esperança de renovação do sistema nacional de ensino, a possibilidade dos cursos seqüenciais. Essa afirmação é no mínimo discutível, pois os cursos seqüenciais podem entrar em contradição com os princípios defendidos pelas próprias diretrizes. Por exemplo, a integração curricular será mais difícil com módulos seqüenciais, pois estes reforçarão a segmentação do conhecimento em engenharia em módulos coesos, mas com pouco acoplamento com os demais. A vantagem da terminalidade dos módulos seqüenciais seria oferecer formações aplicáveis imediatamente. Exatamente por esta característica será difícil de introduzir módulos de ciência básica, módulos com interdisciplinaridade, módulos com integração com visões sociais e ambientais. A tônica nos currículos modulares será de módulos que "agreguem valor" ao estudante sob o ponto de vista profissional, portanto com visão tecnicista de aplicação imediata.

OS DESAFIOS

Apesar das críticas colocadas acima, as novas diretrizes curriculares são um avanço, se comparadas às anteriores. Elas consideram o currículo não como uma grade curricular, mas como o conjunto das atividades desenvolvidas para a formação dos engenheiros, e colocam no centro do currículo o perfil do profissional que devemos formar. Exatamente por estes motivos, as diretrizes colocam o desafio de como atingir o perfil definido. Para vencer esse desafio vamos discutir várias propostas.

Para formar um engenheiro pró-ativo, empreendedor, inovador, necessita-se de um projeto pedagógico que coloque o aluno, e suas interações, como o centro do processo educacional. A iniciativa educacional deve estar no aluno, com a orientação do professor. Podemos manter aulas tradicionais, expositivas, mas o centro do processo educacional deve ser baseado em atividades com ampla iniciativa por parte do aluno e com a orientação do professor, ou mesmo de outros alunos mais adiantados. Esta é uma evolução a ser tentada, sabendo-se que os professores não estão preparados para esse tipo de método. Em geral os professores repetem os métodos de seus antigos professores, baseados em aulas expositivas. Quando questionados sobre o método de ensino, em geral afirmam que ele é bom, mesmo que hoje 50% dos alunos de engenharia desistam e não completem o curso. Há portanto a necessidade de preparar os professores para essa nova proposta. Como o ensino não é valorizado nas universidades na mesma medida que a produção científica, é difícil convencer os professores a investir tempo para aprender novos métodos de ensino, principalmente quando interferem na relação com os alunos. A mudança nos métodos pedagógicos passa portanto pela valorização do ensino nas IES, e por esforços continuados na formação dos professores Há que se vencer também uma concepção simplista do ensino superior, que considera o domínio de um assunto como a condição necessária e suficiente para o ensino. Ela é necessária, mas não é suficiente. Para ensinar é necessário dedicar tempo e esforço, pois é uma atividade tão complexa como aprender. Para começar esta mudança, os espaços de discussão da educação em engenharia devem ser valorizados, assim como a atividade docente, e oferecidas facilidades para a formação dos professores.

Os currículos devem ser reformulados para permitir a interdisciplinaridade, fundamentalmente introduzindo disciplinas de humanidades nos currículos. Só essa medida no entanto não mudará a situação atual. Os estudantes não valorizarão essas disciplinas, se as IES continuarem a não valorizar essa área em suas atividades, se no cotidiano das IES não houver discussões sobre os problemas atuais da engenharia, que exijam os conhecimentos das áreas humanas. Sem isso, as humanidades serão vistas apenas como um verniz cultural que o engenheiro deve ter, mas não como uma base científica para uma visão crítica do trabalho do engenheiro na sociedade.

Outra possibilidade é incentivar que os aspectos sociais sejam discutidos em todas as disciplinas básicas e tecnológicas.

Um assunto interessante para discutir nos cursos de engenharia é a evolução do conceito de qualidade. Esse conceito começou como a conformidade de um produto com normas e exigências, evoluiu para o controle do processo de produção, na versão 2000 das normas ISO chegou ao que se chamou de "satisfação do cliente", portanto alargando o conceito de qualidade para toda a vida de um produto, e em alguns países o conceito de qualidade está integrando a relação dos produtos e dos processos de produção com a natureza e com a sociedade. Na Alemanha, por exemplo, a partir de 2004 as empresas serão obrigadas a receber seus produtos, ou o que restar dos mesmos, de volta. Este é o início da saída de um paradigma de processo de produção industrial que transforma bens naturais em bens artificiais para a satisfação das necessidades humanas, só num sentido, com o conseqüente esgotamento de recursos naturais e a degradação dos mesmos, para um outro paradigma em que o processo de produção deve estar em equilíbrio com a natureza. Podemos transformar bens naturais em artificiais, mas devemos aproveitar bens artificiais para gerar outros bens artificiais, como o aproveitamento de dejetos e lixos, e transformar bens artificiais novamente em bens naturais. Assim a qualidade de um processo será julgada não mais por seu produto, mas pela vida total do produto, e pelas interações desse processo e dos produtos com a natureza e com a sociedade.

Finalmente devem ser previstas na estrutura curricular atividades que integrem os conhecimentos desenvolvidos nas disciplinas do curso. O projeto final tornou-se obrigatório, o que é um bom passo, mas não é suficiente. São necessárias mais atividades durante o curso para realizar a integração dos conhecimentos.

CONCLUSÃO

As diretrizes curriculares foram um grande passo. O desafio agora é fazer com que os cursos de engenharia formem egressos com o perfil definido nas diretrizes. Neste sentido a valorização do trabalho docente e a inserção das IES na discussão dos problemas da engenharia atual são aspectos fundamentais. Sem esses aspectos será difícil mudar os projetos pedagógicos, e não chegaremos a engenheiros críticos, inovadores, pró-ativos e conscientes de suas responsabilidades sociais e ambientais. Ao mesmo tempo deve-se procurar facilitar a formação docente para a educação em engenharia, para permitir novas formas de ensino/aprendizado que coloquem o aluno e suas interações como elementos centrais no processo educacional.

O desafio é colocar a engenharia a serviço da sociedade, preservando a natureza. O desafio é utilizar a imensa capacidade transformadora acumulada pela humanidade a seu serviço. Este é o nosso desafio.

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SUPPORT SERVICE TO DISTANCE STUDENTS: THE IMPLEMENTATION PROCESS IN ONE BRAZILIAN DISTANCE EDUCATION INSTITUTION

2003

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Abstract *-The Distance Education Laboratory – LED, offers the structure and support to the distance education courses offered by the Post Graduation Program in Production Engineering – PPGEP. In order to offer the best support to its students, the Laboratory created a support structure based in collaborative work, where teachers and students are followed by a team from the beginning to the end of the course, as well as prepared to the correct utilisation of the media/technologies adopted. This article introduces the student support service model being implemented in the Distance Education Lab since 1997.*

Index Terms — *Distance Education,Internet, student support services, videoconference.*

INTRODUCTION

The widespread use of Distance Education – DE in Brazil observed from the beginning of the 90´s until now may be related to the changes in the regulatory process of Education, most specifically the so-called Lei de Diretrizes e Bases da Educação –LDB, that is the most important law regarding Education in Brazil was launched as Law 9.394, from December 20 1996 and is being continually refined in order to attend specificities identified by represented categories, and practitioners. One of the important points in this law is related to Teacher's Education, stating clearly that all teachers must have at least a College degree in order to work in K-12 education, and a Masters degree to work in universities, at the graduation level. For this reason, a significant amount of DE initiatives in Brazil are structured in order to attend this demand created by the LDB, and oriented to the improvement of Teacher's Education using different structures and media, and basically inside traditional universities.

So, the demand for DE reflects the changes that challenged Brazilian Education during the last decades, and the changes the country is passing through right now, that make the demand for professionals with a wide and specialized formation grow in an exponential way. There is a urge to supply the demand for places in Education for the adult workers looking forward to improve their formation, and to attend the many ones that had to leave school early in their lives to work, or for any other reason. They all have the right to Education, and the public and private institutions are making many efforts in order to get every one that needs or wants to study inside a classroom – traditional or virtual.

In this article, we describe some aspects of the experience of the Distance Education Laboratory –LED, of the Federal University of Santa Catarina –UFSC, a traditional public university located in Florianópolis, South of Brazil. In a open view, the experience with DE being developed in the UFSC is attending a identified demand related to very specific and technical areas, but if analysed more closely, that experience is also attending the demands for Teachers Education, and general Adult Education. Our main focus inside this experience is the implementation of the student's support services structure, describing the process, and the role of the professionals involved in this work. That is the purpose of this paper.

STUDENT SUPPORT SERVICE IN DISTANCE EDUCATION

The fundamental importance of an organised student's support service has been pointed out by many authors writing in the DE (Distance Education) field [1]; [2]; [3]; [4]; [5]. However, if there is agreement about the importance of such a structure, there is no definitive model for that. Each DE institution will invest in the development of its own model based on the characteristics of the students it serves [6]; [7]; [8]; [9].

There is an established necessity to offer support services for distance students, since these are pointed as the main alternative to reduce the high rates of dropout that characterizes DE. In the 2001 ICDE – International Council of Distance Education Conference in Düsseldorf, Germany this discussion

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was the main theme of the sessions dedicated to student support, where the majority of the works presented exposed the long range planning to reduce the scaring dropout rates using student support, especially in the case of the Mega Universities as the Open-UK [10]. Also, [6] showed the dropout numbers at the Athabasca University, Canada, that rise to 75% in order to illustrate how important is for any DE institution a well organised student's support structure.

Still pointing out the importance of the student support services in DE, the work of Ormond Simpson [4] describes how the student support service is organized in the OUK (Open University – UK), one of the most widely recognized DE institution in the world. Also, [4] pointed out that in Open and Distance Learning (ODL) the student support services may be related to a wide range of activities, from counseling to academic orientation. However, this tendency to define this area in a very open way does not deny its importance in DE. It implies that it is a really wide area, and according to [11], it involves activities before the student even registered to the course or discipline, like information about the courses, the University/institution, and about studying at a distance.

The importance of this area for the success of any DE initiative also appears in [12], where that author affirms that "We must aim for the provision of services which are appropriate to the external cohort we are serving, while recognizing that we should not attempt merely to replicate on-campus learner support services via technology" (75).

STUDENT'S SUPPORT SERVICES IN THE DISTANCE EDUCATION LABORATORY - LED

The creation of LED in 1996 was a direct result of the Strategic Planning established by the PPGEP in 1985, where the necessity to invest in new technologies, and new modalities to Engineering Education in order to be more close to the productive sector was underlined.

The moment when the LED was created was very favorable to the development of DE initiatives inside Brazilian universities, and more intensely applied to Post Graduation programs, since the existing demand was expressive [13]. Also, at that moment was very clear a growing demand for programs offered at a distance or with more flexible modalities in knowledge areas where the PPGEP was specialized, as Logistics, Entrepreneurship, and Media and Knowledge. Media and Knowledge is a teaching and research area that started to be developed in Brazil in the PPGEP, being related to the production and distribution of knowledge, DE, and the use of Information and Communication Technologies in Education.

In order to attend the identified demand a decision was made regarding the technologies to be used, and videoconference was selected as the core media to be used to offer Post Graduation courses at a distance. This choice was made based on the interactive possibilities of this media, that allows the synchronous communication by audio and video, of people that are located in different places. In a country with the Brazilian dimensions and cultural diversity, it proved to be very effective. Also, the established model used Internet based communication and information tools, and printed materials. Another important characteristic of the DE initiatives in the LED was the decision to make alliances and partnerships with different institutions and companies, aiming at the creation of a network that could attend all the Brazilian territory, offering the registered distance students the best possible service in their local place of study.

In this context, LED's "student support service" structure was created in July, 1997, when the first Post Graduation Program at a Distance, a Masters Degree to be offered to Engineers and technicians of Petrobras, the Brazilian Petrol Company was being implemented. This first program, called "Technological masters in Logistics", was the first structured experience of LED, served as the basis to the creation of the "Presencial Virtual" model, distinguished by the Brazilian Association of Distance Education (ABED) with it's Prize of Excellence in 2002. The perception that there was a need to offer technical, social, and administrative support to the students and teachers involved in the DE program led to the creation of the first working team that was responsible for the elaboration and distribution of supporting material – online manuals, guides, routines, calendar, etc. - and for the preparation of students and teachers to use the technologies adopted – videoconference and the Internet.

This initial phase was very intuitive since it was still difficult to find references in the available literature that could help to define the best pathway to be followed because of the very specific characteristics of the experience being developed – using videoconference, offering a complete Post Graduation program at a distance, attending working students. Also the benchmarking with Brazilian and international institutions working with DE showed that every single one has a different model, a different structure, specially in the area of student support. All of the previously quoted factors were very influential in the decision to develop a local model.

The first student support structure established in the Laboratory had only three professionals allocated to do all the work related. This group had a very wide array of responsibilities, and a great lack of references, of research to support their work. So, besides the direct work with students and teachers, this group started to make some related readings, benchmarking research, and to register the process, studying and learning, and gradually becoming a reference itself inside the Laboratory.

Until the end of 1997, LED offered technical and pedagogical support and structure for two Master's programs with a total of 49 students and not more than four professors for each trimester. However, in the first trimester of 1998, more three new programs had been implemented. As a consequence, the number of students to be supported started to rise. At that moment, the necessity of establishing a more organized and defined structure to support students and teachers involved in the programs was perceived as urgent. New professionals were contracted, and the role and function of the monitor (student supporter) started to be defined, the model of student support as monitory was implemented [14].

Once the importance of the student support structure was recognized, the team responsible for the students and teachers support in the LED was identified as the Monitoring and Research Team. Like all the other teams working in the Laboratory, this team is formed by professionals form very different backgrounds, like Sociology, Psychology, Engineering, and Pedagogy. All of them are Graduate students, and are doing their Master or Doctorate researches in areas related to DE, and Adult Education.

Since the "turning point" in 1998, where the fundamental questions were identified, the professionals working with student support inside the Laboratory are dedicated to three main lines of activities: informing, following, and answering students and teachers in the different models of courses offered, form Internet to printed materials. It is important to make it clear that in this work we are looking at the implementation process of the student support services in the Laboratory as a whole, but with a focus on the experience with Masters programs using videoconference and the Internet. These activities may be described as related to the keeping the students motivated, stimulating the communication and interaction among the students outside classroom time, and helping students and teachers to learn how to use the different media applied to the courses.

The importance of motivation to distance education students was discussed by some authors [15]; [16]; [17]; [18]. For this reason, the student support team invests in many activities to keep the students motivated, specially by using all the media the students have access to interact with them, and to make every student feel that there is somebody that is concerned with her/his success in the studies, sending motivational messages, helping and answering in a timely and cheerful way. The most important thing for a monitor is to establish a contact with the students he/she is responsible for, making them understand that they are part of a group, and that everyone is trying to make the best they can. To build that situation of empathy, the monitor that is responsible for a group usually has a face-to-face meeting with the students in the beginning of the course. This kind of activity already proved o be very important in order to create a sense of proximity and confidence between the students and their monitor [18].

The report wrote by [19] shows the results of a research done with a group of students of the Laboratory, where she found out that the motivational role of the support team is highly valued by the students, specially related to the utilization of the technologies (4.64 points in the used Likert scale), and in keeping the motivation (4.08 points in the used Likert scale).

An important point related to the motivational role of the LED's student support team is related to the practice of process evaluation established in the Laboratory since its creation, in 1995. All courses, and all disciplines offered are evaluated at least once. The process of evaluation is digitalized, where the students can access the online forms from any place, answer it, and in a very short period, have the answers of all the group analyzed together in a final report produced by the monitor. From 1997 to 2001, 71,2% of the disciplines offered where evaluated, and the results of this evaluation process used to solve the identified problems, and improve the process, attending the students demands [19].

Also, in the beginning of each new course a diagnostic evaluation is made, in order to have some basic information about the students, the so-called "Perfil da Turma", what helps the planning process, for the support team, and for the teachers involved. Knowing the students background, their previous experience with the media applied in the course, and their motivation to take the course, makes it easier to offer a personalized service to all students of the group.

The other two lines of activities developed by the LED's students support team - stimulating the communication and interaction among the students outside classroom time, and helping students and teachers to learn how to use the different media applied to the courses – may be seen as a unique block. In order to stimulate the communication of the group of students outside classroom time, the monitor is also stimulating the use of the different media adopted in the course. Using the Internet, or the telephone, or videoconference, the students may interact among them, do their activities in a cooperative and collaborative manner, contact the teachers, and exchange reference material, among other things. The role of the monitor (student supporter) is to make the students – and teachers – feel that all the technical or operational problems will be quickly solved, and that they can dedicate themselves only to learn and teach, always at a distance, but feeling close. It is important that the interactive communication process goes as smoothly as possible, so the mediating technology seems invisible [21].

CONCLUSION

LED's experience in offering DE courses, specially Post Graduation courses by videoconference and Internet, points up to the importance of offering to students and teachers a well structured support service, and well prepared professionals, trained to attend the constant demands in a timely and sympathetic way. A result of the work being done by the student support team in the Laboratory is the number of students that evaluated the support structure as Excellent or Very Good in the evaluations done since 1998 – 71% of the students enrolled [20].

It is important to say, in order to conclude, that the activities related to student support in DE cannot be seen as static, it is a dynamic process that needs to be permanently improved, adapted to new students, new situations, and specially, the new possibilities of communication and interaction at a distance offered by the new technologies, always evolving.

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LEARNING STYLE IN THE CLASSROOM: A RESEARCH-GUIDED APPROACH

Teresa L. Larkin[1]

***Abstract* — *This paper will explore relevant research which documents that a learning style approach in the classroom can lead to enhanced learning gains. Particular emphasis will be placed on the Dunn and Dunn Learning Style Model. The basic tenets of this learning style model will be highlighted. The Dunn and Dunn model forms the basis of the Productivity Environmental Survey (PEPS) which is a valid and reliable learning style instrument. The PEPS is currently being used as a research tool within the introductory physics course for non-majors at American University. Two teaching approaches which have been developed based on a learning style approach will be shared. These approaches include the use of writing as well as interactive on-line discussions using Blackboard technologies. Ideas for effective adaptation of these approaches by educators in other branches of science, as well as mathematics, engineering, and technology (SMET) education will be discussed.*

Index terms — Learning style, writing, assessment, student learning, on-line discussions.

INTRODUCTION

The rapid changes that are continuing to occur in modern society, and in academia in particular, suggest that learning must be a continuous process. A growing body of research on adult learners suggests that increased learning gains can be achieved when instruction is designed with students' learning styles in mind [1]-[6]. In addition, several practitioners within the domain of physics as well as engineering education have noted the importance of teaching with learning styles in mind [7]-[14]. Attention to learning styles and learner diversity in the classroom has also been shown to increase student interest and motivation to learn. Increasing student interest and motivation to learn may lead to enhanced learning.

The particular population of students that encompasses the focus of this paper is non-science majors taking introductory physics at American University. Most students take this introductory physics course to satisfy the university's General Education Natural Sciences requirements for graduation. Because the backgrounds and ability levels of the group of students that elect to enroll in this course is quite broad-based and diverse, it is anticipated that the teaching and learning strategies to be described in this paper can be adapted for use with other populations of students as well. The underlying message is quite simple - a learning style approach CAN be successfully applied with ANY population of students.

This paper addresses the critical role that a learning style approach can play in terms of teaching introductory physics. A detailed overview of the learning style model used by the author will be provided. In addition, two specific teaching and learning strategies developed, in part, from current research on learning styles will be highlighted. These strategies involve extensive use of writing as a teaching and learning tool as well as the use of live, online chats using Blackboard technologies. Student perceptions regarding these strategies will also be shared. It is anticipated that these teaching and learning strategies can be adapted for use within the international community of science and engineering educators.

DESCRIPTION OF STUDENT POPULATION

The introductory course for non-science majors at American University in Washington, D.C. is entitled *Physics for the Modern World (PMW)*. PMW is a large enrollment, one-semester, algebra-based course. Topics covered in PMW typically include kinematics, Newton's Laws, conservation of momentum and energy, rotational motion, fluid mechanics, waves, and sound. Although traditional in its content, the course is not taught in a traditional lecture format. Many traditional teaching methodologies have clearly been shown to put students in the role of passive rather than active learning [15]. Numerous teaching strategies are used which correspond to the accommodation of students' needs and diverse learning styles [16]. The use of a variety of teaching strategies is very desirable, especially in a large enrollment course. In addition, the course includes strong conceptual and problem solving components.

PMW is a 3-credit course and consists of a lecture and a laboratory component. Students meet twice a week for class sessions that are 75 minutes long. On alternate weeks students meet for a two hour laboratory. Approximately 120 students, with 60 students in each of two sections, enroll in the course each semester. Of this enrollment, roughly 20% of the class is made up of international students.

Attention to learning style and learner diversity begins on the first day of class and continues throughout the semester.

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Students are given a learning style assessment on the first day of class. The assessment is completed by the students and returned for analysis during the next class period. The analysis process takes approximately one week at which time students are given an individualized learning style profile for their use. Students are also asked to write about their individual learning style preferences for their first writing assignment. Before a more detailed discussion of the specific teaching and learning strategies that utilize a learning style approach can be outlined, a description of learning style and the learning style model that is used in PMW will be presented.

LEARNING STYLE DESCRIBED AND DEFINED

What exactly is a learning style? Several definitions of learning style currently exist. Keefe [17] defined learning style as being characteristic of the cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment. Learning style is a gestalt of combining internal and external operations derived from the individual's neurobiology, personality, and development which are reflected in learner behavior. Learning style also represents both inherited characteristics and environmental influences.

Dunn [18] described learning style as "... the way each learner begins to concentrate, process, and retain new and difficult information" (p. 224). She noted that this interaction occurs differently for everyone. Dunn also highlighted that "To identify and assess a person's learning style it is important to examine each individual's multidimensional characteristics in order to determine what will most likely trigger each student's concentration, maintain it, respond to his or her natural processing style, *and* cause long-term memory" (p. 224). The assessment of individual student learning styles provides both the student and the instructor with valuable information regarding factors that influence learning.

Dunn [19] has suggested that the uniqueness of individual learning styles could be thought of as a fingerprint. She said "Everyone has a learning style, but each person's is different - like our fingerprints which come from each person's five fingers and look similar in many ways" (p. 27). Interestingly, Sternburg [20] indicated that an individual's learning style can be compared to her/his ability and is therefore not etched in stone at birth. In fact, a person's learning style can change over time as a result of maturation [21]. Kolb [22] has suggested that "As a result of our hereditary equipment, most people develop learning styles that emphasize some learning abilities over others." (pp. 76 – 77).

Dunn contended that strong preferences can change only over a period of many years and that preferences tend to be overcome only by high levels of personal motivation. She further asserted that teachers cannot identify students' styles without the use of appropriate instruments. Assessing an individual's unique style is vital to the teaching/learning process. A significant number of research studies have shown that students instructed in a classroom environment where individual learning differences are acknowledged and accepted are more receptive and eager to learn new and difficult information [23 – 28]. Dunn also suggested that a match between a student's style and a teacher's style will lead to improved student attitudes and higher academic achievement. A description of the Dunn and Dunn learning style model employed with students enrolled in PMW is given in the next section.

DESCRIPTION OF THE DUNN AND DUNN LEARNING STYLE MODEL

Many different learning style assessment models and instruments are available. De Bello [29] indicated some models are multidimensional, encompassing cognitive, affective, and psychological characteristics, and others are limited to a single variable, most frequently from the cognitive or psychological domain. This section will focus on the learning style model developed by Dunn and Dunn [30] as shown in Figure 1 and the associated learning style assessment instrument developed by Price, Dunn, and Dunn [31].

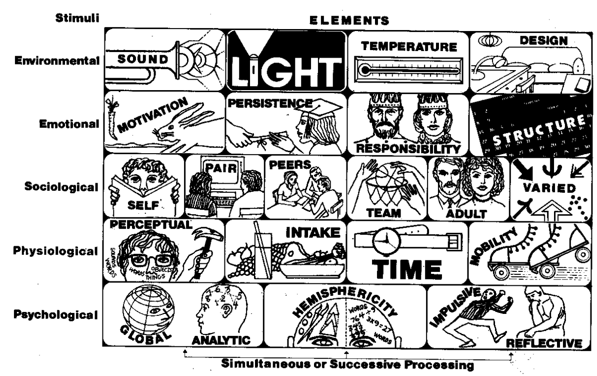

FIGURE 1.
THE DUNN AND DUNN LEARNING STYLE MODEL

Price, Dunn, and Dunn suggested that productivity style theorizes that each individual has a biological and developmental set of learning characteristics that are unique. They further suggested that improvements in productivity and learning will come when instruction is provided in a manner that capitalizes on an individual's learning strengths. Attention to learning styles does not mean that a student should only be taught through their strengths, however. The utilization of a variety of teaching strategies helps to ensure that students have an opportunity, at least a portion of the time, to learn new and difficult information through their strongest preferences while simultaneously allowing them an opportunity to build up and enhance their weaker preferences.

As a model, Price, et al. indicated that productivity style embraces several general principles that they state in the form of philosophical assumptions:

1) Most individuals are capable of learning.
2) The learning conditions in which different individuals learn best vary extensively.
3) Individual learning preferences exist and can be measured reliably.
4) Most students are self-motivated to learn when they have the option of using their learning style preferences and experience success.
5) Most teachers can learn to use individual learning styles as a basis for instruction.
6) When selected teachers are not capable of learning to use individuals' learning styles as a basis for instruction, students can be taught to teach themselves and, thus, bypass their teachers' styles.
7) Use of individual learning style strengths as the basis for instruction increases learning and productivity. (pp. 21 -22)

As De Bello noted, the basic tenet of the Dunns' model is that individual styles must be assessed, and, if a student is to have the best opportunity to learn, instructional techniques must be used that are congruent with each student's style. Not all theorists agree with this tenet because they feel it is extreme. Other theorists wrestle with the question of whether we should teach to an individual's strengths or try to help them develop their weaknesses. The best answer is actually both. One of the best ways, especially in large classes, to teach to individual students' strengths is to use a variety of instructional styles and modes of delivery.

The learning style assessment instrument chosen for this study is the Productivity Environmental Preference Survey (PEPS) by Dunn, Dunn, and Price. This instrument was chosen because of its comprehensive nature, and, because of the relative ease of assessing students and interpreting the results. The PEPS was developed from the Dunn and Dunn Learning Style Model and is described in the following section. As Figure 1 shows, the Dunn and Dunn Learning Style Model is based on five different stimuli: (1) Environmental, (2) Emotional, (3) Sociological, (4) Physiological, and (5) Psychological. These categories provide the basis for the elements displayed in the feedback profile obtained after student responses to the PEPS have been scored.

The Dunn and Dunn Learning Style Model has had widespread use with adult learners, however its use in physics as well as other branches of science and engineering education has been quite limited. As a result, the use of this model in physics, as well as in other branches of science and engineering education becomes even more interesting to study.

THE PRODUCTIVITY ENVIRONMENTAL PREFERENCE SURVEY (PEPS)

The PEPS consists of 100 questions on a Likert scale. This instrument uses a standardized scoring system that includes scores that range from 20 to 80. The scale is further broken down into three categories. These categories are referred to here as Low, Middle and High and are represented in Figure 2. The Low category represents standard scores in the 20 - 39 range; the Middle category scores in the 40 - 59 range; and the High category scores in the 60 - 80 range. Individuals who have scores lower than or equal to 40 or higher than or equal to 60 for a particular element find that variable important when they are working. Individuals who have scores in the Middle category find that their preferences may depend on many factors such as motivation and interest in the particular topic area being studied.

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            PRODUCTIVITY ENVIRONMENTAL PREFERENCE SURVEY

                       INDIVIDUAL PROFILE              PAGE 1 OF 7

   NAME: STUDENT                                  DATE: 06-03-2002

   SEX:                    GRADE:                 BIRTHDATE:
                                                           YR/MO

     *********************     SCALE     *********************

  SCORE  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
   RAW  18 22 18 13 25 21 35  6 12 17 16 12 24 17 20 29 29 10  6 22
   STD. 58 52 54 41 63 61 68 44 37 66 55 52 59 63 63 64 55 55 45 63

 *************** P R E F E R E N C E   S U M M A R Y ***************

     20        30        40        50        60        70        80
     +---------+---------+---------+---------+---------+---------+
   1 /    Prefers Quiet    /    NOISE LEVEL   -*-/    Prefers Sound    /  1
   2 /     Prefers Dim     /       LIGH-*-       /   Prefers Bright    /  2
   3 /     Prefers Cool    /    TEMPERATU-*-     /    Prefers Warm     /  3
   4 /   Prefers Informal -*-     DESIGN         /   Prefers Formal    /  4
   5 /         Low         /    MOTIVATION       / -*-     High        /  5
   6 /         Low         /    PERSISTENT      -*-        High        /  6
   7 /         Low       RESPONSIBLE(CONFORMING)        -*-igh         /  7
   8 /    Does Not Like    /   -*-TRUCTURE       /         Wants       /  8
   9 /   Prefers Alone -*- /    ALONE/PEERS      / Prefers With Peers  /  9
  10 / Does Not Want Pres  / AUTHORITY FIGURES   /   W-*-s Present     / 10
  11 / Does Not Learn In   /    SEVERAL WAY-*-   /  Prefers Variety    / 11
  12 /  Does Not Prefer    /      AUDIT-*-       /         Prefers     / 12
  13 /  Does Not Prefer    /       VISUAL      -*-         Prefers     / 13
  14 /  Does Not Prefer    /      TACTILE        / -*-     Prefers     / 14
  15 /  Does Not Prefer    /    KINESTHETIC      / -*-     Prefers     / 15
  16 /  Does Not Prefer    /       INTAKE        /  -*-    Prefers     / 16
  17 /  Prefers Evening    /    TIME OF DAY-*-   /  Prefers Morning    / 17
  18 /  Does Not Prefer    /  LATE MORNING-*-    /         Prefers     / 18
  19 /  Does Not Prefer    /    -*-TERNOON       /         Prefers     / 19
  20 /  Does Not Prefer    /      MOBILITY       / -*-     Prefers     / 20
     +---------+---------+---------+---------+---------+---------+
     20        30        40        50        60        70        80

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FIGURE 2.
RESULTS OF THE PEPS (REPRINTED WITH PERMISSION)

Looking at one specific example, within the category of environmental stimuli are the elements of sound, light, temperature and design (formal versus informal). The elements within this category are self-explanatory. This category is one that is difficult to accommodate in the classroom. However, learners can easily satisfy their preferences when working outside of class. For example, a score ≥ 60 for the element of sound would mean that an individual has a preference for sound when learning new and difficult information. An individual could accommodate their preference for sound by listening to soft music. A score ≤ 40 on the sound element would imply that an individual does not show a preference for sound and thus should work in a quiet environment (using earplugs if necessary). A score in the middle category means an individual might prefer sound at one time, and not at another. In this case, an individual's preference would depend on other factors.

Once the PEPS has been administered, students receive an individual feedback profile as quickly as possible. Students must immediately be made aware that no high or low exists on this scale in terms of superiority of scores. Furthermore, no scores are bad scores - all are simply unique. No scientific evidence shows that one type of learning style is academically superior over others.

Numerous research studies [32] have documented the reliability and validity of the PEPS. Dunn and Dunn [33] posited that research on their model is more extensive and more thorough than research on many educational topics. As of 1998 research utilizing their model had been conducted at more than 112 institutions of higher education, at all levels K - college, and with students at most levels of academic proficiency, including gifted, average, underachieving, at-risk, dropout, special education, vocational, and industrial art populations.

Dunn, et al. [34] performed a meta-analysis of the Dunn and Dunn model of learning style preferences. They reviewed forty-two different experimental studies conducted with the model from 1989 to 1990. Their results indicated that overall academic achievement of students whose learning styles have been matched can be expected to be about three-fourths of a standard deviation higher than those of students whose learning styles have not been accommodated. Further, when instruction is compatible with students' learning style preferences, the overall learning process is enhanced.

The need to identify individual learning styles through formal assessment has never been more important than it is at present. Instruction responsive to individual learning styles is especially critical as the pool of students who enroll in introductory physics classes becomes more and more diverse. The following section highlights two instructional approaches developed for use with introductory physics students. The underpinnings of each approach are grounded, in part, in the results of current research on learning styles.

TEACHING AND LEARNING APPROACHES: STRATEGIES TO ENHANCE STUDENT MOTIVATION AND INTEREST

All students enrolled in *Physics for the Modern World* at American University are given the PEPS at the beginning of the semester. Students receive a computerized individual feedback profile approximately one week after that. This profile is similar to a prescription in that it identifies categories (based on the Dunn and Dunn Model) in which students have strong preferences and gives them information as to how to best utilize these strengths. Students are also extended an invitation to visit with the instructor individually regarding their learning style profiles. The instructor also maintains a copy of each student's profile and makes use of that when working with them individually during office hours.

Teaching approaches utilized in the introductory physics course have been designed, in part, using the Dunn and Dunn Learning Style Model. Two unique teaching approaches will now be described. One approach involves a writing activity developed by the author called a *folder activity.* A second approach involves the use of a live, interactive, online chats that make use of Blackboard technologies. These approaches are described in the following sub-sections.

Approach (1): Writing Activities

The first teaching approach to be described involves the use of writing and is called a *folder activity*. Writing has long been established to be an effective means of expressing one's ideas, thoughts, and understanding about nature and the world. The folder activity was developed by the author more than 10 years ago to help students elicit and confront their misconceptions in physics in a non-threatening way [35]. This is particularly important as science classes are often viewed by many students as threatening and intimidating places to be. The folder activity also allows students to be creative and use their unique learning style preferences when they prepare their written responses. Writing can also be a very effective vehicle for allowing students to develop and enhance their critical thinking and problem solving skills.

As part of their homework assignments, students are required to keep a two-pocket folder. Students receive 5 - 10 writing assignments each semester. Upon collection of the folders, a block of time is set aside (approximately 6 - 8 hours) to read them and provide each student with written feedback. This direct written feedback is absolutely essential. When students take time to reflect on their writing and on the instructor's comments, the folder becomes a highly effective tool in helping them uncover and then wrestle with their misconceptions while the learning is actually taking place. Typical folder activities range in length from 1 - 4 pages. To eliminate some of the burden on the instructor of reading 120 papers at a time, assignments are sometime alternated between sections. For example, a folder assignment might be given to the first section *prior* to the introduction of a new topic, and the same assignment given to the second section *after* discussion of the topic has take place. This strategy allows the instructor to gauge where students are at in terms of their understanding of a topic before and after it has been covered in class. If the students' writing shows that they have not made the desired progress on a particular topic, additional class time can be devoted to reinforcing it.

The specific emphasis of the writing activities depends on the goals and objectives for a particular topic or content area. For example, for some activities students are asked to explain a problem or a concept that was highlighted or discussed during a class session. Thus, students essentially have the "answer" to the problem in their hands when they write up this folder assignment. The rationale for this type of activity is that learning can be enhanced when students take on the role of teacher through their detailed written responses and explanations.

An additional example of a typical folder activity involves the creation of sample exam questions. In addition to writing a question, students must explain their choice of responses (i.e. for multiple choice questions) including the reasoning behind both the correct response as well as the incorrect options. In some cases, exemplary student exam questions are organized and distributed to the entire class as a means of a review. The student sample exam questions are never actually used on a classroom quiz or exam. The questions are simply used to help enhance student understanding.

Students are always encouraged to share their understanding of a particular topic or concept in their own words. Thus, students are not pressured to bog their writing down with a lot of scientific jargon. This provides a much clearer window into the students' thoughts and to their level of understanding and often offers deeper insight than can be ascertained from traditional paper and pencil assessments. Interestingly, as the semester progresses, the students begin to naturally make correct use of more sophisticated scientific terminology in their writing.

An important aspect of the folder activities is that students are permitted to be as creative as they would like to be. They are encouraged to write their responses in a fashion that allows them to make use of their individual learning styles. For example, some students like to enhance their writing through the use of manipulatives and artistic drawings. Other students choose to write their responses in the form of a story, a poem, or a short play. Students know that they have complete control of this activity and are free to put their learning styles to good use. Students also know that they don't receive any type of "bonus" for being creative. However, allowing a good of flexibility with the format of the writing offers more students an opportunity to demonstrate their understanding of a topic or concept in a manner best suited to their particular styles of learning.

The assessment of the folder activities is somewhat unique in that students are not penalized for incorrect use of physics. Not penalizing students helps make the folder activities non-threatening. The written feedback provided by the instructor indicates to the students that their writing is taken very seriously, and that it should be used as a vehicle to promote understanding. In addition, numerical scores are not put on students' papers until the end of the semester. The intent here is to get the students to pay attention to the written feedback from the instructor and not the grade they received. For example, if a student received a score of 17/20 on an assignment they might be tempted to say to themselves "Well, 17/20 is a pretty good score, I'm happy with that" and then never look at the assignment again. Then later on, the 3 points they missed come back to haunt them on an exam, only the 3 points have now magnified into many more points.

The bottom line is that students need to be encouraged to take the time to understand the flaws in their thinking and if they simply file a graded assignment into their notebooks without taking the time to seriously look at it, then no real learning is taking place. Students are provided a grading rubric in the course syllabus and they understand that as long as they complete the assignment according to the prescribed directions, they will receive full credit. The purpose of this grading scheme is to encourage students to think deeply about the comments they have received and then do whatever they need to do to correct any problems with their thinking and understanding of a particular topic or concept. Thus, the folder activities give students an opportunity to learn from their mistakes without risk of penalty. Students are very comfortable with this grading scheme, and genuinely enjoy receiving the written feedback provided on their folder assignments. In fact, students often times bring their folder assignments in during office hours once they have received the written feedback in order to address the flaws that might have existed in their thinking.

Approach (2): Interactive Online Chats Using Blackboard Technologies

The second teaching approach used with introductory physics students involves the use of live, interactive online chats using Blackboard technologies. This approach was piloted during the fall 2002 semester. The *Blackboard Learning System*™ [36] is a technology platform aimed at achieving several objectives including:

1) Measuring and improving student performance.
2) Increasing instructor productivity.
3) Enabling "Web-enhanced" classroom-based teaching and learning.
4) Delivering distance learning.
5) Supporting lifelong continuing education.
6) Blending the benefits of face-to-face and online learning through the use of hybrid courses.
7) Leveraging technology to enhance institutional competitiveness, applicant selectivity and retention.
8) Providing a platform framework that integrates course and learning management capabilities with an organization's student information, security, and authentication protocols.

9) Providing a framework for managing an institution's digital assets and content. (p. 3)

The *Blackboard Learning System*™ also features an online environment that has been designed to supplement either traditional learning or distance learning. Through an intuitive interface, instructors are able to manage online environments for teaching and learning by using the following utilities:

1) Content Management and Content Sharing.
2) Assessment Management.
3) Gradebook.
4) Collaboration and Communication.
5) Assignment and Portfolio Management. (p. 4)

Blackboard Inc. recently announced the charter release of the *Blackboard Learning System ML*™ in Brazilian Portuguese [37] in October 2002. The *Blackboard Learning System ML*™ is a multi-language edition of the company's market-leading course management system. Other languages available through this system include Chinese, French, German, Japanese, Spanish, and English. In addition, others including Dutch, Italian, and Korean are currently being developed. Thus, the global nature of this learning environment has broad ranging potential for use at the international level.

The particular feature to be explored in this paper involves the collaboration and communication utility of Blackboard. During the fall 2002 semester all students in PMW were enrolled in a course-specific Blackboard site. Students had immediate access to course documents such as syllabi and assignments. The instructor was able to communicate with all students by email through the Blackboard site to send reminders, announcements, etc. In addition, the Blackboard site provided a forum for interactive online chats. The chats are similar in nature to AOL *Instant Messenger*™ (AIM) [38] that is so commonly used by students to chat with their friends on the web. With AIM the chats with friends appear on separate screens. Thus, if a student is chatting with several friends simultaneously, the desktop contains a screen for each person they are chatting with. The unique feature of Blackboard is that the instructor and students can chat on a single screen. This feature allows for a continuous discussion to take place between everyone logged into the chat.

The online chats provide a useful way of allowing for peer-, rather than instructor-given feedback. In addition, online chats allow students to use a different form of writing to communicate with their peers. The online chats have also proven to help students elicit and confront their misconceptions [39]. The most common use of the chats has been for the discussion of homework questions. During the semester, chats were routinely scheduled for days that coincided with when homework assignments were due. The chats were set up on different days and at different times each week so as to allow more students an opportunity to participate. The chats were not required, but rather they were advertised as an additional way for students to get assistance on their homework when they needed it. One feature of Blackboard allows the instructor to prohibit anonymous postings. Thus, each chat participant was recognized by name. During the chats students would often refer to each other by first name. This recognition created a very professional working environment for the online chats.

The format of the chats consisted of a student(s) posting a specific question to the group. Other members of the class were then free to jump in and offer the student help and advice. If the students fell off course with their discussion, the instructor would offer some guidance and attempt to steer the discussion back on track. Oftentimes the instructor would make use of Socratic dialogue techniques during the chats. Hake [40] developed the Socratic Dialogue Inducing (SDI) lab method which combines interactive engagement teaching and learning strategies with various forms of hands-on experiences. The SDI method was the outgrowth of the work of Arons [41]. Much of Arons work stemmed from the work of cognitive science and often blended ideas from scholars such as Socrates, Plato, Dewey, and Piaget. SDI labs have proven to be an effective way to guide students to a more solid conceptual understanding of Newtonian Mechanics [42]. Hake has suggested that the SDI method might be characterized as "guided construction" rather than "guided discovery" or "inquiry". Through the online chats the instructor encouraged guided construction by posing frequent, probing questions to the students. The instructor also used the chats to facilitate a "think out loud" protocol in which both the students and the instructor could offer assistance and guidance to a particular student's question or comment. This strategy appears to be a very effective way to assist students in confronting their personal misconceptions about a particular topic or concept.

Typically about 20 students would log into the online chats. This represents approximately 15 – 20 % of the total number of students enrolled in the PMW class. However, this number is potentially misleading as many more students took advantage of the discussions generated during the chats. A unique feature of the Blackboard chats is that they are automatically archived online. This means that a student who is unable or chooses not to log in and participate in the live chat, can access the archives at any time. Through informal discussions with students the instructor determined that a much larger percentage of students were actually taking the time to look at the archives prior to completing their homework assignments. As a result, the quality of the homework papers submitted by many students during the semester was very high in comparison with previous semesters.

The use of online chats offers a relatively new avenue through which the learner can take an active role in the learning process. Furthermore, the online chats can be viewed as one form of computer-assisted communication that promotes interactive engagement of the learner with the content being studied. In addition, the online chats may offer some students a more "comfortable" environment in which to interact than the traditional large lecture class. Although students are identified by name during the chats, the instructor works to be sure that each student is treated with respect. Students were very comfortable with the fact that their comments could be identified by name and never expressed any discomfort with this concept.

Certainly there are advantages as well as disadvantages associated with any form of computer-mediated instruction. This mode of communication has the potential to offer greater consistency and to enable students to improve their communication skills while engaging in problem-solving activities [43]. In addition, key differences between computer-mediated conversations and face-to-face discussions include: place dependence, time dependence, and structure and richness of communication [44]. However, if used as an additional learning tool, the online chats can offer students an alternative to traditional instruction and simultaneously appeal to a wider diversity of learning styles [45]. In the section that follows, a brief synopsis of student perceptions regarding the two instructional approaches described is presented.

STUDENT PERCEPTIONS OF THE LEARNING APPROACHES

Student perceptions regarding the two learning approaches highlighted in this paper were elicited through classroom surveys as well as through informal communication between instructor and students. A summary of the results of several surveys regarding the folder activities given in recent semesters will be presented. These results will be shared in the form of typical student responses. Given that the Blackboard chats were first used in the fall 2002 semester a survey was not conducted. Thus, a summary of student feedback elicited through informal discussions will be shared. In future semesters, additional forms of assessment of student perceptions as well as of student learning will be employed.

Regarding the folder activity, students were asked whether or not they found that the written feedback they received had encouraged them to think more deeply about the physics concepts discussed in class. Some common student responses were:

- "It made me think more about the common sense behind the physics."
- "With the amount of writing on the paper and the fact that I knew you took the time to look at my work I knew that I needed to spend more time on my physics, but not necessarily a specific concept."
- "The feedback makes me think more deeply about what I have written. The feedback on the **learning style** made me think more than the second one [folder assignment]."

In terms of the online chats, many students acknowledged that even if they could not log into the live chats, they did make use of the archives when they were completing a homework assignment. Several students indicated that the live chats as well as the archived discussions were so useful that participating was a "no-brainer!" In some cases, students would request a chat, which indicates that they genuinely found them valuable to the learning process.

Overall, the results of these surveys and informal discussions suggest that students found the writing and online chats beneficial and useful to them in some way. A fundamental difference between each of these learning approaches involves the nature of the feedback students receive. With the writing activities, students receive feedback directly from the instructor. However, with the online chats feedback is predominantly from students' peers. These approaches, albeit quite different, provide students with diverse learning styles some additional learning tools and strategies.

CONCLUSIONS

Acknowledgement of students' individual learning styles can play a critical role in the learning process. Furthermore, the use of formal learning style assessments can provide useful information that benefits the student as well as the instructor. Important to note is the fact that the learning style assessment tool used is not as critical as the actual assessment of learning styles. Through the specific teaching and learning strategies that have been described in this paper, the value and importance of adopting a learning style approach in the classroom has been illustrated. It is the contention of the author that the adoption of a learning style approach in the classroom can increase student interest and motivation to learn, in part, through the development of alternative learning strategies designed to accommodate an increasingly diverse population of learners.

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AN EXPERT SYSTEM OF THE ESTIMATE TECHNOLOGY FOR DISPLAY MEANS

Park, Sang-bong[1]

Abstract — *An estimate technology for standard machining time focused on the large size TV set has been studied. Generally speaking, the estimate calculating work of mould is achieved by experienced engineers. However, at most mould manufacturing enterprises, there are frequent cases that they calculate by rule of thumb because they have neither established standardization nor have determined clear estimate method. As the result, in fact, it is natural that not only much time is wasted but also absolutely draw up and submit non-consistent quotation, which leads to raise major and minor quarrels with their clients continuously. Therefore, in order to remove such a problem point, in this study, the development and application of expert system is studied for estimate calculation at the mould manufacturing process. The application of the developed system to the working site has the advantage that even beginners can create better quoting result than experts. The developed system used visual BASIC language and SQL Data Base under Windows environment.*

Index Terms — *Estimate technology, Expert system, Machining time, Mould base, NC data*

INTRODUCTION

The mould technology has been developing pretty rapidly as well as being in good harmony with the technical renovation of the 6T. And, this trend is expected to continue at an increasing tempo, while deepening the width and depth of its application even more. The rapid economical and social transition in recent years have changed the technologies of production and cost management in manufacturing sector remarkably. In particular, the mould manufacturing sector requires innovative changes in quality, cost and delivery and, accordingly, the improvements in technical development, productivity and reliability are on the way to meet the requirements. Also, the trade volume of moulds are increasing continuously and the various restrictions on international trading are strengthening more than ever before.

The countermeasure of the mould enterprises in this circumstance, unlike what had been in the past, is to submit more rational, rapid and objective data, and only a settlement of management technology, say of one stage more advanced, will enable enterprises to survive and develop steadily in the future. However, still now most of enterprises follow neither objective nor scientific estimate method and are still facing with occurrence of frequent and indefinite claims from their clients. So they are suffering great damage in judgment of right or wrong.

In spite of an importance of the scope there has been very few relevant reported works in literature. In particular, Olsen[1] analyzed the prime cost for magnesium die casting mould in 1988, and Rosen et al.[2] studied and presented the prime tool cost for injection mould and die casting in 1992. On other hand, some large enterprises have developed their own system for mould prime cost calculation. However it usually can be applied only to some specific conditions. Clearly that the variety of real situation and need at many enterprises requires general but much more sufficient approach and development.

In order to remove such a problem, this study aims to build up an expert system in order to handle mould for display means. The built up system consists of Ini-MOULD 2002™ for initial estimate calculation.

STANDARD PROCESSING TIME FOR MOULD MANUFACTURING

Standard Processing Time

Based on researches so far, the standard process time in mould manufacturing can be measured by the Time Study Method, Pre-determined Time Standard Method and Standard Data Method, etc. Figure 1 is showing the content of mould processing time by disintegrating its structural elements.

- **Preparatory time, Setting time:** It includes time for preparing clearance and spare time for preparing as necessary preparing and clearing for machine processing occurred only one time for specific manufacturing quantity (1 processing lot) of the same processed good. Much time for thinking how to work is included in the preparing work. Generally speaking, we don't separate time for clearing from the time to spare in considering the preparation time. From the mould processing stage to the stage of finishing preparation requires some time for test processing.

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- **Cycle time:** The time necessary for mould processing for a unit of processed good includes the real repeat time (the real processing time and the real supply demand time) and the time to spare.
- **Net cycle time:** The repeat clearing time includes the machine time (real processing time) of automatic transfer and manual transfer, and the supply demand time (real supply demand time) accompanied to the mould processing. The necessary clearing time for cutting after the machine is operated includes the time for removing cutting chips or the time for air cut, when the cutting chips are not discharged due to approach to tools and over run. In the case of the NC machine, it is the length of time for tools to approach the processed goods from the machine origin to return the original location after finishing the necessary cutting.
- **Net handling time:** As doing mould processing for a unit of the processed good, it's the worker's working hour, such as installation and removal of the processed goods, maneuvering of machines and measuring of the processed goods, occurred incidentally.
- **Automatic feeding time:** It's the real processing time in the case that the mould processing is implemented through automatic transfer or numerical control.
- **Allowance time:** As a factor occurred irregularly during the repeated work, it's the length of time considered as time to spare since the insert is difficult during the real repeat time. The allowance time is calculated by multiplying the values required man hourly and materially in the type of percentage by the real time. The spare man hour means the fatigue spare to compensate the damage appeared due to the fatigue during work, and the physiological spare, such as going to the lavatory and drinking water, etc. The material margin means the so-called work margin, such as the irregular and various time to spare occurred materially from machines, tools and materials, etc.

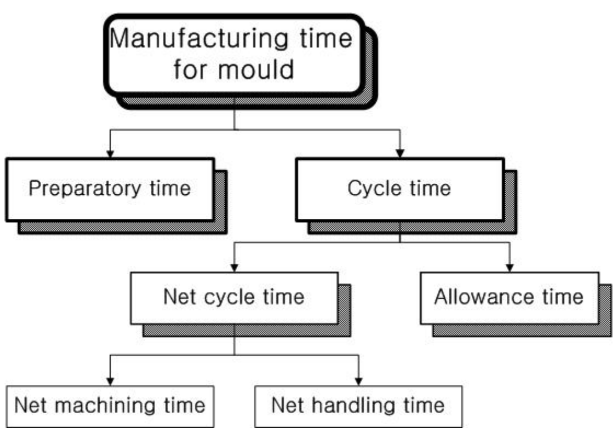


FIGURE. 1
CLASSIFICATIONS OF MANUFACTURING TIME FOR MOULD.

There is a work place margin to compensate the time to spare occurred due to the managerial irrationality during work. It is not related with mould processing, and divided by the non-processing time.

CONSIDERATION OF THE MOULD FOR DISPLAY MEANS

In the case of TV products, we are going to examine in this study, are moulds composed of big mould base, having 1 cavity. The mould base can not use the standard type. A TV mould part can be largely divided by two parts, front and back. We are going to research on the front and the back.

FIGURE. 2
FRONT PART OF TV PRODUCT.

FIGURE. 3
BACK PART OF TV PRODUCT.

Figure 2 shows the front part. The front is characterized by the precise small electrical discharge machining to accommodate speaker holes in the front side and the installation of the bottom side core for installing a control knob in the bottom side.

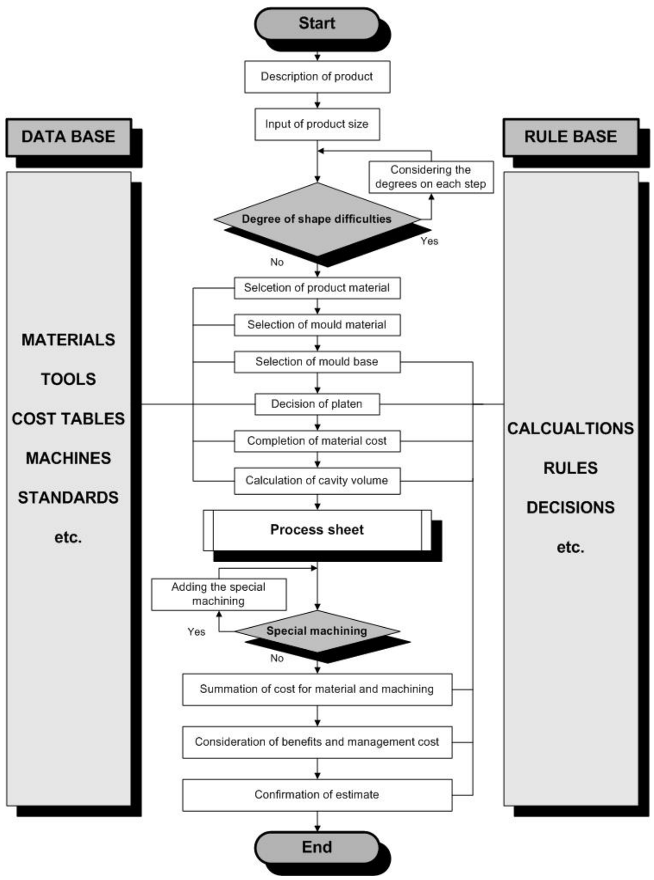


FIGURE. 4
MAIN STRUCTURE OF SYSTEM.

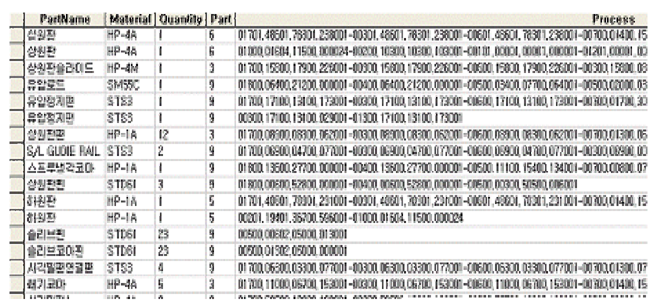
Figure 3 shows the back components. The pivotal point is to calculate the processing time for machining a lot of holes for air vent on the back side and for the milling machining to make deep cavities. Also, a lot of electrical discharge machining is required to form the bosses and the ribs. The calculating technology for the standard processing time of mould manufacturing is needed by both sides of placing and receiving orders at the same time. The order placing side can utilize it for suggesting standards and the order receiving side can utilize the system for producing quotations, considering the company's working load. The suggested amount can be modified through verification and coordination, and the final quotation can be decided objectively.

Figure 4 shows the organization of the developed system. The input data for the system includes the general specification, size, materials and mould base type, etc. The material cost and processing cost are calculated based on those things. The mould base can be selected by deciding the weight of mould base and the size of the stationary and movable platen. The decision on the cost for hot runner and other mould factors is made in this stage. The processing cost is divided by the general processing cost and the special processing cost. The general processing cost means the cost for each process, from design to test, required to make a mould. We have established a system to calculate the processing time for the pertinent processing factor by inputting specific processing parts and shapes for the contents that are included in special processing cost like polishing, carving, core machining, corrosion and electrical discharge machining, etc.

The output unit calculate the mould manufacturing cost considering profits and general expenditures, and the processing cost, standard manhour rate and standard processing time for each process are printed on specific forms. The system is designed to store the results into the database for future reference in preparing quotations for the similar products and for the records management.

Process Sheet

The previous study[3] calculates all factors of moulds by repeating the degree of shape difficulty, and then the standard processing time for special processing is calculated by considering the necessity of special processing. In this case, we were able to get the adequate result if the mould is based on the standard mould base or the mould assembled by the standard mould factors.



PartName	Material	Quantity	Part	Process
상원판	HP-4A	1	6	01701,48601,78301,238001-00301,48601,78301,238001-00601,48601,78301,238001-00700,01400,15
상원판	HP-4A	1	6	01000,01604,11500,000024-00200,10300,10300,103001-00101,00001,00001,000001-01201,00001,00
상원판슬라이드	HP-4M	1	3	01700,15800,17900,226001-00300,15800,17900,226001-00600,15800,17900,226001-00300,15800,08
유압로드	SM55C	1	9	01800,06400,21200,000001-00400,06400,21200,000001-00500,03400,07700,064001-00500,02000,03
유압정지판	STS3	1	9	01700,17100,13100,173001-00300,17100,13100,173001-00600,17100,13100,173001-00700,01700,30
유압횡지판	STS3	1	9	00800,17100,13100,029001-01300,17100,13100,173001
상원판판	HP-1A	12	3	01700,08900,08300,062001-00300,08900,08300,062001-00600,08900,08300,062001-00700,01300,06
S/L GUDIE RAIL	STS3	2	9	01700,06900,04700,077001-00300,06900,04700,077001-00600,06900,04700,077001-00300,06900,00
스프루부싱각코마	HP-1A	1	9	01800,13600,27700,000001-00400,13600,27700,000001-00500,11100,15400,134001-00700,00800,07
상원판핀	STD61	3	9	01800,00600,52800,000001-00400,00600,52800,000001-00500,00300,50500,006001
하원판	HP-1A	1	5	01701,40801,70301,231001-00301,40801,70301,231001-00601,40801,70301,231001-00700,01400,15
하원판	HP-1A	1	5	00201,19401,36700,596001-01000,01604,11500,000024
슬리브핀	STD61	23	9	00500,00602,05000,013001
슬리브코어핀	STD61	23	9	00500,01302,05000,000001
사각밀판연결판	STS3	4	9	01700,06300,03300,077001-00300,06300,03300,077001-00600,06300,03300,077001-00700,01300,07
웨기코마	HP-4A	5	3	01700,11000,06700,153001-00300,11000,06700,153001-00600,11000,06700,153001-00700,01400,15

AN EXPERIMENTAL CREATIVITY RESEARCH IN DESIGN EDUCATION BY HIERARCHICAL APPROACH

Elmira Sener[1], *Secil Satir*[2]

Abstract — *Design education is an area which has a broad point of view in its context. It consists of the feelings, thoughts and conception of both the designers and the users. Design students are confronted with some design problems in order to gain general continuity of creativity and ability. In some cases, these problems are based on some theoretical thought but they can also be formed with various materials, geometric shapes and objects exemplified in environment.*

The main subject of this paper is the experimental studies conducted by grouping student according to their classrooms in design education. Consequently, only creative structures based on figure is received from the least-educated students. At the same time, knowledge-base structures were increased as the education level increased. Maintaining original compositional structures was a result based on knowledge and experience. According to the conclusions, the study states that design education should be a motivator, not a demander even in a knowledge-providing phase of the education process.

Index Terms — *Design, design education, design students, design process, creativity.*

INTRODUCTION

Designing is an area and a notion which has creativity in its essence which is combined with the concept of creation. To design means to create in the mind and to find solutions. Basically, almost all the problems of architecture, industrial design, engineering or the daily life, reach the first step of the solution process by the formation of the creative ideas in mind.

Designing is a process in which creativity constantly appears. This process is formed in the mind while being reflected outside as a behavior or an act. The designing or the creation process of designing which happens in mind, is generated as a new knowledge by combining the knowledge base formed from the necessary past experiences and the information sets of a given problem. According to this, creativity is not a notion which was present before (a priori) but an ability that is developed through time. Because, the formation of a synthesis is impossible without the presence of similar perceptions in mind [1].

In our time, it is understood that creativity that is known as the flexible feature of the mind about sensibility can be improved. If the course of the improvement of the creativity is initiated from the early ages and appropriate setting is defined, successful results can be obtained. Feldman (1999) has studied the dimensions, which affect the development of the creativity during individual development. In this context, the subjects that affect the creativity during individual's growth are the family structure, formal and informal education, social and environmental specifications, social-sensitive proceedings, cultural and historical effects, variables dependent to situations, inclinations [2].

The process of the improvement of the level of creativity of the design students in the level of higher education is initiated with the "Basic design" course in almost all of the design schools. All the design problems both in the scope of the basic design course and the projects, which are done in other science and art courses, are specifically designed to prepare the students for their professional lives.

CREATIVITY IN THE DESIGN EDUCATION

Design education is a kind of process, which makes a synthesis of science, technology and art fields, which generally have a wide point of view, according to their importance. Design education in which both theory and application are delivered together, includes the human thinking, sensitivity and perceptions about creativity all together.

According to Cooper and Press, design education should aim to be involved in creativity process as an inseparable part of creative thinking. The ability, knowledge and perceptions of the students differentiate from each other. Throughout the education, the evaluation of these components in order to improve the creativity is very important [3].

The basis of the design education is constructed specifically to improve the creativity of the first year students. Experimental and introductory design and design project courses in which students communicate directly with materials, get familiar with the potential of the material and combine with their creativity; teaches the student to make their thinking systems more flexible and helps them to form solutions for the problems.

An important problem about the professional practices of all the students is their difficulties in putting creative ideas together and their ignorance about what kind of a strategy they can follow.

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AN "EXPERIMENTAL CREATIVITY" STUDY IN DESIGN EDUCATION BY HIERARCHICAL APPROACH

An experiment has been conducted for seven hours in a rectangular area of 900 m² in order to emphasize the creativity in design education and to test the necessity of giving a quality of basic course in each class. This experiment is conducted with 70 architecture and industrial design students.

Although this creativity experiment has been planned to be conducted with 25 volunteer students, because of the reduction of the number of students in the list, it is directed with 20 first year, 17 second year, 13 third year and 20 fourth year students. Some materials and questions were given to students and they were differentiated according to the levels of experiment groups.

Students were divided into four groups according to their classes. The materials given to the groups were simple ones like, wood sticks, wood pieces in geometric forms, matches, plasterin, string, textured aluminum pieces, cardboard, colored pieces of paper, pasta, egg, craft paper, synthetic wires, synthetic fiber board, synthetic pipe covered with folio.

An explanation was made to experiment groups about the experiment subject before the distribution of the materials. A pre-explanation were performed with a slide show about creativity, how it is formed in thinking process, how does knowledge and perceptions can effect the creative thinking and how does it feed the allusions of the thinking system .

After such an explanation, in the study in which everyone was asked to work individually, 2 hours were given for each question and at the end, three creative design applications were maintained. In addition to this, they have been asked to determine ten concepts about each application. The materials and design subjects given to first and the third year students were the same and similarly they were the same for the second and fourth year students.

It was not possible for students to watch or to look at each other because the experiment took place in different parts of a long studio, and in a short amount of time.

Evaluation of the Experimental Creativity Study

Criterias on the evaluation of the studies were,

- Students' general level,
- The concepts they chose,
- The structural appropriateness in terms of basic structure concepts such as weight, force and balance,
  - Harmony with the material,
  - Appropriateness to the structure of esthetical rules: balance, rhythm, proportion,
  - Structural construction
- Reflection of creativity on the design,
- Its ability to combine knowledge and creativity.

Evaluation of the First Year Students

First year students had worked on three different design questions with the designs made of given materials such as wood sticks, wood pieces, matches, plasterin, cardboard, an egg, strings and wires, craft paper, synthetic wires, synthetic fiber board and pieces of aluminum. In addition to that, 10% students had interpreted the part "a" of the first question, which was asked also to others, as the preparation phase of the "b" part. %90 of them had done according to the concepts.

Hundreds of concepts were emerged like, "difference, ordinariness, contrast, elevation, excitement, chaos, unity, life, balance, sharpness, emptiness, solidarity, helplessness, summit, permeable, crater, danger, etc. Like all the other students, the first year students determined in 10 concepts for each of three questions and produced designs evaluating these designs. 90% of the student designs were in harmony with the concepts.

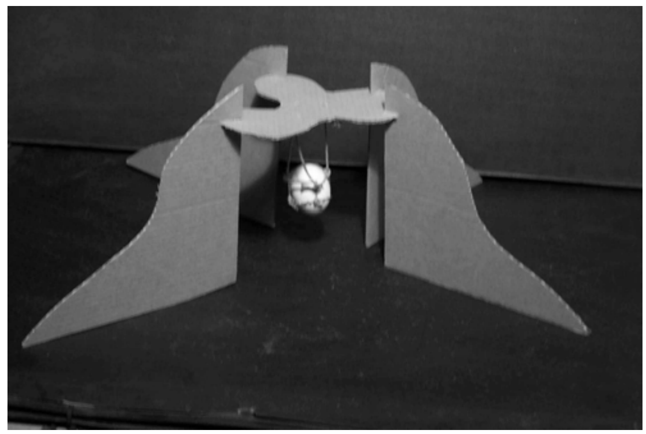

FIGURE-1 A SAMPLE OF FIRST YEAR STUDENTS' DESIGN

When the structural construction of the material was in question, the proportion of encouragement of the light structured buildings was low. When it was asked to carry the egg 15 cm above the ground, cardboards were usually folded in various sides in order to produce structural constructions. Because of the lack of knowledge of structure, determination of maintaining security was stressed.

FIGURE-2 A SAMPLE OF FIRST YEAR STUDENTS' DESIGN

Apart from this, conclusions of the study which were produced with little knowledge and which could be attained only through the textures of the material were in lack of creative, flexible sensitivity.

Evaluation of the Second Year Students

The common materials that the second and fourth grade students used were pasta, strings, cardboard, wires, colorful pieces of paper, synthetic strings, wood sticks and a synthetic pipe covered with folio. In the second year, %85 of all the three questions were done. The 15% was in excess because some of the students combined the "a" and "b" part of the question.

Again, designs were prepared in accordance with the ten concepts chosen for each question such as, "expectation, privacy, curiosity, symmetry, rhythm, eternity, courage, solidarity, dialectics, balance, focusing, explosion, beginning-end, firmness, energy, multiplication, emptiness, trustworthiness, horizontal-vertical, music, motion, protection, shield, fullness, unity, contrast, space, transformation, asymmetry, axe, fluidity, pass through".

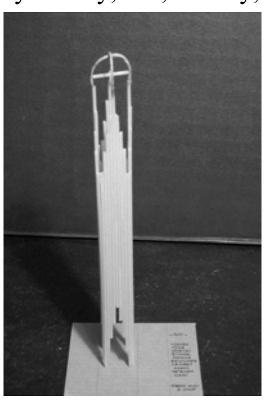

FIGURE-3 A SAMPLE OF SECOND YEAR STUDENTS' DESIGN

Although their concepts of solutions were in harmony with their designs, it was realized that second year students were able to evaluate their creativity in terms of establishing links between the problems by 50 %.

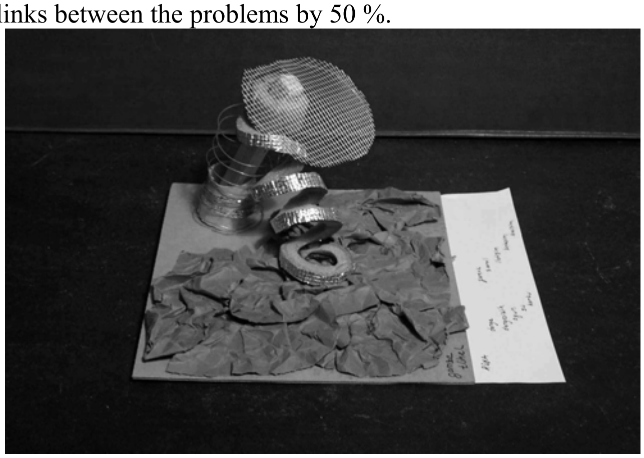

FIGURE-4 A SAMPLE OF SECOND YEAR STUDENTS' DESIGN

88% of them preferred to use color. In the concepts they chose, a kind of order was realized which was emerged from the their own knowledge of rhythm, symmetry, balance, energy, fullness, contrast, etc. In 87% of the designs, the consciousness about space, order and geometrical knowledge was observed. 13% of the students designed really complex designs.

Evaluation of the Third Year Students

The participation of this group was very low. Only 13 of the invited students had participated to the workshop. Yet, designs produced were sufficient to demonstrate the improvement of creativity between the classes.

The questions and the materials given were the same with the first year students. In those designs the concepts were different than the previous ones. They were cooler and more "frozen" such as "elevation, sign, direction, bayonet, fewness, grief, shadow, motion, nothingness, umbrella, system, logo, linkage, guitar, chaos, frontier, tying, inner, hardness, continuity, division, differentiation, individual life, section-whole, geometry, messy, complex, ugly, ordinary, artificial, permeable, bird nest, labyrinth, hard work, craziness, shadow, lost, time, speed, illogical, cry".

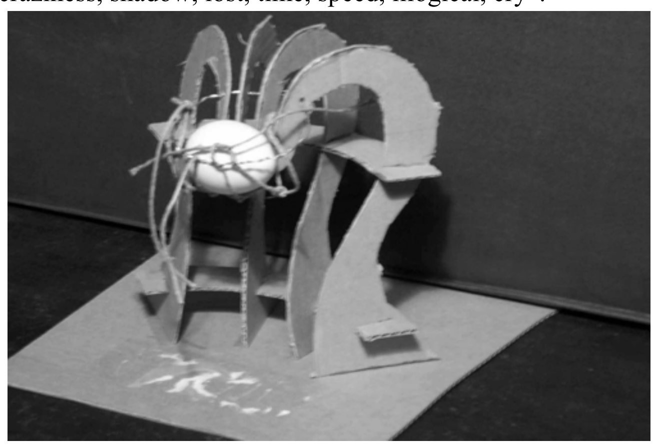

FIGURE-5 A SAMPLE OF THIRD YEAR STUDENTS' DESIGN

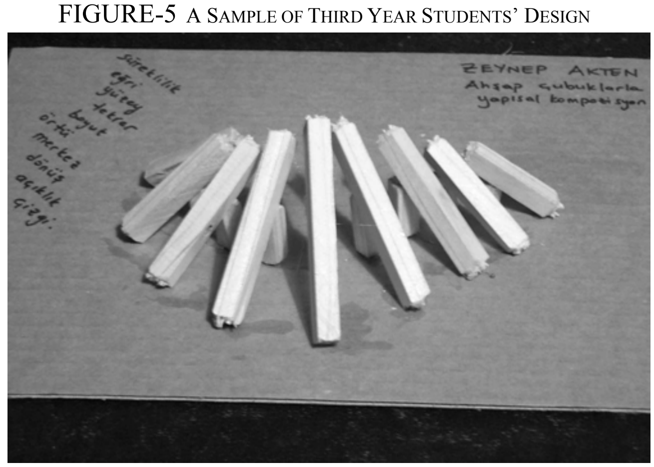

FIGURE-6 A SAMPLE OF THIRD YEAR STUDENTS' DESIGN

Designs were, again in harmony with the concepts. Throughout the concepts of the third year students, it was realized that the positive concepts were quite a few. Designs were observed to be created directly by analogies by using meaningless and negative concepts by 50%.

In the second question, 18% of the students hadn't completed their tasks and in the last questions, they changed their materials and started to use other groups' materials.

Evaluation of the Forth Year Students

Participation rate of the fourth grade students was high like the first year students. The materials given were the same as the second year students. 50% of them had not differentiated between the "a" and "b" part of the question and answered both of them with the same design.

The concepts they used were extremely structural and esthetical concepts like "emptiness-fullness, tearing, rhythm, balance, order, wave, knot, holding, valve, to approach, to go away, support, emptiness, folding, stretched, to direct, to stretch, horizontal, vertical, underground, above the ground, open-closed, spatialization, back bone, trust, arcade, bump, direct, triangle, energy, sails, roads, to hold, dreaming about thinking, willing to think, orthogonal, superposition, coordinate". The high participation rate showed that the students were aware of their design consciousness and they were willing to learn more. They preferred to use these materials to organize concepts like rhythm, balance, and proportion.

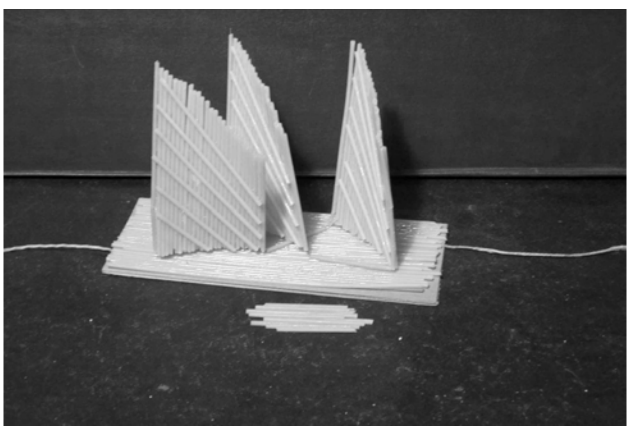

FIGURE-7 A SAMPLE OF FIRST YEAR STUDENTS' DESIGN

55% of this group worked neatly and completed their designs. Apart from them, 65% of the students managed their designs mainly with knowledge-base concepts.

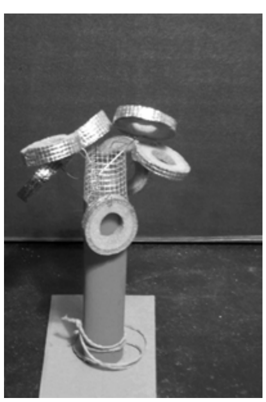

FIGURE-8 A SAMPLE OF FIRST YEAR STUDENTS' DESIGN

Fourth year students were more inclined to use the material more freely. Shiny, cylindrical isolation material was commonly used both by the fourth and the second year students. 79% of the fourth year students specifically used this material.

GENERAL EVALUATION

This experimental study about the need of creativity education in the programs of all the years cannot be expected to give 100% true conclusions. To provide more accurate conclusions this experiment is needed to be repeated over and over for some years. Additionally, the backgrounds of each student, their capabilities, and way of living and growing up will also affect the research.

However, many students had participated to a weekend workshop without any obligations. Although they were not over a hundred people, the enthusiasm of the curious students who were aware of the importance and the meaning of design constituted a firm base for this evaluation.

The high participation rate of the first year students was because of curiosity whereas the fourth years' was because of consciousness.

In all levels, the chosen concepts and the designs were in harmony. Some designs are differentiated according to different levels of construction, structural and esthetical knowledge.

CONCLUSION

We think that design courses should be given not only in the first years as a basic design education, but in all years in the context of design projects or creativity courses. These courses should be supported by structural concepts.

The structural knowledge which fourth year students observed to have, should not be constructed as partially learned knowledge in design studios. They should be thought in creativity courses from the first year until the fourth year where structural concepts and philosophical concepts will support the imagination. The imagination and thinking capacities of the students should be enriched with the design made from different materials and compositions.

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LABORATORY PROGRAMS ON PHYSICS WITH USAGE OF MODERN INFORMATION TECHNOLOGIES

Konstantin A Ekimov[1], Roman V Prichodchenko[2], Anatoly D. Khakhaev[3].

Abstract *— A set of laboratory programs used in education courses of atomic and quantum physics, metrology, spectroscopy and plasma diagnostics has been presented. The training is performed with use of new information technologies and a possibility of remote access to the equipment. Students come to know a subject area (e.g. determination of fundamental atomic constants, Zeeman effect, plasma diagnostics, temperature determination, eliminating the apparatus distortions etc.) in parallel with acquiring habits in usage of modern information systems and effective methods of accumulation, processing and transformation of data. They are trained in usage of local and remote information resources and study the operation principles and possibilities of various measurement sensors. Such an approach promotes both a knowledge basis in the subject under study and formation of a specialist, who is ready to work in the modern information environment.*

Index Terms — Atomic physics, information technologies laboratory program, remote access, spectroscopy, virtual instruments.

INTRODUCTION

In the Department of Information- measuring Systems and Physical Electronics of Petrozavodsk State University laboratory programs on the following courses: Quantum and Atomic physics, Metrology, Optical methods of plasma diagnostics are carried out with usage of new information technologies: virtual instruments and opportunity of the removed access to the equipment. The virtual instruments is essentially an information- measuring system, with the interface which is similar to the panel of the usual device and has been created in graphic programming environment (for example, LabView) Thus, simultaneously with studying problems of a subject area (for example, Zeeman effect, plasma diagnostics, temperature determination, eliminating the instrument distortions etc.), our students gain experience in application of modern effective data acquisition and processing methods.

They are trained in usage of local and remote information resources, get acquainted with a principle of action and opportunities of various measuring sensors.

Alongside with fastening of knowledge in an investigated subject, such laboratory programs form the expert ready to work in the modern information environment. The brief description of our typical installations and laboratory programs are given below.

LABORATORY PROGRAMS CARRIED OUT ON AUTOMATED SPECTROSCOPIC SET UP "LIGHT"

The set up is destined for local spectroscopy of inhomogeneous and non-stationary plasma. It allows to carry out spectrum scanning by large aperture diffraction spectrometer with resolution 0.015nm in the range 300-800 nm, scanning of spatial source surface radiance distribution by special spatial scanning block and to choose for radiation measurement the certain time moments, if a source characteristics are periodically varying . Experiment control is based on Labview and instrument interfaces, compatible with this system. The system runs under the control of the IBM-compatible computer with OS Windows-98.

The software includes the following functional modules:

a) Module of spectral device calibration on wave lengths by a source with a known spectrum ("Spectrum calibration").

b) Module of the photodetector sensitivity calibration by the registration of a certificated temperature lamp spectrum. ("Sensitivity calibration").

c) Module of spectrum scanning in the given spectral range with the given step ("Spectrum scanning").

d) Module of spatial gating at a given wave length ("Spatial scanning").

e) Module automated spatially and spectral scanning in the given spectral and spatial intervals and time phase ("Spectrum -spatial scanning").

f) Module of data loading for subsequent analysis ("Spectrum load/Analysis").

g) Module of the remote access server.

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Each module is made as a "virtual instrument", on the panel of which there are windows for input of the necessary information, control buttons (start of the module, save file) and graphic field for result representation. The example of such panel is given in Figure 1.

The module "f" allows to transform automatically the digital reading array to array of a source surface radiance, if earlier calibration by the module "b" was executed, and also to derive various information from a spectrum (e.g. maximum positions and values, line widths) by Labview tools for graphic processing (scaling and cursor positioning).

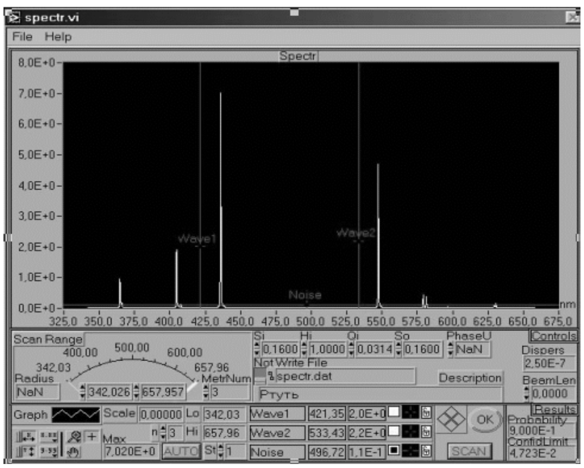

FIGURE. 1
VIRTUAL INSTRUMENT " SPECTRUM SCANNING".

The module "g" provides an opportunity for the removed experiment control.

When a user saves data file, the information file is automatically created, where date of the experiment and all experiment conditions (spatial and spectral range, gating steps, spectrometer slit aperture parameters and so on) are written together with any additional information entered by the user (e.g. type of the source, discharge current, etc.).

On this set up the following laboratory programs are carried out:

Studying Serial Laws in the Hydrogen Spectrum and Rydberg's Constant Determination

This program is included in the course "Atomic and Quantum Physics "

In the simplified variant of work the student with the help of the module. " Spectrum scanning " registers a survey spectrum in a range 405- 660 nm. Then for more exact definition of waves lengths spectra in the interval of 5 nm from the found lines are registered with the minimal step.

For each measured wave length the wave number $\tilde{\nu}$ and Rydberg's constant R is determined by the formula:

$$\tilde{\nu} = R\,(1/4 - 1/n^2), \qquad (1)$$

It is supposed, that all registered lines belong to the Balmer's series. Taking into account, that wave lengths and line intensities in the Balmer's series decrease with growth of the main quantum number n, for a line with greatest wave length n=3. The received R values are averaged over all lines and then it is checked, whether the theoretical value ($R=109737.31\ cm^{-1}$) lies in 95 % confidence interval for R.

The complicated variant of work assumes preliminary spectrometer calibration on wave lengths by module "a" with use of cadmium spectral lamp.

Metrology Certification of Information Measuring System

This program is included in the course" Metrology".

The certification consists in an experimental establishment of correspondent of a system metrology characteristics to their values specified in the system documentation.

This program offers to execute operations on certification of set up "Light" as a tool for wave length measurement in the range 400-600 nm. The systematic error in a measurement of wave lengths should be no more than 0.1 nm, random - no more than 0.03 nm.

Using a source with a known spectrum (cadmium spectral lamp), in which the wave length values are known with the accuracy of 0.001 nm, and modules "Spectrum scanning" and "Spectrum load/Analysis", the student repeatedly determines the measured wave length values and calculates the random and systematic errors of the measurement.

By results of the experiment the standard " Protocol of metrology certification" has to be drawn up.

Determination of Temperature by Radiation

This program is also included in the course " Metrology". It reveals the concepts of radiance and color (spectral) temperature and methods of their measurement.

Having registered a spectrum of radiation of a filament lamp in a range 400-600 nm with help of the module "Spectrum scanning" and having transformed file of readings in file of values of spectral radiance B of a source surface by the module "Spectrum load/Analysis", the students determine source radiance temperature T for several wave lengths λ by the Planck's formula:

$$B(\lambda,T)=2hc^2\lambda^{-5}\{\exp[hc/(\lambda kT)]-1\}^{-1} \qquad (2)$$

Here h- Planck's constant, c - light velocity, k- Boltzmann's constant .

Spectral temperature of a source is determined from the slope of the graphic $Y=f(1/\lambda)$, received from (2) with the assumption, that it is possible to neglect 1 in comparison with exponent for the visible spectrum part and also that absorption coefficient Q of a light source material in some spectrum area does not depend upon the wave length. Then:

$$Y=a+ b*(1/\lambda),$$

where

$$Y=\ln B+5\ln\lambda,\ a=\ln(2hc^2)+\ln Q,\ b=-hc/kT \quad (3)$$

The least square method is used for calculation a and b; from b the spectral temperature is determined.

Emission Spectroscopy of Inhomogeneous Plasma

This program is included in the course " Optical methods of plasma diagnostics ".

The experiment consists in registration of visible intensity spatial distribution of the arc discharge in several spectral lines along the directions, perpendicular to discharge axis. After appropriate data processing the radial distribution of excited level densities in discharge should be received. For this purpose the following modules are used:

-"Spectrum scanning"- for the registration of a survey spectrum and choice lines for discharge diagnostics.

-"Spatial scanning"- for spatial gating of chosen lines radiation along a direction x, perpendicular to the axis of a source and optical axis of system. Previously spectrometer is precisely adjusted to a maximum line intensity by the module "Tuning", which is called from the module "Spatial scanning". The input and output spectrometer slits are extended enough to receive integrated over line profile intensity.

-"Spectrum load/Analysis" for transformation the file of readouts to the file of values of spectral radiance B.

For each line from a file of radiance B (x) one can find the line intensity J for a distance r from the source axis by radial transformation:[1]

$$J(r)=-\frac{1}{\pi}\int_{r}^{r_0}\frac{\frac{dB}{dx}rdr}{\sqrt{x^2-r^2}} \quad (4)$$

(r_0- radius of a source border).

The students are offered independently to choose and to realize in program the decision of the integral equation (4) and on found J to determine of appropriate excited level densities N, since

$$J=ANhc/\lambda \quad (5)$$

A - the transition probability may be found in a reference book. Having determined densities N_k of levels with various excitation energy $E_к$, the students should check up the validity of local thermodynamic equilibrium model [1] in the given plasma point. The model is correct , if the next condition is fulfilled for all levels:

$$N_i/N_k=g_i/g_k\cdot\exp[-(E_i-E_k)/k] \quad (6)$$

(g_i, g_k-the statistical weights of the appropriate levels).

Laboratory Programs carried out on Automated High Resolution Spectroscopic Set up "Spectrum "

The installation is intended for research of spectral line structures and shapes. The single line is picked out by the prism spectrometer or the interference filter, high resolution is achieved by the Fabry-Perot interferometer. The spectra registration is carried out with the help of virtual instruments based on LabView.

Two variants of installation might be possible:

The first one uses the Fabry-Perot in a scanning mode.

The interference rings are drawn on spectrometer input slit, which with a cross slit, established in front of it, forms a scanning diaphragm, allocating in the center of the interference picture. Behind the spectrometer output slit the photo-electric recording system is established. Spectrum scanning is carried out by pressure change in compression chamber , in which Fabry-Perot interferometer is placed. Photo-electric system signals are converted into digital form and remembered by the managing module through determined time intervals, given by the user. The module of data viewing and processing one can see in Figure 2 .

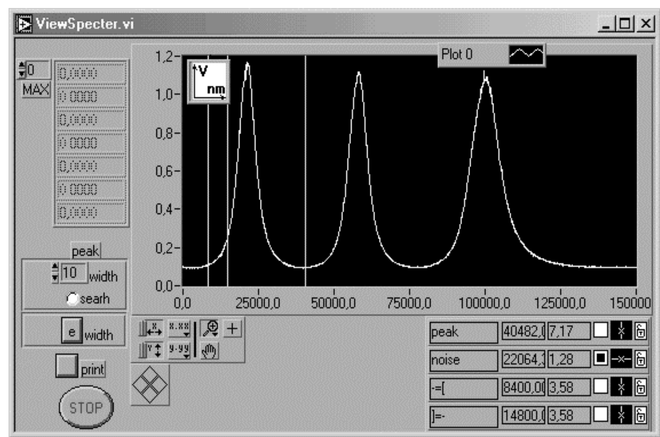

FIGURE. 2
THE RESULT OF SPECTRUM SCANNING BY FABRY-PEROT .

This module allows to save the results in a file, and also to analyse line shape and structure (e.g. maximum positions and values, line widths) by Labview tools for graphic processing

The second installation variant based on usage of a videocamera. Selection of spectral line is carried out by interference filter. The CD camera focused on infinity draws interference patterns on photodetector matrix . The panel of the virtual instruments for this experiment is shown in Figure 3. The module of data processing finds the center of rings and builds the dependence of interference pattern intensity on the distance from the center of a picture averaged over various directions. (Figure 4). The result can be printed out, saved in a file or processed directly by Labview graphic tools.

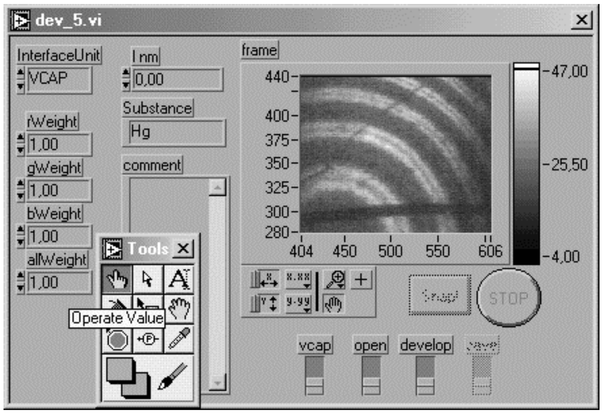

FIGURE. 3
VIRTUAL INSTRUMENT FOR CD CAMERA CONTROL.

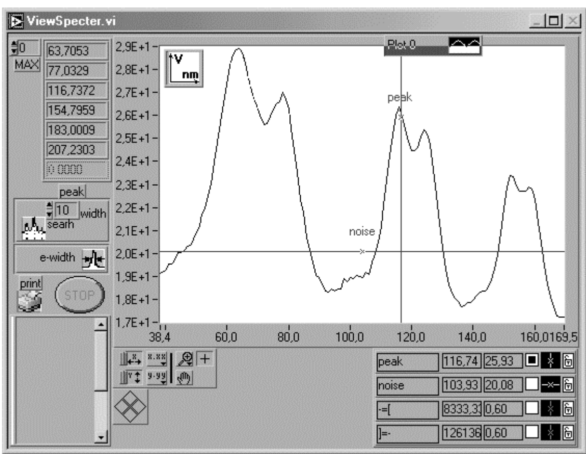

FIGURE. 4
VIRTUAL INSTRUMENT FOR ANALISIS CD CAMERA DATA .

On this set up the following laboratory programs are carried out:

Zeeman Effect

This program is included in the course " Atomic and Quantum Physics" .Spectral line splitting in permanent magnetic field is studied

The effect is observed on mercury lines of 579 and 546 nm, which are excited in a mercury discharge lamp placed between poles of permanent magnet. The analyzer of light polarization is placed between the light source and the Fabry-Perot interferometer.

By rotation of the analyzer one can see spectral line splitting components polarized along and perpendicular to magnetic field. Observation of the splitting and measurement of its value are possible in any of the described above variants of set up.

By the distance between the components, polarized perpendicularly to a field, of a line 579 nm, on which the simple Zeeman effect is observed, the magnetic field induction B_0 is estimated.

$$B_0 = \frac{hcx}{2\mu_B dX} \tag{7}$$

Here X-distance between nearby interference maximum in any units, x- the distance between components inside one maximum in the same units, d - interferometer thickness, μ_B-Bohr's magneton.

Measurement of Line Width and Determination of Plasma Atomic Temperature

This program is included in the course "Optical methods of plasma diagnostics ".

The light source is any low pressure discharge lamp.

The set up is used in the first variant. Some spectral lines are picked out by spectrometer and line shapes are received and saved in files.

In the assumption of absence of instrument distortions and Doppler line broadening mechanism [1] the atomic temperature T_a may be estimated from the line width $\Delta\lambda$.

.

$$\Delta\lambda = \frac{2\lambda_0}{c}\sqrt{\frac{2(\ln 2)kT_a}{M}}, \quad \Delta\lambda = \frac{\lambda_0^2}{2d} \tag{8}$$

Here λ_0- wave length of a profile center, M- atomic weight. This temperature will be obviously too high, since when working with Fabry-Perot interferometer, the instrument distortion, as a rule, could not be avoided. The interferometer spread function is:

$$P(\beta) = \frac{(1-R)^2}{(1-R)^2 + 4R\sin^2 \pi\beta} \tag{9}$$

Here β is the fraction of the distance between the nearby interference peaks (for each point x in the interference order β =x/X.) R- mirror reflectance. It is known. Students are offered to calculate the spread function and to eliminate the instrument distortion by free accessed program [2] . (Figure 5).

Having measured the width of the corrected line shape, it is possible to estimate atomic temperature in plasma more accurate.

The averaging over several lines gives even more reliable result.

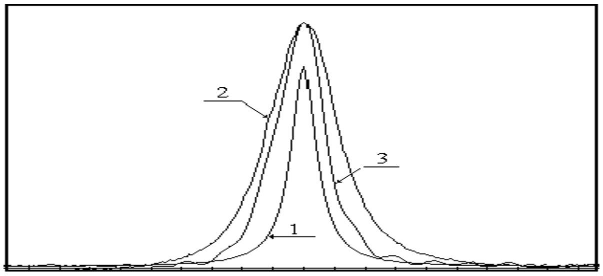

FIGURE. 5
THE PROFILE OF THE NEON SPECTRAL LINE BEFORE (2) AND AFTER (3) ELIMINATION OF INSTRUMENT DISTORTION .1- THE INTERFEROMETER SPREAD FUNCTION [2].

Having measured the width of the corrected line shape, it is possible to estimate atomic temperature in plasma more accurate. The averaging over several lines gives even more reliable result.

VERIFICATION OF THE ANALOG-DIGITAL CONVERTER (ADC)

This program is included in the course " Metrology".

The analog-digital converter is one of the main device of automated physical experiment instrument interface

The control of correspondence its metrology characteristics to required values is the necessary condition of experiment results reliability.

In this program the ADC, which is one of the CAMAC modules, have to be calibrated. The special driver allows to operate with CAMAC from LabView environment.

The precision voltage generator is used as voltage source. The student varies the test voltage according to randomized experiment plan and registers the ADC output by virtual instrument presented in Figure 6

The results are saved in a file for subsequent processing, which consists in estimation of the systematic and random errors of the device in all working range. As a result the conclusion should be made, whether this ADC metrology characteristics correspond to limits specified in the passport of the device.

REMOTE ACCESS OPPORTUNITIES.

All above described laboratory programs may be carried out with the remote access to apparatus. It is organized by LabVIEW tools on the basis of information interchange protocol TCP/IP.

Simultaneously with the experiment (e.g. spectrum scanning) the observation is possible with the help of the video-equipment with program support of videoconferences. Due to this technology, it is possible to observe visually and control the experimental process from another room (even from another country) if a computer is connected to a network and LabView "Remote access Client" is loaded.

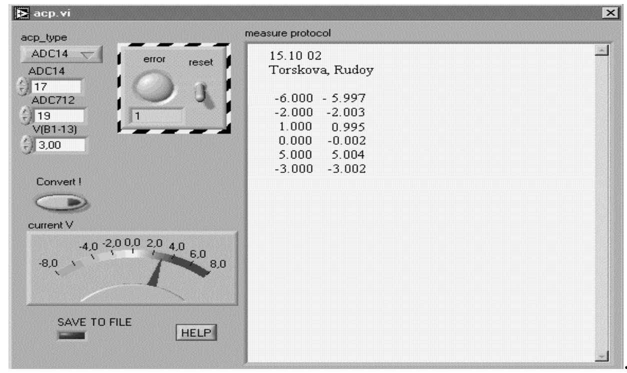

FIGURE. 6
VIRTUAL INSTRUMENT FOR ADC CALIBRATION TESTING .

This software is free accessed at http://194.85.172.228/index.html. Following the instruction the user can receive the list of laboratory programs. Having chosen the necessary program, the user will see the panel of the virtual instrument appropriate to the chosen experiment.

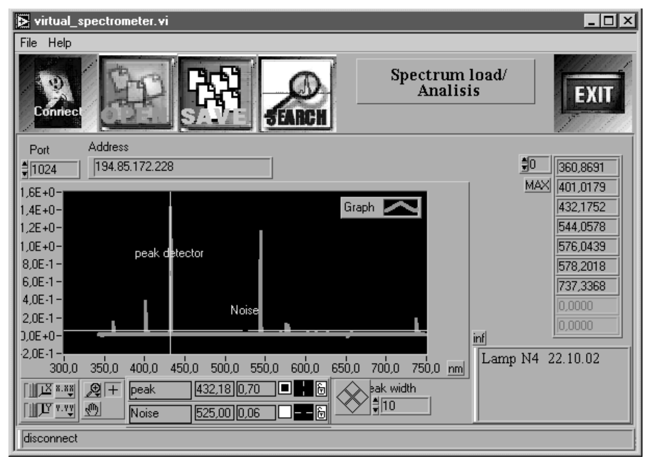

FIGURE. 7
VIRTUAL INSTRUMENT FOR REMOTE ACCESS TO THE EQUIPMENT. ONE OF THE SET UP "LIGHT" MODULE IS LOADED .

It is also possible to start the module of a videocamera control separately.

ACKNOWLEDGMENT

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FREE ACCESSIBLE WEB-BASED PROGRAMS "SIMULATION AND ELIMINATION OF INSTRUMENT DISTORTION" FOR EDUCATIONAL AND SCIENTIFIC APPLICATIONS

Alexei Soloviev[1] and Lidia Luizova [2]

Abstract — *In radioelectronics, image processing or spectroscopy one often cannot ignore the instrument distortions of data. If the instrument pulse response is known the reconstruction of input signal is possible, but the noises are significant obstacles on this way. Computer training programs for educational and scientific applications are described. The programs are designed for simulation of instrument distortions, elimination of those from simulated and real experimental functions, as well as demonstration of noise influence and opportunities of noise effect decreasing. The programs have been successfully used in courses on metrology, spectroscopy, plasma diagnostic, and image processing. One program, performing simulation and elimination of instrument distortion for one-dimensional functions, is executed on local workstation and requires Microsoft Windows 95/98/2000. The second one, destined for 2-D function processing, is implemented as web-service and only requires HTML 4.0 compatible browser. The programs and user's guide is accessible on web site dfe3300.karelia.ru.*

Index Terms — *computer program, Fourier transform, image processing, instrument distortions, noise, simulating experiment, training, web-based service.*

INTRODUCTION

Before computer engineering physicists solved complex problems approximately (for example, by means of processed function description with a few parameters, that is implicit a priory information about expected results). Calculating capabilities of computers cause the illusion of the absence of such information requirement. It seems a problem of any complexity could be solved if there is a principal solution, even it requires to solve 20-40 combined equations or reverse a matrix of 100x100 dimension. Although received results have no physical sense. Then mathematicians formulated the term "improperly posed problem" [1]. They called so the problems of obtaining information from experimental data when there is a strict unambiguous solution but this solution is highly sensible to experimental errors and even limited precision of calculation. So any variation of source data for a fraction of percent causes the result to vary for hundred times that is out of common sense.

The example of improperly posed problem is the elimination of instrument distortion. We deal with instrument distortion while performing dynamic measurement, i.e. when not a single value should be found but some function should (for example, the voltage as the function of time, the spectral intensity as a function of wave length etc).

Future engineers in optics, metrology, electronics, computer science have to understand the essence of this problem, to know how it may be solved and to see the limited nature of computing methods. The objective of this work is to develop computer programs for educational and scientific applications that allows:

- to simulate and graphically demonstrate the instrument distortions,
- to eliminate these distortions from simulated functions as well as from functions, received in real experiments,
- to demonstrate the influence of noise on the result of exclusion of instrument distortions,
- to show the opportunity of noise effect decrease by using a priory information and to demonstrate the limitations of this method.

These programs have an easy and clear interface and were successfully used in educational laboratories in courses on metrology, spectroscopy, plasma diagnostics, and image processing.

MATHEMATICAL BASIS

We consider only the instruments that could be described as invariant linear filters. Almost every design for dynamic measurement corresponds to this model in definite limits of input signals and usually one avoids to work outside of these limits. So the output function is the result of the convolution of the input signal with the instrument spread function.

$$f_{out}(\tau) = \int_{-\infty}^{+\infty} f_{in}(t) \cdot g(\tau - t) \cdot dt \qquad (1)$$

The instrument spread function *g(x)* (also known as *pulse response*, or *spread function*) characterizes the device

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and corresponds to the output signal when the input signal is a single pulse or delta-like signal.

Of course, in real experiments the input and output coordinates are quite different, for example, wave length at the input and the element number of photodetective matrix at the output of spectrometer. But there is always correspondence between input and output coordinates that have been ascertained at the stage of graduation, so that we can use the same variable x for input and output coordinates. For simplicity, we consider one-dimension functions, but computation may be easy generalized to 2-D case of image processing.

The process of the elimination of these distortions and the reconstruction of true function is referred as "reduction to ideal instrument". We can lead this problem to solution of integral convolution equation (1). The well known way of solving this equation is using the convolution theorem [2]: Fourier transformed convolution is equal to product of Fourier transformed convolution components.

$$\Phi\{f_{out}\} = \Phi\{f_{in}\} \cdot \Phi\{g\} \qquad (2)$$

Here Φ is the Fourier transform operator. Obviously, we only have to divide Fourier transform of the output signal to Fourier transform of the spread function and restore the input signal by inverse Fourier transform of the result. In case of noise present we deal with sum of "true" signal and noise.

$$\Phi\{f_{rest}\} = \frac{\Phi\{f_{out}\} + \Phi\{\xi\}}{\Phi\{g\}} = \Phi\{f_{in}\} + \frac{\Phi\{\xi\}}{\Phi\{g\}} \qquad (3)$$

Noise's spectrum $\Phi\{\xi\}$ is much wider than spread function's one as a rule. That's why after division of Fourier transformed output function to Fourier transformed spread function, the result of Fourier inversion is a fast oscillating function, so we receive no information about the input signal. Clearly the simplest way of noise effect diminution is to limit the operative spectral range. The narrower this range the less the noise amplitude in reconstructed signal, but as a result resolution of instrument is worsened too. That's why thin details in input signal would be lost by limitation of spectral range. The constriction of operative spectral range is equivalent to using a priory information about smoothing degree of input function.

This property of the process of reduction to ideal instruments is readily illustrated by our programs. During the simulating experiments one can be assured that noise sets limits on information about the investigated signals.

BRIEF DESCRIPTION OF THE PROGRAMS

Simulation and elimination of instrument distortion for one-dimensional functions can be performed by the "Apparat" sotware [3]. This program is executed on local workstation and requires Microsoft Windows 95/98/2000. The second program was designed for 2-D function processing. It is implemented as web-service and receives its calculation parameters from HTML 4.0 compatible browser on any platfom.

"Apparat" Software

This program was developed by means of Borland C++ 5.5 free command line tools. It uses system modules only, so extra DLLs aren't required. This program was designed to simulate output one-dimensional function when input signal and spread function are given and to restore input one-dimensional function when output signal and spread function are given. The user can simulate noise and can study its influence on the quality of restored signal.

The main program window (Figure1) contains the menu, the toolbar, the graph field and the status line. The program uses both English and Russian labels and messages. The user switches the languages by means of corresponding command from the "Options" menu. The most common commands are placed as buttons on the toolbar. The user can determine the exact value of one of functions if he or she chooses it from the list on the toolbar and clicks on the graph of this function. The function value in this point is placed into the status line. The chosen function can be easily scaled by means of the trackbar on the toolbar.

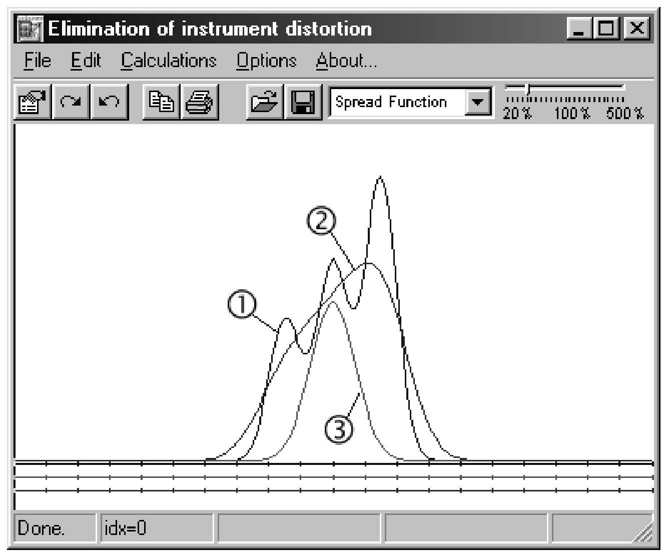


FIGURE. 1
THE MAIN WINDOW OF THE "APPARAT" PROGRAM.
(1 – INPUT SIGNAL, 2 – OUTPUT SIGNAL, 3 – SPREAD FUNCTION)

Various functions charts are drawn with various colors in the graph field. For each chart in the graph field the abscissa axis is drawn with corresponding color. Zero is always located in the center of the graph filed. Each graph presents absolute values of a function. The contents of the graph field can be printed or copied to clipboard.

Calculation starts when the user selects one of the command from the "Calculations" menu. The program places the information about the current step of calculations and its progress into the status line. The user can load input signal, spread function or output signal from file. Fourier-images can't be loaded. They will be calculated. The user can save any function if it is given (or calculated) and visible. The input and output files are texts. The first file line contains the amount of function values, initial value of argument, argument increment and maximal function value. From the second line of the file complex numbers are placed. Real part of a number is separated by space from imaginary part. Except loading from a file, function can be defined as internal one. The “Functions tuning” dialog (Figure 2) allows to configure internal functions, to specify precision and to add noise to a signal. The internal input function is the sum of 3 gaussians. The user should specify for every gaussian the amplitude (A), the abscissa of peak (B) and the C parameter, which determines the width at half-maximum. Spread function can be defined as normalized gaussian (the user specifies the C parameter only and the program recalculates the amplitude to normalize spread function). Fourier transform is performed by means of calculation of integral sum, so there are no restrictions to functions limits.

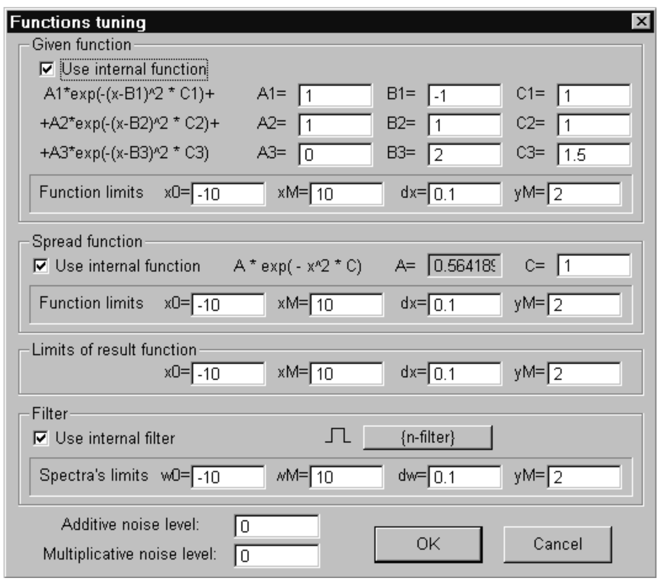


FIGURE. 2
THE FUNCTIONS TUNING DIALOG OF THE “APPARAT” PROGRAM.

The program adds two kinds of noises: additive and multiplicative. The user may specify "noise level" σ in a corresponding field, then the program changes every calculated value f of the output function to $f'=f+\xi f$, when multiplicative noise is chosen, and to $f'=f+\xi Y_{max}$ for the additive one, where ξ is a normally distributed value with zero mean and variance equal to σ^2, Y_{max} – window size, specified in the "yM" field for result function.

For decreasing the noise influence, one can use filtration of Fourier transformed restored function. There are two types of filter selected by the “filter” button:

1) binary filter – in this case the restored function Fourier transform, calculated according to (3), is multiplied by 1 inside of the limits specified in fields “Spectral limits”, it is equal to zero outside of this limits;

2) smooth filter – it this case Fourier transform is also multiplied by 1 inside of “Spectral limits”, but outside them Fourier transform is multiplied by exponential decreasing value with an index specified in the “C” field.

User can load other specific filter from file as well.

Web-based Service

Web-based service named “Instrument Distortion: Simulation and Elimination” (http://dims.karelia.ru/distort) is a web application, which consists of a set of HTML pages, CGI engine and low-level calculation engine. HTML pages provide a user with graphical interface (Figure 3). CGI engine provides interaction between web-server software (Apache) and low-level calculation engine by means of handling user requests, preparing data for calculations and forming result pictures. It is implemented as a set of platform-independent Perl language scripts. Low-level calculation engine performs required Fourier transforms. It is implemented in C language and compiled for particular platform (Linux).

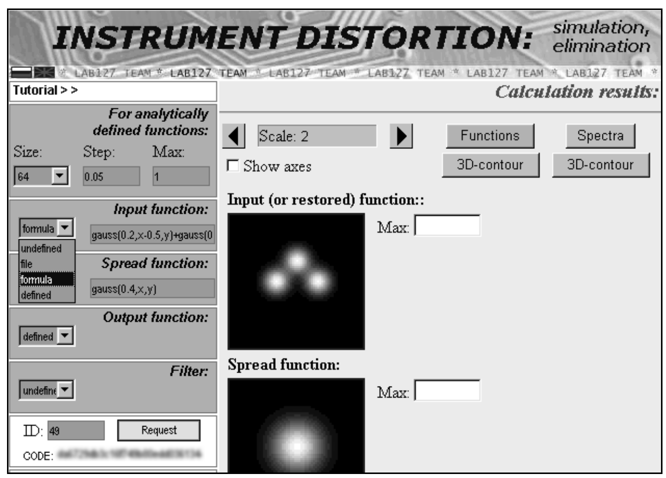


FIGURE. 3
WEB-SERVICE GRAPHICAL USER INTERFACE.

This web-service simulates two-dimensional instrument distortion when the input two-dimensional function and the spread one are defined, or eliminates two-dimensional instrument distortion, when the output two-dimensional function, the spread one and, possibly, the filter are defined. To define a function the user should select the appropriate way of function definition in the drop-down list: "file" or "formula". If user defines a function analytically (by means of formula) he or she should specify the size of the sample, the sample interval and maximal value of the functions. To send data to server when all these fields are filled user presses the "New request" button.

All the requests are registered and numbered. CGI engine stores request information (number, time stamp, client's IP, session code etc.) in MySQL database. Results are stored on the server for 1 hour since the first access. During this time the user can view calculation results: he/she enters its number in the "ID" field and presses "Request" button. User can change some functions of calculated request. Unchanged functions won't be transferred over the network. The low-level calculation engine will use their server copy.

At first CGI engine generates the session code (the "CODE" field). This code expires in one hour. Every time user accesses the server CGI engine prolongs the term of the session code for another hour. After long-time inactivity the other session code is generated. On user's computer the session code is stored in browser cookies. All the registered requests require the session code to be specified. If the specified session code doesn't match the request, the access to data on the server is denied. This feature has a side effect: the user can't access his or her registered requests from the other computer or browser without specifying the correct session code manually. The session code is the "password" for access user's data.

Real function for this service can be specified as formula. The user can compose a formula from arithmetical, logical and bitwise operators of widely used C-like programming languages, from a few internal functions like sine, cosine, gaussian etc. as well:

gauss(σ,x,y) is equivalent to $\exp\left\{-\frac{x^2}{2\sigma^2}-\frac{y^2}{2\sigma^2}\right\}$

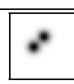
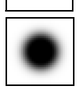
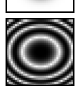
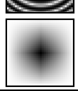
smooth(R,σ,x,y) is equivalent to

$$\begin{cases} gauss(\sigma, x-R\frac{x}{\sqrt{x^2+y^2}}, y-R\frac{y}{\sqrt{x^2+y^2}}), & x^2+y^2 \le R \\ 1, \quad x^2+y^2 > R \end{cases}$$

The latter function is useful for specifying as filter.

Table I contains a few examples of analytically defined functions:

TABLE I
EXAMPLES OF ANALYTICALLY DEFINED FUNCTIONS

gauss(0.2,x+0.5,y)+gauss(0.2,x,y-0.5)	
smooth(0.5,0.3,x,y)	
*cos(2*x*x+3*y*y)*	
(1-abs(x)/1.6)(1-abs(y)/1.6)*	

Data files for this service have the same format as the files for the "Apparat" software except for it is strictly recommended to compress data files when transfering over the network. This web-service can handle archives in ZIP (PkZip, WinZip etc) or GZIP (http://www.gzip.org) format. The calculation results are always compressed by GZIP.

The problem of two-dimensional instrument distortion elimination is usually the interest of image processing. So this web-service supports some image file formats: PNG (Portable Network Graphics) and JPEG (Joint Photography Experts Group). When converting image to real values it is supposed that green color gradation "255" corresponds to 1.0. Red and blue color gradations are ignored. The left bottom corner of the image corresponds to the function value for the least argument values.

SIMULATING EXPERIMENTS IN LABORATORY TRAINING

If student simulates an input function as three clearly separate peaks and a spread function as a gaussian with width comparable with peak separation, the result function has no gap, so by visual observation three lines could not be resolved (Figure1). Restoring input function by the "Apparat" program one can receive almost correct input signal. If a noise is added to the output function an attempt to restore the input signal is failed. Even with low values of noises student may receive senseless results (Figure 4). The noise effect can be decreased by reducing the operative spectral range. (Figure 5.)

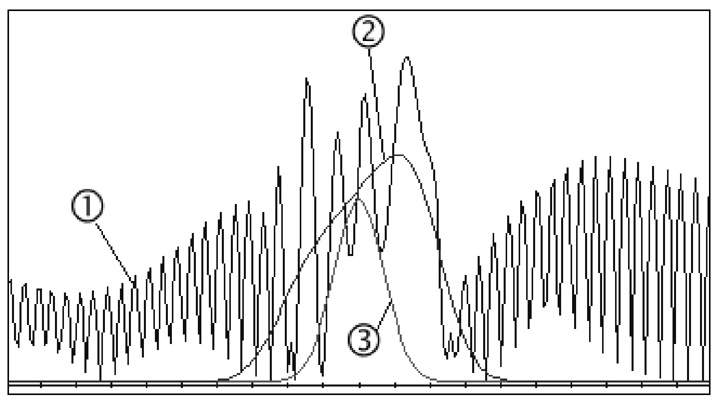


FIGURE. 4
AN ATTEMPT TO ELIMINATE INSTRUMENT DISTORTION.
(1 – RESTORED SIGNAL, 2 – OUTPUT SIGNAL WITH ADDITIVE NOISE σ=0.00001, 3 – SPREAD FUNCTION)

Then student has to investigate the effect of spread function width on the result of reduction to ideal instrument. But if the spread function is wide and the noise level is not low the oscillations disappear with the narrow operative spectral range (Figgure 6), so restored function is now more similar to the output function than to the input one, that is to say the instrument distortion elimination in this case is impossible.

So students have to understand that inevitable noise puts the real limit for optical instruments resolution. The better is the instrument and the narrower is its spread function the lower are the demands to noise level.

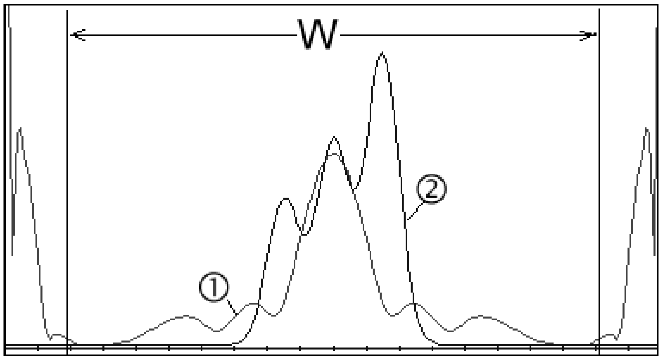


FIGURE. 5
AN ATTEMPT TO ELIMINATE INSTRUMENT DISTORTION
WITH REDUCED SPECTRAL RANGE W.
(1 – RESTORED FUNCTION SPECTRUM, 2 – RESTORED AND "TRUE" INPUT SIGNALS ARE ALMOST IDENTICAL)

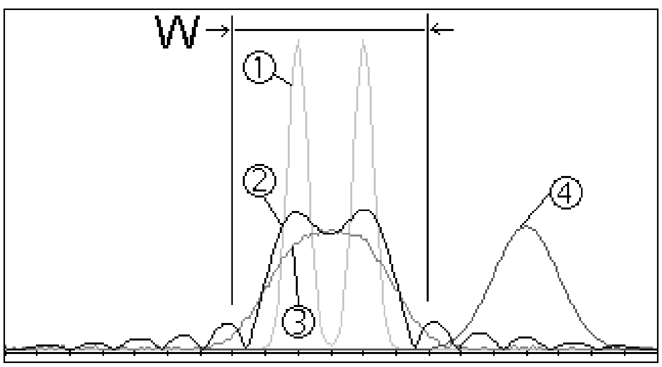


FIGURE. 6
AN ATTEMPT TO ELIMINATE INSTRUMENT DISTORTION
WITH WIDE SPREAD FUNCTION AND REDUCED SPECTRAL RANGE W.
(1 – "TRUE" INPUT SIGNAL, 2 – RESTORED SIGNAL, 3 – OUTPUT SIGNAL WITH ADDITIVE NOISE σ=0.005, 4 – SPREAD FUNCTION IS SHIFTED FROM "NORMAL" PLACE FOR CLEARNESS)

Even if specified noise level is zero, the limited accuracy of computer calculation may have an effect like noises. This effect appears to be the major problem for elimination of 2-D instrument distortion.

If student simulates 2-D instrument distortion by means of the web-service (Figure 7), restoring of input 2-D functions is always a nontrivial problem. Even without special noise simulation, most likely, attempts to restore input signal would failed because of limited accuracy. In most cases reduction of spectral ranges required (by means of filters).

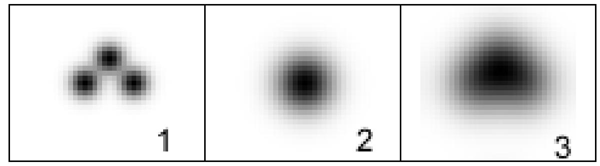


FIGURE. 7
SIMULATION OF 2-D INSTRUMENT DISTORTION.
(1 – INPUT SIGNAL, 2- SPREAD FUNCTION, 3 – OUTPUT SIGNAL)

If student compares various results of instrument distortion elimination when output functions are determined in various ways, he or she will notice that text data files allows to achieve better results than image files (Figure 8 and 9). For text data files elimination of instrument distortion is possible with wider filters. Student should explain this by less accuracy of image data files.

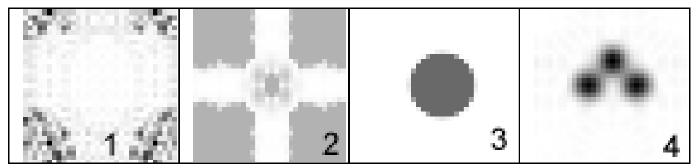


FIGURE. 8
ELIMINATION OF 2-D INSTRUMENT DISTORTION
WHEN OUTPUT FUNCTION FROM FIGURE 7 IS LOADED AS TEXT DATA FILE.
(1 – FIRST ATTEMPT TO RESTORE SIGNAL, 2- RESTORED SIGNAL SPECTRUM, 3 – APPLIED FILTER, 4 – RESTORED SIGNAL AFTER FILTRATION)

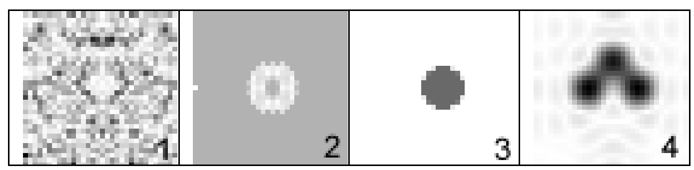


FIGURE. 9
ELIMINATION OF 2-D INSTRUMENT DISTORTION
WHEN OUTPUT FUNCTION FROM FIGURE 7 IS LOADED AS IMAGE FILE.
(1 – FIRST ATTEMPT TO RESTORE SIGNAL, 2- RESTORED SIGNAL SPECTRUM, 3 – APPLIED FILTER, 4 – RESTORED SIGNAL AFTER FILTRATION)

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TEACHING FRESHMEN THE NEED FOR SUSTAINABILITY IN THE NEW MILLENNIUM

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Abstract *— When you look at the freshman curriculum, most engineers believe it is necessary for the student to learn proper writing, mathematics, physics and chemistry skills. However, there is also an interest in teaching the concept of Sustainability to students as soon as the freshman year. The problem is how to add material and content to a curriculum that is already full. To address this problem the University of Pittsburgh began teaching Sustainability to the entire freshman class in Spring 2000, by incorporating the concept of Sustainability into the students Introduction to Engineering Course through the concept of writing to learn.*

The educational benefits of adapting a writing approach in the classroom have been widely documented. Writing can serve as a tool to improve the quality of teaching as well as to promote deeper and more meaningful student learning. In this paper we will explore strategies in which writing can be used to both introduce the concept of sustainability and enhance student understanding in introductory engineering courses. To accomplish this goal, students were asked to prepare and present a professional research paper for a "conference". Highlights of the curriculum developed will be discussed. Through a description of the curricula and strategies developed, we hope to provide other science and engineering educators with useful tools to assist them in developing and/or enhancing the use of writing within their own classrooms.

INTRODUCTION

Traditional teaching methodologies have been shown to put students in a role of passive rather than active learning [1]. In addition, traditional instructional methods have also been shown to be very inadequate in terms of the promotion of deep learning and long-term retention of important concepts. Students in traditional classrooms acquire most of their "knowledge" through classroom lectures and textbook reading. A troubling fact is, after instruction, students often emerge from our classes with serious misconceptions [2 - 6].

A significant body of educational research supports the fact that students must be functionally active to learn [7 - 9]. Furthermore, Koballa, Kemp, and Evans [10] note that "ALL students must become scientifically literate if they are to function in tomorrow's society". Scientific literacy is of critical importance for all students at all educational levels.

The *National Science Education Standards* [11] strongly emphasize that inquiry-based techniques should form the core of what it means to learn and do science. Edwards [12] suggests that the publication of the *National Science Education Standards* offer reason to be optimistic that inquiry-based learning will become a central part of science education. Inquiry-based learning strategies originate from the constructivist model and encourage an active, hands-on approach to learning [13 - 14]. The constructivist approach embraces the idea that knowledge cannot be acquired passively [15]. In addition, the National Science Foundation currently has several programs that promote the integration of standards and inquiry-based SMET educational materials and instructional strategies from elementary through graduate school [16].

In recent years, a number of writing techniques have evolved that make use of various writing-to-learn strategies within the domains of engineering, mathematics, and the sciences [17 - 25]. The use of writing in introductory classes may be an effective vehicle for allowing students to enhance their critical thinking and problem-solving skills. Writing can also assist students with the identification and confrontation of personal misconceptions [26, 27].

Science classes are seen by many students to be threatening and intimidating places to be. Tobias [28, 29] also indicates that writing can serve as a means to help students relieve their anxiety and help them unlearn models and techniques that have been shown to be scientifically unsound.

This article describes a novel technique for infusing the concept of sustainability into the freshman engineering curriculum that is based on research the authors are conducting on using writing as a means of providing "hands on learning". [31 - 35]. The techniques to be described here permit students to experience all aspects of preparing a professional paper for publication. The students' experiences culminate with a presentation of their papers at the *Sustainability in the New Millennium Conference* at the University of Pittsburgh. The writing technique was initially modeled at American University then adapted for use at Pittsburgh [36]. The specific courses in which the writing

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strategies were adapted, *Introduction to Engineering Problem Solving*, will first be described. The curriculum involved in the development of the writing activity will then be discussed. This discussion will be followed by a summary of the conferences in which students participated. Feedback from student participants will also be shared. In addition, lessons learned during the initial phase of the study will be shared along with how those lessons translated into effective changes for this year. Finally, a summary of this technique will be presented in light of its relevance to science, mathematics, engineering, and technology (SMET) education.

Since the population in the classroom is freshman, their knowledge of sustainability is very limited. In fact the vast majority of the students have never been exposed to the concept. This factor highlights the importance of this assignment and explains why as part of the freshman course syllabus, we must take time away from the typical freshman engineering topics and replace it with a definition of sustainability. Since this program is for all freshman regardless of their major, another concern is the presentation on sustainability must be such that a Civil, Bio or Computer Engineering student will get enough information to develop a definition they can understand. Thus, the first task is to define sustainability.

WHAT IS SUSTAINABILITY

Since the advent of civilization, engineers have sought to alter the environment and shape it in ways that would serve the various needs of society. While our lives today can attest to the success of this endeavor, it has not been without cost. Often times, the alteration of the environment - whether purposeful or unintentional - has led to undesirable consequences. Only in the past several decades have engineers become acutely aware of the consequences of their actions on the environment and society. As a result, growing public demand has led to various legislative and regulatory actions attempting to minimize the adverse consequences of civilization on the environment. Unfortunately, many of these measures - such as the "no net loss" of wetlands policy and the industrial restrictions placed on various parts of the US classified as air pollution "non-attainment" region - often have negatively impacted growth and development. A seeming contradiction between development and environmental protection exists.

In recent years, however, a realization has developed that both development and environmental protection are necessary and that either need not be sacrificed for the other. A growing movement recognizes that environmental protection can and must co-exist with development and must be planned for accordingly. Under the general umbrella of "sustainability", this movement encompasses various facets. "Green Engineering", "sustainable development", "environmentally conscious manufacturing", and "green construction" are some of the terms recently entering the engineering lexicon that describe the move towards sustainability. The confusion surrounding sustainability, is each of these terms means different things to different people. Whether constructing a new highway, designing a new product, or improving a manufacturing process, sustainability issues are at the forefront of challenges today's engineers must face.

What exactly, is meant by "sustainability"? The 1987 Brundtland Report, prepared for the UN's World Commission on Environment and Development, defines it as "satisfying the needs of the present generation without compromising the ability of future generations to meet their own needs"[37]. The 1992 UN Rio Conference on Environment and Development [37] offers a slightly modified version, describing "sustainability" as follows: "the right to development must be fulfilled so as to equitably meet development and environmental needs of present and future generations". Other organizations and individuals propose somewhat different definitions of sustainability. Through all the differing descriptions, however, a common thread remains: sustainability seeks to minimize our footprint in nature, both now and in the future.

Most issues revolving around sustainability, quite naturally, involve subjects traditionally thought of as environmental. These include conventional environmental engineering topics such as waste minimization, pollution prevention and control, and water/wastewater treatment. A second set of issues revolves around energy/resource conservation. It incorporates such items as recycling, alternative fuel sources, alternative fuel vehicles/mass transportation, and energy efficiency. A third group of subjects entails items thought of as environmental ecology. This subset comprises areas such as urban forestry, landscaping and biodiversity.

Although most sustainability issues deal with topics affecting the environment in some manner, one facet of sustainability is unique in that it generally has seemingly little to do with minimizing our footprint on nature, but deals with subjects commonly referred to as "quality of life" issues. Although sometimes not thought of as "sustainability" per se, "quality of life" concerns often are as important, and in some cases, more than the conventionally defined sustainability topics. What exactly is meant by "quality of life"? An admittedly imperfect definition is that they are issues that make human existence more enjoyable, less burdensome, or life extending. Most medical advances, for example, fall under the quality of life definition. These advantages might not impact the environment directly, but often improve human life. Whether it is nano-medicine, nano-probes, new antibiotics, new surgical techniques or new and improved prosthetics, these areas all directly impact the quality of life. Another area of engineering that could be thought of as impacting the "quality of life" is the computer industry. For example, a new piece of software might make it easier to do your taxes, but does not have a direct impact on the environment. There are a large number of other areas that could fall into the "quality of life" definition. Even thought these areas do not directly impact the environment, all of the products must be manufactured, or operate in a computer that must be manufactured and have environmental issues involved with their production or use. Thus, they directly affect the quality of life and indirectly impact the environment.

The final area of "sustainability" that must be considered is that of "trade offs" or balancing environmental, societal and economic factors. Sustainability becomes a study in benefits versus cost. No panacea exists for sustainability. There are no easy, obvious solutions. Each potential answer to a sustainability concern has potential drawbacks. As an example, assume you design a building to reduce energy consumption by using materials and using building practices that reduce the outside air that enters the building. This will reduce the energy use but also reduce the number of air exchanges in the building and could lead to a "sick building syndrome". A second example is the use of alternate energy sources to generate electricity. Wind and hydroelectric power do not produce greenhouse gases as burning fossil fuels do. However, both have other downsides. Areas favorable to wind are also common migratory pathways for certain birds. When a bird meets a metal turbine, the turbine always wins. Similarly, dams required for hydroelectric power often prevent fish from migrating. Economics also plays a part in sustainability. For example, computers and software development benefits the productivity of the average worker. However, the process used in the manufacture of the microchips presents significant environmental challenges. Environmentally friendlier procedures are available but at an added cost. As a final example, assume that an automaker could produce a car that achieves 100 miles/gallon, but costs $100,000. How many of the cars would be sold?

What is more important? No loss of woodland or more homes and industry? Is energy efficiency more important than indoor air quality - or vice versa? Is it more important to produce clean energy or do the birds and fish take priority? What good is an environmentally safe computer or automobile if no one can afford it? The fact is the population will continue to grow, and energy, food supplies, and habitats will need to keep pace to ensure a consistent and acceptable quality of life. The task for all future engineers will be to balance the quality of life against the environment against the cost to develop the best solution for us and generations that will follow us.

BACKGROUND

All students are required to take four core engineering courses during their first year. There are two zero-credit seminar courses [38, 39] and two three-credit introductory problem solving courses [40] that are a part of this core. ENGR0011 and ENGR0012 are required first and second semester three credit courses, for all freshmen engineers that meets twice a week for 2 hours in a computer-equipped classroom. They are *integrated* courses that have the overall goals of:

1. Teaching the basic computer skills (Excel, Matlab, C), and their role in problem solving,
2. Introducing teamwork,
3. Improving writing and communication skills,
   a. Introduction to Technical Report Writing,
   b. Effective Use of the Library;
4. Promoting and encouraging good programming practices; and
5. Illustrating the role computer programming plays in solving real-world engineering problems, and
6. To begin understanding how material in the basic sciences and mathematics is used by engineers to solve practical problems of interest to society.

It is the experience of the faculty that students know very little about the actual operation of a computer or computer software as problem solving tools. The students are good at using AOL instant messenger, and finding music files on the web, but when it comes to organizing files in directories, or organizing their thoughts into a structured program the vast majority of the students are lost. Thus, the main focus of ENGR0011 is to begin the process of structured thinking then ENGR0012 expands this concept into the structured programming area.

The class sections are taught by faculty members from various departments within the School of Engineering, and the course topics focuses on material that overlaps with various disciplines in engineering. Emphasis is placed on the application of various computer-based tools to solve real-world engineering problems. The course also illustrates how engineering differs from, as well as how it coalesces with, the disciplines of science and mathematics.

In addition to the various activities related to problem solving, students are also exposed to a richer and more robust writing experience in both ENGR0011 and 0012. This experience involves the preparation of a written research paper and oral presentation. These activities will now be described.

DESIGNING THE INTEGRATED LIBRARY RESEARCH PROJECT

To introduce sustainability through the concept of a writing assignment, a communication link had to be installed into the course. This link was in the form of introducing the various word processing software and computer presentation software. Thus, from the students' perspective the writing assignment was a requirement for the communication portion of both courses.

The Spring writing assignment is introduced early in the Fall semester, students were informed that one of the key components of the spring course would be the preparation of a formal written paper for publication and presentation at a conference to be held at the end of the second semester. Through the context of a conference, students are now introduced to the culture of academic research and the scholarly communication system and how the engineering profession interacts with this skill. Specifically the educational objectives of the library including introduction to some of the library's resources and research processes, and introduction to critical thinking skills to analyze the validity and utility of information are incorporated into the project.

Given that Pitt uses an integrated curriculum approach for their freshman courses, students were told that where possible, their papers should relate to topics covered in the fall or spring semester of their Physics, Chemistry, Calculus or Engineering classes. In addition, students were to link their chosen topics to an area of engineering using the idea of sustainability in the new millennium as the common conference thread. The key idea was to expand upon the concept of curriculum integration by having students merge material from their core courses with material they had learned in their introduction to engineering seminar courses and explain how the product they were researching dealt with the various science topics they were learning and how the engineering profession dealt with the concept of sustainability when designing this product.

To prepare the students for this Spring semester project, it was decided to introduce the students to writing in the Fall semester. It was decided that a trial run of writing and presenting a technical paper to a small group of their peers using PowerPoint software would best prepare the students for the conference in the spring semester. The ENGR0011 faculty agreed that the overall theme of the Fall library research project should focus on the student's exploration of an area of engineering that interested them. Thus, in addition, to the concept of sustainability, the freshman program faculty and advisors wanted the students to be able to answer the question "What is an Engineer"? and how does sustainability fit into every field of engineering?

Each component of the research project included a statement of purpose (or learning objective) so the students would understand why they were doing this work. Research/Resource Guides for each assignment were designed by the library staff in order to supply the students with additional guidance to the resources they would need to consult.

Within the library, the librarians and staff met to discuss the project. A binder containing the Library Research Project was kept at the front desk of the Engineering Library. All of the library staff became familiar with the project; they were aware of which assignment the students would be working on in any given week, as well as the resources students were being asked to access and use.

Throughout the second semester, students were exposed to all aspects involved in the preparation of a formal paper for publication. These aspects included: responding to a call for papers, being notified of the acceptance of their abstracts, conducting the necessary research, preparing and submitting a paper for review, conducting a review, and receiving and utilizing the feedback to prepare a final paper. Each of these items are further described and illustrated in the sub-sections presented below.

The Call for Papers

The conference call for papers was distributed at the beginning of the semester, see Figure 1. Students received a paper copy as well as an electronic copy of the call via the class web page.

Figure 1 Call for Papers

Abstracts are now being accepted for the ***Third Annual Sustainability in the new Millennium Conference*** to be held on **April 5, 2003** at the University of Pittsburgh in Pittsburgh, PA. A wide range of topics will be considered. Where possible, papers should involve some topics listed in the fall or spring semester Physics, Chemistry, Calculus, or Engineering course syllabus.

Possible presentations/paper topics include (but are not limited to):
1) Historical, current, or futuristic views on a physics topic related mechanics, linear, or rotational motion, collisions, energy oscillations, waves, electricity, magnetism, light, color, quantum mechanics, or other topics;
2) Historical, current, or futuristic views on a chemistry topic related to kinetics, entropy, liquids, gases, thermodynamics, materials science, chemical relations, ionic bonding, organic chemistry, polymer chemistry, biochemistry, nuclear chemistry, or environmental topics;
3) Historical, current, or futuristic views on computer science topics related to software development, the internet, programming languages, or other related topics;
4) Physics, computer science and/or chemistry as it relates to the design, development and/or function of a commonly used devise (e.g. What is the physics involved in a burglar alarm? What is the chemistry involved in batteries or fuel cells? How is sound created for a movie film? How does the detector in the light meter of a camera work?);
5) Science or computer applications and public policy issues;
6) Science or computer applications and social issues;

Note: Each paper must not only address the above topics, but also discuss some aspect of sustainability.

The purpose of having students prepare an abstract was threefold. First, the preparation of an abstract gave students a sense for how the abstract submission process is handled for a professional conference. Second, it provided students the incentive to choose a topic for their papers early and to begin to focus on the research aspects of the project. Third, it was obvious that many students had never been asked to prepare an abstract before. Many students were challenged to effectively summarize a paper they have not yet written into a 150 word abstract. Thus, this task required the students to think within the "big picture".

To manage the process, the 380 students were paired with another student with common interests. This reduced the number of abstracts to 190.

All abstracts were submitted to a web-based electronic format. The electronic submission of abstracts encouraged professionalism from the outset of the paper preparation process and facilitated a more efficient and effective review.

Preparing the Sessions

Once the submission process was completed, all the student abstracts were reviewed by the course instructors and organized into common theme sessions. The abstract review allowed the instructors to prepare a preliminary conference schedule and to make sure the paper topics were consistent with the call for papers. Some students were asked to revise their abstracts because their initial topics did not parallel the conference theme closely enough.

The final conference will have approximately 30 sessions with approximately 6 papers presented per session. Because of the large number of papers to be presented it is not possible for one person to perform all the associated review tasks. To address this issue, 30 alumni volunteers from the Pittsburgh area together with 30 faculty volunteers were solicited to act as co-chairs for each session. Each session was co-chaired by one alumni and one faculty volunteer. These individuals also served as reviewers for the papers to be presented in their sessions. Over the past 3 years, the conference has had the following sessions topics:

> Chemistry Issues, Computer Issues, Bio-Engineering Issues, Mechanical Issues, Environmental Issues, Energy Sources, Transportation Issues, Military Issues, Physics/Civil Issues, Communication Issues, Medical Issues, Structural Issues, Electrical Issues, Industry Concerns, Future Issues, Manufacturing Issues, New Millennium Issues, and Aviation Issues.

A review of the session titles shows that the conference theme of sustainability has reached well beyond the classic “green construction” or “green engineering” definition used by many people. Thus, the goal of raising the awareness of sustainability has been achieved.

Preparing and Submitting a Formal Paper for Review

When students initially received notification that their abstracts had been accepted, they were given a copy of the formatting guidelines to be followed as they prepared their papers. The guidelines that were given to the students were essentially the same guidelines given to authors submitting a paper to the ASEE Frontiers in Education Conference. The paper submission process was a web-based format.

Receiving Reviewers’ Feedback

All students’ papers were subjected to a formal review process. To facilitate this process, each of the 180 teams of student authors met weekly with to give a short progress report. During the first year of the program, this meeting was with a team of TAs whose assignment was to supervise the students. In the second and third year of this conference, this task has been transferred to the undergraduate mentors. Thus, the success of the involvement of the mentors during the first semester, has resulted in expanding their involvement into the spring semester.

During these meetings students must demonstrate completion of various milestones set by the faculty. For example, during one weekly meeting students were required to submit an extended 2-page outline of their papers, during another they were required to submit a copy of the articles they were using for their papers, and during another they were required to submit short summaries of each of the articles they had collected thus far. Table 1 lists a summary of the various activities for each week.

The paper review was a multi-step process. After the abstracts were submitted, the ENGR0012 faculty initially reviewed the abstracts to establish the 30 sessions. Students were then required to submit an extended outline of their papers. This outline was posted on the conference web site so the session co-chairs could review the abstract and outline. The session chairs then met with their students to discuss the paper outlines. After this meeting students prepared the draft version of their papers and submitted it electronically, the week before spring break. The co-chairs were responsible for reviewing these submissions for technical content. A second meeting with the students to discuss the reviewers' comments was then held. In addition to being reviewed by the co-chairs, each paper was also reviewed by a faculty member in the English department. The reviews conducted by the English faculty members focused on writing style, form, and grammar.

An additional peer review process was also part of the process. The usefulness of this approach has been widely documented [41, 42]. Thus, in both courses, every student was assigned another student's paper to review. Since the students were paired in teams to write the papers, and each student did their own review, each paper actually received two student revfiews.

In summary, this process produced 5 independent reviews, one from the English department, one from an alumni, one from a faculty member and two from students.

Table 1 List of weekly activities in review process

Week of	Assignment	Comments
08-Jan	No Meeting	
16-Jan	- Choose partner for project	
22-Jan	- Turn in preliminary topic	**Purpose** --- To get the students to begin to research their topics and read the articles
29-Jan	- Bring in 3 articles on topic - Explain 1 randomly picked article - Explain their topic a little and what they want to explain in their paper	**Purpose** --- (1) To have students continue to research their topics and read the articles (2) To get students to relate sustainability issues to their chosen topics
05-Feb	- Bring in 3 articles on topic (2 from mag/journal) - Explain 1 randomly picked article - Identify 3 sustainability issues and explain how they relate to the student's chosen topic	**Purpose** --- (1) To get students thinking @ how they will write their paper. (2) To get students actually writing parts of their papers
12-Feb	No Meeting Students are meeting with their session chairmen	
19-Feb	- Bring in copy of outline - Talk to the outline and discuss what they want to discuss in their papers - Bring in 1 page typed paper about some topic in their outline	**Purpose** --- (1) To continue to have students actually writing parts of their papers. (2) To get students writing their bibliography and procure additional sources if required
26-Feb	- Continue to talk to their outline - Bring in copy of bibliography - Bring in 1 page typed paper about some other topic in their outline	**Purpose** --- Explain peer review process
05-Mar	Spring Break	
12-Mar	No Meeting Students are meeting with their session chairmen	
19-Mar	- Bring in peer review papers - Explain peer review process (meeting chairman)	**Purpose** --- To get the students thinking about their presentation and to start putting it together
26-Mar	- Bring in preliminary outline for presentation and discuss what points the student wants to make	**Purpose** --- (1) To get the students to prepare their presentation for the conference. (2) To go over the presentation and make corrections/ suggestions
03-Apr	- Bring in charts the student wants to present to the conference or a hard copy of their power point presentation - Talk to the charts/hard copy.	

THE CONFERENCE

Students utilized the reviewers' comments to prepare final copies of their papers. Typical papers ranged in length from 5 – 8 formatted pages. Because of the magnitude of the conference, the conference proceedings was only available on line, however, a matrix was created and distributed at the conference.

The students prepared and made use of overhead transparencies, PowerPoint slides, and demonstrations during their presentations. Students were also asked to wear appropriate attire for the conference.

Students were given 15 minutes for their presentations and then allowed two minutes for questions. It was not possible to hold the conference during regular class time because of the sheer size of the conference. Thus, the conference was held from 8 am to 4 pm on Saturday, with lunch being provided.

The following section highlights student impressions regarding their overall experiences during the paper preparation process. In addition, feedback received during Phase I from students via a written questionnaire is summarized.

RESULTS

In the first year we were able to design the basic concept of the writing and library integration into the freshman curriculum. As faculty and staff we learned a lot about what could and could not be expected from the students, how to introduce the material, how to grade the student presentations, what type of handouts and grading keys were required, what could be expected from the mentors, and all the various logistic concerns. Thus, the main results we obtained during the first year were administrative issues. We also discovered that the content in the two - zero credit seminar courses had to be totally redesigned. Thus, in the second year we moved the department presentations from the Spring semester to the Fall, we added open house presentations into the Spring semester, and we extended the peer mentoring to the second semester ENGR0082 course. In addition, we added an intensive one week mentor training program to the week before school started. In this training we exposed the mentors to training in the areas of advising, diversity, communication skills, and mentoring skills.

The results from the Fall semester of the second year supported the changes we made as the students' acceptance of the project was much more positive than the first year. Based on the feedback from the students during their spring semester registration period at the end of the Fall semester, the project meet the advising concern, since the vast majority of the students stated the project made self evaluate their choice of major. The students either found that by researching their fields and talking to fellow students in their mentoring class they were questioning their choice and wanted to learn more about all the fields of engineering, or were now convinced the field they selected was the correct field for them. This is a very important result. One of the largest problems faced by advising centers is students changing their major after they have been taking classes for 2 - 3 semesters. Thus, by having the students research the concept of sustainability, we are finding that the students are also doing the same career exploration in the first semester of the freshman year, that typically takes place during their third of fourth semester. This has the potential of saving the student a large amount of time and money.

It was also clear that for the project to be successful, you must have the assignment well organized with handouts that can walk the students through the process. You cannot assume that a freshman knows how to write a report, this was the biggest error we made in the pilot.

By the end of the semester a number of goals were reached with the first writing assignment. First the students were exposed to the library and how to conduct a research paper. Second the students were exposed to the actual skills required to write a formal paper and give an oral presentation on an engineering topic. The last and most important concept was the students researched an area of engineering that they thought was interesting, and during this process they discovered a product or topic that dealt with sustainability in that profession. Thus, by writing the fall semester paper they discovered a topic for their second semester paper.

During the Fall of the second year we also starting getting feedback from the faculty teaching the Second year courses in the various departments. As one faculty member stated he was "blown away by the quality of the writing of his students compared to previous years". This also confirms the finding of the English department when they stated that the quality of the final papers was equivalent to the results that could be expected from taking a 3 credit writing course. Thus, the goal of improved writing skills was also meet by the project. It is clear that the main reason the writing skills of our undergraduates is so poor is because they do not know how to use the library to write a research paper, and the results we are getting this year support the concept that if you teach them how to do it they will improve their skills.

FEEDBACK FROM STUDENTS

Near the beginning of each semester, the students were quite apprehensive about the prospect of preparing a formal written paper. None had ever been given a writing assignment of this magnitude before. Although the students had done some writing when they were enrolled in the foundation course, ENGR0011, the task facing them seemed quite daunting. In addition, many students expressed anxiety regarding the fact that they were also being asked to present their papers orally. Comments from students suggested that they felt they would never be able to fill the 10-minute time period allotted them for their presentations. In reality, once students had completed their written papers and had prepared their materials for presentation, most found that they had too much material to fill the 10-minute time slot! Thus, the real challenge faced by most students was the condensation of their papers into a 10-minute presentation. Each and every student author was, however, successfully able to present their papers within the given time period.

On a questionnaire given students last year, students were asked to describe their overall impressions regarding the conference paper assignment. Typical student responses included:

- *I've never written a technical paper like that before. The topic was much more involved - and required you to really understand what you were writing about.*
- *I thought this was a difficult assignment that taught me a lot and was worth doing. It was a lot of work, but after doing it, I felt like I learned a lot. I never had to write a technical paper before and I'm happy that I can now say that I wrote a conference paper.*
- *I learned a lot about a subject that I would not otherwise have learned about. I had never written one of this magnitude, or that required so much in-depth research. We were allowed to pick the topic - which was nice.*
- *I have never written any form of technical paper at all. At first, I was not very excited about the idea of writing such a paper, but I did feel that I had a very valuable experience. I feel that I have learned so much - beyond physics principles. I also appreciated you forcing us to do rough drafts, so I was able to pace myself and put more effort into it than I otherwise would have.*

The following questions to sustainability were also part of the survey:

- How did the conference activities (research, paper, presentation) help teach the concept of sustainability as it relates to Engineering?
- Was the concept of sustainability adequately explained in the Freshman Seminar?
- Did the TAs do an effective job explaining the concept of sustainability in the weekly meetings overall and how it related to your topics?

On a scale of 1 - 5, with 5 high, the students responded an average of 3.5 on each of these topics. Thus, they found the paper did indeed help introduce them to the concept of sustainability. We also pre and post tested them on their views of what requirements engineers have should have related to issues involving social responsibilities and ethical concerns. On each item the difference between the pre and post scores was on the average of 20%. Thus, the students are developing an understanding on the need to consider the environment and society when they make their engineering decisions.

On the short answer survey questions the general response was they did not know anything about sustainability before the activity or they thought it was just an environmental engineering concern. Thus, with this rather simple task we were able to introduce all engineering students to the concept of sustainability and got them thinking about how sustainability could be included in all engineering projects.

The most interesting result, however, is not during the freshman year, but after they have completed a Co-op or intern work assignment during their second or third years. We continue to survey the students after each of their years at the university, and each year we ask them to evaluate their freshman experience. What we are finding is when you ask a second or third year student the same survey questions, the scores on the questions continue to increase with each year. We are finding that freshman do not truly understand the value of the conference experience, however, once they experience an opportunity to spend time in the work force they are being asked to consider many of the same topics we discussed in the freshman sustainability conference. Thus, the conference is introducing them to a topic that was never discussed in the past, and is preparing them for issues in the work force that deal with society, and sustainability.

SUMMARY AND CONCLUSIONS

All aspects of the conferences, from submission of an abstract to the formal submission of a camera-ready copy of their paper for publication and presentation, allowed students the opportunity to link the active process of writing to sound, scientific content. In addition, these activities allowed students to demonstrate their understanding of a topic or set of topics using their individual learning styles. This activity also provided the instructors with an additional assessment tool outside of the limits of more traditional assessment measures.

At the conclusion of the conference, it was clear that the students felt that all of the time, energy, and hard work they had devoted to the preparation for the conference had paid off. Many expressed that they had experienced a fairly steep learning curve on both the content covered as well as the rules and regulations they were required to follow as they prepared their formal papers. In addition, many students expressed gratitude for the opportunity they were provided to participate in such a formal and professional activity.

The underlying premise is that <u>all students</u>, no matter what their gender, cultural, or demographic backgrounds, can learn! In a recent report on its review of undergraduate education, the Advisory Committee to the National Science Foundation's Directorate for Education and Human Resources concluded that "… while K – 12 programming can expand the pool of those interested in pursing careers in SME&T [Science, Mathematics, Engineering, & Technology], it is at the undergraduate level where attrition and burnout can be most effectively prevented. What we in SME&T education must do is to concern ourselves with *all* students, not just those who historically have been represented in science, mathematics, engineering, and technology. Such a breadth of concern has important educational benefits as well, as it will force us to think more about how individuals learn and recognize what research has made clear: that there are differences in learning style which profoundly effect achievement. And let us not forget that increasing student achievement in SME&T education is exactly what is needed [43]" (p. 28).

Writing has proven to be an effective way to assist students in articulating their thoughts. In addition, the opportunity to research and then write about a topic of personal interest can allow students a chance to demonstrate their understanding in a way traditional assessment measures do not permit. Hence, the application of a writing component into a course has enormous potential within both science and engineering communities.

ACKNOWLEDGMENTS

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DIRECTIONS AND CHALLENGES IN INFORMATICS EDUCATION ON ENGINEERING AND COMPUTER SCIENCES COURSES

Clara Amelia de Oliveira[1]

Abstract *— XX Century culture has emphasized specialization paradigm in all knowledge domains. Globalization times have increased complexity on this scenery putting real challenge to earth people, including Engineering and Computer Sciences domain. In this direction, this paper presents an Educational methodology-the Thematic Oriented Methodology. The concrete experience occurred on a Computer Programming Introductory discipline, on Engineering and Computer Sciences courses. This pedagogic experience pointed out how important is to built a clear object of study definition under Complex Though approach as a knowledge domain. The Complex Though is, by its side, close related with XXI Century educational demands, as proposed Edgar Morin, from UNESCO Itinerant Educational cathedra. The central question to be discussed here is, how new curricular trends can profit from this approach? Some conclusions enhance thematic oriented proposal as an answer to educational demands under globalization approach.*

Index Terms — Complex Though, Computer Sciences and Engineering Education, Educational Methodology Thematic Oriented Methodology.

INTRODUCTION

The presence of Informatics on modern civilization has been a central discussion point on several scientific forums, all over the world. But the informatics contribution on education can be wider than just referring to instrumental support, specifically on technological careers educational scope. Engineering and Informatics curricula have a deep question to be faced, at first. It is how to organize contents, such way, students can develop, both, analytic thinking, required in focused knowledge aspects, and synthetic thinking, required on multifocus knowledge aspects. Some tasks refer to modeling systems practice under very complex environments, but, at same time, at closed systems, leading with specific details. The question is how to promote, pedagogically, this movement causing internal link between broad and specific knowledge aspects? Can engineering and informatics students, at same time, pay attention on special inner machine tool contents, aligned with high abstract values, as society engaged citizens? This is possible, for several reasons, and the simplest one is that because this is natural. This is not only possible, but it is desired on all kind of knowledge domain, including Engineering and Informatics one. Those educational trends looking for necessity of synthesis at curricular level, have been proposed by ABET criteria 2000 [1], as a directive, for engineering careers, emphasizing synthetic approach. Those principles are, also, in accordance with generic educational trends present in recent documents from UNESCO, looking for Complex Though studies proposed by Edgar Morin Itinerant Cathedra [2]. There is notable convergence of educational principles related with engineering, and Informatics, careers because of nowadays demands of modern professional profile. In this direction, there is available a theoretical tool, proposed by Nygaard, applied, at first, in information systems modeling [3], but, ready to support education systems demands, as it will be discussed below.

THEMATIC ORIENTED EDUCATIONAL METHODOLOGY AS A PEDAGOGIC AXIS ON INFORMATICS AND ENGINEERING CURRICULA

Thematic Educational methodology is a proposal that is developed around thematic as a pedagogic axis. The central idea of Thematic Oriented proposal is to lead with enough wide categories of knowledge. Because of wide scope it implies in a long life cycle time activities around proposed activities named as projects. On this sense, a project is a thematic implementation traducing a kind of open knowledge domain category, in witch technical to social, ecological, or economics aspects, can be inserted. It is crucial here the definition of level of generality of object of study. Object of study level must to be carefully defined at curricula instance because of its pedagogic potentiality. It creates new relationships between disciplines, altering traditional disciplines structure. Figure 1 illustrates a pedagogic choice between two different levels of generality associated to the same thematic, or, object of study. It refers to *Water studies* thematic. Water thematic can be chosen at high level of generality, for example, as an Earth Life thematic under an open knowledge domain. It can be chosen at low level of generality, for example, as a Physical Chemical thematic, under a closed scientific knowledge domain. This choice is what is relevant at curricular proposals.

This educational proposal is theoretic inspired in several authors ideas. It expresses a concrete pedagogic implementation of Bertrand Meyer Inverted Curricula idea.[4]. At curricular level, Thematic Oriented design

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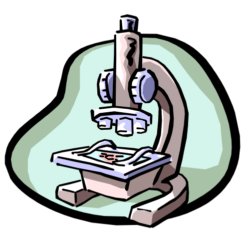
affects directly basic sciences disciplines organization. Inverted Curricula trend, in terms of disciplines contents suggests insertion of more specific disciplines later on the course schedule. For example, Numerical Methods, Physics and Maths specific contents are better explored, later, on curricula disciplines, when projects are associated to more sophisticated, or specialized categories of knowledge. By the other side, those contents can, indirect, be present, at some first basic approach also in projects at fresh curricula disciplines. Same way, other very abstract and wide aspects as insertion of technologies in society are suggested to be discussed early at all kinds of technological curricula. In addition, it does not matter if curricula is divided in pieces of knowledge called disciplines, or even, projects. At this discussion level, both terms can be treated as synonymous without lacking the pedagogic proposed idea.

Object of Study: WATER
Level of Generality choice:
level 1 (+ generic)
level 2 (– generic)

Level 1 - *Water* associated with *Earth Life* thematic (+ generic)



Level 2 - *Water* associated with *Physical-Chemical* thematic (- generic)

FIGURE. 1
DEFINITION OF THEMATIC LEVEL OF GENERALITY.

But, Thematic Oriented methodology [5] is not, only, a pedagogic proposal to treat knowledge. Actually, it affects the other educational aspects belonging to a teaching/learning environment, such as instrumental issues, evaluation process. This is called Complex Educational Approach that is the central axis of this pedagogic proposal.

A MODELING TOOL TO TREAT AN OPEN KNOWLEDGE DOMAIN

First step: definition of Object of Study, or Thematic searching to a high level of generality. After defining the object of study, as a generic thematic, it emerges the complex view, or open knowledge domain perspective. This aggregates flexibility aspect regarding the way knowledge is treated. This direct affects the way pedagogic tasks can be developed. After this first step, treating knowledge as a wide scope, it emerges a second and important step.
Second step: what a kind of tool is adequate to support open knowledge modeling? This step is related with the necessity of an adequate tool just to support implementation aspects on, day by day, pedagogic activities. What a kind of modeling tool could help and could be closely harmonic to lead with such broad knowledge categories under complex approach? Let's see.

Tribute to Nygaard and Dahl – Two Eminent Scientists of Complex Modeling in Informatics

The answer to pedagogic demands on complex, or open, models of knowledge is given by an Informatics modeling tool. Complex modeling in Informatics is related with Object Oriented tool principles. Those principles were derived at XX century, by the years sixties. The abstract operation principles are operational possibilities, just contributing to convert open models from seeds to big trees. XXI century, certainly, will profit of this. Unfortunately the author of this theory, Professor Kristen Nygaard, emeritus professor of Department of Informatics of Oslo University is died some months ago. The author of this paper met Prof. Nygaard several times and think he was a great man, human people and great citizen. But, what is important is that his voice go ahead because, today, many scientists can develop open models over those derived Object Oriented formal principles. They are special applied and known at computer systems domain, or even, at least, in internet packages. It is possible that, nowadays, young scientists do not remember that some time ago, computer programming and thinking followed a sequential approach. Its evolution toward structured approach was a wonderful but this emphasized horizontal modeling. This Object Oriented formal organization was particular useful in increasing complexity models. Object Oriented practical implementation occurred through Nygaard and Johan Dahl hands. The partner of Prof. Nygaard, Ole Dahl, was also professor from Oslo University. He has implemented Simula compiler on the sixties. Both passed away some month ago, causing consternation on scientist community.

Harmonic wedding between Object Oriented Modeling Tool and Complex Knowledge Domain

Complex approach finds a natural link with Object Oriented modeling tool if pedagogic axis is defined as a broad Thematic as the scenery adequate to build a curricular design. Here it can be taught about engineering curricula, informatics or elsewhere, it does not matter.

It is considered that the abstract operations are the core of Object Oriented tool. They allow vertical models development. It is in accordance with nowadays necessity regarding complex knowledge models. Informatics domain as information models solver, deep benefit itself from those principles. By the other side, vertical development of knowledge representation can be limited according with modelers objectives. At Informatics domain, the roof of generality can be a concrete project or machine associated with its costs, or its time to run. This is equivalent to a less generic level in terms of knowledge modeling. This is something like level 2 presented on Figure 1. Generality of thematic modeling is a crucial aspect because potentiality of Object Oriented thinking will be limited by this issue. What is absolutely positive is that Object Oriented tool is always potent because of its intrinsic generality of principles. It does not lack the horizontal domain enhanced on structured modeling, which was the precedent modeling paradigm, great performed on the years seventy. Object Oriented proposes includes vertical, as well as horizontal modeling. So it is important to reinforce necessity of changing way to treat knowledge to arrive to globalization times demands. In the case of Object Oriented potentiality, it grows up, exponential way, in complex models associated with real world open domains. In this case, knowledge categories are treated all together. They include economics, ethics, bio, eco and technical issues. Engineering domain, in this sense, seems to be more harmonic than Informatics because it usually, is more generic than Informatics domain of knowledge. So it profits the maximum from this knowledge modeling tool. Object Oriented approach will transform, in the future, the vision also in Informatics, putting it, in a harmonic place of knowledge category, not, at all, at the top of knowledge category, but as a support of knowledge humanitarian vision.

THEMATIC ORIENTED METHODOLOGY TO FACE GLOBALIZATION DEMANDS AT CURRICULA PROFILE

New trends at curricula level points out integrative directives to face globalization context and its demands. In this sense, thematic oriented methodology represent the union of those aspects because it affects the deeper level of contents organization as a central directive. And what is this deeper level? It is the new look to knowledge categories as open knowledge ones. An open knowledge vision facilitates to increase towards vertical direction all pieces of knowledge. Here it is important to perceive that the way you treat knowledge affects much more educational structure than pedagogic practices. Despite of this, all practices, including instrumental one are benefited by integrative curricula trend. This occurs because the integrative view offer a broad approach for all kind of minds, not only to experimental oriented minds but also to abstract ones.

Thematic as a Complex Object of Study

Complexity is a key word considering new professional profiles at globalization context. Complex, following Edgar Morin cathedra about Complex Though, is *what is treated together with its wide context*. This also can be traduced by what can not be fragmented[6]. Here appears the definition to generality level to be associated with thematic as a complex object of study. So, this way, thematic is treated as a real world object of study. There is to say, thematic will be modeled during a long period of activities. Their possibilities are from a discipline period till a whole curriculum built around disciplines or even projects units. In this sense thematic is equivalent to a meta project that can be developed creative way under infinite possibilities.

Pedagogic Directives under Thematic View

There are two pedagogic directives to be considered by thematic vision in education. The first directive is the bi-directional movement between knowledge categories, from generic, as ethics, ecological, economics and social ones, to specific categories, as maths physics, computer sciences ones. The second pedagogic directive is the inversion of general direction of knowledge categories to be treated. The suggestion is to treat first generic categories, and, the specific categories will appear, according to necessity of self inclusion, permitting understanding of thematic aspects increasing. Those two directive alter curricula vision because knowledge is distributed around projects of with longer life cycle than traditional specific knowledge vision.

Some Concepts related with Thematic Approach

Depending on the level of generality, thematic exploration demands a long time cycle to develop all categories to be treated in thematic context. Considering traditional curricula organization built around disciplines, Thematic Life Cycle corresponds, at least, to a whole discipline. It is a previous condition to consider thematic as a complex object of study. Here it appears, again, the concept of complexity related with open knowledge domain. This concept is different from specific concept of complexity of parts, concerning to closed domains of knowledge. For example, complexity of algorithms, or, math complexity are related with closed domain of knowledge. Both, algorithms and math complexity, appear, naturally, embed as part categories, or horizontal categories of open knowledge domain. They correspond to horizontal development of knowledge, encountered in close, or specialized knowledge domains. So it is important to perceive that open knowledge domain is not at all opposite to closed knowledge domain but the open domain embed the close one.

CONCRETE EXPERIENCE WITH THEMATIC APPROACH AT FRESH MAN CURRICULA

After thematic definition level (Figure 1), several versions of meta project implementation are presented (from Figure 2 to Figure 4). Thematic approach here refers to a fresh man curricula experience. Water Studies is related with at government level. The treatment of knowledge, traduced by several project versions, is supported by 'abstraction principle'. Through abstraction, a generic thematic can be treated as several concrete projects with increasing complexity. This way, what is already defined as thematic can be traduced as a meta project. Each project to be implemented during semester, or annual pedagogic activities, normally called disciplines, is a stage of the same metha project. Figure 2 shows a project proposal at energy ministry level. It appears generic aspects as ethics, economics and social ones. Of course here there are no technical details, not at this first moment. They will appear, step by step, soon, as illustrate by figure 3 and figure 4.

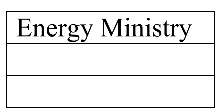


FIGURE. 2
PROJECT INITIAL VERSION: HIGH LEVEL OF GENERALITY AND HIGH LEVEL OF ABSTRACTION.

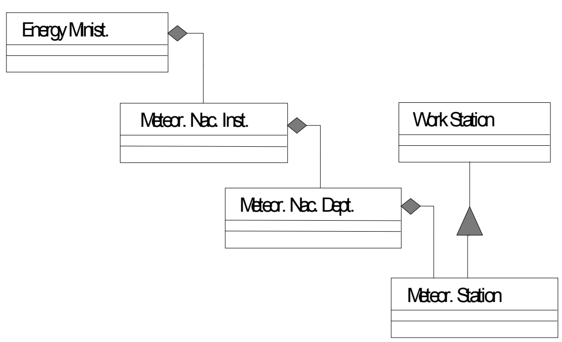


FIGURE. 3
PROJECT VERSION ONE – GENERIC KNOWLEDGE LEVEL.

Figure 3 shows project version N. It is later developed over project initial version. Thematic is still the same. Here they are included aspects, as governmental structure to treat this theme, and, also, it appears some specific aspects, related with professional career technical contents.

As time goes by, thematic exploration arrives to more specific stages as you see at Figure 4. This example refers to details of rain follow data which is manipulated under a math structure of data of an information system. Math, physics and informatics specialized knowledge grow up, as the versions are implemented.

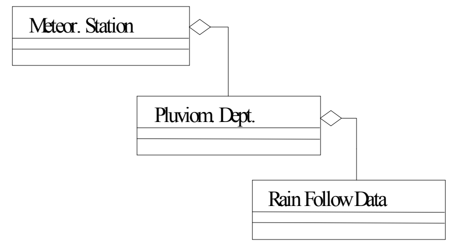


FIGURE. 4
PROJECT VERSION N – SPECIFIC KNOWLEDGE LEVEL.

CONCLUSIONS

*On the Union of Thematic Oriented Approach + Object Oriented Tool as a contribution to Computer Programming disciplines.*Thematic Oriented Approach together with Object Oriented modeling contributes to curricula integration under complex view. From sophisticated modeling principles till little programming details, or even, high abstract values as the insertion of informatics on human life, all can be treated together in an introductory computer programming discipline.

*On the integration of basic disciplines on fresh man curricula under thematic Oriented approach.*Thematic Oriented Approach, supported by Object Oriented Modeling Tool, promotes easy and harmonic integration between several basic disciplines, as introductory computer programming, information systems modeling, numerical methods, statistics methods, physics and maths. The abstraction principle aids to develop several project versions creating reusable knowledge.

*On the Thematic Oriented Vision as an Open Pedagogic Proposal Looking to Tecno Careers New Profile.*Integrated, open, or even, Complex Vision on education contributes to new professional profile and to alter professional life, under globalization demands. Integrative tendency is an important pedagogic option because it considers all educational aspects together changing pedagogic axis to human development process. And this is a high abstract pedagogic directive that is welcomed regarding future life at earth.

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THE EVALUATION OF HIGH-RISE BUILDINGS IN ISTANBUL

Çiğdem Eren[1]*, Ayşe Tütengil*[2]

Abstract — *This paper aims to propose a model to be implemented in the analysis of the qualitative and the quantitative aspects of high-rise buildings and the evaluation of existing high-rise buildings to define objectives and strategies considering the conditions for today and the future. The computer-aided approach adopted in the model is based on the implementation of Microsoft Excel enables flexible, explicit and dynamic flow of the relevant information required for evaluation. The proposed interactive evaluation model comprises two major stages; implementation of an evaluative method for the assessment of the high rise buildings in relation to a preset criteria, implementation of an utility analysis method for the evaluation.*

INTRODUCTION

The aim of the study is to propose a model to be implemented in the analysis of the qualitative and the quantitative aspects of the high-rise buildings and the evaluation of existing high-rise buildings to define objectives and strategies considering the conditions for today and the future. Istanbul has been chosen for the case study for being the most active and most criticized region in Turkey for its high-rise buildings, being the most populated city of the nation primarily due to domestic migration; and possessing a remarkable cultural heritage. (Figure.1)

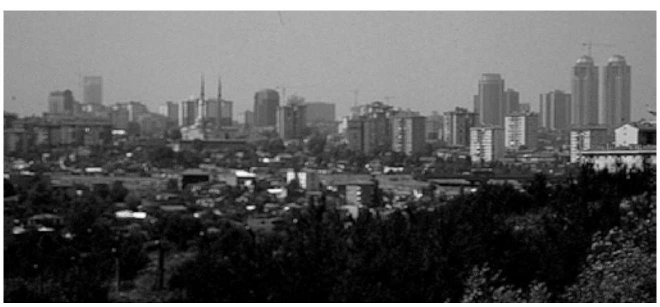

FIGURE. 1

The proposed evaluation model comprises three major stages:

- Implementation of an evaluative method for the assessment of the high rise buildings in relation to a preset criteria,
- Implementation of a utility analysis method using Microsoft Excel for the evaluation of the high rise buildings under consideration and,
- Definition of objectives and strategies considering the conditions for today and the future.

HIGH-RISE BUILDINGS IN ISTANBUL

High-rise building constructions involve many complex problems; requiring high technology use, need of considerable knowledge and experience through serious discussions and decisions at design level. In developing this important and essential building type in Turkey, initial problems faced are how to control such projects according to different side effects and how to identify and evaluate its advantages and disadvantages [3].
Therefore the following specifications are used for the definition of high-rise buildings in various countries (Table I):

TABLE I

Country name	Buildings defined as "high-rise"
Germany	22m.height and over
U.S.A (Massachusetts)	21m.height and over
U.S.A (San Francisco)	23m.height and over
Britain	28m. height and over
Switzerland	25m. height and over
Russia	9 floors and over
Austria	10 floors and over
Poland	12 floors and over
Hungary	11 floors and over
Czechoslovakia	Shows variations according to buildings around the neighborhood
Mexico	30m. height and over
Turkey	10 floors and over

Slender buildings like towers and minarets reaching the skyline have a long history in Turkey, but multi- storey and multi-functional buildings started to be developed as recent as 1950's. Istanbul, which is one of the most important cities

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of the world, with its natural and historical beauties rapidly began to grow in size and population in 1950's due to political and social reasons. The technical and financial deficiencies of local authorities added further problems on the undisciplined growth in industrial, commercial and servicing functions, hence the city's development became extremely unplanned and disorderly. The high prices of land due to heavy demand for construction areas, which has already been developed, caused the horizontal expansion of the city in an uncontrolled and unstoppable way. The constant decrease in land, increases in price, speculative pressures brought about a dense use of land through development of high-rise buildings, which added further functional, environmental and constructional problems on the existing city pattern. Particularly the inefficiency of existing control plans and constant changes made on them necessitated planning and development of high-rise buildings.

FIGURE. 2

After 1985 high-rise buildings became status symbols, which started to mushroom around Taksim - Gümüşsuyu - Maçka, Beşiktaş- Levent - Ayazağa, Mecidiyeköy - Zincirlikuyu, Ataköy-Zeytinburnu regions. (Figure.2)

DESCRIPTION OF THE EVALUATION METHOD

.In order to highlight the qualitative and the quantitative values of high-rise buildings a chosen utility analysis method is implemented. The aim of the proposed utility analysis method of evaluation is to guide the decision making process related with future developments. The program Microsoft Excel is adopted in the method. Using the means of a computer makes it possible to archive data about high-rise buildings properly, to work with tables having compatible format and to achieve results rapidly and correctly. The created evaluation files are flexible, explicit and dynamic [1].

The advantages of the above mentioned evaluation method could be summarized as follows:

- Value criteria for preservation are made explicit.
- By using the weight assignment method during the evaluation process, the relative importance of initial criteria and expert opinions are properly reflected during all stages of implementation.
- Initial decisions can be revised by reconsidering the weight assignments of various factors if and when necessary.
- Results of evaluation, due to its explicit structure, can be easily reviewed and checked by those who are outside the group of the decision-makers at any stage.

The proposed method is arranged so that it can evaluate each high-rise building individually by reflecting its intrinsic value. The method with its aforementioned explicit, flexible and dynamic structure provides a proper basis for the evaluation of the high-rise buildings. The described evaluation method can be summarized in the following stages:

- The development of a system of objectives by the experts, which come under the five headings:
  - Architectural and cultural objectives;
  - Technical objectives;
  - Environmental objectives;
  - Environmental control objectives;
  - Financial objectives.
  -

These objectives, in turn, have their appropriate sub-objectives, which are listed in Table II, III and IV, Column 1.

- A priority assignment method has been used in connection with the first stage of the synthesis. Weights are assigned to the sub-objectives to reflect their relative importance. (Table II, Column 2-4). Here, the experts assign a value on a scale of 0 to 10, for each sub-objective on Table II, Column 2 of the program. Through Microsoft Excel, to accelerate the effect of the most important sub-objective; related weights are reorganized according to the adopted Churchman Ackoff method (Table II, Column 3) [2]. The last step of the weight assessment process, through Microsoft

Excel weights are standardized and real values for evaluation are determined (Table II, Column 4).

TABLE II

PRELIMINARY ANALYSIS

OBJECTIVES	SUB-OBJ. WEIGHT 1. STEP	SUB-OBJ. WEIGHT 2. STEP	SUB-OBJ. WEIGHT 3. STEP	WEIGHT OF EXPERTS						EXPERTS TOTAL WEIGHTS
				1	2	3	4	5	6	
1. ARCHITECTURAL & ARTISTIC OBJECTIVES										
1.1 ARTISTIC VALUE	7	22	3,67	4,0	0,5	2,5	0,5	0,5	2,0	10
1.2 AESTHETIC VALUE	9	37	6,18	4,0	0,5	2,0	0,5	0,5	2,5	10
1.3 ASSOCIATION WITH IMPORTANT EVENTS	6	16	2,67	4,0	1,5	1,5	0,5	0,5	2,0	10
1.4 WORK OF A WELL KNOWN ARTIST	5	11	1,84	4,0	1,5	1,5	0,5	0,5	2,0	10
1.5 SCARCITY VALUE	7	22	3,67	3,0	3,0	2,0	0,5	0,5	1,0	10
1.6 FAÇADE VALUE	6	16	2,67	4,0	1,0	0,5	0,5	3,0	1,0	10
1.7 SPATIAL ORGANIZATION VALUE	6	16	2,67	4,0	0,5	0,5	0,5	0,5	3,0	9
1.8 HISTORICAL VALUE	5	11	1,84	3,0	2,0	3,0	0,5	0,5	1,0	10
2. TECHNICAL OBJECTIVES										
2.1 TECHNICAL INNOVATION VALUE	5	11	1,84	1,0	3,0	0,5	2,5	2,0	1,0	10
2.2 CONSTRUCTIONAL VALUE	7	22	3,67	3,0	3,0	1,0	1,0	1,0	1,0	10
2.3 EARTHQUAKE RESISTANCE VALUE	9	37	6,18	3,0	4,0	1,0	1,0	0,5	0,5	10
2.4 FIRE CONTROL VALUE	9	37	6,18	0,5	0,5	0,5	4,0	4,0	0,5	10
2.5 LIGHINING PROTECTION VALUE	6	16	2,67	0,5	0,5	0,5	4,0	4,0	0,5	10
2.6 STRUCTURAL SYSTEM VALUE	9	37	6,18	2,0	4,0	1,0	1,0	1,0	1,0	10
2.7 LEGAL ASPECTS AND REGULATION	9	37	6,18	3,0	3,0	1,5	1,0	1,0	0,5	10
2.8 MECHANICAL TRANSPORTATION VALUE	5	11	1,84	2,0	2,0	0,5	2,0	2,0	1,5	10
2.9 SOIL PROPERTIES VALUE	3	4	0,67	2,0	4,0	1,0	1,0	1,0	1,0	10
2.10 SECURITY VALUE	6	16	2,67	3,0	1,0	1,0	2,0	2,0	1,0	10
2.11 AIR TRANSPORT SECURITY VALUE	10	46	7,68	3,0	3,0	1,0	1,0	1,0	1,0	10
3. ENVIRONMENTAL OBJECTIVES										
3.1 ENVIRONMENTAL LANDMARK VALUE	6	16	2,67	4,0	0,5	4,0	0,5	0,5	0,5	10
3.2 ENVIRONMENTAL SYMBOL VALUE	6	16	2,67	4,0	0,5	4,0	0,5	0,5	0,5	10
3.3 ENVIRONMENTAL GROUP VALUE	4	7	1,17	4,0	0,5	4,0	0,5	0,5	0,5	10
3.4 SKYLINE VALUE	7	22	3,67	4,0	0,5	4,0	0,5	0,5	0,5	10
3.5 DENSITY VALUE	5	11	1,84	4,0	0,5	4,0	0,5	0,5	0,5	10
4. ENVIRONMENTAL CONTROL OBJECTIVES										
4.1 MICROCLIMATE EFFECTS	6	16	2,67	4,0	0,5	3,0	1,0	0,5	1,0	10
4.2 SOLAR CONTROL	4	7	1,17	4,0	1,0	0,5	3,5	0,5	0,5	10
4.3 NATURAL VENTILATION	2	2	0,33	4,0	1,0	0,5	0,5	0,5	3,5	10
4.4 WIND MOVEMENTS IN & AROUND BUILDING	4	7	1,17	3,0	3,5	2,0	0,5	0,5	0,5	10
4.5 ORIENTATION OF BUILDING	2	2	0,33	4,0	0,5	4,0	0,5	0,5	0,5	10
4.6 COLOR OF BUILDING	2	2	0,33	4,0	0,5	3,5	0,5	0,5	1,0	10
5. FINANCIAL OBJECTIVES										
5.1 COSTS	7	22	3,67	2,0	2,0	0,5	2,0	1,5	2,0	10
5.2 SALE & REVENUE VALUE	7	22	3,67	2,0	2,0	2,0	1,5	1,5	1,0	10
5.3 FUNCTIONAL VALLUE	7	22	3,67	4,0	0,5	1,5	0,5	0,5	3,0	10
TOTAL		599	100,00							

Likewise the experts from different disciplines (architect, structural engineer, town planner, mechanical engineer, electrical engineer, interior architect) have been subject to a similar weight assignment to enable them to evaluate sub-objectives according to their disciplines (Table II, Column 4-9). Weighing the expertise of the participating experts requires the partaking of the total of 10 points among the experts in regard to their fields and its probable relation to the sub-objectives. This completes the preparation procedure of the evaluation method.

- Weights determined during the preparation process are then transferred to the Table III, where each expert contributes his/her field of expertise followed by the evaluation of each sub-objective on a scale of 0-4 (Table III, Column 2).

TABLE III

EXPERTS EVALUATION TABLE

IDENTIFICATION NR. OF THE BUILDING:	1
EXPERTS DISCIPLINE CODE NR:	1

OBJECTIVES	VALUE OF SUB-OBJ.	WEIGHT OF SUB-OBJ.	WEIGHT OF EXPERTS						SUB-OBJ. UTILITY VALUE
			1	2	3	4	5	6	
1. ARCHITECTURAL & ARTISTIC OBJECTIVES									
1.1 ARTISTIC VALUE	2	3,67	4,0	0,5	2,5	0,5	0,5	2,0	29,4
1.2 AESTHETIC VALUE	3	6,18	4,0	0,5	2,0	0,5	0,5	2,5	74,1
1.3 ASSOCIATION WITH IMPORTANT EVENTS	0	2,67	4,0	1,5	1,5	0,5	0,5	2,0	0
1.4 WORK OF A WELL KNOWN ARTIST	1,5	1,84	4,0	1,5	1,5	0,5	0,5	2,0	11
1.5 SCARCITY VALUE	1	3,67	3,0	3,0	2,0	0,5	0,5	1,0	11
1.6 FAÇADE VALUE	2	2,67	4,0	1,0	0,5	0,5	3,0	1,0	21,4
1.7 SPATIAL ORGANIZATION VALUE	3,5	2,67	4,0	0,5	0,5	0,5	0,5	3,0	37,4
1.8 HISTORICAL VALUE	0	1,84	3,0	2,0	3,0	0,5	0,5	1,0	0
2. TECHNICAL OBJECTIVES									
2.1 TECHNICAL INNOVATION VALUE	1	1,84	1,0	3,0	0,5	2,5	2,0	1,0	1,8
2.2 CONSTRUCTIONAL VALUE	3	3,67	3,0	3,0	1,0	1,0	1,0	1,0	33,1
2.3 EARTHQUAKE RESISTANCE VALUE	3	6,18	3,0	4,0	1,0	1,0	0,5	0,5	55,6
2.4 FIRE CONTROL VALUE	3	6,18	0,5	0,5	0,5	4,0	4,0	0,5	9,3
2.5 LIGHINING PROTECTION VALUE	2	2,67	0,5	0,5	0,5	4,0	4,0	0,5	2,7
2.6 STRUCTURAL SYSTEM VALUE	2	6,18	2,0	4,0	1,0	1,0	1,0	1,0	24,7
2.7 LEGAL ASPECTS AND REGULATION	4	6,18	3,0	3,0	1,5	1,0	1,0	0,5	74,1
2.8 MECHANICAL TRANSPORTATION VALUE	2,5	1,84	2,0	2,0	0,5	2,0	2,0	1,5	9,2
2.9 SOIL PROPERTIES VALUE	2	0,67	2,0	4,0	1,0	1,0	1,0	1,0	2,7
2.10 SECURITY VALUE	3	2,67	3,0	1,0	1,0	2,0	2,0	1,0	24
2.11 AIR TRANSPORT SECURITY VALUE	4	7,68	3,0	3,0	1,0	1,0	1,0	1,0	92,2
3. ENVIRONMENTAL OBJECTIVES									
3.1 ENVIRONMENTAL LANDMARK VALUE	2,5	2,67	4,0	0,5	4,0	0,5	0,5	0,5	26,7
3.2 ENVIRONMENTAL SYMBOL VALUE	2	2,67	4,0	0,5	4,0	0,5	0,5	0,5	21,4
3.3 ENVIRONMENTAL GROUP VALUE	2	1,17	4,0	0,5	4,0	0,5	0,5	0,5	9,3
3.4 SKYLINE VALUE	3	3,67	4,0	0,5	4,0	0,5	0,5	0,5	44,1
3.5 DENSITY VALUE	2,5	1,84	4,0	0,5	4,0	0,5	0,5	0,5	18,4
4. ENVIRONMENTAL CONTROL OBJECTIVES									
4.1 MICROCLIMATE EFFECTS	2,5	2,67	4,0	0,5	3,0	1,0	0,5	1,0	26,7
4.2 SOLAR CONTROL	2,5	1,17	4,0	1,0	0,5	3,5	0,5	0,5	11,7
4.3 NATURAL VENTILATION	0	0,33	4,0	1,0	0,5	0,5	0,5	3,5	0
4.4 WIND MOVEMENTS IN & AROUND BUILDING	2	1,17	3,0	3,5	2,0	0,5	0,5	0,5	7
4.5 ORIENTATION OF BUILDING	1,5	0,33	4,0	0,5	4,0	0,5	0,5	0,5	2
4.6 COLOR OF BUILDING	2	0,33	4,0	0,5	3,5	0,5	0,5	1,0	2,7
5. FINANCIAL OBJECTIVES									
5.1 COSTS	3	3,67	2,0	2,0	0,5	2,0	1,5	2,0	22
5.2 SALE & REVENUE VALUE	2	3,67	2,0	2,0	2,0	1,5	1,5	1,0	14,7
5.3 FUNCTIONAL VALLUE	2,5	3,67	4,0	0,5	1,5	0,5	0,5	3,0	36,7
TOTAL		100,00							

- Through the evaluation of the sub-objectives; Microsoft Excel determines related values, weights and weights of expertise of the participating experts, utility value of each sub-objective. The determined values are transferred to Table IV, where displayed in relation to other experts' opinions. This constitutes the last step of the evaluation process (Table IV).

TABLE IV

SUMMARY OF EVALUATION RESULTS

IDENTIFICATION NR. OF THE BUILDING: 1

OBJECTIVES	THE UTILITY FOR EACH SUB-OBJECTIVE ASSIGNED BY THE EXPERTS					
	1	2	3	4	5	6
1. ARCHITECTURAL & ARTISTIC OBJECTIVES						
1.1 ARTISTIC VALUE	58,8	5,5	18,4	5,5	3,7	14,7
1.2 AESTHETIC VALUE	74,1	7,7	30,9	7,7	6,2	46,3
1.3 ASSOCIATION WITH IMPORTANT EVENTS	0	0	0	0	0	0
1.4 WORK OF A WELL KNOWN ARTIST	7,3	4,1	1,4	0	0,9	5,5
1.5 SCARCITY VALUE	0	11	11	2,8	1,8	3,7
1.6 FAÇADE VALUE	21,4	2,7	1,3	2,7	16	5,3
1.7 SPATIAL ORGANIZATION VALUE	21,4	3,3	2,7	2,7	4	28
1.8 HISTORICAL VALUE	0	0	0	0	0	0
2.TECHNICAL OBJECTIVES						
2.1 TECHNICAL INNOVATION VALUE	1,8	11	0,9	9,2	7,3	1,8
2.2 CONSTRUCTIONAL VALUE	22	33,1	9,2	9,2	11	11
2.3 EARTHQUAKE RESISTANCE VALUE	55,6	61,8	15,4	18,5	9,3	9,3
2.4 FIRE CONTROL VALUE	9,3	6,2	6,2	49,4	49,4	9,3
2.5 LIGHTNING PROTECTION VALUE	2,7	3,3	3,3	26,7	21,4	2,7
2.6 STRUCTURAL SYSTEM VALUE	37,1	74,1	12,4	12,4	12,4	12,4
2.7 LEGAL ASPECTS AND REGULATION	74,1	64,9	37,1	21,6	24,7	12,4
2.8 MECHANICAL TRANSPORTATION VALUE	11	9,2	2,3	9,2	9,2	6,9
2.9 SOIL PROPERTIES VALUE	1,3	4	0,7	1,3	1,3	1,3
2.10 SECURITY VALUE	16	5,3	8	16	16	8
2.11 AIR TRANSPORT SECURITY VALUE	92,2	92,2	30,7	30,7	30,7	30,7
3. ENVIRONMENTAL OBJECTIVES						
3.1 ENVIRONMENTAL LANDMARK VALUE	32,1	2,7	26,7	3,3	3,3	3,3
3.2 ENVIRONMENTAL SYMBOL VALUE	21,4	3,3	10,7	2,7	2,7	2,7
3.3 ENVIRONMENTAL GROUP VALUE	9,3	1,2	14	1,8	1,8	1,2
3.4 SKYLINE VALUE	44,1	5,5	44,1	5,5	5,5	5,5
3.5 DENSITY VALUE	22	2,3	14,7	1,8	2,8	2,3
4. ENVIRONMENTAL CONTROL OBJECTIVES						
4.1 MICROCLIMATE EFFECTS	32,1	3,3	20	6,7	3,3	6,7
4.2 SOLAR CONTROL	4,7	2,3	0,6	8,2	1,2	1,5
4.3 NATURAL VENTILATION	0	0,2	0	0	0	0
4.4 WIND MOVEMENTS IN & AROUND BUILDING	7	10,2	5,8	1,5	1,2	1,2
4.5 ORIENTATION OF BUILDING	2,7	0,3	2	0,3	0,3	0,3
4.6 COLOR OF BUILDING	2,7	0,3	3,5	0,2	0,2	0,7
5. FINANCIAL OBJECTIVES						
5.1 COSTS	14,7	18,4	4,6	29,4	22	22
5.2 SALE & REVENUE VALUE	22	22	14,7	11	11	7,3
5.3 FUNCTIONAL VALLUE	44,1	5,5	16,5	5,5	4,6	27,5
SUM:	765	476,9	369,8	303,5	285,2	291,5
TOTAL SUM	2491,9					

DESCRIPTION OF THE SUB-OBJECTIVES

During the application of the proposed method the experts in regard to the relations with various attributes of the entities evaluate sub-objectives. [1]

The relevant sub-objectives of the objectives system can be listed as follows:

1. Architectural and aesthetic objectives

1.1. Artistic value: Artistic value can not be defined by any objective criteria, though it is a long and intriguing process of formation though accumulated knowledge and common wisdom gained by humane expertise. Notably, the design approach for a building and its integrity with its built and natural environment as well as its location within it are the main constituent factors for this formation.

For the determination of the artistic value, factors such as its relative comparisons with building of the similar characteristics and spatial organizations should also be taken into account.

1.2. Aesthetic value: Aesthetic value is based on a number of complicated factors, such as, variety of elements, rhythmic effects, different materials and pattern, play of matte and reflective surfaces, play of light and shadow.

There is no objective method for the determination of the aesthetic value, it can be only established by a comparative analysis of several different buildings by the experts

1.3. Association with important historical events: Important buildings have a documentary value, since they reflect the trends of the eras in which they were completed. A high-rise building could be constructed to symbolize the beginning or the end of a significant historical event. Many buildings are also the most reliable witnesses of the political, social and cultural aspects of the times in which they were built.

1.4. Work of a well-known artist: A historical or contemporary work of an architect, who is master in design approach, has a remarkable value, which should be considered in the overall valuation.

1.5. Scarcity value: A high-rise building, which has unique characteristics such as a path-breaking and innovative approach in design and construction, should be considered as symbol of the development.

1.6. Facade value: Surface treatment reflects the scale and important lines of a high-rise building. Articulation of the building, cladding material, material changes, play of light and shadow, reflections on the surface, color and ornaments are some of the important factors in the ultimate formation of the visual effect of the façade.

1.7. Spatial organization value: A building is a synthesis of exterior skin and interior organization. Interior design also includes decoration, furniture system, sculptures and other works of art. Other factors, such as allowing maximum design flexibility in the interior space for technology upgrades in the future must be taken into account by the determination of the spatial organization value.

1.8. Historical value: Buildings are lasting memorial with their locations as well as their capacities to reflect the urban and social history of the times they were built.

2. Technical Objectives

2.1. Technical innovation value: A high-rise building can be innovative in its design approach, construction and structural system and become the symbol of a new development.

2.2. Constructional value: The valuation should also cover beside aesthetic appeal technology and construction elements.

2.3. Earthquake resistance value: Turkey, especially Istanbul, is situated in a potential earthquake zone; therefore the structural systems of all high-rise buildings should conform with the earthquake design criteria to withstand any deformations to be caused by the possible future earthquakes.

2.4. Fire control value: The initial objective should be to take every precaution to prevent fire incidence. Sprinkler systems, smoke exhaust systems, pressurized stairwells, dedicated recall firefighter elevators, emergency exits supported with a sophisticated fire command center are the main elements for these precautions.

2.5. Lightning protection value: High-rise buildings should accommodate strong lightning conductors for lightning and similar natural causes.

2.6. Structural system value: In the selection of the structural systems for the high-rise buildings, time and cost calculations are the foremost priorities. The structural systems should provide the necessary lateral resistance to the forces of wind and earthquake, while supporting the vertical loads.

2.7. Legal aspects and regulations: Various authorities from the beginning of the design level to the end of construction process should enforce controlling mechanisms. The inefficient legal procedures and regulations may cause serious problems. All high-rise buildings should be evaluated both under the city and building scales.

2.8. Mechanical transportation value: Elevators and escalators should be planned and constructed by using high-tech, considering the building's mode of function and the density at peak hours.

2.9. Soil properties value: The soil characteristics and the problems of bearing capacity of the ground at the building site should be checked with soil examples taken from the site and with their appropriate laboratory tests. The evaluated input from these tests will help deciding the structural system.

2.10. Security value: The quality of a newly completed high-rise building should reflect proper security measurements. The computer-controlled environmental safety and security systems, such as interior automation control (air conditioning, elevators etc.), security measurements (alarms, detectors, visual control systems etc.), emergency plans for fire, earthquake, accidents etc. are the main elements of the safety and security measurements.

2.11. Air transport security value: Location of high-rise buildings can endanger air traffic. Due to security reasons high-rise building projects must be developed outside flying routes and airport borders.

3. Environmental objectives

3.1. Environmental landmark value: In the geographic, historic and economic environment a high-rise building rises as a focal point of the skyline. They are visible landmarks and dominate the skyline.

3.2. Environmental symbol value: With the historically accumulated public interest a building may have a special aura hence becomes a symbol of its location. With their impressive appearance great buildings become symbols of their city.

3.3. Environmental group value: A high-rise building can be an important element in defining the urban streetscape or a square. It may provide continuity or define a boundary in the skyline.

3.4. Skyline value: Historical developments and general characteristics of a city define its skyline. The protection of Istanbul's natural and historic skyline, which goes back to hundreds of years, is very essential. The placement of high-rise buildings should take the existing skyline into account and should be carefully decided with various skyline studies carried out from different viewpoints of the city.

3.5. Density value: The additional problems related with the infrastructure (traffic, electricity, water, sewer etc.) must be identified at project level. The density must be decided according to existing characteristics of the region.

4. Environmental control objectives

4.1. Microclimate value: Elements like the buildings' shadow effect and period, air corridors between buildings, prevention of sunlight that effect the microclimatic value of the building should be solved at design level.

4.2. Solar control: The effects of high-rise buildings to neighbouring buildings and open space should be checked from the health point of view. Sufficient sunlight should be available during the day. This is especially important for the solar energy facilities if and when they are available.

4.3. Natural ventilation: Suitable positioning of openings can improve the natural ventilation and lower air-conditioning costs.

4.4. Wind movements in & around building: The positioning of a high-rise building should minimize the unwanted air turbulences within the surrounding area.

4.5. Orientation of the building: The orientation on the site should serve functional as well as aesthetic purposes. Suitable positioning can improve sun shading, which results in lower lighting, heating and air-conditioning costs. A strategically located high-rise building can be visible from every axis of the city. The design should be determined primarily through conformity with technical specifications such as shadow restrictions, positioning the building to minimize heat lost on the northern face. Adjacent buildings and views of the city are also vital factors to be considered.

4.6. Color of the building: The color and the material used in the exterior surfaces are important decisions for the building. Selection of the color should be based on environmental conditions such as the existing city pattern, far and near appearances, silhouette and building type.

5. Economical objectives

5.1. Costs: There are elements that can dramatically effect the structural unit costs. These are mainly the use of cladding and interior materials, the selected structural systems, as well as the number of floors, method of transportation of materials, construction equipment etc.

5.2. Sale and revenue value: The market value of the building indicates its sales or interchangeability value. The revenue value, on the other hand, is the income obtained from rental or entrée fee etc.

5.3. Functional value: The functional value bases on the composition of several spaces, the determination various functions and flexible spaces.

CONCLUSION

Istanbul's topographical and historical location makes it necessary to evaluate the high-rise buildings on different scales. The potential problems must be discussed both under city and building scales. The city's constructional state and the territories should be examined for achieving the targets for a healthy city life with high-rise buildings.

Istanbul's structural status and existing high-rise buildings should be evaluated and objectives and strategies should be defined by considering conditions for today and for the future developments. Especially in Istanbul, high-rise building sites must be evaluated, based not only on the area they cover but with the surrounding environment data as well [3].

A healthy territory research should be carried out to define

- The restricted zones for high-rise buildings,
- The zones that are permitted whether certain conditions are met,
- The zones that high-rise building constructions may be encouraged.

Istanbul's natural, cultural and historic specifications should be preserved within these definitions.

Proposed model is designed to evaluate the high-rise building in Istanbul and through the implementation of the utility analysis method of evaluation; objective values of the entities under consideration were made explicit in order to determine the guiding principles in future decisions. Within the framework of set objectives for evaluation, the findings related to architectural analysis of the buildings and available data related to them can be used as guidelines for the future developments.

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Chaos, Cognition and Cyberculture – an environment

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Abstract — *The representation´s concepts of knowledge and semantic databases can be applied to object orientated concepts to knowledge, such as, objects and classes of information in properties representation and relationships of them. This work is an environment project to provide applications of using knowledge-based data, organized in Content Management and user interface in an self-organizing mode. It includes considerations about knowledge, networking and formats. There are brief theoretical considerations about knowledge and intelligence, to justify the need of this chaotic system, described soon afterwards. The data is put in matrix model and used the algorithm SOM (Self Organizing Maps) in a syntax for the representation called RDF (Resource Description Format - an extension of MCF) in XML (EXtensible Markup Language) and a vocabulary (or descriptors group) for the Internet. The use of the language Java will give support for the metadatas models and interoperability among several patterns. Measurements with 100 virtual users were made.*

Index Terms — *Chaotic database system, knowledge-based, cognition.*

1 - INTRODUCTION

Most of the theories and humans believes (the believes are nearer to us than what is imagined) are codified by a cultural compound creating a semantic set that includes its language and its knowledge, as well as the language is related to the code, knowledge is related to information but the intelligence is something superior capable to releasing men from these conditioning and build something really new, and this is what is called here current intelligence, in narrow connection with Pierre Lévy´s [14] concepts of actual (but not the real) opposing the virtual.

Language, codes and codification can be considered as fundamental part of what called reality, but this reality is different from the abstract reality that it is more related to the knowledge. Of course, we have an entire philosophical discussion here on reality and knowledge. In the practical sense in this work, knowledge is used as Levy´s definitions: “Knowledge, values and tools transmitted by the culture...” , “But always...of a dialogue or of a multi-dialogue, real or imaginary” and “"we will end up in the instruments... it is impossible to exercise our intelligence independently of language, vocabulary and systems of signs” [13].

In this subject, we speak about certain levels of abstractions and of realities, or more concretely as defines by Pierre Lévy [13], intelligence levels linked at certain levels of technologies, but like he says technology is "classification to help to locate the poles", what can be made not only in relation to technology, but also to the productive development, the complexity of the language (orality levels, for Lévy only two) and why not, the level of elaboration that get together man and nature as a complex life, that it is our thought.

Apprenticeships different from the man allowed different orality forms, code, languages and thought styles, and for its time they generated differentiated forms of storage and classification of the information. For the current cognitive sciences [17] they are called of code strategies [1] and but they also present the result that the conscience no resulted of the language [3], and many errors and fallacies about consciousness and intentionality [5].

But this doesn't mean that language and code are not important, and it is possible to maximize its potential in the information age, we will need a better understanding of nature intelligence and technological knowledge in matter, and the human concepts and its limits in general.

Recent researches give some hints that certain mechanisms of the brain work in a self-organizing way [10].

The elaboration in this first part of the work is to build a digital system of easy access and of great interconnection capacity for networking, and for that is necessary to choose a storage format, proposed with the name Small Embedded of Data Center Environment “Cognitio” (SEDEC).

The system uses feedback information from its users to change its representation about the data (e.g., in digital library: about of authors, index terms, and documents), is possible the users to change its representation of data, index terms, and documents over time, so this include cognition on the system, so “Cognitio” is the name. Many systems are developed using a similar model of three-layer network of queries [12] also, index terms, and documents and others use modified Hebbian learning rule [7] which was used to reformulate probabilistic information retrieval [19].

While the above systems represent information retrieval applications in terms of their main components of documents, queries, index terms, authors, etc. other researchers have used different neural networks for more specific tasks. The “embedded” is because any applications will be included in target system (e.g. digital library).

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Mind, cognition and consciousness

Good part of the contemporary knowledge leaves concrete for the abstract, as if the theory was the arrival point. But the new scientific paradigms make a more complex way, they leave the abstractions to elaborate other abstractions, worst, because we always have multiple theoretical points of departures and they turn the theory arrival points, while the reality, even if not completely understood (the real intelligence) it is always closer of the human problem than the abstraction.

It is right that the knowledge comes from reality of the real (not actual), but the real has different reality levels, for simple example, four apples are 4, but what is 4? - an abstraction and a sign! Then remove the quantitative factor: an apple will be a code to indicate a group of complex qualities of certain fruit, in agreement with the intelligence of who hears he translates it in a certain representation level, or abstraction level.

Cognition is defined in the dictionaries as: "the action or process of knowing in the widest sense; specifically, an intellectual process for which there is a knowledge earnings, of perception or ideas" and in a certain way is quite compatible with the Hebbian neural learning systems [7].

But, is the mind that translates the world of particles and waves in a world of colors, sounds and smells, how? If we know the answer that can make the machines imitate our human mind's processes and we can put them to aid our work.

The psychology, philosophy, information's theories, the cognitive sciences and the neurophysiology tried this to answer while the artificial intelligence initially tried its own road, but today its is closer to this because of the Internet and the development of a cyberculture.

It is possible to simplify move the discussion foreward, defining mind as:

Mind = cognition + consciousness

where: the cognition is omnipresent in the nature, and consciousness is a natural phenomenon, present in the man as subjectivity.

But the remaining question is: "How do brains work?" The studies of technical tools [18] and others enables us to model brain functions that transcend the present limitations of computational or schematic models, and go to the domains of non-cartesian concepts of consciousness emerges, any insight was arrived in past century: the cycle of "action, assimilation and adaptation" [18], "Mind is the structure of behavior" [8] or the ecopsycology of the "an affordance ... of an object offers what it does because it is what it is" [6].

Knowledge in technological information age

As well as the primary orality and the writing they generate a relationship different with the knowledge, the cyberspace supports intellectual technologies that enlarge, they utter and they alter many human cognitive functions: the memory (databases, hipertexts, digital files [numeric] of many types and orders), the imagination (simulations), the perception (sensor digital, telepresence, virtual realities), the reasonings (artificial intelligence, neural networks or other model of complex phenomena).

The actual cyberspace is Web, but the Web is still very rigid, it offers a group of options but the user's possibility to create their own ones and stiller, of to show his intention and to ask the machine that helps him in the development of his insight is still a distant possibility.

The elaboration in this first part of the work is to build a digital system of easy access and of great interconnection capacity for networking, and for that is necessary to choose a storage format.

There is a large number of different formats of different kinds of information can be stored, but knowledge includes more general information such as: voice, images, songs, feelings, or simply a conversation with a friend to be registered as a note or release. Therefore the best format doesn't exist nor one best piece of software to access the data in general the document is served as different information source about a number of different formats. Like this we don't intend to define an unique format of input, but a concise formatting that gives the maximum flexibility to the user that makes the consultation as a possible source. It is intended besides to allow, at the interface level, that the user organizes his search in a personal way, and the group of this search will be in chaotic mode using self-organization.

Chaos and self-organizing information

The chaotic mode is not disarranged or disturbed organization, or its organization named self-organizing, it is a complex way of organization and it is compatible with a new science: Chaos Theory.

This theory is specially applied to non-linear system in different techniques, one technique is to detect special singularities named "atractors" in time series analysis.

In this work the concept of special method of self-organization named SOM (Self-Organizing Maps) is use to search words and texts, tags and special words in Web environment and special data in Database Content. Metadada in the environment compounds this Data Content.

Lin [15] adopted a Kohonen network for information retrieval. Kohonen's [11] self-organizing feature map (SOM), which produced a two-dimensional grid representation for many features, was applied to construct a self-organizing (unsupervised learning), visual representation of the semantic relationships between input documents. Many type of SOM algorithms is being built, but a special algorithm was made for to searching in the WEB, and is named WEBSOM [9].

2- AN ENVIRONMENT – THE SEDEC

Many companies, organizations and several enterprises that use digital information that use on-line digital systems and are now upgrading their systems to WEB systems [16] or beginning a new Web system, e.g. e-commerce system.

But now any new characteristics are happening and new problems are detected:

- a lot of information is on-line in the net, but without patterns and a lot of duplicated "lineal" information (e..g. letters, emblems, gifs, images)
- many light devices are available (e.g. Palms, PDAs.), but the connection with information is difficult.
- there is a lot of memory available in the net, but the security and administration is critical.

The first problem is standard and the new concepts that discussed more and more this problem to search more and more patterns, but the reality sense is use any special patterns in an special box named container. This concept appear in programming Java language in connection to components, that is the element that add to a container are tracked in a list.

The second, lineal information is stored in two types of documents: Content Management to typical texts, emblems, etc. and Backup/Reporting to schedulers, securities info, the copies or other needs. This information is related to Content Database, that is, the metadata where any patterns is related and is provided to add or exclude any field, tags or labels to this metadata if the any point manages. One very fast station control this Content Database, and two others station treat small (e.g.text) and big data (e.g.images).

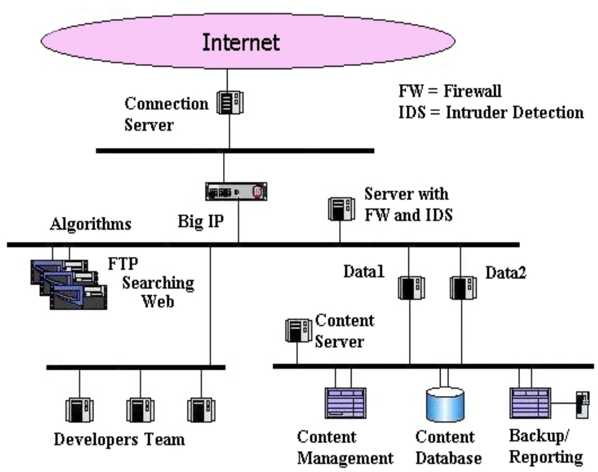

FIGURE. 1 –A SEDEC “COGNITIO” ENVIRONMENT.

The security problem is solved using Firewalls (FW) and IDS (Intruder Detection Systems) in a system named in-depth model, because track each connection traversing all the firewall’s interface to make sure they are valid. As FIGURE 1 shows, is a partial system because it lacks a system of applications.

Special devices: downloads, search and WEB

The special effort for this system is the use of small Data Centers geographically separated, that is, distributed, and this result new problems: downloads, searching and WEB organization. Other problem cited later, is the WEB offers a group of rigid options and doesn’t has flexibility for user search his proper paths.

The special device Big-IP is to perform local load-balancing (LLB). The machines provide load-balanced IP address to the Internet and distribute incoming request locally based on any server’s availability and response times.

For primary stage in this implementation, we installed two device named Data1 and Data2 in the same place, for academic reason, but in application target we think implementation in data centers distributed and geographically separated. Three primary facts drove our goals: ease of management, low costs and democratizes the resources. The main goal is distributed data centers.

Any organization’s requirements was evaluated: trace ability to a common problem, a document is commonly the final goal of activities in business and research but has many complex documents (multimedia), documents as corporate or group memory and others.

A common technique in linear system is to use linear, random or stochastic mapping for information organization to searching and sorting, included: sorting method (bubble or shell, for example), neural networking and other. But ordinary people, which are unaware of these methods, have a proper way to organize information, that realization motivates the development of self-organized systems.

Three software devices are proposed: WEB, FTP/ Downloading and Searching. Current FTP is made in software, but in target system will be in FPGA devices.

An important requirements is the management of different formats, for this we determined that the Content Management Application (CMA) should reside wholly in staging. The use of XML and the concepts of RDF (Resource Description Format - an extension of MCF) in XML (EXtensible Markup Language) and a vocabulary (or descriptors group) is done to solve these problems.

Searching WEB using the SOM algorithm and special search (e.g. using descriptors group), guarantees good results, but he main advantage is that distributed centers can have searches self-organized done in each user's owner formatting. The final implementation will provide the own interfaces. Separate users (or servers in goal application) at each location handle all available devices and backups/reporting, or documents with Content Management.

In the heart of this problems is a SOM (self-organizing algorithm), and initial evaluation is to simulate this devices environment, tests and evaluations they can prove the need that these devices are made in hardware, in this case, we will opt for algorithms in FPGAs.

The self-organizing map (SOM)

The self-organizing map (SOM), developed by Teuvo Kohonen in the decade of 80, present a map topologically based in the cerebral cortex. It is known that the brain of the most sophisticated animals has areas that are responsible for specific functions. Areas exist, for example, dedicated to the speech, to the vision, to the motor control, to the sensibility, to the touch, etc. Each one of these areas contains subareas (each subarea map is responsible of the sensorial organ represented by the map). For example, cortex auditory map capture the different sound frequencies and cortex visual map capture visual primitive characteristic, such as light intensity, orientation and curvature of lines [2].

As all the artificial neural network, the Kohonen's map are formed by a group of simple elements, called neurons, organized in more complex structures, that work together: the net (or map). Each neuron is an unit of processing that receives incentives (of out of the system or of another neurons), and it produces an answer (for another neurons or outside of the system). Just as the neurons of the brain, the one of the neural network are interconnected itself through ramifications which the incentives are spread. Every entrance is connected to all the output neurons.

A Kohonen's model is based in a competition of the information representation presented in the input data by output layer neurons. Choose a winner neuron, this is readjusted to answer still better to the received incentive. Inside of this not supervised model, not only the winner, but also its neighbors (in a physical sense) are adjusted.

Two important aspect of data are developed in SEDEC: storage, management and organization using metadada in Data Content Management, and a second aspect, the relationship between related data for intelligent search and research using SOM algorithms.

3- The environment (SEDEC)

In first aspect (Data Content Management), is important the use of RDF (Resource Description Format) and XML.

Starting from the model MCF (Meta Content Format), RDF created is a Formal Model of Data and it can be defined like "Architecture Components to Support Metadata Interoperability", with a transfer syntax based on XML, being this a Syntax human-readable and machine-processable, or be allowed each description community (in our case the user) to define its own semantics, without the need of an only pattern for all, like this she provides a structural interoperability. This model uses graph addressed and a tool (Resource) that is described through a collection of properties (Property.) call of RDF Description, where each property has a Property Type and Value. Through the property Type the resource obtains a value. URI is a value constant defined using strings. The FIGURE 3 shows RDF:

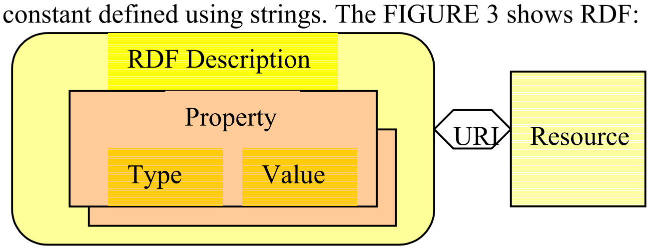

FIGURE 2 – GENERAL RDF DESCRIPTION.

This neighborhood region can assume several different formats. Although the square format is the most common, the neighborhood area can also present, as in the FIGURE 3, the form of a hexagon or circle (gaussian). The definition of the most appropriate format depends on the problem and the data's distribution.

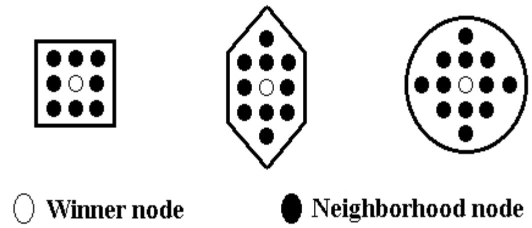

FIGURE 3–DIFFERENT FORMAT OF NEIGHBORHOOD

To understand how the algorithm works, consider the follow input data, the weights and the output neurons in the FIGURE 4. For each input data, has a weight, and each input data is linked to each output neuron, so W_{ij} defines the weight, where i represents the entry X and j the output neuron [4].

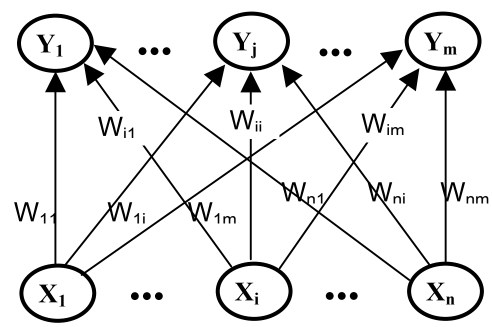

FIGURE 4 – EACH INPUTA DATA X IS CONNECTED TO OUTPUT NEURON Y.

The neighborhood region, or topology, of self-organized map, can be square, hexagon, circle, like in the FIGURE 3, for a didactic reason, a lineal topology will be used, shown in the FIGURE 5. The nodes (or neurons) they are represented for *, and the winner node for #. The rays of action of the winner node is illustrated by symbols: {}, (), [].

* * * {* (* [#] *) *} * *

{ } R = 2 ( ) R = 1 [ ] R = 0

FIGURE 5 - LINEAL TOPOLOGY .

Consider a weight Wij, an input vector Xi, a group of output nodes Yj and the learning rate α that can be modified by each group of entrance vector, so step-to-step:

0. Initialize weights Wij.
   - 0.1. Set topological neighborhood parameters.
   - 0.2. Set learning rate parameters (α).
1. While stopping condition is false, do step 2-8.
   - 2. For input vector x, do step 3-5.
     - 3. For each j, compute:

$$D(j) = \sum_i (W_{ij} - X_i)^2$$

4. Find index j such that D(j) is a minimum.
5. For all units j within a specified neighborhood of Yj, and for all i:

$$Wij(new) = Wij(old) + \alpha[Xi - Wij(old)].$$

6. Update learning rate.
7. Reduce radius of topological neighborhood at times specified.
8. Test stopping condition.

The learning rate α is a slowly decreasing function of time (or training epochs). Kohonen indicates that a linearly decreasing function is satisfactory for practical computations; a geometric decrease would produce similar results [4]. The radius of the neighborhood around a cluster unit also decreases as the clustering process progresses.

The formation of a map occurs in two phases: the initial formation of the correct order and the final convergence. The second phase takes much longer than the first and requires a small value for the learning rate. Many iterations through the training set may be necessary, at least in some applications.

4 – RESULTS AND CONCLUSION

Before going live with the initial infrastructure, we realize tests to verify that it met necessary performance requirements and to remove any possible bottlenecks.

Testing simulating up to 100 simultaneous virtual users in intranet (the most interesting is use modem but for the time being we don't have this possibility), using a set of virtual users to travel specific paths of varying lengths through the site and download documents and data of various sizes and formats.

The Table 1 illustrates, the primary resources linear and primary resources used in self-organizing model, using transfer rate of the 100 Mbps in FastEthernet, the storage progression (in Mbytes by minute) for two machines Data1 (simple texts) and Data2 (images), the storage in minutes is:

TABLE 1

Storage	1 Virt Users	5 Virt Users	50 Virt.Users	100 Virt.Users
Data1	33.4 Mb	9.45 Mb	4.77 Mb	2.12 Mb
Data2	33.2 Mb	8.40 Mb	4.20 Mb	1.86 Mb

The conclusion is there are many specific methodologies for developing Web and popular Web-based application, in our work is user-based in an approach self-organizing. The use of XML and Java (or C#) languages in connection with RDF formats implements the interoperability among different format of data.

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DEVELOPING MINI-APPLICATION ON AUTOMATIC CONTROL WITH INTERDISCIPLINARY TEAMS.

Osvaldo Clúa, María Feldgen and Fabiana Ferreira [1]

Abstract *∞ . We developed an interdisciplinary course to train different engineering branches students in teamwork. We found that the application we asked to develop played a central role in the success or failure of the course. The application has to be complex enough to avoid a birds of a feather approach, but it has to be completed in a standard semester work time. We decided to follow a well defined project life cycle model as the axis to develop teaming skills and as an overall structure of the project. We used the TIDEE guidelines to develop teaming skills. As a result we found ourselves involved in a capstone design course with changing faculty roles as the project progresses.*

Index Terms ∞ Interdisciplinary experiences, soft skills, teaming, capstone course.

INTRODUCTION

The society perceives engineers to be technically competent with good math and science skills. However, society does not necessarily believe that engineers have good communication skills. In other words, the stereotype exists that engineers do not need to have good oral skills since they do not work with a lot of people. Clearly, this is an incorrect perception, but it nevertheless it exists.

Traditionally engineering education starts with a common core of math, science and basic engineering knowledge. This common background gives students a foundation for advanced studies in different but related areas of engineering.

Present time projects, on the other hand, require the cooperation among these different branches; but this cooperation is seldom addressed in undergraduate courses.

In order to overcome these teaming skills education deficit, we decided to transform an elective course in a capstone course which aims to show students the big picture of an engineering project. In the paper we present the project life cycle we use in the course, and how we use it as the integration axis of an interdisciplinary experience.

PROJECT'S LIFE CYCLE AND TEACHING MODEL

Modern project management departs from simple ongoing, repeated operations to a scenario where there is less certainty about anticipated outcomes. In more traditional project management, management procedures rely on centralized decision making and strict adherence to hierarchical authority.

In the teaching-learning arena, this management practice has its complement in the way traditional project assignment are conceived. The centralized decision making model is called teacher centered model [1], where every important design decision is made by the faculty (or following the faculty's ideas) and the student is expected to discuss and follow the faculty's directions. As a result, the experience of faculty leads generally to well finished and clean design, but the students are not allowed to follow their owns ideas and are in some sense "protected" from failure. Unfortunately, this way may also prevent students to develop an attitude of learning from their failures, which is considered a central path in building experience [2].

When adaptability and rapid response to change are called for, such as in the volatile present technological market, more complex and adaptive forms of organization and management are required, expanding considerably the degree of decentralization. Such an approach is sometimes called a systems approach [3]. An important aspect of the system approach to a project is the concept of life cycle. It is the basic pattern of change that occurs from beginning to end and that is similar in for all projects.

In the teaching-learning process, this management style can be mapped to a student centered model [4] where students are challenged to follow their own decision using faculty as consultants or facilitators of their design experience. To put the student centered model in action, some structure must be followed in order to achieve a measurable (or gradable) work. The project life cycle is a way of logically ordering the activities of the project and provides a control scheme for the assignment.

The project life cycle used as a model in the assignments had four phases: Conception, Definition, Acquisition and Operation.

For the Conception and Definition phases, students are asked to write a *Request for Proposal* to outline the idea and to state the objectives, scope, specifications and constrains. They answer the R.F.P. with a *Feasibility Study* which is used as a control point and a *Proposal.* As we will describe in the next section, these documents are used to develop some teaming skills. After writing the *Proposal*, teams are ready to enter their Performing stage and the Acquisition phase begin.

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During this phase, students are asked to make a detailed project planning. They have to get the *User Requirements* describing what the user wants the finished system to be and do. Using this document, the final product will be evaluated as acceptable or not. It is a refinement of the R.F.P. and some changes to the original *Proposal* are included to test the adaptability of the teams. The *User Requirements* is used to derive another set called the *System Requirements,* where requirements are stated in technical jargon. By having teams write this document, we aim to develop a common technical language among specialties and to have each one understand the whole project. After writing the documents, the actual system design begins. We asked for the complete technical documentation depending on the specific project, including economic profiles such as return of investment, personnel training plans and maintenance procedures.

Depending on the complexity of the project, the availability of materials and the economic possibilities, the artifact has to be actually built in a whole, or some mix of simulation and building is asked. During a presentation, the team has to explain the operating procedures and identify maintenance issues and improving opportunities.

INTERDISCIPLINARY TEAMING

The project is developed using the TIDEE competencies [5]. TIDEE is an acronym for Transferable Integrated Design Engineering Education. TIDEE is a multi-university project supported by National Science Foundation. The TIDEE project focuses on the first two years of engineering design education in the state of Washington, and focuses on the improvement of both educational methods and materials used to prepare students for engineering design and practice. It can be described as an outcomes-based approach to engineering education and uses structured teams for learning and performing engineering design and is used as a model within the first and second courses. Using the TIDEE competencies as a guide, students learn to work together.

TIDEE identifies three major categories of competencies are required for team-based engineering design: design process, teamwork, and design communication.

The design process is further divided in six distinguishable elements. This elements are:

❖ Gathering information relevant to a need or opportunity,

❖ Definition of the problem establishing product requirements.

❖ Creating alternative solution concepts to address the requirements.

❖ Evaluation and decision making by analyzing options and selecting the ones best meeting requirements.

❖ Interpreting and synthesizing information and decisions an taking action to convert these decisions into deliverable products.

❖ Managing, evaluating, and improving design activity to use information and resources to achieve design objectives optimally.

The selected Project Life Cycle approach allowed to use these elements as control points by mapping then in the deliverables.

Teamwork is the second category of competencies required for effective performance of team-based engineering design. This encompasses capabilities associated with managing the personnel involved in a project to achieve the performance expected from effective teams.

Bruce W. Tuckman [6] stated that a group of people goes through well-defined developmental stages so as to becomes an effective team.

❖ In the forming stage, people act in a socially appropriate manner. They tend to focus on their territories and do things the established way.

❖ In the storming, team conflict begins. People are busy having differences and learning how to deal with them. They begin to gain confidence bringing up issues without going on the attack and blaming others. They also learn to listen to other's concerns without going on the defensive and counterattacking. Successfully dealing with conflict gives the team member a sense that they can bring problems to the group, and that the group will deal with them.

❖ In the norming phase people are able to put issues out for group consideration, and the group established ground rules and its own norms for acceptable behavior.

❖ In the performing stage the group can diagnose and solve problems.

To help students form effective teams and deal with the different stages in every class we scheduled some previous labs and lectures before they began with the project. We used the two first stages of the Life cycle to have teams pass the forming and norming stages.

Design-related communication comprises the third category of the TIDEE competencies for team-based engineering design. This category addresses capabilities associated with managing the information and its transfer during completion of a design project. A final presentation of the teams was scheduled to address this goal.

We did not use the TIDEE suggested scoring schema to asses the level of competency achieved.

THE MINI APPLICATIONS APPROACH

To avoid a sense of failure due to the complexity of a modern standard application, we choose to use mini applications that hopefully can be completed in a standard semester work time. In past experiences we used full blown applications asking students to develop only a part of it, but the winners or losers mood of the society induced a feeling of failure that prevented teams to evaluate positively what they learned. In fact, this is part a common underestimation of the present day everyday technology complexity.

To develop the subjects program, the mini applications have to be built using a distributed layered approach, using sensors and actuators at the field level, controlled by Programmable Logic Controllers (PLC). The PLC are integrated in cells communicated by a Fieldbus and some supervisory work is done using the Web in a conventional computer network. This basic structure allows to form teams with Electronic, Electric, Industrial and Computer Engineering students. Achieving a positive interdependence among different fields students is not easy and a carefully planned teaming set of activities was developed after some failures. An account of these activities is found in [7].

The chosen application is central to teaming efforts. It must provide a highly effective means of turning abstract ideas into project realities and difficulties, supporting a vast array of concepts to be taught and skills to be developed. In a similar effort, the Texas A & M implemented a Real-Time Lab, equipped with a model railroad system and five networked Linux-based control computers, two ActivMedia Pioneer class and two ActivMedia AmigoBot autonomous mobile robots, and 10 LEGO MindStorms robot kits [8] in order to excite student interest and provide an integration axis for different subjects. We choose industrial networks as the integration axis.

The industrial network technology applies the multiple advantages of the well-known OSI model [9] in automation. This fact is useful not only to explain the control concepts, but as a pedagogical tool. The cleanness of the layer model aids to understand the cooperation among different devices with well-defined functions.

The layered architecture calls for a well-structured and defined way of presenting the material in an undergraduate course. It also allows different abstraction levels, according on how the different engineering fields view the automation. This helps to integrate students from different field disciplines, in the same way that the industrial networks integrate different devices to deploy a complex field control, communication and control network. In this way, Industrial Engineers see the industrial networks as the integrating automation device they need for their processes, considering them at the application level and concentrating their interest in requirements' specification. Electronic Engineers are interested in sensors and actuators, so they deal with the physical and data link layers in order to interconnect the devices. Communication Engineers take care of the factory network integration and it connection with CAD, CAM, inventory and logistic applications. Software Engineers assure the work of layers 4 to 7, and integrate or develop applications in order to get the information properly presented to the user, e. g. using the enterprise intranet and the requirements specification. Control Engineers design the overall control and monitoring applications to meet the industrial specification.

As a grading objective, each student shall acquire the necessary skills to understand the system as a whole, and to implement a similar subsystem in her/his engineering field. And the instruction to the students is to convince the examiner in a public presentation that this objective is meet. This evaluation schema introduces students to the complex topic of public presentations, and faculty is required to do some preparation work regarding it.

The spectrum of mini applications used in the courses varies a lot. Some of the examples are automating filling facilities, bottling and boxing of fluids, hydroponic growing of industrial chili (used in cosmetics), water treatment and plastic packaging. Each one developed in an special environment with facilities, labor, communications and services corresponding to different places of Argentina.

CONCLUSIONS

By using Mini Applications, students become involved in problem management, instead the common approach of *closed* problem solving. This attitude emphasizes the fact that the design of a solution is only a stage in the project life cycle.

Understanding and interpreting the environment where the project will be developed plays a key role in the design process. students have to solve "secondary" issues as qualified labor availability vs. in house training or third part hiring of services vs. in house providing. By developing "parts" of a big project, these problems were neither identified nor addressed.

The rol of faculty changes during the different team stages. Initially, before the students are able to develop a shared understanding of what to do and how to do it, teachers have to play the rol of a project leader. As students gain control of the project, teachers become more a consultant and sometimes a customer to give some feedback ideas on functionality, structure and other project characteristics.

As every student centered experience, it implies a lot of work for faculties and a love it or hate it answer of students. Some of them argued they felt really identified with the engineering task and some of them were more comfortable with the "closed problem" approach and complained about faculty not having the problem well defined.

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PRACTICAL CLASSES AND EXAMINATIONS ON BASIC ELECTRONICS LABS IN COMPUTER ENGINEERING

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Abstract *— This paper describes how the Computer Engineering students at UCDB are motivated in lab lessons and exams, to get more out of lab experiments, to better understand future classes but also aiming at their professional life after graduation They have to try the experiments with simulators on their own, before lab lessons, coming more prepared and participating more effectively on them. A practical exam was devised to measure their practical proficiency in using lab equipments and in using their intuition to better analyze and understand basic electronic circuits. The help of teaching assistants (TA) was used in part of the practical examinations to speed them up, but in a structured rigid way to avoid variability of criteria by the TAs. These were developed over the years of the course existence, resulting in an increase in the students confidence and interest also for theoretical lessons, having encouraged their initiative and group skills.*

Index Terms — evaluation, laboratory, basic electronics, instrumentation.

INTRODUCTION

When the computer engineering course at UCDB was first created, we seeked a balance between hardware and software aspects in our students formation. Therefore, several classes were designed to have both theoretical and laboratory lessons, with these serving as motivation and reinforcement of concepts covered concurrently at the theoretical lessons. This happened to programming classes as well as those involving hardware, including classes for electricity, basic electronics, digital circuits, computer architecture, computer networks and notions of telecommunications, to name a few. Based on the authors work experience in design of digital hardware, commercial and scientific software development, and network infrastructure and management, it was clear the profile the an employer would look for in a future engineer.

Hence, it was necessary that the student didn't get to the end of the course by just being approved by passing written tests of what had been seen in the lab experiments, or by repeating one of the experiments. It was necessary to develop autonomy, self-confidence and experience to use lab equipments such as multimeters, oscilloscopes, function generators (FG), power supplies and the like. Mainly, it was important to develop the student's creativity to let him use it later with confidence in later classes, and even more, to let him practice his intuition in solving daily problems, like debugging computer network cables and NICs (network interface cards). For example, it is important for a computer engineering to recognize when a network is done according to cabling standards, at least to assess hired third party contractors.

The lab classes and evaluations were not only on the authors' experience from their students days at FEI, Georgia Tech and USP, but also from the exchange of ideas with professors from other schools, and from books like Leach [5], Malvino [4], Capuano & Marino [8], Chui [7] and other examples at the reference section. After a few years applying this methodology, we found out that USA universities also applied similar exams, as seen in Webster [1]. Every year new ideas are added, improving the exams and trying to correct any faults.

GENERAL DESCRIPTION

At UCDB lab and theory are part of the same class, with the same joint grade. To force the students make an effort at the lab lessons, the grades are defined in such a way that it is almost impossible to pass the course without learning the lab techniques. The passing grade without extra exams is 70%. Between 40% and 70% there is another test to complement the grade. Therefore, we forced 30% of the whole grade to come from the practical activities. If the students choose to ignore lab lessons, they need 100% on the theoretical part, which is highly unlikely. And for 30% of the practical activities, 10% comes from experiment reports and 20% from a practical proficiency examination.

Also, in the first lab classes they see basic concepts and learn to use simulators, like Electronics WorkBench (now renamed to MultiSim) [1],[5] or PSPICE [8]. From then on, to attend lab classes the student is required to bring a simulation of the experiment, done before the class. This

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intends to make him try to understand the experiment before, bringing doubts, making better use of the professor and TA time at class, guaranteeing the completeness of the experiment during class time. We also intended for him to figure out that design problems can be debugged at a simulator, but a later practical assembling is crucial to handle practical problems, like assembling, noise, interference, etc. On the following week a report on the experiment has to be produced, one per bench, a team of three, with the grade emphasis being on the conclusions reached from the experiment.

For the remaining two thirds of the practical grade, a practical skill examination was created, so the student can show his abilities in using instruments and assembling basic circuits, as well as his qualitative understanding of the basic RLC and diode circuits.

It is not reasonable that a engineer graduates and could not, for example, use a multimeter to test on outlet voltage or not be able to test a network TP (twisted pair) cable, or still not being able to visualize the waveform of a modem or digital circuit. Flaws like that is what we try to avoid, trying to create an engineer who is not afraid to "get his hands dirty".

Simple instruments were chosen, more likely to be found on labs outside of universities. They were intentionally not automated by IEEE488 (or GPIB, general purpose interface bus, a network protocol for instrumentation), so the real skills of the students could be observed.

At its first edition, this exam proved to be too long to be given by a professor alone. Besides, there was a problem to keep the same level of exam throughout the long exam. The level should be the same for the first and last students, regardless of the teacher getting tired, or from one day to the next.

Starting on the second year of its application, the help of other students were used to speed things up. The TAs, or students from previous semesters who stood out, were used for the simpler parts of the exam, more direct and objective. The qualitative concepts were still managed by the teacher in charge.

WANTED KNOWLEDGE

The students receive a list of instructional skills to be done under supervision of a TA, shown partially on appendix 1, part of it was repeated on appendix2, and omitted here. The tasks are such as identifying resistors by color code, assembling series, parallel and mixed circuits, measurement of current, voltage and resistance, with both analog and digital multimeters, and the use of function generators and oscilloscopes. These are supervised and graded by the TA, with the teacher being responsible for the qualitative questions on behavior of circuits.

To let the exam have a rigid structured way, avoiding variability of criteria from one TA to another, a series of items to be checked was created. This list contains the 40 most common errors predicted to be made by a student, including connecting cables to multimeters (MM), and adjustments of MM, oscilloscopes and function generators, among others (refer to the appendix 2). A form to be filled by the TA was created, to better control and make grading easier (appendix 3). It contains the code for the possible errors on the lines, and the names of the students on the columns. Each wrong item takes 0.25 down the practical exam final grade.

To make it practical the students take the test in pairs, better described later on.

To check the competence of each pair, at each new pair the TA is oriented to randomly change components and adjustments of the equipments, like trigger, intensity, position, output level of the generator, ranges and so on.

As the years went by, suince the exam time is limited, the students started to practice in advance in the days before the exam, reviewing experiments and using the list of common mistakes as a study guide, as the minimum necessary, using the lab on its free off hours. There is no problem in letting them know this list, what will be asked, since what is asked is exactly what he is expected to know by the end of the semester, and later, after graduation. This way, we end up making them really get interested in using the lab off hours.

APPLING THE EXAM

As mentioned, to speed the tests up, the students are grouped in pairs, but with both being asked. If one of them does not know something, both of them loose the points of that item. With this, a solidarity atmosphere is formed, but without a weak student relaxing and leaving all the work to a competent friend. By the way, in 5 years applying this methodology, there has never been a non-homogeneous pair, of students with too different skills.

Three or four test benchs are assembled, with TAs applying the straight forward questions, and as each pair finishes, it waits to go to the teachers bench for the more subjective interpretative questions. Each TA writes down each pair mistakes on the form and randomly changes the settings and components for the next group.

The TA should not give any hints to the group, stopping them only to avoid mistakes that could damage the equipments, like burning a multimeter fuse, but still writing down this mistake. Initially this possibility was not foreseen, delaying the following groups because of having to stop for repairs.

Each pair has 20 minutes to execute all procedures, allowing up to 30 minutes but taking one point off in this case. After 30 minutes they should stop where it is to avoid exceeding the days reserved for the test.

The teachers bench is assembled with real or simulated circuits, like RLC in DC or AC, or supplied by square waves. Also half of full wave rectifiers can be used, having their behaviors analyzed and explained by the students. The teacher also asks for the identification of capacitors and diodes. After this, by changing the value of a component or characteristic of the injected signal, the group is asked to predict the behavior of the waveform. Or by showing a waveform they are asked what should have happened with the frequency or injected waveform or component values.

Each group is given different questions to different circuits, avoiding that in the waiting time a friend who has just done the test gives them tips.

The TA part accounts for 80% of the test, 20% is from the teacher, who assesses each student domain of the subject and gives the final grade of the exam test.

CONCLUSIONS

The use of simulators before lab lessons improved the use of the small time destined to them, but it was after the implementation of the described practical exams that we noticed a greater motivation of the students, even improving the learning of concepts given in the theoretical lessons. This way, the lab really reinforced concepts seen in theory.

The limited time of the practical exam forced the students go to the open lab to practice their skills and solve their doubts, increasing the percentage usage of the labs. The participation in class increased, as well as the students interest, and many students started to enjoy the practical aspects.

Although the effort was present in all experiments during the semester, it was at the end, when really asked for, that the students found out their capability of thinking on their own, increasing their self-steem and confidence.

We noticed a greater participation and pleasure in the all exam even by students who traditionally did not show interest or responsibility in solving lists of exercises, participating in theory classes or looking for a teacher or TA office hours to clear doubts.

By exchanging ideas with other university professors we felt the need to share these successful ideas on this paper.

The appendixes try to illustrate and help the accomplishment of similar ideas by whoever gets interested.

APPENDIX 1: DIRECTIONS THE STUDENTS (HANDED TO THEM)

Instructions:

The idea of this test is to measure your proficiency in using lab equipments, needed for the next semesters, as well as measure your intuition in understanding the behavior of some basic circuits. The student who fails an item lowers both students grades. Each wrong item counts for 0.25 of the total. You have 20 minutes to take all items. It can go to 30 minutes, but then one point will be discounted. At 30 minutes stop where you reached, the remaining is counted as wrong. The first 8 points are measured by a TA, the other 2 by the teacher, measuring your comprehension of some circuits. The TA will only stop you if there's a risk of damaging the equipment, but you still loose the item.

Procedures

The same as listed at appendix 2, the list of items to be done with possible common errors for the TA to grade. The list handed to student taking the test on appendix 1 obviously ommits the possible common errors.

APPENDIX 2: LIST OF ITEMS TO BE DONE AND OF RESPECTIVE COMMON ERRORS (FOR THE TA)

COMPUTER ENGINEERING – UCDB
BASIC ELECTROCNICS – practical evaluation

The student should know the items below. For each sub-item not known, decrease the total score.
The corresponding value is indicated on the table.

1. Identify the nominal values of 3 resistors (color code).
2. Assemble the mixed circuit in figure (1).

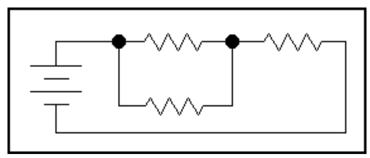

FIGURE 1

3. Measure R (resistance) and V (voltage) in each R with an AMM (analog multimeter).
a. tips should be inserted correctly in the MM (common=black, V/R red).
b. in AMM use the best possible range (with the tip in the middle of the display).
c. to measure resistance, R should be isolated from the circuit
d. at each change of R range, adjust the 0 (tips shorted).
e. read R multiplying the range position
f. read V in parallel to the element.
g. at each change of range of V, SHOULD NOT adjust 0 (tips shorted)
h. on AMM read in the proportional range, multiplying by factor 10,100, etc..

4. Measure I (current) in each resistor with AMM.
a. tips should be inserted correctly in the AMM (common=black, I(A) red).
b. in AMM use the best possible range (with the tip in the middle of the display).
c. I should be measured in series (break the circuit).
d. on AMM read in the proportional range, multiplying by factor 10,100, etc..
e. read the display value, with unity given by the chosen range (K, M...).

5. Measure R and V with DMM.

a. tips should be inserted correctly in the MM (common=black, V/R red).
b. in DMM use the best possible range (largest detail without exceeding the display).
c. to measure resistance, R should be isolated from the circuit
d. at each change of R range, it should NOT adjust the 0 (tips shorted).
e. read the display value, with unit given by the range (K, M...) (in DMM cannot multiply by the range)
f. read V in parallel to the element.

<u>6. Measure I with DMM</u>
a. tips should be inserted correctly in the DMM (common=black, I(A) red).
b. in DMM use the best possible range (largest detail without exceeding the display).
c. on DMM read the display value with unit given by the range (K, M...) (in DMM should NOT multiply by range factor)
d. at each change of R range, it should NOT adjust the 0 (tips shorted).
e. I should be measured in series (break the circuit).

<u>7. Measurement with Osciloscope:</u>
Connect the output of the function generator (FG) to the channels of the scope, with the FG with a sine or triangular wave, 100, 500, 1k or 5kHz, changing for each pair.
-.Read V and f (frequency).
-.Measure the sine RMS voltage DMM and compare to the scope's reading. (Vp/1.41).

a. adjust beam to horizontal central position.
b. adjust intensity a little under maximum.
c. adjust focus to maximum visibility.
d. adjust horizontal scan to have at most 2 cycles on screen.
e. adjust vertical deflection so the wave occupies 40 a 80% of the screen. (not too large nor too small)
f. adjust trigger to automatic.
g. knobs of vertical deflection, horizontal e trigger should be on calibrated position.
h. V should be measured in parallel, multiplying the divisions by the range.
i. should measure V peak and calculate Vrms=Vp / 1.41
j. measure period T (divisions x hor. sweep) and calculate frequency (f=1/T).
k. should know how to adjust the FG to sine wave and to choose output level and wanted frequency.
(CHANGE SETTINGSAT EACH NEW PAIR)

EXAMPLES OF QUESTIONS OF CIRCUITS FOR ANALISYS
<u>8. Interpret the DC circuit behavior:</u>
a. recognize the different types and values of capacitors and diodes
b. observe the division of current in parallel circuits and the division of voltage in series circuits.

<u>9. Interpret the behavior or AC circuits (requires 2 channel scope).</u>
a. observe the difference of phase between Vr and Vc to go down as the sine frequency goes up.
b. observe the Vcap in RC circuit, explaining why a square wave transforms into a triangular one by increasing the frequency (the period decreases, there's not enough time for the capacitor to totally charge and discharge it on dV/dT, but they hadn't seen that yet).

<u>TIME</u>:
a. the exam should last 20 minutes at most; up to 30 is allowed, but cuts 1 point from total;
b. If after 30 is not finished, interrupt and count only what is done, to avoid exceeding total number of days due to too many students. DON **<u>NOT</u>** EXCEED 30 MINUTES!

APPENDIX 3: EXAMPLE OF STUDENT CONTROL PER STUDENT (0.25 POINTS PER ITEM)

1							1
2							2
…							7j
7k							7k
8ª							8a
8b							8b
9a							9a
9b							9b

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Working with differences: keeping motivation and generating satisfaction

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Abstract — *A central problem for institutions that provide distance education is how to develop courses that are adequate to the existing demands, preventing the high rates of "dropout", and increasing students' satisfaction. The Distance Education Laboratory of the Federal University of Santa Catarina/ UFSC (Brazil) has been researching the possibilities to attend the specific needs of several groups of students, and at the same time paying attention to the individual expectations. In this paper we present some results of the empirical observation of graduate programs offered to working adults, registered through their companies and/or institutions, using interactive media - videoconference and Internet. Despite some common characteristics, these programs have been observed as intrinsically different, since the student enrolled came from diverse contexts and had very different demands. Observing the results obtained by the students in terms of performance and completion of the 15 graduate programs that begun in 1998/1999 we noticed that despite of the above mentioned differences among the student groups the drop out rates were below the data found in the related DE literature. In this sense we may conclude that the importance of the instructional design process, students support service (local and remote), and the professional circumstances of the students are determinant factors of success.*

Index Terms — Distance Education, drop out rates, motivation, students support service.

INTRODUÇÃO

Um problema central para as instituições que ministram cursos a distância é o de garantir que os alunos consigam terminar seus estudos de maneira satisfatória. A partir da proposta de alcançar uma grande diversidade de estudantes mas ao mesmo tempo garantindo a atenção às suas necessidades individuais é que foi desenvolvido o modelo dos cursos de Pós-Graduação Stricto Sensu em Engenharia de Produção da Universidade Federal de Santa Catarina, mediados pelo Laboratório de Ensino a Distância. Baseado na utilização consorciada da videoconferência e da Internet, o modelo permite uma ampliação das possibilidades de contatos síncronos entre alunos e professores, e entre estes e os colegas. Além das aulas por videoconferência, outras estratégias são utilizadas com o objetivo de incrementar a interação e a construção de um senso de pertencimento, de comunidade, como as aulas presenciais no início de cada disciplina, *workshops*, seminários presenciais e um ambiente de aprendizagem on-line com espaço para aprendizagem colaborativa, além da atuação do monitor.

Apesar de serem todos cursos de Mestrado a Distância, há uma grande variedade de áreas de conhecimento, com alunos vindos de diferentes contextos e demandas as mais diversas. Essa diversidade no entanto, resultou em uma taxa de *dropout* dos primeiros cursos bem abaixo do verificado na literatura da Educação a Distância. O objetivo deste artigo é o de tentar, através da descrição do modelo e das características das parcerias e de seus alunos, levantar algumas hipóteses sobre quais seriam os fatores responsáveis por esses índices de finalização e retenção dos alunos na EAD.

SISTEMA DE APOIO AO ALUNO

Uma breve revisão da literatura sobre o papel dos serviços de apoio ao aluno na Educação a Distância, nos mostra que este setor e os profissionais que nele atuam são fatores determinantes para o sucesso de qualquer iniciativa de EAD. Ref. [1] afirma que a melhoria da EAD nas últimas décadas está parcialmente relacionada com a melhoria da oferta de serviços de apoio aos estudantes. Ref. [2], vão mais longe e afirmam que apoio ao aluno é fator crítico para o sucesso dos programas de educação a distância. A importância dos serviços de tutoria, monitoria e suporte é fundamental para desenvolver a autonomia dos alunos, especialmente se considerarmos o fato de que na EAD, o aluno será sempre estimulado a demonstrar habilidade de trabalhar sozinho (ou em grupos "virtuais") e saber buscar apoio quando necessário [3].

O NOVO ALUNO A DISTÂNCIA: AUTONOMIA E MOTIVAÇÃO

Partindo-se do pressuposto de que o aluno é o centro de qualquer processo educativo de qualidade, tal deve ser o caso na EAD. O aluno a distância é figura central do

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processo de ensino-aprendizagem e todo o curso é desenhado objetivando a otimização do seu desempenho. Uma das regras de ouro para o sucesso de um programa de EAD é o conhecimento do público-alvo para o qual se está planejando [4]; [5];[6]. Quem é este aluno? Quais as suas expectativas? O que ele busca/necessita? Responder estas questões, ainda que de forma ampla e genérica, é uma tarefa primordial para as instituições de EAD.

Diversas pesquisas mostram que para que uma abordagem educacional realmente possa ser vista como "centrada no aluno" [7]; [8]; [9], são necessários investimentos efetivos nos aspectos críticos que afetam a disposição do aluno para estudar a distância, o que pode impedir o aluno de se matricular e progredir, assim como os aspectos motivacionais, sendo que devem ser consideradas aí as questões familiares, econômicas, disponibilidade de tempo, características pessoais, etc. [10].

Os estudantes que buscam cursos à distância formam, segundo [8], "(...) uma clientela especial. Ela é diferente da do (sic) estudo com presença, porque por via de regra se trata de adultos *um pouco mais velhos*. Sua idade média situa-se entre 20 e 30 anos, sendo que para cima dificilmente se coloca um limite".

Para o aprendiz adulto, o mais importante é incorporar novos conhecimentos ao que já possuem, obter respostas para suas necessidades e não apenas em aprender por aprender. Eles estão mais inclinados a desafiar professores e colegas com experiências da vida real que contradizem estudos hipotéticos. "Estudantes adultos trazem uma grande variedade de interesses e experiências para a sala de aula; instrução que aproveita esta riqueza torna-se mais profunda e envolvente para todos" [11].

Estar motivado é um fator fundamental para que o aluno a distância realize as suas atividades e conclua satisfatoriamente seus estudos. Segundo [12], a motivação é um fator primário para o processo de aprendizagem. Para esta autora, "Sem o desejo de aprender, raramente irá acontecer uma aprendizagem efetiva" [12]

Para Ref. [13] a motivação é uma disposição autônoma, algo que é interno a pessoa. Para a autora este fato por si mesmo determina que qualquer intervenção no processo motivacional só irá até onde o alvo da ação permitir.

Ao falar sobre a importância da motivação do aluno na EAD, Visser destaca que ainda existem poucas iniciativas especificamente elaboradas com o objetivo de estimular e manter o aluno motivado para os estudos:

"A importância do desenvolvimento de estratégias para aumentar a motivação foi muito pouco estudada e não foram feitas muitas tentativas para auxiliar no design de materiais para cursos e/ou auxiliar instrutores a produzirem materiais motivadores" [13, p. 4].

Ainda segundo [13], na EAD, ao contrário do ensino-aprendizagem convencionais onde o contato presencial regular entre estudantes e professores permite que os problemas de ordem motivacional sejam rapidamente identificados, é mais complicado detectar este tipo de situação e, portanto, não há uma ajuda externa efetiva para aumentar a motivação. Ou seja, para a autora, a inclusão de estratégias motivadoras nos materiais didáticos é uma forma de estimular a motivação dos estudantes a distância para a aprendizagem.

Em pesquisa realizada com um grupo de estudantes em um curso a distância oferecido pela OU, a autora identificou uma série de fatores positivos relacionados com a utilização de mensagens de caráter motivacional e o desempenho e a persistência dos alunos no curso. Abordagem adotada foi o envio de mensagens motivadoras aos estudantes de um curso baseado em correspondência durante oito meses, oito vezes; resultaram em um aumento das taxas de finalização de 35% para 71% e de 35% para 84% no caso dos alunos que se matriculavam pela primeira vez. Os resultados também foram efetivos no sentido de que houve um aumento da autoconfidência (self-confidence), como um aprendizado para toda aa vida [14].

Ref. [15] aponta para a necessidade de se desenvolver uma estratégia para a retenção de alunos na Open University - OU, uma vez que o problema de evasão é um dos mais importantes para a universidade, como indicam alguns números: 5% dos alunos abandonam cursos no início ou no primeiro terço; 30% dos que iniciam seus cursos, não chegam a fase de exames; apenas 65% dos que chegam a fase de exames, passam. Por essa razão a OU está implementando um projeto denominado "Student Retention Program", voltado justamente para a retenção dos alunos e baseado no apoio ao aluno e na manutenção da motivação para os estudos [15].

Ref. [16], também destaca em seu trabalho a importância da motivação para o desempenho e persistência dos alunos em cursos a distância. A realização de atividades busque estimular o aluno para manter-se motivado e persistir até a conclusão efetiva de seu cursos é vista como uma atividade central no modelo de apoio ao aluno a distância implementado no LED.

ÍNDICES DE DESISTÊNCIA E EVASÃO NA EAD – DROPOUT RATES

Índices de desistência e evasão (*dropout rates)* mais altos que na educação tradicional são, infelizmente, uma característica que ainda marca a EAD, como é possível identificar nas citações a seguir:

> *"Ainda que as pesquisas mostrem que os estudantes a distância aprendem tanto quanto estudantes convencionais, estudos realizados com estudantes em cursos por correspondência*

> *identificaram que estes tendem muito mais ao abandono de seus cursos, com as taxas de evasão e desistência variando de 19% a 90%, com uma taxa média de 40%" [17].*

> *"Mesmo que as estatísticas variem em diferentes instituições, administradoras escolares concordam que as taxas de conclusão de cursos a distância são geralmente 10 ou 20% mais baixas que em cursos tradicionais" [18].*

Em relação aos números de dropout apontados na literatura e os números percebidos no contexto do LED, é importante destacar uma diferença básica: a característica da oferta (aberta/fechada) e dos cursos (extensão, graduação, pós-graduação). No caso do LED, os cursos analisados são de pós-graduação e oferecidos, em sua maioria, para um único parceiro, que conhece os alunos, que formam grupos mais ou menos homogêneos. Nos casos descritos na literatura os cursos são em sua maioria oferecidos de forma aberta, para alunos de origens diversas.

Ainda, segundo [19], é preciso também que, ao se fazer comparações entre dados oriundos de cursos tradicionais e cursos a distância se leve em consideração as características de ambos os grupos de estudantes, especialmente quando se analisam cursos regulares. Para o autor, os alunos a distância fazem parte de um grupo onde os fatores externos (trabalho, família, finanças) têm muito mais chances de levar ao abandono do curso.

As discussões sobre índices de evasão e desistência são freqüentes na EAD, muitas vezes levantadas por profissionais que não acreditam na eficácia desta modalidade de educação. Mas, uma análise mais detalhada das pesquisas indica que, se a estrutura de apoio oferecida pela instituição de EAD for eficiente, os índices de evasão e desistência tendem a ser menores [15].

LED – LABORATÓRIO DE ENSINO A DISTÂNCIA

O Laboratório de Ensino a Distancia (LED) foi criado em 1995 no Programa de Pós-graduação em Engenharia de Produção (PPGEP), da Universidade Federal de Santa Catarina (UFSC), para estabelecer uma ligação efetiva entre a indústria e a academia, visando atender a uma crescente demanda por estudantes vindos das empresas. O objetivo de garantir uma relação com o setor produtivo presente no processo de implementação do LED incluía inclusive em seu projeto inicial, a criação de salas de videoconferência dentro dos empresas parceiras.

A videoconferência foi escolhida como mídia principal dos cursos de pós-graduação tendo como mídias de apoio a internet e o material impresso. Os cursos por videoconferência do Programa de Pós-Graduação em Engenharia de Produção (PPGEP) da UFSC começaram a ser oferecidos para as empresas e instituições educacionais com base na estrutura da pós-graduação das universidades brasileiras.

Em 1996, foi realizado o primeiro curso de especialização para engenheiros da Equitel, uma empresa da área de telefonia integrante da Siemmens do Brasil, em Curitiba, em que a base para a transmissão dos conteúdos era a videoconferência e o envio de material didático era feito através dos correios.

O segundo curso nasce em 1997, com o parceiro A, uma empresa líder mundial na produção de petróleo em águas profundas, oficialmente o primeiro realizado a distância pelo PPGEP. Por necessitar treinar engenheiros localizados em sete cidades brasileiras, decidiu-se pelo multiponto e, por possuir uma intranet ativa, o curso foi planejado para incluir as ferramentas da Internet, além de material impresso e aulas pela videoconferência.

FORMATO DOS CURSOS

O Mestrado por videoconferência do Programa de Pós-Graduação em Engenharia de Produção (PPGEP) da UFSC para o parceiro A acabou sendo o marco para todos os outros cursos que se seguiram. Na adaptação para educação a distancia, seguiu o modelo presencial de tempo, conteúdo e carga horária de aulas. Seu formato básico era composto por aulas por videoconferência e comunicação extraclasse principalmente pela Internet, três ou quatro trimestres de duas disciplinas, ministradas em dois períodos por semana, de quatro horas-aula de 50 minutos cada, com pelo menos um encontro presencial entre alunos e professores durante a época dos créditos, foi seguido com poucas variações na maioria dos cursos atualmente em vigor.

Apos o período das aulas, os alunos entravam em fase de orientação visando a execução do projeto de pesquisa e a redação de uma dissertação de Mestrado a ser defendida de forma oral para uma banca de no mínimo três doutores. A finalização desse processo segundo a legislação brasileira da pós-graduação deve levar 24 meses. Os alunos que não conseguirem terminar a dissertação nesse prazo podem pedir mais um ano e, na eventualidade desse ano não ser suficiente, a coordenação do Programa pode conceder mais um, somando um total de quatro anos ao final. Como indicação da pressão exercida sobre professores, alunos e cursos, e preciso dizer que conta ponto na estrutura educacional da pós-graduação brasileira a finalização das pesquisas e a defesa das dissertações no prazo mínimo de dois anos. O adiamento ou a demora na defesa pode acarretar entre outros prejuízos o rebaixamento no ranking nacional de cursos e a conseqüente perda de bolsas de estudos para os alunos e financiamento de projetos do governo federal para os professores.

A ORIENTAÇÃO DAS DISSERTAÇÕES

Encerrada a etapa de cumprimento dos créditos, começavam os seminários de orientação para a realização da pesquisa e da dissertação. Pelo modelo do PPGEP usado com o parceiro A, uma vez concluídos os créditos, tinham início os seminários trimestrais de orientação a distância, realizados em sessões multiponto por videoconferência. O objetivo dos seminários era o de servir como mecanismo de sistematização da pesquisa, que auxiliasse os alunos a socializar suas experiências, trocar bibliografia e discutir seus trabalhos com os colegas recebendo orientação não só dos seus mas também dos outros professores-orientadores, presentes à sessão. Planejados como um encontro de todos os alunos, os seminários visavam criar um espaço necessário para impedir que após o período de créditos, eles se dispersassem ao iniciar seus trabalhos individuais de pesquisa, buscando manter a coesão e o sentimento de pertencimento à instituição educacional.

A partir de 1999, quando os outros cursos por videoconferência do PPGEP entraram em fase de dissertação, o modelo foi modificado para seminários presenciais, já que estes eram essencialmente realizados ponto a ponto, ou seja, ligando apenas uma sala da instituição parceira ao LED. Por essa razão, ao invés de reunir-se com todos os professores orientadores, os alunos passaram a se encontrar apenas com o coordenador acadêmico dos cursos, que viajava até a cidade da instituição para realizar o encontro, mais para um atendimento socializante, de motivação e esclarecimentos metodológicos do que de discussão dos conteúdos, como era o caso da Petrobras. Com isso, a orientação de conteúdo específico para cada dissertação passou a ser canalizada para acontecer apenas através da relação individual entre orientador e orientando, ocorrendo na maior parte do tempo, à distância. Isso porque, numa grande parte dos casos, o primeiro contato presencial do orientador com seus orientandos passou a acontecer quando da visita oficial que os alunos faziam à UFSC, no final do segundo ou do terceiro trimestre letivo. Essa comunicação continuava a distância, com o uso do e-mail ou do espaço de orientação criado no ambiente Web do LED.

No início de 2000, foi criada uma coordenação de orientação, responsável por apoiar os coordenadores acadêmicos na intermediação da relação entre orientadores e alunos. A partir dessa nova estratégia, os seminários de pesquisa continuaram presenciais no local do curso e passaram a ser dirigidos pelo coordenador acadêmico e pelo coordenador de orientação, no atendimento aos alunos principalmente quanto a questões relacionadas às dificuldades pontuais, metodológicas ou de comunicação com os orientadores. Segundo essa dinâmica, os professores começaram a ser informados sobre o resultado desses seminários presenciais com seus orientandos em reuniões posteriores ao encontro, de modo a que pudessem corrigir eventuais problemas ou falhas de comunicação durante o processo de trabalho. O encontro presencial entre os coordenadores e os alunos vem seguindo o cronograma de seminários trimestrais de pesquisa, previstos a partir do final dos créditos e que prevê as etapas de desenvolvimento da dissertação que vão culminar na defesa.

Em meados de 2000, teve início a orientação através de encontros individuais por videoconferência que foi uma reivindicação dos professores no sentido de facilitar o contato e o trabalho com os alunos distantes.

A MONITORIA

A oferta de cursos de pós-graduação a distância, especialmente cursos de mestrado via VC e com o suporte da Internet para comunicação extraclasse, marcou o início do estabelecimento da estrutura de apoio aos alunos e professores no contexto do LED, em julho de 1997[3]. A responsabilidade da equipe de apoio que trabalha nos cursos de Mestrado Presencial Virtual é fazer o atendimento aos alunos sem envolver-se com as questões de conteúdo e avaliação de aprendizagem, pois estas questões dizem respeito ao professor responsável da disciplina.

Para [20] o monitor é o agente responsável pela integração deste modelo, realizando ações de socialização por meio do estabelecimento de contato entre alunos e professores e estimulando a motivação para a aprendizagem. É atribuída ao monitor também a função de auxiliar em questões de acesso tecnológico, incentivando o uso do ambiente on-line de aprendizagem e esclarecendo dúvidas referentes ao mesmo pois, a crescente utilização de tecnologias de última geração criam a necessidade de profissionais capacitados para o preparo de alunos e professores para o seu uso no contexto educacional.

Os profissionais selecionados pelo LED para a função de monitor são selecionados a partir de alguns critérios previamente estabelecidos: serem alunos de mestrado (da área de Mídia e Conhecimento, ou áreas afins), possuírem conhecimentos básicos de informática e principalmente conhecimentos e interesse de pesquisa na área de EAD. A equipe também tem características multidisciplinares contando com profissionais de áreas como sociologia, pedagogia, assistência social, ciências da computação e psicologia [21].

Como resultado de avaliação diagnóstica realizada com 471 (quatrocentos e setenta e um) de seus alunos, professores e instituições parceiras, ficou evidente uma visão bastante positiva das percepções dos alunos sobre o papel da monitoria durante a realização de seu curso, enfatizando a importância da participação do monitor em momentos cruciais. Nesta avaliação, 94% dos alunos participantes consideraram muito importante a participação dos monitores nas etapas presenciais do curso; 90% destacaram a orientação da monitoria para o desenvolvimento de atividades a distância (dicas de como estudar a distância, apoio comunicacional, etc.) e 87% deram ênfase ao contato periódico com os monitores pela Videoconferência [22].

CARACTERÍSTICAS DOS CURSOS, DOS ALUNOS E DAS INSTITUIÇÕES PARCEIRAS

O estabelecimento de parcerias para a oferta dos cursos a distância foi desde o início do processo percebido como fundamental pelo LED, que buscava formar uma rede nacional para o atendimento das demandas por cursos que chegavam ao PPGEP. Mas, o atendimento à demanda era sempre analisado sob o ponto de vista do aluno – qual o tipo de estrutura necessária nos ponto remoto, quais os serviços que deveriam ser oferecidos, etc., para facilitar a vida do aluno e permitir que este se dedicasse ao máximo aos estudos, sem preocupar-se com questões técnicas e administrativas. Neste sentido, aos contratos formais para o estabelecimento de convênios e parcerias sempre realizados pelas fundações da universidade, acrescentou-se um protocolo de responsabilidades, no qual ficava estabelecida a responsabilidade de cada parceiro em relação aos alunos, assim como as responsabilidades do LED.

Este protocolo foi identificado como necessário a partir da identificação de algumas questões problemáticas desde o estabelecimento da primeira parceria para oferta de cursos a distância via videoconferência e foi sendo aperfeiçoado conforme os cursos iam acontecendo. O protocolo determinava que a instituição parceira deveria contar com uma estrutura mínima para o atendimento local aos alunos, com especificações relacionadas às questões técnicas, de pessoal, estrutura física (sala de aula, sala de estudos, biblioteca).

A necessidade de uma estrutura local de apoio, com monitores e técnicos capacitados, foi em muitos momentos apontada pelos alunos em suas avaliações, elogiando ou criticando a estrutura local. Em alguns momentos foi necessário parar os cursos para realizar ajustes nesta estrutura, a pedido dos alunos.

Cursos do parceiro A

Os cursos desta parceria diferenciam-se dos demais especialmente pelo fato de serem oferecidos para uma empresa, o que gera uma grande homogeneidade no perfil das turmas, composta em sua maioria por engenheiros, mesmo que de áreas distintas (Química, Mecânica, Naval), com uma concentração muito grande de alunos na faixa etária entre 35 e 49 anos. A área de concentração – Logística – e o fato de ser baseado na utilização da videoconferência multiponto apresentaram uma preocupação inicial, mas a adaptação do grupo foi rápida e os professores também se apropriaram com alguma facilidade da tecnologia. Em relação ao uso da Internet, este apresentou problemas e a difusão foi bastante lenta, especialmente por causa da falta de familiaridade dos professores e sua hesitação em utilizar também esta tecnologia.

Todos os cursos oferecidos no âmbito desta parceria tinham as mesmas características, sempre na mesma área de concentração e com o mesmo corpo docente. Também os alunos tinham características comuns em todos os grupos, o que variava era apenas dispersão geográfica dos grupos, conseqüentemente, a diversidade cultural de suas origens.

A instituição parceira já possuía anteriormente uma estrutura bastante favorável para o estudo in-company, facilitando algumas adaptações solicitadas pelos professores e alunos. A familiaridade dos alunos com o uso da Intranet da empresa também facilitou a comunicação extraclasse, via e-mail, e a troca de materiais, amenizando os problemas ocorridos com a conexão com a Universidade. A existência de uma biblioteca própria também se apresentou como um fator muito positivo, especialmente na fase de dissertação.

Cursos do parceiro B

A parceria aqui denominada como "parceria B" era formada por um grupo de instituições de ensino superior distribuídas pelo estado de SC, caracterizando-se como um consórcio de IES. Todos os alunos eram professores vinculados as instituições-membros do consórcio e estavam realizando o curso por que necessitavam da titulação para continuarem lecionando em suas instituições, devido às mudanças na legislação trazidas pela nova LDB, homologada em dezembro de 1996. Estes fatores tornavam a realização do curso como obrigatória, em muitos momentos refletindo-se na motivação dos alunos, que viam o curso com "mais uma" tarefa em uma vida já bastante atribulada pelo trabalho como docente, muitas vezes em diversas instituições.

Uma questão importante a ser considerada aqui é a falta de experiência com a tecnologia utilizada – videoconferência – nos pontos remotos (as IES localizadas no interior do estado de SC), pois apesar de terem recebido os equipamentos e terem o acesso ao link dedicado, estas não tinham ainda resolvido questões políticas internas relacionadas ao uso desta mídia.

Em relação a estrutura local oferecida aos alunos, também houve pouco empenho das instituições, pois afinal os alunos trabalhavam naquele local, conheciam os técnicos, enfim, "podiam se virar". Assim sendo, apesar de todas as salas terem recebido equipamentos semelhantes para a realização da aula por videoconferência, não foi montada uma infra-estrutura especial para estudo, biblioteca específica, etc.

Um ponto importante se compararmos os parceiros A e B, é a questão da diversidade de cursos oferecidos. No primeiro caso, somente em uma área, no segundo caso em 5 área diferentes dentro do âmbito do PPGEP. Mesmo para a equipe de apoio no LED estes cursos representavam um desafio, pois envolviam um corpo docente bastante numeroso, e áreas bem distintas (Qualidade, Engenharia de Avaliação, IA).

Cursos do parceiro C

Os cursos oferecidos por este parceiro foram os primeiros a serem oferecidos de forma aberta, pois apesar de existir uma instituição mediadora (a parceira), os cursos eram oferecidos para qualquer interessado que obedecesse aos requisitos formais de admissão do Programa. Esta abertura e a oferta de cursos de áreas de concentração diferentes fez com que o público-alvo atendido se tornasse bastante diversificado, dificultando também a formação de grupos coesos, como aqueles onde todos os alunos estava vinculados às mesmas instituições. Estas turmas eram compostas por professores, administrados de instituições de ensino, profissionais liberais, e outras categorias, sendo um fator de possível identificação entre estes alunos o fato de que a maioria exercia ou pretendia exercer alguma atividade docente.

Desde o início dos cursos, ficou patente no contato da equipe do apoio no LED com os alunos que o parceiro não oferecia a infra-estrutura física e de pessoal estabelecida no protocolo encaminhado pelo LED. Os alunos sentiam-se abandonados e não sabiam com certeza a quem recorrer. Não havia sala de estudos, a biblioteca e a secretaria não funcionavam no horário das aulas, os técnicos eram inexperientes. Estas questões foram sendo solucionadas com a ajuda da equipe de apoio no LED, fazendo com que os alunos se sentissem mais seguros.

Estas diferenças entre os parceiros e nas características dos alunos foram claramente percebidas pelos professores que trabalharam nos cursos das 3 (três) parcerias aqui citadas, como é possível perceber nos depoimentos apresentados a seguir.

OS ALUNOS A DISTÂNCIA SOB O PONTO DE VISTA DOS PROFESSORES

Numa pesquisa realizada no LED com os professores que ensinavam nos cursos a distancia entre 1997 e 2001, [23] levantou depoimentos que mostravam que havia entre os docentes uma percepção de que a origem dos alunos era importante para um rendimento escolar positivo ou não.

Em seu levantamento, [23] demonstra que o fato do aluno a distância ser um adulto que não se afastava da rotina pessoal e profissional para estudar, era visto como um problema para os professores, justamente por que dedicavam menos tempo aos estudos.

A dificuldade de acesso à bibliografia e a questão da idade era entendida como um problema para alguns professores, mas não havia consenso sobre isso. Para um professor, por exemplo, a experiência compensava as limitações de tempo e disponibilidade de dedicação. Já um outro declarou que o tempo de vida impedia um rendimento melhor nas aulas, e que ele tinha mais paciência e preferência em lidar com os alunos jovens pois eles tem mais pique e são mais abertos à descoberta.

Além dessas diferenças apontadas na bibliografia de EAD, [23] mostrou ainda que, no caso dos cursos do LED, os professores identificavam dois grupos de alunos a distância: os vinculados às empresas (engenheiros) e os vinculados às instituições educacionais (docentes). Essa diferenciação se fez sentir especialmente nos depoimentos coletados em 1998, quando os docentes eram em sua grande maioria, oriundos dos cursos de Engenharia de Produção ministrando aulas diretamente para os engenheiros das empresas (como os do parceiro A) e, ao mesmo tempo, para professores das universidades do interior de Santa Catarina (os do parceiro B).

A diferença de origem, formação e motivação para estudar eram sentidos de modo bastante evidente pelos professores do PPGEP:

> *"Eles [os professores] estão ali porque precisam de um título, e na empresa, eles estão ali porque precisam mostrar o que eles fazem. Eles estão sendo julgados, inclusive. Porque o que eles estão fazendo tem que mostrar aplicabilidade. E já é uma coisa da empresa, quer dizer, já é um privilégio a empresa estar bancando..." [23]*

Talvez por essa razão, os docentes-alunos eram considerados mais difíceis de motivar e de participar na aula. Para os professores que ensinavam nos dois tipos de cursos, os alunos "práticos" (engenheiros) eram mais exigentes em termos de aplicação da teoria e os "acadêmicos" (professores) eram mais voltados à discussão teórica. Assim, a homogeneidade de conhecimento anterior da turma, a motivação pessoal, experiência profissional, heterogeneidade ou homogeneidade de informação anterior na área do curso foram apontados como fatores definidores das diferenças entre os dois grupos.

Pelo descrito, pela avaliação dos professores sobre seus alunos a distancia, jogavam papel fundamental na performance tanto a área profissional, a cultura organizacional de origem, as pressões exercidas pelos seus locais de trabalho, como também a estrutura de apoio recebida tanto na instituição presencial quanto na da universidade a distância.

PERFORMANCE E FINALIZAÇÃO DAS DISSERTAÇÕES DOS CURSOS DE MESTRADO A DISTÂNCIA

Do que foi discutido até agora, percebe-se que há uma grande diversidade tanto entre as condições dos parceiros, como entre as áreas e disciplinas dos cursos ministrados como entre os grupos de alunos das diversas turmas. Uma questão interessante a se fazer em uma realidade como essa seria a de investigar se os alunos de cursos de formação homogêneos mais coesos (tais como os da empresa A) teriam mais condições terminar seus projetos ou se o fato da proximidade de interesses profissionais (qualificação para docência no caso dos parceiros B e C) mesmo que heterogêneos em suas origens funcionariam como um fator de motivação para reter o aluno até o final?

Na tentativa de verificar essas questões, foram levantados dados referentes aos prazos de conclusão dos alunos das parcerias A, B e C que iniciaram em 1997 e concluíram em dezembro de 2001 seus Mestrados em Engenharia de Produção na UFSC.

Em primeiro lugar, verificou-se que a taxa de desistência desses cursos durante o período de créditos foi bastante baixa, ficando a grande maioria de não concluintes entre os que não defenderam as dissertações. Por exemplo, no caso do parceiro A, 31% desistiram na primeira turma enquanto que a desistência no curso 2 não houve desistência. A desistência nos cursos do parceiro B variou de 13% em um dos cursos, chegando a 50% em outro, enquanto que nos restantes a media ficou em torno de 31%.

Uma primeira hipótese a que se pode chegar é talvez o fato de que estar em grupo nas aulas por videoconferência pode ter dado aos alunos um sentimento de pertinência com influência sobre a motivação para continuar. Pode ter contado positivamente para essa permanência, a satisfação com o curso, com os professores e o atendimento pela monitoria, cujos índices foram bastante satisfatórios, conforme se pode verificar nas avaliações diagnósticas realizadas no decorrer das aulas.

Para se ter uma idéia da taxa de retenção dos Mestrados por videoconferência em Engenharia de Produção pode-se verificar o número de defesas de cada parceiro.

Quadro de defesas parceiro A

Cursos Parceiro A	Alunos	Defesas	% total
PETRO1	22	12	54
PETRO2	26	13	50

Fonte: Stela, 2002.

Quadro de defesas parceiro B

Cursos parceiro B	alunos	defesas	% total
FUNCESI1	11	10	91
FUNCIA1	22	13	64
FUNCEAV1	16	10	63
FUNCQ&P	16	7	44
FUNCAGRO1	16	6	38
FUNCIGAMB	16	8	50

Fonte: Ferrari, 2002, p. 64.

Quadro de defesas parceiro C

Cursos parceiro C	alunos	defesas	% total
TCEAV1	31	18	58
TCEAV2	31	17	55
TCEAV3	32	18	56
TECERG1	28	16	57
TECQ&P1	31	10	32
TECTED1	30	23	77
TECTED1	31	18	58

Fonte: Ferrari, 2002, p. 61.

Quadro geral dos parceiros por ordem crescente de defesas dos cursos

Parceiros	Alunos	Defesas	% total
TECQ&P1	31	10	32
FUNCAGRO1	16	6	38
FUNCQ&P	16	7	44
PETRO2	26	13	50
FUNCIGAMB	16	8	50
PETRO1	22	12	54
TCEAV2	31	17	55
TCEAV3	32	18	56
TECERG1	28	16	57
TCEAV1	31	18	58
TECTED1	31	18	58
FUNCEAV1	16	10	63
FUNCIA1	22	13	64
TECTED1	30	23	77
FUNCESI1	11	10	91

Uma primeira análise dos resultados dos alunos que concluíram seus mestrados por videoconferência e internet mostra que, dos 15 cursos, apenas três tiveram uma porcentagem de menos de 44% de defesas e dois tiveram 77% e 91% de finalização. O restante, 10 cursos, teve uma média de 50 a 64% de alunos concluintes. Essa taxa de retenção está bem acima da relatada na bibliografia de EaD.

Vistos em conjunto, pode-se dizer que, apesar das diferenças, a porcentagem de finalização não se mostra especialmente diferente apesar da diversidade dos cursos. Uma hipótese seria a de que joga na capacidade de terminar um curso a distância a motivação intrínseca do aluno, ou seja, aquele automotivado que consegue terminar o que se propõe apesar das dificuldades.

No entanto, se for considerado o prazo regulamentar de término do Mestrado, que é de dois anos, a porcentagem de defesas diminui bastante. É o caso do parceiro A, cujos cursos tiveram três defesas no prazo no curso 1 e quatro no curso 2, o que representa um baixo índice de defesas no computo total. Por outro lado, a média de defesa dentro do prazo dos cinco cursos do parceiro B foi de 19%, sendo que dois cursos não tiveram nenhuma dissertação defendida no prazo. Do mesmo modo, dos sete cursos do parceiro C, apenas dois tiveram uma dissertação defendida no prazo e dos restantes, 100% das defesas ocorreram depois dos dois anos. (FERRARI, 2002)

Pode-se dizer que joga papel fundamental nessa tendência de finalização perto do limite dos prazos legais, alguns aspectos já apontados neste artigo, a saber: a) pressão tanto da instituição a distância quanto do parceiro local para que os alunos completassem as defesas no prazo final; b) criação da Coordenação de Orientação em 2000, que coincide com um acentuado aumento das defesas; c) pressão das empresas no sentido de cobrarem de seus funcionários a realização do Mestrado como retorno ao investimento em sua formação; e finalmente, e) como um fator de conjuntura a fortalecer a motivação de todos os envolvidos na finalização dos cursos, poderia se acrescentar a importância das defesas para legitimidade da própria EAD, já que, no caso brasileiro, a pós-graduação a distância ainda não está regulamentada. Uma hipótese para a quantidade de defesas fora do prazo seria a de que elas foram resultado de um esforço das instituições e empresas envolvidas que levou professores, monitores e coordenadores locais e remotos a buscarem nos alunos as condições e a vontade necessárias para finalizar e defender suas pesquisas.

A ocorrência de tempos diferentes de defesa pode apontar para fatores relativos à situação laboral dos alunos. Por exemplo, no caso do parceiro A, relatos dos alunos colhidos tanto durante a fase de créditos quanto na de pesquisa, revelaram que por necessidades profissionais do seu local de trabalho, os estudantes eram chamados a exercer suas funções cotidianas ou mesmo a aplicar suas pesquisas antes mesmo de conseguirem defender as dissertações. Muitos tiveram que desistir por causa da carga intensa de trabalho.

CONSIDERAÇÕES FINAIS

Apesar da dificuldade de se isolar os diferentes fatores intervenientes nos cursos acima analisados, pode-se levantar alguns aspectos que merecem atenção. O primeiro deles é que o desenho instrucional dos cursos do PPGEP, baseado numa alta interatividade com agentes motivadores como os monitores e orientadores pode ser um dos fatores de finalização dos mestrados a distância. A infraestrutura de apoio ao aluno, tanto local como remota, que foi desenvolvida conforme o modelo foi sendo criado, mostrou-se importante especialmente na fase final do limite do tempo para as defesas. E finalmente, o fator profissional, tanto na pressão para voltar a exercer suas funções no local de trabalho, quanto na motivação para alcançar o certificado necessário para continuar trabalhando, pode ter pesado na porcentagem de *dropouts* e finalizações.

Por esses aspectos apontados, percebe-se que ainda há muito que pesquisar nessa área de apoio ao aluno, para se conseguir identificar não só quais são as principais variáveis que interferem na motivação dos alunos mas também até que ponto e de que maneira elas exercem seu papel nesse processo tão complexo.

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TECHNICAL WRITING FOR CONSTRUCTION SCIENCE GRADUATES

Ifte Choudhury[1], Ricardo E. Rocha[2] and Richard Burt[3]

Abstract *—The purpose of this study was to determine the perceptions of the construction industry as well as the construction educators regarding the need for technical writing skills among Construction Science graduates. An instrument was prepared to gather the data related to the technical writing skill set of construction science graduates. This instrument was sent to the CEO's of the construction companies, identified from Texas A&M University's Department of Construction Science Career Fair Database, and faculty members of in the Associated Schools of Construction. The results of the survey were used to determine the importance of different construction documents used within the construction industry for which good technical writing skills are essential. The data was analyzed using stepwise and multiple regression techniques. The results from the study indicate that capability of writing business letters, request for bid information, e-mails, and miscellaneous items such as schedule of values and submittals are important in terms of technical writing. All these factors were found to be related to the overall capability of technical writing skills among Construction Science graduates at a level of significance of 0.05.*

Index terms — Construction Science, Construction Documents, Technical Writing.

STATEMENT OF THE PROBLEM

A person's ability to communicate effectively through the use of technical, written, communication skills can greatly affect their career. An individual's capacity to write effectively is usually regarded as a first-rate attribute. It can be categorized equally with a person's professional skills and knowledge. Professionals in all disciplines, including construction, spend a considerable amount of their time in writing technical reports. It is a critical component to all tasks of significant importance.

Given this importance, industries report that students graduating from technical programs are generally not well prepared for the writing requirements of the contemporary workplace [1]. Industries naturally have their own set of terminology committed to the specific requirements and situations exclusive to their form of business. Communicating effectively within an industry is a direct result of an individual's ability to understand and use the industry's vocabulary and communication practices. Effective written communication skills can assist in the [1]acquisition of sought-after contracts and clients as well as assist in maintaining optimal relationships with vital customers.

Project documentation is critical to the success of many companies. Understanding and learning how to prepare a variety of construction documents is of the utmost importance to construction professionals. The purpose of this study was to identify the importance of different construction documents used within the construction industry. This information in turn will be used as the structural framework in establishing a construction oriented technical writing class at Texas A&M. University.

REVIEW OF LITERATURE

Overview

With the growth of the U.S. college student population in the 1960's and early 1970's universities and community colleges recognized that a high percentage of students had problems writing effectively [2]. Leaders in industry have stated that for nearly 50 years, the continuing weakness of graduating technical students has been their lack of written communication skills [1].

The inability to communicate effectively does little to enhance the image of a company. In fact, it proves to be detrimental. Good writing skills are necessary in order to communicate with clients, as well as with partners and co-workers. How successfully a company communicates potential problems and issues will largely depend on the writing and communication skills of the company employees [3]. In the construction profession, reading and writing are paramount to an individual's performance in successfully completing a project [4].

Every industry has an undefined list of terms that are essential to the specific requirements and situations unique to that industry. An individual can successfully communicate within an industry when they have mastered the terminology and methods of communication relevant to that industry. When students graduate from their

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respective programs, they will be given a wide range of activities and projects that will require them to exhibit acceptable documentation and writing skills [2]. There are few commercial endeavors that use and rely on written language skills as much as construction contracting does [5].

Being unable to acceptably execute these basic skills, new graduates will find themselves at a considerable disadvantage [5]. Many construction programs offer courses in subject areas ranging from building materials and methods to structures and environmental systems. It would be logical to believe that these are the skills essential to one's success in the construction industry [5]. In reality, the most important skill to be taught is the ability to write effectively [5].

It is no secret that construction education graduates are deficient in possessing adequate writing skills for entering the business community [6]. Understanding that these skills need to be improved is the first step in correcting the problem [4].

Teaching Relevant Material

In order to fill the void in writing skills educators must focus their attention on writing as a fundamental communication skill [6]. It is important not only to make students write, but to have them write on subject areas relevant to their studies [4]. It appears to be nonproductive to teach writing without concurrently teaching the subject matter [6]. According to Wright [6], if educators expect writing skills to be developed only in English specific-type courses, it is imperative that such courses be provided relevant content and set the context in the students' limited experience in language usage [6].

Employers demand that entry-level employees effectively write as it relates to specific conditions of a particular project [4]. Professionals spend approximately 20 percent of their time writing reports of some sort. Graduates must know how to write competently and exhibit this competency immediately on entering the industry in order to be successful [5].

If the problem has been readily identified it would be the assumption of many that colleges and universities would make the development of first-rate writing skills an important goal and assign some of their best instructors to the accomplish the task. Unfortunately, this is typically not the case [1].

Many professors in English departments usually specialize in a particular form of literature and not in English composition. Many will privately admit that they do not nor want to know how to teach composition writing courses. Many of these professors are poorly prepared to evaluate the obscure information usually entailed in technical topics. Since the information cannot be judged on content, most instructors will invariably revert to issues of format and technique. In short, the writing in many areas of composition and technical writing courses does not reflect the kinds of writing that the modern workplace expects students to do [1].

Writing-Across-the-Curriculum

Regardless of the style and amount of writing in specific English courses, the evidence was apparent. A "gap" appeared between the writing competency displayed in a composition course and the writing performance in the type used by the individual students' professional disciplines [2]. The response to this performance gap has led to what is now termed writing in the discipline (WID) [2].

This method of writing allows students to become accustomed to the style of writing associated with their disciplines and immerses them in the professional dialogue of their field [2].

Writing across the curriculum at its onset uses the approach that every teacher, instructor or professor should become aware and should introduce into his respective classroom and curriculum, the requirement of student participation by writing [2].

Writing across the curriculum is a theory of writing rested on the basis of deeming writing as a revised process, not a consecutively manufactured product. Other theoretical components of writing across the curriculum can be summarized as follows:

- An interdisciplinary dialogue on writing that brings writing into as many classrooms as possible.
- Brief and varied (cross-disciplinary) writing forms that receive both instructor and peer responses.
- A focus on writing as learning – the principle that cognitive processes involved in writing and knowledge acquisition are very similar [2].

Without a requirement to master writing skills, the graduate is initially handicapped in his/her chosen professional world. This handicap continues until these skills are acquired [6]. This is despite dramatic increases in mandatory reading, writing, and speech courses; writing-across-the-curriculum initiatives; and the heavy emphasis placed on writing skills by business and industry. It is unknown as to why this crucial skill has been and is still being so inadequately addressed. This is considered by some to be the greatest failure of the higher educational system [1].

Need and Promotion

By not teaching our students to read critically and to write logically and clearly, we unsuspectingly limit their personal and professional horizons [1]. An employee's ability to advance in an organization may be dependent on that person's ability to communicate both verbally and with the written word [5]. Most all help wanted advertisement for technical people specifically requires well-developed written communication skills [1]. It is important to note that the ability to write effectively assumes a much larger role as one advances in a technical career. This causes the problem to grow to unsuspected heights.

Without adequate written communication skills, an employee may be passed over for promotion [3]. Almost every technical person can recall cases of ambitious and technically adept colleagues passed over for promotion because they could not write well enough to meet the demands of a higher position [1].

METHODOLOGY

Data Collection Procedure

A total number of 400 Chief Executive Officers were randomly selected from Texas A&M University's Department of Construction Science Career Fair database. Another 400 of faculty members teaching at different schools of construction were randomly selected from the web site of Associated Schools of Construction. A survey instrument was prepared to collect the data. It was administered via email in hopes for a speedy response, but individuals had the opportunity to mail in their responses as well. Some chose this option. Respondents were given two weeks to respond. A few days prior to the deadline, an email reminder was sent. Due to a poor response rate relative to the population, an extension of a week was given to those who had not yet had the opportunity to respond. The number of responses was 81 — 57 from the industry and 24 from the faculty. The rate of response was only 20.25 percent.

Variables and their Operationalization

Overall Technical Writing Skills (TECWRITE)

It is the reported importance of overall technical writing skills for construction science graduates.

Business Letters (LETTER)

It is the reported importance of skill for writing business letters by construction science graduates.

Schedule of Values (VALUE)

It is the reported importance of skill for writing schedule of values by construction science graduates.

Request for Information (RFI)

It is the reported importance of skill for writing request for information by construction science graduates.

E-mail (EMAIL)

It is the reported importance of skill for writing e-mail by construction science graduates.

Notices (NOTICE)

It is the reported importance of skill for notices of safety, compliance, etc. by construction science graduates.

All the variables were measured using a 5-point unidimensional scale, ranging from "strongly disagree" to "strongly agree." A value of 1 was assigned if the respondents "strongly disagreed" with a particular statement, elevating to a value of 5 if the respondents "strongly agreed" with the statement.

RESULTS

A multiple regression analysis was performed in order to ascertain the relationship between overall technical writing skills of construction science graduates and the importance of their ability to write business letters, schedule of values, request for information, e-mails, and notices. Regression analysis is a modeling technique for identifying a function that describes the relationship between a dependent and one or more independent variables. The following model was used for the analysis;

$$TECWRITE = \beta_0 + \beta_1 LETTER + \beta_2 RFI + \beta_3 EMAIL + \beta_4 NOTICE + \beta_5 VALUE + e \quad (1)$$

Where
β_0 = Intercept
β_1, β_2, etc. = Regression coefficients, and
e = error term.

The results of the analysis are shown in Table 1.

TABLE 1
Multiple Regression Analysis of Overall Technical Writing Skills

Variable	Regression Coefficient	$\|T\|$	$p<\|T\|$
LETTER	0.31447	3.30	0.0015
RFI	0.27084	2.46	0.0160
EMAIL	0.29769	2.26	0.0267
VALUE	0.19502	2.20	0.0311
NOTICE	0.19178	1.67	0.0993
Intercept = 0.64141		Model $R^2 = 0.59$	
Model $F = 21.32$		Adjusted $R^2 = 0.56$	
$p<F$ <0.0001		$DF = 5, 80$	

The F-value of the model used for the multiple regression analysis was found to be statistically significant at a level much lower than 0.05. This statistic basically tests how well the model, as a whole, accounts for the dependent variable's behavior. The predictive efficacy of the model was found to be moderately high with an R^2 of 0.59 and an adjusted R^2 of 0.56. R^2 is the coefficient of determination of the model. The larger the value of R^2, the better the fit of the model, and higher is its predictive efficacy.

The results indicated that writing skills for business letters, request for information, e-mails, and schedules of values were perceived to be important for construction science graduates. These independent variables were related to overall technical writing skill at the level of significance lower than 0.05. Only variable found not related to overall technical writing skill at this level of significance was writing of notices.

CONCLUSION

Effective skills are important for any professional. An industry depends on the ability of the skillful use of its communication practices by individuals employed by it. The study reveals that writing of construction related business letters, request for information, skillful use of electronic communications, and preparation of schedules of values are important for construction science graduates. Both the construction industry and faculty perceive that in order to achieve technical writing skills with reference to the industry, the construction science graduates should focus on achieving excellence in these industry-specific areas.

It may be worthwhile to include the topics that have been found to be important in the curriculum for technical writing for Construction Science students. A longitudinal study may be done to assess the impact that the modified technical writing course has had on the industry.

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ON THE USE OF VIRTUAL REALITY TO TEACH ROBOTICS

Marcelo da Silva Hounsell[1], *Alexander Pimentel*[2]

Abstract *-- This article discusses criteria to the use of Virtual Reality (VR) for engineering and computing teaching, in particular the teaching of robotics (robots anatomy, functioning and off-line programming). How a web-based VR system for teaching purposes has been implemented will not be discussed but the advantages and potentials that such implementation can bring to the teaching of robotics. These expected benefits will be compared against what was actually achieved considering limitations of the technology as well as human (students') factors and expectations. Therefore, a borderline will be suggested to help identify the suitability of an application to be implemented using a specific VR approach (high-end immersive or low-end non-immersive). It was found that there is a great enthusiasm that surrounds the topic but a lot has to be done in order to find a proper matching between VR and traditional teaching resources, in particular, to the teaching of robotics.*

Index Terms -- Immersive and Non-Immersive Systems, Robotics, Teaching, Virtual Reality.

INTRODUCTION

Robotics and Virtual Reality (VR) are two distinct concepts surrounded by a lot of misconceptions. The former is usually related to intelligent and mobile human-like robots. The later is usually related to computer-generated and visually appealing reproductions of the world, good enough to confuse the viewer and his/her sense of reality. In fact neither of them are at this marvelous stage yet. These understandings however, could be put as goals for the (still distant) future. Despite the confusion, Robotics has been evolving fast as well as VR [4] and it is not difficult to see how the second can help understand the use of the first ([8]-[14]).

Much has been said and researched on the use of high-end VR into education and this has proved very successful ([5] and [12]) despite the fact that it can not be easily widespread to a bigger audience due to costs restrictions. What seems to be very important to investigate is the use of low-profile VR environments into education because these tend to be the entry-level environment that most learners are destined to face in the near future, at least in developing countries.

This paper not only discusses the use of VR for educational purposes but also the requirements and suitability of an application to a specific VR system implementation.

DEFINITIONS

Rescuing Virtual Reality Basics

Virtual Reality is considered the most advanced computer interacting technology which can promote multi sensorial experience and involve the user in such a way that s/he will not bother to acknowledge if it is the real world or a synthesized one. The user involvement with the system is much more important than the graphics which, not always, is trying to model a real environment [11]. Therefore, the term Virtual Reality (VR) was severely criticized and the term Virtual Environments (VE) came later. Despite the fact that the scientific community has accepted the arguments, people in general refuses to use the correct terminology because VR became very popular. It is important though, to the discussion in this paper, to understand the technology's correct goals and definitions.

VR systems can be divided into two main approaches: Immersive VR (**IVR**) and Non-Immersive VR (**NIVR**). The distinction is not really related to the ability to promote the immersion sensation but to the use of devices that hides the real world from the user, or not.

IVR imply the use of output (such as a Head Mounted Display - HMD) and input (such as a Data Glove) devices which transfers the user's gestures to the synthesized world. Because of the extra hardware configuration and the need to produce better and fast graphics, the computer power is of high requirement. In addition, there were reports that users of IVR experienced motion sickness and fatigue [10].

NIVR, on the other hand, do not imply any specific hardware beside the existing user's monitor, CPU and mouse. This simplification eases the hardware requirement at the same time that widespread the technology's concepts. Even to graphics, it can be said that NIVR do not need to look good but roughly good; on the verge of the reasonable. In this way, it does not demand much computational performance.

Special cases of NIVR systems are those that can be explored through the Internet and which became feasible much thanks to VRML (Virtual Reality Modeling Language) technology (www.VRML.org). Web-based NIVR is considered a great advantage of Non-Immersive VR over Immersive VR approach. It also allows the use of VR-like

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applications for marketing and collaborative works at acceptable costs. Although Web-based NIVR is much simpler than IVR, it cannot be confused with Simulation softwares. IVR excels in interactivity while Simulation is far the best in accuracy. In most cases, VR needs to **look** accurate, not necessarily to **be** accurate. Table 1, summarizes the differences between Simulation, Non-Immersive VR and immersive VR softwares.

TABLE I

COMPARISON OF SIMULATION, NIVR AND IVR SOFTWARES

Simulation	Based on complex mathematical models, must be accurate Aims at precision and completeness High computational cost for calculations Not very much interactive Useful for detailed analysis via playback
Non-Immersive VR	Based on simpler mathematical models Do not demand much calculations and graphics Aims at interactivity on conventional hardware Promotes immersion by intense interaction Do not need to be correct but, look correct
Immersive VR	Based on mathematical models, focused on the phenomena of study Demands special hardware and high computational costs Allows highly interactive environments Immersion is facilitated by the hardware

While promoting VR, developers are used to convince clients to adopt it based on the benefits and advantages that outcome from high-end IVR implementations. But due to cost restrictions, contracts are usually settled on low or medium-end NIVR implementations, only to end up with frustrated clients. The benefits that can outcome from IVR and NIVR implementations are not fully clarified nor completely identified. Application's features need to be analyzed against the suitability to an IVR and NIVR implementation. What this paper discusses is the actual borderline of potential benefits for different approaches and discusses if it is really interesting to consider VR implementation at all.

EDUCATION AND TRAINING

Another clear distinction that must be drawn is between education and training to help identify the role of VR in this context [11]. The later has found in IVR applications great proficiency and productivity. The former is yet to be proved, although there is a general feeling that many benefits can come from it. Education is related to concepts, knowledge and understanding while Training is related to reflex development, know how to do and, handling skills.

For educational (not training) purposes there must be a pedagogical paradigm to guide the experience and direct the development. Interactivity is the concept that will allow the students to explore the environment which therefore, must be implemented in a way to make clear the knowledge structure and hierarchy and consider all types of pertinent media (text, graphics, animation, video, etc.) as well as when, how and why use that specific media for that specific information. The visuals of a VR application also help build a motivating environment if modeled as interesting scenarios.

For training purposes, the use of the environment is different. Training requires a realistic response to events. Also, a better degree of realism (real time rendering) is also required due to the fact that the sequencing of events should not be compromised or the whole experiment would be also compromised.

The trainee should develop motor skills as well as strategies to solve them problems. To assess the trainee performance it is much more difficult because most of the metrics are based on a mix of strategies and timing.

ROBOTICS FUNDAMENTALS

A standard "robotics fundamentals" syllabus would include: History, Concepts Evolution, Robots Classifications, Anatomy, Kinematics (direct and inverse, Denavit-Hatenberg calculation), Task Planning, Teaching and (off line) Programming [13]. The ideal scenario would be to allow the students to have hands-on the actual robot for some experimentation in order to give them the sense of complexity, to understand the relationship and co-ordination of the robot links movements and hierarchy as well as their response to pitch, yawl, roll and other commands either at joint spaces (Robot coordinate system) or world space (Euclidean coordinate system).

To that aim, schools face the problem of offering enough robots for all students and, at the same time, giving continuous assistance and supervision in order to help the students avoid accidents to themselves and to the robots. This dilemma can be better handled (not fully answered though, as we will see later) if some sort of specific Robot Simulation package is used. However, specific Robot Simulation softwares are very expensive, tailored to a specific robot manufacturer, can not be experienced through the internet, have closed codes that do not allow the students to understand how they work and do not allow them to interfere into the code (for post-graduate students, for instance). An alternative approach must be considered.

GENERAL EXPECTED BENEFITS OF USING RV FOR ROBOTICS TEACHING

Computer graphics as a whole has evolved considerably and has aided a lot on engineering teaching and, VR applications are no exception. The use of a VR approach to implement robot simulators could be very training effective. For instance, McLachlan [8] has developed a NIVR robot simulator that paid special attention to the interface: it could be via 3D mouse or by a robot's specific Teach Pendant model. There is a lot more convincing evidence that one can use VR systems for educational purposes ([12] and [14]).

Some of the most significant expected benefits related to the use of VR to teaching robotics are summarized as follows:

Space and Proportion. VR applications can be used very effectively to develop the sensation of space and proportion at the same time that it can be totally non-dimensional as it can model and present galaxies in the same way it can show molecules and atoms. Robots are composed of articulated limbs that reach objects within a specific working volume. A working envelope is a spatial and proportional feature of all robot's limbs working together.

Automatic Monitoring. As an educational aid, a VR application must offer a way to assess the experience automatically and this can be made explicitly and textually via direct questioning but also by monitoring all the interactions implied by the user to achieve his/her tasks. Continuous monitoring not only guarantees the contents understanding but also help on their apprehension.

Scenario Variability. The option of various scenarios is a must in case of training because the trainee must be able to perform consistently despite of the details of the experience. To that effect, the system should be able to automatically construct different situations intelligently and with a high degree of integrity to what is being learnt, promoting both variety and quality. For educational purposes there is the same requirement but it is because of the boredom of unchanging environments.

Availability. Simulators as a whole (including VR ones) are much cheaper than the actual apparatus and because of this can be much more available. Details that contribute less or nothing to the actual operation can be filtered out of the virtual environment and installing a software is, most of the time, a much easier task than installing a complex, big and expensive machine (those that are complex enough to justify an exhaustive, detailed and rigorous training program).

Security. Security issues are one main advantage of using a VR approach at all. Not only the equipment and the whole investment are protected from misuse and accidents but also, the students' integrity are guaranteed. Other real and specific security measures can be imposed by the system, making sure that the student get used to them before going after the actual robot and, even better, this can also be assessed automatically and individually by the system. These features are considered of much importance because they relate to attitudes before the technology.

ACTUAL BENEFITS

A Web-based NIVR robot simulator implemented. Particular interest has been paid to allowing off-line programming, not yet fully implemented though. The technology applied was Virtual Reality Modeling Language (VRML).

Handling Proficiency. It was found that a Web-based NIVR robot simulator could help the student get acquainted with the interrelationships between the robots limbs. Students explore and start to develop strategies to get around fast in order to complete a task. This exploration allow proficiency on controlling the robots movements one degree-of-freedom (DOF) at a time and this is very useful for a later Teach Pendant programming task.

Open Source. One very important feature of the Web-based NIVR approach is the fact that the students can have free access to the source code of the VRML implementation and thus, they can investigate how the calculations are performed but also, they can modify the code to comply to new situations on teacher's demand. Further, the code can be re-used and fine-tuned to more complex models (with an extra DOF, for instance).

Supervision. Although thought unnecessary to supervise the students on performing a task, it was found later that some students feel more comfortable to have the teacher's continuous assistance and to do this, a Web-based NIVR approach can also be useful because it allows various students to get together in a lab and the teacher to assist all of them at the same time.

Strategies. Better than simply allowing off-line programming, which is a reasonably simple task if compared to computer programming, exhaustive repetition of the same experiment allows benefits that resembles a training approach. Beyond this, due to the high availability of the "virtual robot" the student can be freed of the pressure to complete a task but concentrate on establishing better strategies to solve the task. Strategies usually come from a lot of experimentation and experience and are difficult to teach because it is a complex mental model on how to solve a problem. To that aim, a Web-based NIVR can be very helpful.

PROBLEMS FOUND

Analyzing the actual use of the Web-based NIVR robot many problems can be pointed out:

Expectations. NIVR are not up to the user's expectations standard (built upon distorted concepts that came from science fiction novels). Although useful, NIVR approach would not substitute "the real thing" because they lack the ability to involve the user in such a way that can promote an effective immersion. This is so because the environment in focus does not actually provide, and is not much interested, in the exploration or navigation resource once the object of study is a fixed location object (manipulator robot).

Visuals. The visual fidelity was not an issue at the beginning because it was understood that "RV is not really about perfect graphics and perfect visual aimed to confuse the viewer but RV is actually an interactive technique demanding satisfactory graphics that could transport the user to another world" ([3] and [11]). In addition, as the object of study is fixed to a position this also compromises some of the great benefits advocated to IVR: exploration. Therefore, as the user's attention is most of the time focused on a specific object (robot), the visuals start to become an important issue.

Timing. The robot that was implemented did not actually take the time that a real robot would take to move about. This was thought as an advantage at the beginning because it could speed up the experimentation process and analysis. However, the sense of mass and fast/slow response was found to be an important information to be embedded in the virtual robot in the same way that a giant do not move about so fast and that a dolly lady has a high-pitch voice, which are well established 3D character animation features that brings real live constraints to viewers subconscious [7]. Fast-forward simulations go in the opposite direction of those well-accepted and mature ideas from 3D character animation. This could give the students an extra and important information: common sense relationship between inertia and movement. Also, students would value the fact that robots do not respond as fast as they want and that inertia and other physical phenomena are controlling the robot movement.

Despite of the virtual environment, students have shown interest in using the actual robot, maybe because of the limitations of a Web-based NVR approach that is not really very suitable to develop a proper perception of mass, proportion and dimension.

Cost-benefit analysis. The enthusiasm on VR applications has diminished the need of a proper cost-benefit analysis. It must be said that there are a lot of situations where the use of the "real thing" is feasible and cost-effective or where other cheaper techniques can be very appropriate [2].

Care must be taken because VR has been considered as a "silver bullet' for every graphical application. This is also a misconception but VR potentials must be recognized. VR is a good alternative if one of its basic concepts (immersion, interaction and imagination; [3]) is effectively implemented or if, preferably, all of its concepts are thoroughly explored. However, we have found many applications where **some** of VR concepts are roughly explored. This unsuitable and unmatching attempt raises the questioning not only on the applications of VR to that specific application but also on VR as an interesting and feasible aid to teaching at all.

No methodology. It is worrying to find that, although some claims have been made on new methodologies targeted on developing VR applications ([1], [6] and [9]), no specific development methodology targeted could be found. A specific methodology would emphasize and maximize the potentials of VR concepts (immersion, interaction, navigation and exploration) in the same way that it would exclude graphics-oriented-only applications. Even more, if no specific VR development methodology were found, one can tell how difficult it could be to find a methodology that comply to a sound teaching-learning paradigm and, to our knowledge, no pedagogical-didactical theory yet have suggested the use of VR as an inherent medium.

Therefore it is still important to discuss how VR can be used for educational purposes, what sort of content's features could be better valued on a NIVR or IVR approach. This paper aims to bring some findings into this discussion.

It seems promising to borrow and adapt methodologies from web-sites design and multimedia development to build NIVR applications because there are some similarities.

TABLE II
MATCHING OF VR APPROACHES TO APPLICATION'S FEATURES

Feature	NIVR	IVR
User need to alter the source code for free experimentation	++	--
Availability through the internet/ Can be used for distance learning	++	--
Allow collaboration between students (Taxen:594)	++	--
Cost effective	++	--
Availability of "developing methodologies"	++	--
Single fixed object of study	++	--
User need to interact with textual media (access and run an off-line program, for instance)	++	--
Interactivity	-	++
Sense of Immersion	-	++
Allow eavesdropping supervision/monitoring	++	--
More than one user at a time in the same room	++	--
Requires better graphics and realism	++	+
Motivational Environment	+	++
Facilitate interaction with "the real thing"	-	++
Need to develop skill related to proportion and dimension	--	++
Resembles science fiction devices, which raises the user's (misconceived) expectation	--	++
Resembles simulation packages, which raises lower expectations	++	-

Because of this NIVR applications development is closer to mature into a more adequate tailored methodology if compared to IVR applications.

Table 2 shows of the application's characteristics highlighted above together with others and the suitability of them to be better implemented as an IVR or a NIVR approach. The sign "++" indicates a feature to be most suitable to that specific VR approach while "--" indicates that it is not really suitable to that approach.

CONCLUSIONS

This paper has briefed robotics and virtual reality (VR). VR systems have been divided into two main approaches (immersive - IVR - and non-immersive - NIVR) and these have been compared altogether with simulation softwares. It was highlighted that a big gap exists between NIVR and IVR systems in a way that the first is tied to simulation or video game standards and expectations while the last is much more productive but requires a much better financial background.

It was found that some high expectations exist by the audience due to misconceptions broadcast through science fiction films and novels. These expectations are even farther from reality if considering a NIVR approach. The tricky business is to morph expectations into a motivational drive in a way to avoid frustration instead.

The paper have shown potential benefits of an IVR and of a Web-based NIVR approach which were then discussed against actual benefits. A comparison of these benefits have shown clearly that a big gap exists between them and a clear borderline can be drawn to the suitability of one approach to achieve an specific application's feature.

Despite great advantages, VR do not give students the confidence to play with the real thing and some skills (mainly related to the equipment and its surroundings security) need to be further developed. It is believed that students have shown interest in using the actual robot because of the limitations of a Web-based NIVR approach that is not very suitable to develop a proper perception of mass, proportion and dimension.

Researchers are still exploring development methodologies that could be adequate to VR applications, in the way that it assess the fitness of the application as well as matches and emphasizes the conceptual framework backing VR: immersion, interaction, navigation, involvement.

It can be finally concluded that a Web-based NIVR approach to develop an application to teach robotics is an ideal tool because it is cheaper, more easily available and allow more intensive trial and error use of the concepts. Also, the basics of robotics seems to be better explored if using an IVR approach while programming seems to be better implemented if using a NIVR approach and, valuable benefits outcome from both approaches that suffices to maintain the enthusiasm on using VR to teaching robotics.

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ANALYSES OF CURRENT METER DATA IN THE COASTAL AREA OF SAO PAULO STATE (BRAZIL)

Joseph Harari[1] and Alexandra F. P. Sampaio [2]

Abstract — *Oceanographic measurements in the coastal area of Sao Paulo State (Brazil) were obtained by using an Acoustic Doppler Current Profiler (ADCP). Nine records of approximately one month each (in 1998 / 1999) are relative to 7 positions, with local depths ranging from 13 to 33 meters; the sampling rate was 15 minutes, from 5 meters below the surface up to 5 m above the bottom (typically), at 1 m intervals. The current meter data were submitted to analyses, in order to obtain information about the circulation characteristics in the coastal region. For every point and at every depth, time series of east-west and north-south current components were analyzed, giving basic statistical parameters (mean, median and extreme values, standard deviations, histograms, polar histograms, progressive vectors) and spectra (of amplitude, energy and rotatory). The analyses will provide an important support to several environmental issues in the region, such as water quality and pollution.*

Index Terms — *Current meter data, ocean circulation, time series analysis, Sao Paulo State coastal area (Brazil).*

INTRODUCTION

The ADCP (Acoustic Doppler Current Profiler) is formed by three or four acoustic transductors fixed under the ship (or deployed at the sea bottom); they are oriented in different directions and behave like transmitter-receiver.

Signals are emitted towards the bottom (or the sea surface), with a 30° angle to the vertical, being reflected by micro-organisms and particles suspended in the water; the acoustic transductors receive the reflected signals with a change in their frequency, proportional to the particles radial speed (Doppler effect). A sampling of time enables to calculate the Doppler changes in layers of water evenly matched in depth.

Then, the grouping of the signals enables to obtain a representation of the speed of the ship against each layer of water (or the speed of the layers relative to the sea bottom). Emission frequencies are between 38 to 150 KHZ with respective ranges between 1000 to 4000 m. The delivered data are speed and direction of the layers of water (with typically 1% accuracy).

Present study is relative to ADCP´s moored in the ocean floor, at 7 positions in the coastal area of Sao Paulo State (Figure 1), giving 9 records of approximately one month each, in the period of 1998 / 1999. These positions have depths that range from 13 m (point 6) to 33 m (point 5) and the observations were from 5 m below the surface up to 5 m above the bottom, at 1 m intervals, with sampling rate of 15 minutes.

The analyses of the time series generated by the oceanographic observations will provide an important support to several environmental issues in the coastal region of Sao Paulo State, especially pollution and water quality control.

METHODOLOGY

The time series of current meter data were obtained for each point and depth by decomposing the intensity and direction values into east and north components.

The time evolution of the current components was initially represented graphically and then submitted to statistical and spectral analysis, using software developed for the mathematical package Matlab (1999).

The basic statistical parameters computed for each series were: mean, median and extreme values, standard deviations, histograms, polar histograms and progressive vectors. In the frequency domain, spectra of amplitude, energy and rotatory were obtained (Jenkins & Watts, 1968).

RESULTS

A selection of results will be presented, relative to point 5 (24° 15.056' S 046° 17.076' W), at the depths of 5 and 28 meters, with observations in the period from 29 January 1999 18:00 to 19 February 1999 14:15 (local time).

Figures 2a and 2b present the stick plots of the daily mean currents near to the surface and the bottom, respectively, considering 20.5833 days of measurements: the currents are quite homogeneous along the vertical, being mostly to Northeast but with some observations to the Southwest. This feature is confirmed by the correspondent polar histograms, shown on Figures 3a and 3b, which give the number of observations in each direction.

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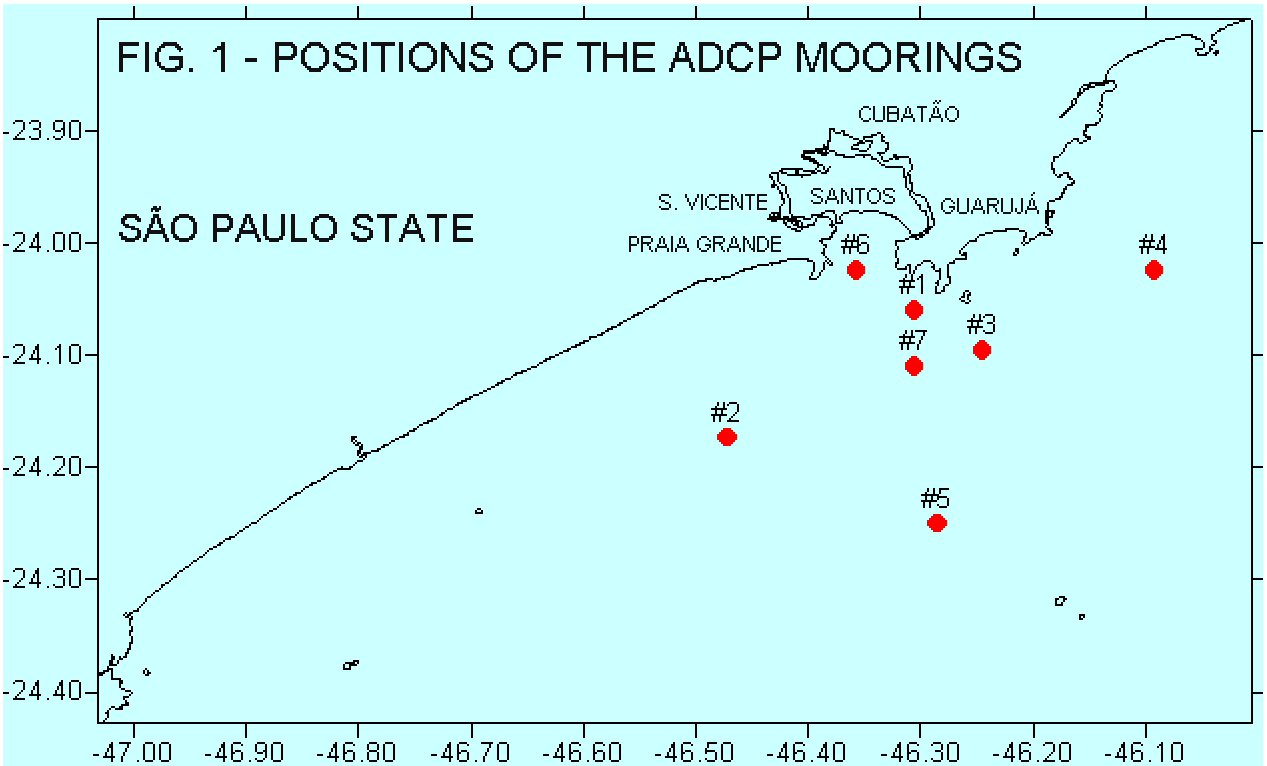

FIG. 1 - POSITIONS OF THE ADCP MOORINGS

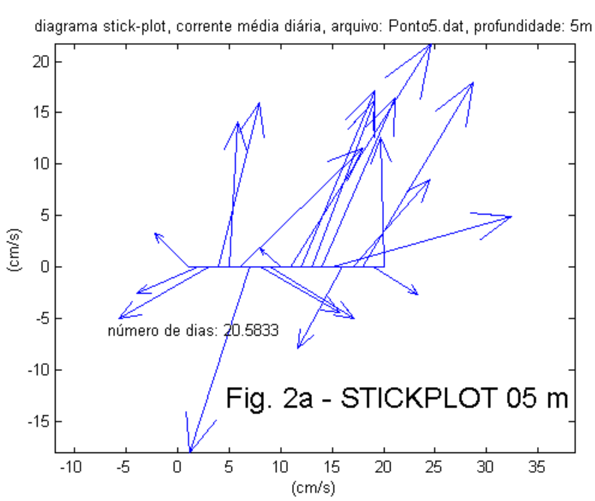

Fig. 2a - STICKPLOT 05 m

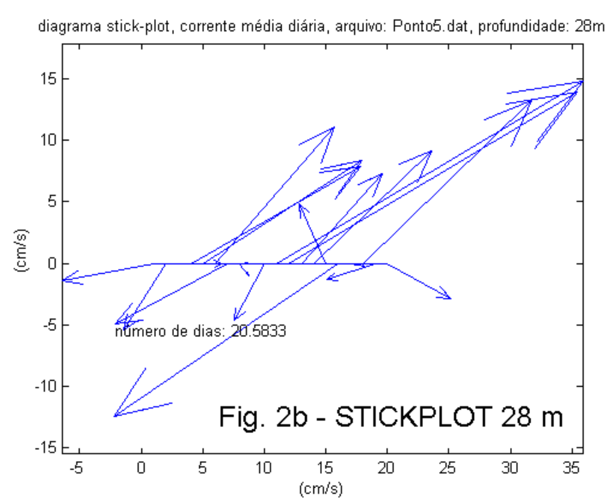

Fig. 2b - STICKPLOT 28 m

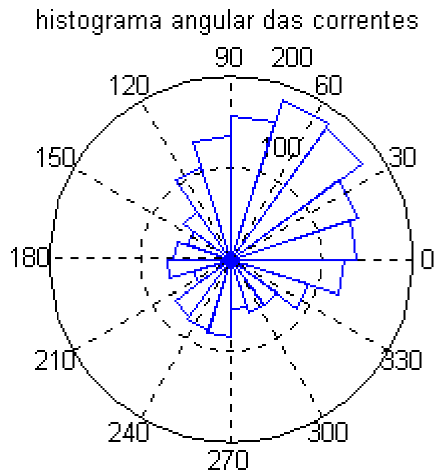

Fig 3a - POL.HIST. 5 m

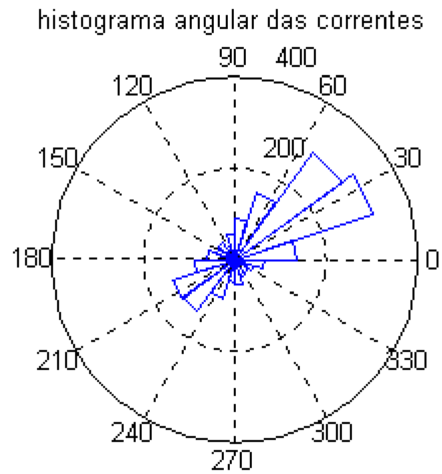

Fig 3b - POL.HIST 28 m

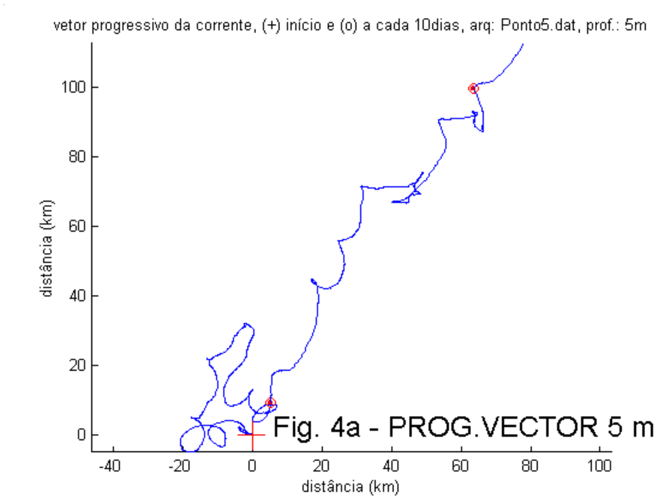

Fig. 4a - PROG.VECTOR 5 m

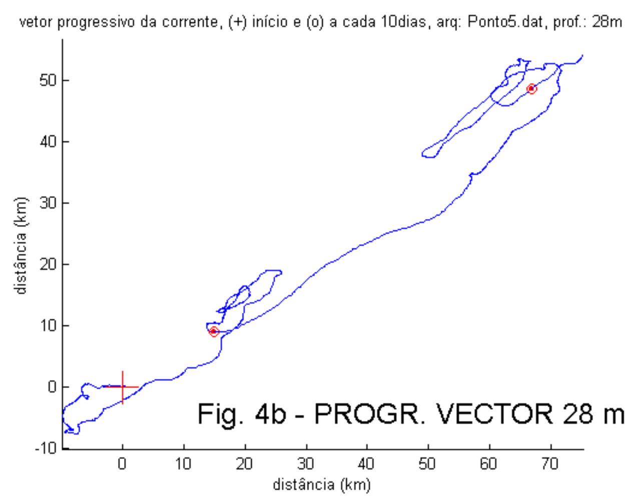

Fig. 4b - PROGR. VECTOR 28 m

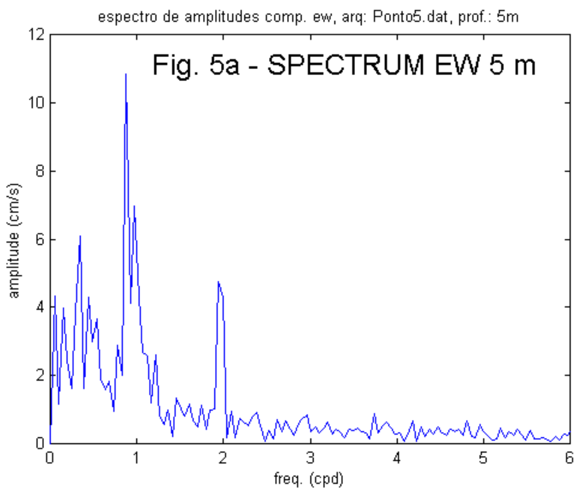

Fig. 5a - SPECTRUM EW 5 m

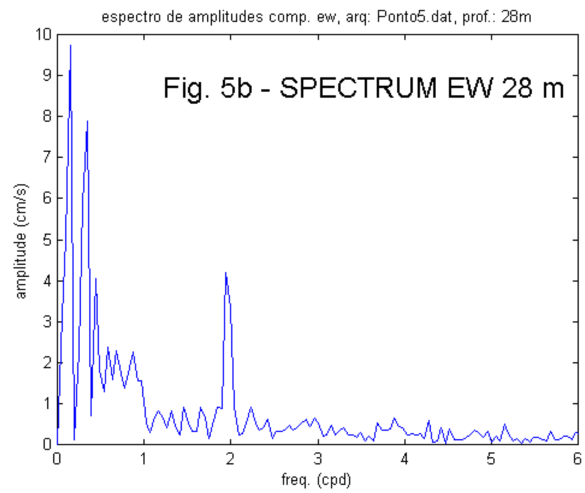

Fig. 5b - SPECTRUM EW 28 m

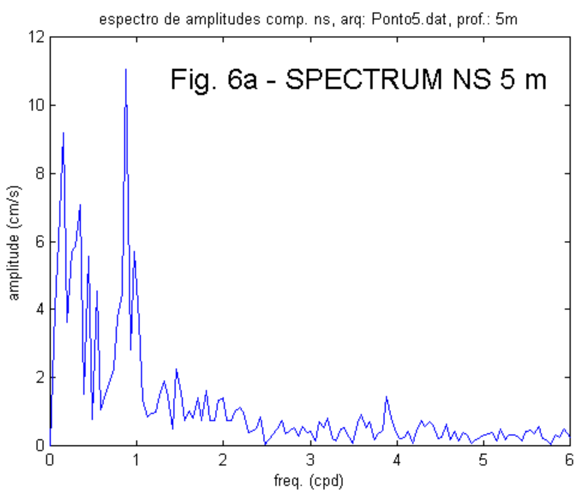

Fig. 6a - SPECTRUM NS 5 m

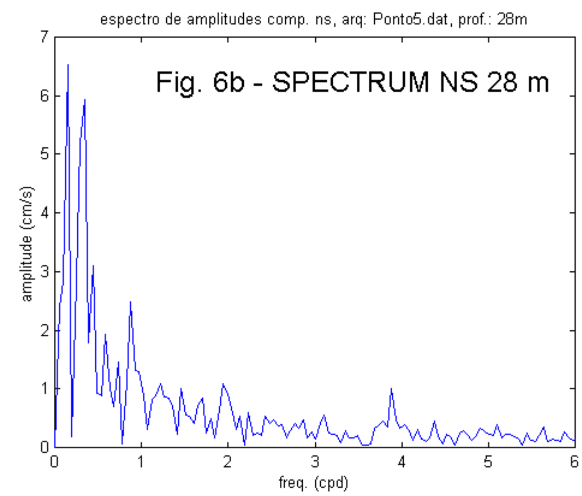

Fig. 6b - SPECTRUM NS 28 m

Figures 4a and 4b show the progressive vectors near to the surface and the bottom, considering samples at every 15 minutes, both with resulting values to the Northeast

The spectra of the current components are given in Figures 5 and 6, again considering the observations at 5 and 28 m depth. These figures show important differences between the surface and the bottom circulation. In the EW direction, long period components (with frequencies below 1 cpd) are energetic at the bottom and much weaker at the surface; on the other hand diurnal components (around 1 cpd), are stronger at the surface and nearly disappear at the bottom; finally, semi-diurnal current components (2 cpd) are nearly constant from the surface until the bottom. In the NS direction, long period components are significant both at the surface and bottom, the diurnal components are damped at the bottom and the semi-diurnal ones have small amplitudes.

The basic statistical parameters relative to 5 and 28 m depth, for the velocity intensities and EW, NS components are given on Table 1, which indicates that both mean and extreme values are stronger at the surface.

These circulation features agree with other publications; particularly the expressive decay of the diurnal components and much smaller one of the semi-diurnals were also observed in other current time series of this continental shelf, such as the ones of Mesquita & Harari (2000, 2001).

CONCLUSIONS

Present study shows recent developments in coastal Oceanography and Engineering, both in observations and analyses, with the use of automatic sensors for high quality field measurements and quick analyzing procedures.

The ocean circulation characteristics inferred by these analyses may be used in several applications, such as numerical predictions, navigation security, coastal protection, sedimentation, erosion and water quality control.

TABLE 1
BASIC STATISTICS OF OCEAN CURRENT DATA
(POSITION 5)

5 m depth	Values in cm/s		
	Velocity	EW comp	NS comp
Minimum	1.0	-47.0	–32.7
Maximum	65.0	49.6	61.4
Mean	22.5	4.4	6.3
Median	21.0	4.8	5.3
Standard deviation	11.8	16.0	18.1

28 m depth	Values in cm/s		
	Velocity	EW comp	NS comp
Minimum	1.0	–28.4	-26.5
Maximum	46.0	41.7	31.4
Mean	15.4	4.2	3.0
Median	14.0	4.1	3.9
Standard deviation	8.2	13.3	10.2

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Napkins, Knives, and Forks: Etiquette Education at the University of Cincinnati's College of Applied Science

Linda Ginter Brown[1]

Abstract--*When students finish their degrees they have mastered certain levels of expertise in their chosen disciplines. However, an important gap exists in their knowledge base. These students often lack the requisite social skills (etiquette knowledge) to successfully climb the corporate ladder. Professionals in business and industry know that how they look and act in social settings often determines the level of success they achieve in their organizations. This report describes the results of a course developed at the University of Cincinnati's College of Applied Science to teach business etiquette to engineering technology students. The course covers subjects employers confirm as crucial to successful entrance into the corporate world. Units such as appropriate business dress, proper table manners, proper introductions, telephone use, and how to conduct business in another country are covered. Examples of problems to help students analyze and apply etiquette knowledge are also included.*

Index Terms—business etiquette, international protocol, table manners, social skills

In contemporary society, technology reigns. Palm pilots rule. Cell phones abound. American society, and others as well, operates around the clock. We eat fast food, drive fast cars, and we have the ability to conduct business 24 hours a day. We skimp on sleep, electing instead to rise early to exercise before work. We speed to our jobs while gulping down coffee or some fast food item purchased at the drive-thru. After work, we rush home to a quick dinner, ferry the children to various activities, and arrive home dead-tired, although we still have email to answer before falling into bed. The next day we do it all over again. People are continually in a hurry, multi-tasking themselves into oblivion. Is it any wonder that nerves are frayed and that many people find themselves operating "close to the edge"? In the aftermath, politeness and courtesy, civility if you will, often get left behind.

The media report stories such as the woman who became enraged when the customer in front of her at the check-out line exceeded the 12 item limit. She actually followed the woman to her car and began to beat her. Or the out-of-control man who was cut off in traffic by another driver. His anger was so great that he jumped from the car and pulled the woman's little dog from the car window and flung it into traffic to its death. Extreme examples you say? Perhaps. Yet, they reflect the attitude and lack of self-discipline some folks exhibit on a daily basis. As tragic as these examples are, they happen because some one chose to ignore the code—the proper protocol. People violate protocol every day.

Yet protocols hold our society together. Even technology functions within them. Consider the computer. It won't function properly, if one doesn't follow the proper protocol for booting it up and letting it check the internal system. Even machines have to follow rules. Likewise, society needs rules to function properly. Rules of behavior are nothing new. As Dorothea Johnson, C.E.O. of the Protocol School of Washington, notes: "Protocol has been observed since the ancient Egyptians produced the first known book,

The Instructions of Ptahhotep. Along with the plow and the twelve-month calendar, they invented manners…The term 'protocol' is derived from two Greek words, protos, meaning 'the first' and kolla meaning 'glue'…Today, the word protocol serves as the code of international politeness that blends diplomatic form, ceremony, and etiquette"[1]. Just as protocol or etiquette serves as the "glue" to hold society together in positive ways, etiquette smoothes the way for successful relationships in the corporate sector. College graduates who display knowledge of business etiquette have an edge over those less-informed. As Lillian Chaney, points out "Schools, particularly institutions of higher learning, must convey to students that good manners are essential to climbing the corporate ladder" [2].

At the University of Cincinnati's College of Applied Science we've addressed this need. Our students earn baccalaureate degrees in various fields of engineering technology. In addition to their technical courses, our students study professional communication, both spoken and written, as well as ethics. Recently, we've added an entire course in etiquette to our curriculum, "Global Civility" (Civility and Manners for the Global Age). I developed this course last year in response to industry's request. Our graduates have fine technical knowledge, both theoretical and applied, but they often lack knowledge in the social graces.

I've taught this course twice now, and the response has been overwhelmingly positive. Students are enthusiastic and appreciate the opportunity for such a course. Our local paper, *The Cincinnati Enquirer*, wrote an article about our final dinner exam, and the Associated Press picked up the

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story. Ever since, calls and emails continue to arrive daily. The BBC even called to request an interview. Manners matter. People have an interest in the course. The need exists, and others recognize it as well.

The course covers areas personnel managers deem necessary in order to advance to managerial levels. These areas include:

- Making introductions properly
- Using proper table manners
- Managing social functions
- Dressing appropriately
- Showing thoughtfulness by responding to invitations, writing thank-you notes, sympathy notes, and notes of congratulations and appreciation
- Speaking correctly (grammatically)
- Using the telephone properly (including cell phones)
- Conducting business in another country

The course meets twice a week, for 75 minutes each class period and is highly participatory. It culminates with a final dinner exam at one of Cincinnati's finest upscale French restaurants. I begin the course by discussing the concept of civility. We talk about what it means to behave as a civil person, and why it is important to the concept of professionalism. I introduce historical examples such as one Dale Keiger noted from the

Galateo, in 1558, 'Nor is it seemly, after wiping your nose, to spread out your handkerchief and peer into it as if pearls and rubies might have fallen out of your head… What, then shall I say of those…who carry their handkerchiefs about in their mouth?" [3] Others include George Washington's translation of *Rules of Civility & Decent Behavior In Company and* Conversation circa 1744 [4] and Margaret Visser's work which notes that "every human society without exception obeys eating rules, what ritual is and why we need it at dinner (cannibalism, for instance, is found to conform to strict laws and controls); and the meaning of feasting and sacrifice [5]. Then we move into subjects such as dining skills. We cover things such as proper napkin use, posture at the table, how to excuse yourself, and proper dinner conversation.

Throughout the first half of the course we practice proper handshakes, introductions, giving and receiving toasts, and we also discuss what constitutes proper business dress in the contemporary corporate arena. I've written problems to help students think critically about what it means to apply business etiquette knowledge in the workplace. One problem focused on the duties of a host who entertains a visiting dignitary:

PROBLEM

You are a recent graduate with a degree in Mechanical Engineering Technology, and you have been working nine months at Triton Steel Corporation. Your boss tells you he has big plans for you. He informs you that you will host a dinner at the Shady Nook Country Club in honor of Mr. Tren Wong, an executive from Singapore. What do you know? What do you need to know?

Students research the various duties of a host. One student wrote, "I made arrangements with the country club for our company to pay for the event and to reserve enough table space for our party of 12 people. I gave the names and ranks of individuals attending to organize the seating arrangement. Singaporeans feel an even number of guests is a sign of good fortune. The seating arrangements were set up in a hierarchical manner, for this is standard protocol in Singapore. Obviously, removing our shoes will not be a part of this dining event for we are in America… I have been practicing my toast, '*yam seng*,' meaning 'bottoms up' to further impress our colleague. We will be toasting all of his hard work and dedication to our fine company these past 10 years." When I developed the problem a bit further and asked them to assume the duties of the guest of honor, another student wrote," I know that I do not drink when toasted as the guest of honor. I also know that I will need to give a short heartfelt acknowledgement and thank you to the guests and especially the host. Therefore, after the toast is given I will stand and say the following: Thank you all very much. I am very happy to be here this evening. I would like to give my appreciation to our distinguished host, Mr. Smith, for his work putting this dinner together for us. You have all been very kind and generous. Thank you all, and thank you, Mr. Smith."

Another problem focused on rampant cell phone use:

PROBLEM

Your boss, Rhoda Finkelstein, has had it with the proliferation of cell phone use at your company in particular and society in general.

She wants to inform employees about the proper and improper use of cell phones. She tells you she wants you to write an article for the employee newsletter which gives the proper etiquette involved with cell phones. You, Pat Woodward, are a bit taken aback. You can't tell her that you're a cell phone junkie yourself. You adore your cell phone. You talk on it as much as possible, even while driving, shopping, and in restaurants. You find it an amazing tool. Yet Ms. Finklestein is your direct supervisor. What kinds of information will you put in the article? Who will your audience be? Write the article.

One student noted in his paper, "Rage against cell phone abusers is quickly rising thanks to the many discourteous users. The novelty of someone having a cell phone has worn off now that the phones are so common… let your ears cool off once in a while…NEVER let the phone ring during a movie, wedding, or funeral. This is the quickest way to bring your own funeral."

PROBLEM

Another assignment includes writing a note of congratulations to a colleague who's just been promoted. One student wrote, "Congratulations on your new promotion to District Manager of XYZ Corporation. The hard work that you put in as store manager did not go unnoticed. It's great that you have been given this opportunity, but you will be missed at this location. It will be tough finding a replacement for you here. Congratulations again, and good luck in this new position. Sincerely …"

PROBLEM

This problem proves a bit more difficult for students. They are asked to write a sympathy note, a sensitive situation, to a colleague who's just experienced the loss of a family member. This particular student rose to the occasion. He wrote, "I was sorry to learn about the passing of your mother. I want to share your sorrow, and let you know that my thoughts and prayers have been with you. The love of a mother can never be replaced, but I hope you can take comfort knowing that you have family and friends that care about you. May God be with you and your family during these difficult times. Sincerely..."

Students learn through these exercises that the person who can write an effective personal note is light years ahead of the one who just sends a card with a pre-printed message.

The last four weeks of the term students form groups of four to five members. Each group chooses a country to research and uses the following problem:

PROBLEM

Your boss has just informed you that your company has now landed a contract with Reibold International in (insert name of country), and you will be sending executives there to conduct business. The executives who will be going there have little knowledge about this country, and none has ever visited it. Your boss tells you that you are now the head of the newly formed Business Etiquette and International Protocol Committee. Your committee's job is to compile a document which employees traveling to this country can use in order to successfully represent your organization. What should the document contain?

Students research various topics such as dining skills, gift-giving, gestures, exchange of business cards and topics to avoid. They compile an executive's business guide to that country. During the last week of class, each group gives a twenty minute presentation where they share their findings as well as the final guide. It's interesting to observe some of their reactions such as the group who were surprised to learn that if one is given a gift in Korea, one shouldn't open it in the presence of the giver since to do so is considered rude. Rather, one should set the gift aside for the time being. The same group noted that political conversation might be fraught with tension and that one ought to avoid discussing the Korean War or the Japanese Occupation A member of another group, s first-year female student, was shocked to learn that if she visited Saudi Arabia, she would not have the same freedom to move about as a male counterpart. The group that studied Australia was delighted to discover that it is common practice for Australians to split the bill for business dinners and that tipping at restaurants is optional. They were also relieved to learn that most Australians have never eaten kangaroo meat, a delicacy, so business visitors would probably not encounter it while dining Down Under. Students see how easy it is to offend someone without meaning to do so. They learn to sensitize themselves to the different customs of various cultures.

We end the quarter by reviewing proper business attire and proper dining skills in anticipation of the final dinner exam. Students are excited and understandably nervous. However, without exception they rise to the occasion, and a truly, gratifying metamorphosis takes place. These same students who sat before me with their baseball caps on backwards, wearing their trusty Reeboks for the past ten weeks change into men and women enjoying a business dinner in an elegant restaurant. They have learned important skills and acquired the necessary confidence to make a successful entrance into the corporate world.

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MODERN INFORMATION TECHNOLOGIES AND A DREAM ABOUT INDIVIDUAL EDUCATION

Zoia Sazonova[1]*, Nina Chechetkina*[2] *and Tatiana Tkacheva*[3]

Abstract — *The Internet conducted the informational integration of all the countries in the world. Introducing modern information technologies to the sphere of education accelerates the process of the unification of national educational systems. A united international educational environment is being formed. The accessibility of qualitative study information and the existence of an effective system of the educational process management can make our dream of the individualization of education come true.*

Index Terms — Information technology, individual education, pedagogy, management of education, testing.

BODY

The computerization era came to Russia much later than to Europe and the USA.

Just 10 years ago in the Moscow Automobile & Road Construction Institute there were just a few computers. By nowadays the amount of computers has increased by hundreds. Nowadays computers are used in the Russian system of education very intensely.

Lecturers and students of MADI actively use personal computers for various scientific and educational purposes: for instance, to model different processes, to make the control over experiments automatic, to create electronic text-books and so on.

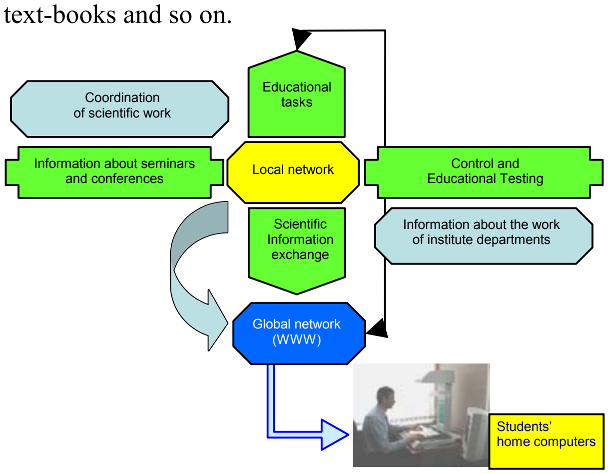

FIGURE 1.

In MADI there is a local computer network (Fig.1). We use it to coordinate scientific work, to get information about the work of institute's departments, to learn about seminars and conferences, to carry out educational & control testing, to give students their tasks and to exchange scientific information.

MADI's local network is plugged into the Internet. Students & lecturers can get to MADI's local network from their home computers via the Internet.

Students use various mathematical packages while performing different calculations. For example, during the exploration of the dependence of oscillations on different parameters MathCAD is especially intensely used (Fig.2).

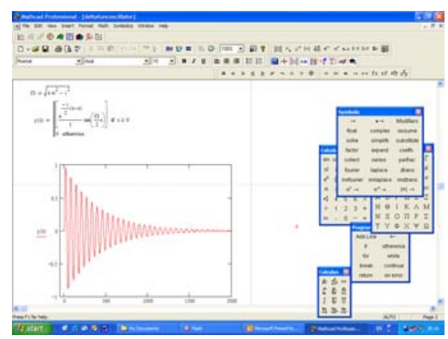

FIGURE 2.

In our university different local systems of testing of the quality of knowledge in different subjects have been

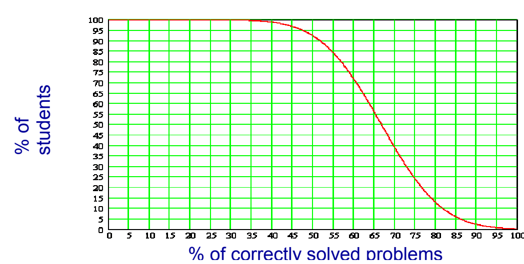

FIGURE 3.

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created and successfully used. At this photo you can see students of the 3-rd course, who have just completed one of their tests – they're waiting for the results. The results and their analysis are presented below. The students were to complete 15 tasks. The vertical axis on the graph represents the percent of students, who have successfully coped with some task. We can see that some of the tasks turned out to be difficult for the students. This information is then analyzed and the corresponding parts of the material are then revised in a more detailed way.

Testing is not just a method for controlling the quality of the students' comprehension of the material, but it's also a way of controlling lecture material.

Testing provides us with an opportunity to set a feedback between students and lecturers. The staff of the engineering pedagogy department uses testing as an important instrument in the process of introducing new pedagogical technologies [1,2].

The Internet and a personal visit to England's universities helped us to collect some information about the organization of educational process in Great Britain and the

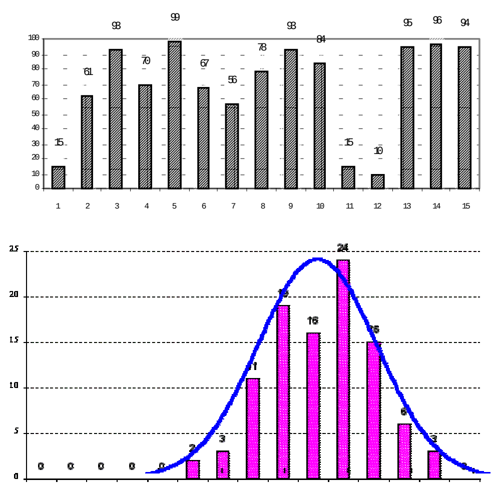

FIGURE 4.

A) **X-AXIS:** THE NUMBER OF THE TASK
Y-AXIS: PERCENT OF STUDENTS, WHO SOLVED THE TASK

B) **X-AXIS:** THE NUMBER OF SOLVED TASKS
Y-AXIS: PERCENT OF STUDENTS, WHO SOLVED EXACTLY THIS NUMBER OF TASKS

USA. We then conducted a technical analysis of the educational programs of foreign and Russian technical universities. The work carried out by us let us make the following conclusions:

1. Universities of the USA and England have very well developed structures of management of the independent work of the students. Decrease of the number of auditorial classes in these conditions gives positive results.
2. In Russian universities a lot of variants of perspective innovational pedagogical technologies, which take advantage of modern information technologies, have been developed. However, unfortunately, the integrity of the combination of all the conditions, which in all universities can ensure the students' independent work, leaves much to be desired, and the timeliness of the decrease of the number of auditorial classes gives rise to doubts.
3. Study plans of Russian and foreign technical universities have a lot in common, but there are some significant distinctions as well. As an example, we'll consider study programs for the civil engineering specialization in two different universities: in the Imperial College, which is a part of the University of London, and in the Moscow State Automobile & Road Construction Institute.

Foreign programs even on the first two courses already have greater practical orientation than Russian programs do. For instance, in the programs of British universities there's no united course of general physics. Nevertheless, different parts of physics, vitally important for a concrete specialization, are taught in a very detailed way.

For Russian universities very deep fundamental basis is characteristic. Those parts of physics, which are especially important for some concrete specializations, are taught at the so-called "elective" courses. Serious fundamental education provides students with a broad scope and the opportunity to work on the border between different types of scientific or engineering directions.

In the universities of the USA, England and Europe students start working in a team of 5-6 people on their projects already during the first year of study. During subsequent courses this work is continued. It is great when the study process tries to incalculate in the students the ability to work in a team. In Russia the work in this direction is only beginning.

Modern information technologies have created a great deal of new opportunities. The use of modern information technologies in the system of education let us modernize the organization of the study process and give a lot of study time to the students for their independent work in the framework of a well-organized educational structure. Independent work must be manageable.

In order to realize this idea it is important to have an effective structure of management of the process of students' professional development. If such a structure existed, a student could decide himself if he needed to attend lecture classes regularly or if he could work on his own, using those educational materials, which are presented on the web-site of his university.

In this case, when independent work results in good testing score, the student can continue working on his own for most of the time. Otherwise, a student will definitely go to the auditorium. He can sensibly evaluate his abilities and choose his own method of study. Such an approach is respectful towards the personality of a student and can help to solve the problem of education humanization. The creation of an effective management structure of the process of students' independent work is a very important problem. This problem is discussed in the following paper.

CONCLUSION

Modern information technologies let us realize an individual approach towards the education of every concrete student [3]. Every student can optimize his own study timetable himself in order to study in a convenient routine.

Structure of the management of the independent work of the students:

1. A full complex of educational materials required for successful study (in classic and electronic forms)
2. Effective system of constant feedback between students and teachers (Fig.5)

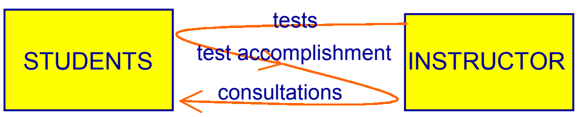

FIGURE 5.

3. System of registration of testing results supposed to support the lecturer marking students' work for the whole course.

ACKNOWLEDGMENT

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FLOW AROUND SPHERES: A DIDACTIC EXPERIMENT

Marcelo Ferreira Pelegrini[1] *and Edson Del Rio Vieira*[2]

Abstract *— A steady incompressible isothermal flow past a rigid smooth sphere in an infinitum medium is experimentally investigated for Reynolds number up to 1000 in a fluid mechanics laboratory class. All tests have been carried out in hydrodynamic medium utilizing a water tunnel with 146×146×500 mm of test section, operating by gravitational effect in continuous or blow-down modes, and in a water tank with Plexiglas walls in order to visualize a sphere in free fall in a rest medium. Flow visualization by direct liquid dye injection and hot-film anemometry has been utilized in order to determine, qualitatively and quantitatively, the flow structure and turbulence characteristics in the wake. This proposed experimental activities represent good work opportunities on the teaching process, illustrating several different phenomena relative to the fluid mechanics theoretically discussed in the classroom. The complex measurement made using hot-film anemometry, and the flow visualization images generated, captured and processed directly by student's action in the hydrodynamic tunnel and in the water tank have awaked great motivation in undergraduate students of fluid mechanics.*

Index Terms — Flow visualization, Fluid mechanics learning, Hidrodynamic tunnel, Hot-film anemometry.

INTRODUCTION

The fluid mechanics study, without shadows of doubts, is a complex human activity, with a hard mathematical load and several intricate physical concepts. Traditionally, fluid mechanics laboratory teaching develops several challenges. The choice of adequate experiments to be offered to the students that implicate in better didactic results shows to be an arduous task. Elementary experiments should be offered allied additionally with others more complexes and showing a more elaborated thinking. Nowadays, several new flow didactical experiments, with different degree of difficulty, have been proposed, in technical literature, to be incorporated at fluid mechanics discipline of a undergraduate mechanical engineering course.

The problem represented by a rigid smooth sphere moving into a viscous incompressible fluid far of interference of the walls is a very old engineering problem, utilizing a relatively simple geometry that represents a high degree of complexity. Generally, the understanding of this problem by students is an arduous task and a challenge to the teachers.

Wakes behind a sphere are encountered so frequently in engineering applications implicating in large amounts of research that have been conducted and massive amounts of numerical and experimental data have been accumulated. The studies of the sphere wake that have been done show that the vortex topology and shedding process is significantly different from that found in the well know flow around a circular cylinder. Of course, the wake formed downstream a sphere shows high complexness of the vortex dynamics. This very complex flow exhibits several instabilities with complicated kinematics and vortical interactions and complex flow structures with fully three-dimensional unsteady flow fields in spite of the symmetry of the body.

The experience of the authors in offer the experimental class of a moving sphere in a viscous "infinite" medium to undergraduate students of a mechanical engineering course is reported in this work.

FLOW REGIMES AROUND A SPHERE

The problem of a sphere in movement on a viscous fluid wake up the attention since the Middle Ages due to interest in the cannon balls ballistic problems. The authors recommend the reading of the refs. [1,2] about the problem of the free fall of solid bodies to provide a historic understanding of this problem, including the happens of Galileu Galilei and the Pisa Tower.

The Reynolds number, $Re = \rho\, V\, D\, /\, \mu,$ – based in the no perturbed upstream velocity (V), the sphere diameter (D) and the cinematic viscosity (ν), represented by ratio between the dynamic viscosity and the density ($\mu\, /\, \rho$) – can be used as a primary parameter to classify the flow around a sphere. The flow regimes for a single sphere in a infinitum medium, can be described, in accord to ref. [3] as follows:

For Re < 5, in very small Reynolds numbers, a creeping motion is observed and in this region the flow is governed by viscous forces and no detachment appreciable is observed. These forces are proportional to the product of the viscosity, velocity and diameter of the sphere. In this situation, the Navies-Stokes differential equations can be integrated by neglecting the inertial forces. Stokes, in 1845 was the first in solved they for the case of the sphere,

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considering the complete boundary condition of no tangential velocity of the fluid along the sphere surface.

For 5 < Re < 130, the wake forms a steady recirculating eddy of axisymmetric ring shape. In this flow regime occurs a flow detachment and the detachment angle (θ) can be accuracy measured in function of Reynolds number.

For 130 < Re < 300, a wave-like laminar wake of very long period forms behind the sphere.

For 300 < Re < 420, a hairpin vortex begins to shed and a spectral peak shows up in the unsteady velocity spectrum.

For 420 < Re < 480, the shedding of the hairpin vortices becomes irregular. This is the early transition regime.

For 480 < Re < 650, the shedding mode is a continuous state of randomness, or irregularity.

For 650 < Re < 800, The shedding pattern differs from that of lower Reynolds numbers due to pulsation of the vortex sheet. Multiple frequencies can be observed and the shed vortices begin to show signs of turbulence.

For 800 < Re < 3 000, some of the vortex tubes formed by the vortex sheet separating from the sphere surface enter into the vortex formation region, while others are shed in small vortex loops. The large-scale vortices move away from the sphere rotating at random about an axis parallel to the flow through the center of the sphere. The wake becomes turbulent at Reynolds near 2000.

For 3 000 < Re < 6 000, This is other transition region where the measured low-mode vortex shedding frequency decrease rapidly with the increasing Reynolds number. The power spectrum of the fluctuating wake velocity shows one characteristic peak plus considerable broadband energy on both sides of this peak. The vortex sheet is changing from laminar to turbulent in this regime.

For 6 000 < Re < 370 000, the separated vortex sheet is now completely turbulent. The vortices shed from the formation region become stabilized because the separated shear layer is no longer laminar, but turbulent. This stabilization causes the velocity fluctuation spectrum to lose some of the broadband nature observed in the previous region. The Strouhal frequency of regular shedding increases with Reynolds number and then approaches the constant value of 0.19 at Reynolds near 20 000.

EXPERIMENTAL APPARATUS AND METHODS

In this effort of work, two different apparatus have been proposed both operating in tap water medium. The first, a water tank all made of Plexiglas of 0.127x0.127 m in cross-section and 1 m in height was used, depicted in Fig. (1).

A small plastic sphere is painted with an adequate color dye and launched from rest in the water surface. The sphere falls freely in the quiet water medium. In few centimeters run, after the sphere launch, the terminal velocity is rapidly observed. The terminal velocity is determined measuring, with help a hand chronometer, the time necessary to the sphere to move between two black adhesive tape, positioned externally on the Plexiglas wall, separated by a vertical known length (L), showed in the fig. (1). The relative water movement slowly dissolves the fresh dye permitting the wake visualization.

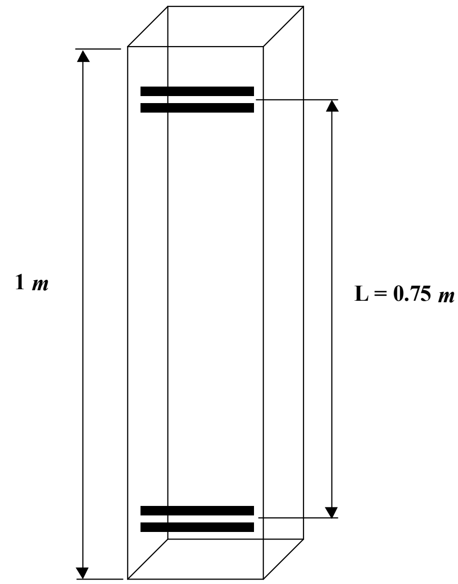


FIGURE. 1
WATER TANK FOR ESFERE WAKE VISUALIZATION.

In order to keep the water still careful attention was paid. Small variation in external air temperature causes water movement due to buoyancy effects provoked by temperature gradient between the tank wall and internal water.

In this device, plastic spheres with approximately 6 mm of diameter were utilized. These plastic spheres are the same utilized in toy guns and they are very cheap and available in toy store in large quantities. Necessarily, each sphere needs to be carefully separated in order avoid the use of egg-shape spheres in the experiment. This separation process can be easily performed with help of an inclined plane. Each individual sphere need to be carefully measured due to a large variation observed in the diameters and in the mass from sphere to sphere. Plastic spheres have internal small air bubbles. This micro-bubbles represent a large variation in the density implicating also in a need to be separation as function of they density.

In order to promote the density classification of the spheres, first of all, take a glass beaker, with one liter of clear tap water, at room temperature. Put a lot of spheres into the beaker. The spheres with density less than water, due to buoyancy force will float. This light spheres can not be utilized, but a large number of spheres remain on the bottom of the beaker. In this moment, you dissolve approximately 25 g of a salt (sodium carbonate, for example) in the water and wait a minute. Some spheres should float on the water surface. These spheres have a density very close with the tap clear water density, and they will produce the better results in the proposed experiment, because the free fall velocity will be very small, producing moderate Reynolds number – up to 700 –, adequate to photographic capture using ISO 400 chemical films.

In order to promote the wake visualization the spheres are painted with a PVA dye. The spheres are launched with wet dye paint. The sphere movement in water provokes the wet dye dissolution permitting the wake flow visualization. An adequate illumination using cold lamps is required for image capture in order to minimize the buoyancy effects due to thermal gradients. This flow visualization process is the same utilized initially in the ref. [4].

The second apparatus utilized to the study of flow around a sphere is a vertical pilot hydrodynamic tunnel device. This equipment, made for research purposes, has been intensely utilized with success for didactical applications, see ref. [5,6,7]. Hydrodynamics tunnels are important tools for didactical purposes using flow visualization techniques. A sketch of this experimental apparatus is depicted in fig. (2).

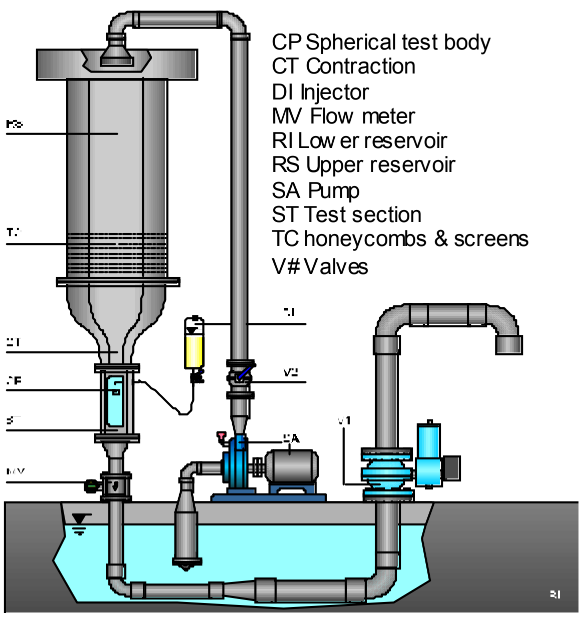
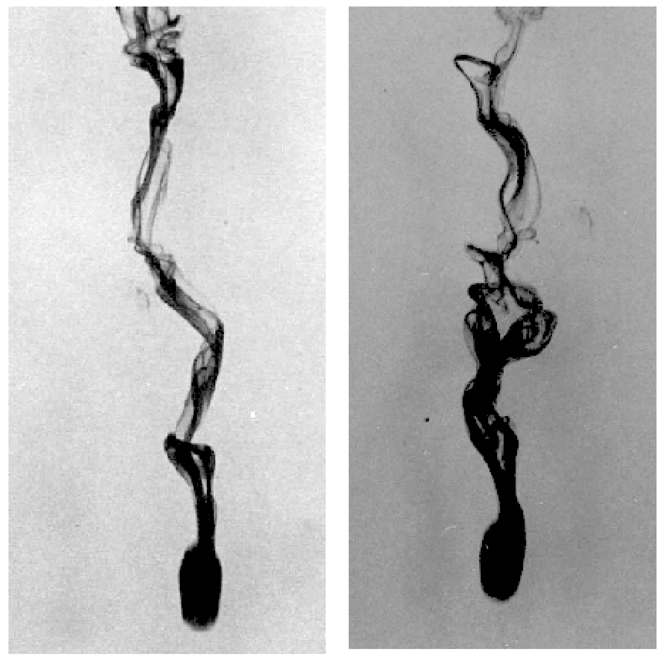


FIGURE. 2
LOW TURBULENCE VERTICAL HYDRODYNAMIC PILOT TUNNEL.

A detailed description of the tunnel operation can be obtained in ref. [8]. A plastic smooth sphere with 35.5 mm of diameter, the same utilized in roll on deodorants, is adequately fixed in the tunnel test section. A long hypodermic needle with 0.7 mm OD permits the liquid dye injection in order to allow the flow visualization. Utilizing this technique the detachment angle (θ) is measured from a processing of the visualized images. These images have been captured utilizing a Sony CD digital camera with only 1 200x1 600 pixel. A digital constant temperature anemometer using 55R11 Dantec probe was utilized to measure the turbulence intensity level in the wake. Details of the anemometer device are found in Ref. [8].

RESULTS

Initially, we will show the result regarded to the water tank. The wake-visualized images showed in Fig. (3), illustrate two different Reynolds regimes.



Re = 440 Re = 532

FIGURE. 3
SPHERE WAKE IMAGES CAPTURED FROM THE WATER TANK.

A terminal velocity (*Vt*) behavior as function of the Reynolds (Re) is depicted in the Fig. (4)

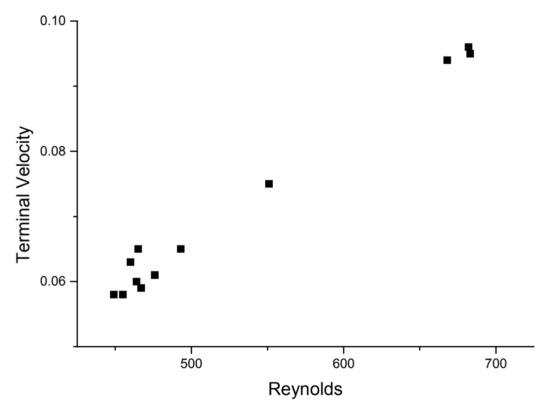


FIGURE. 4
TERMINAL VELOCITY (*VT*) FOR A SPHERE.

The sphere drag coefficient (C_D) – expressed in terms of the ratio between the drag force and the kinetic energy ($0.5\ \rho V^2 A$) – can be also obtained in the same experiment using the water tank. Illustrative results of the drag coefficient is depicted in Fig. (5)

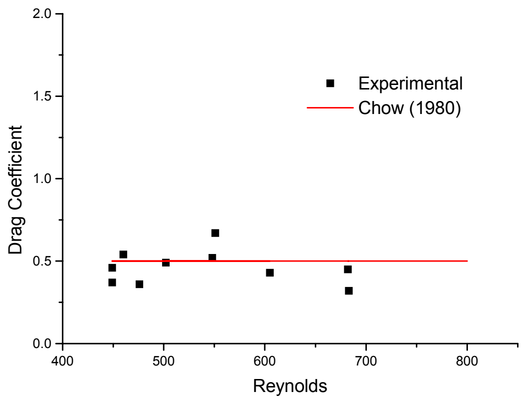


FIGURE. 5
DRAG COEFICIENT (C_D) OF A SPHERE AS FUNCION OF REYNOLDS.

In order to obtain the results relative to the hydrodynamic tunnel can be attacked firstly by the hot-film probe calibration problem. Several methods have been described in technical literature for probe calibration utilizing several different techniques. For example, ref. [9] shows a complete laboratory class utilizing a free jet in order to introduce hot-wire anemometry in a fluid mechanics course. Unfortunately, an expensive apparatus to generate a controlled low turbulence jet is required. The use of hydrodynamic tunnel in order to initiate hot-wire anemometry in undergraduate course is appropriately utilized in ref. [6]. Utilizing a hydrodynamic tunnel good calibration results can be found easily if several delicate procedures have rightly executed.

All hot-film measurements have been carried out utilizing the hydrodynamic tunnel. The hot-film probe has been positioned downstream the sphere (at Y = 5 D) and transversally moved (X direction) in order to obtain the relative turbulence level, depicted in fig.(6).

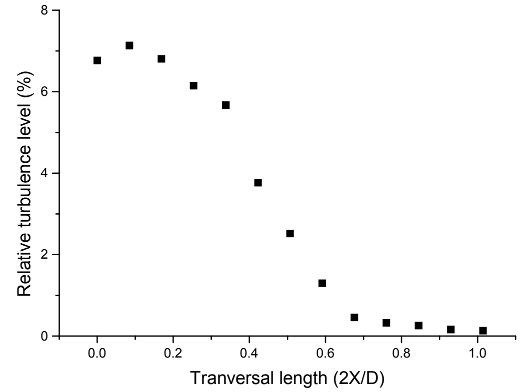
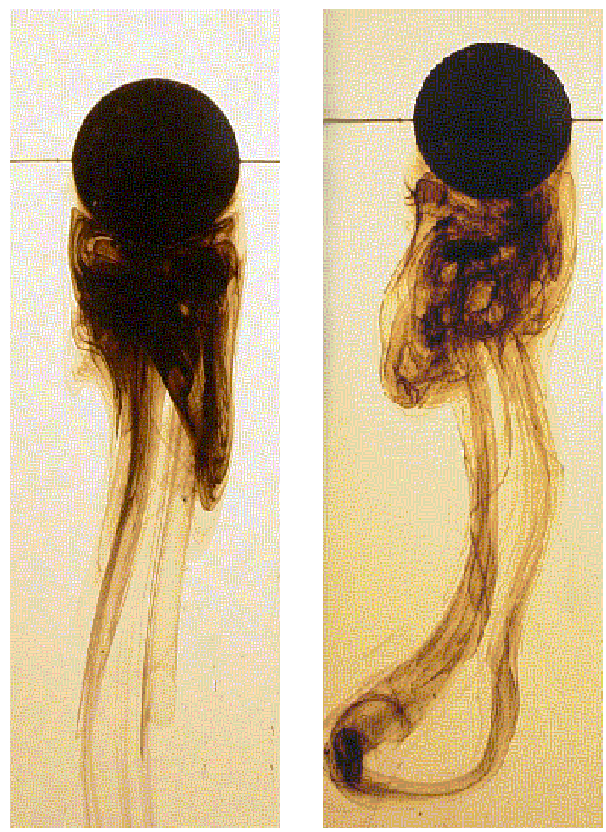


FIGURE. 6
TURBULENCE RELATIVE LEVEL IN THE SPHERE WAKE.

In the hydrodynamic tunnel visualized images in close view can be obtained. An example of these images can be observed in Fig.(7).



Re = 352 Re = 557

FIGURE. 7
SPHERE WAKE VISUALIZED IMAGES IN CLOSE VIEW.

A low level digital image processing of the wake images permits to obtain the boundary layer detachment angle (θ) depicted in Fig.(8).

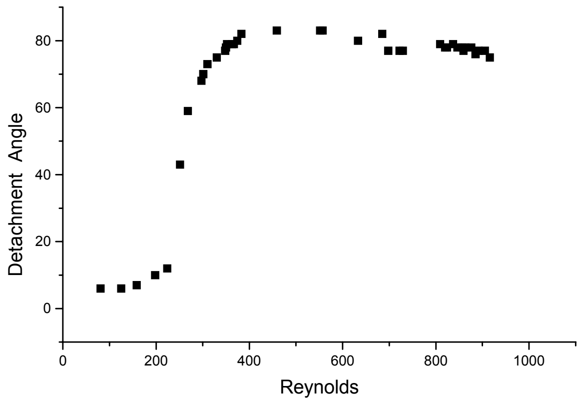


FIGURE. 8
DETACHMENT ANGLE (θ) OF A SPHERE AS FUNCION OF REYNOLDS.

CONCLUSIONS

In this paper a wake configurations observed behind a sphere falling in quiet water at terminal velocity has been proposed to an experimental class in a fluid mechanics undergraduate course. Two proposed devices – The hydrodynamic tunnel and the water Plexiglas tank – allow a careful observation of various wake-shapes images and quantitative measurements with their corresponding Reynolds number.

Experiments realized in water medium has certain advantages as a fluid medium for incompressible turbulence studies compared with air. Lower velocities may be utilized with the same Reynolds number since the kinematic viscosity (ν) of water is only one-sixteen that the air implicating in the use of lower frequency velocity sensors.

A water tank is a very cheap apparatus easy to make and to operate, permitting to obtain relative good results. Several aerodynamic concepts are possible to corroborate in this device.

Those experiments have been developed in a fluid mechanics laboratory class for, in average, six students each time. The less number of students permits a very close accomplishment, eliminating several students' doubts. A more high number of students can be an additional difficulty to the instructor, mainly in the hydrodynamic tunnel operation.

Massively separated flows as observed in a sphere wake or in many other bluff-bodies, found in several engineering applications, has been shown to be an ideal mechanism to introduce good laboratory procedures as well as procedures that have wide use in technological industries and research laboratories.

The different measurements done by student's action in the hydrodynamic tunnel and in the water tank have awaked great motivation in undergraduate students of fluid mechanics.

Other attractive point of this laboratory class is related to the use of sophisticated pieces of instrumentation. In fact, the use of "real instrumentation" like digital processing, constant temperature anemometer and the hydrodynamic tunnel in order to obtain fluid flow velocity, turbulence and other important parameters in a laboratory class, in opposition to demonstration-only experiments, highly increases the student's motivation to grasp a difficult and complex subject. In this way, the use of HWA as a teaching tool has proven to be very important to attain the goals set by the fluid mechanics instructors in engineering undergraduate studies.

ACKNOWLEDGMENT

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DATA TRANSFER PROTOCOL FOR DISTRIBUTED INFORMATION ACQUISITION FOR USE IN PHYSICAL EXPERIMENTS

Alexei Korolkov[1], Alexei Moschevikin[2], Alexei Soloviev[3]

Abstract *— Data Transfer Protocol for Distributed Information Acquisition (DTP/DIA) was designed and proposed to IETF to be an experimental standard (TCP port 3489 have already assigned to DTP/DIA by IANA). DTP/DIA is based on TCP/IP stack and supports such devices as sources of physical information (sensors), transit transmitters and receivers, connected with data base engines. All these devices are usually constructed with embedded microcontrollers (Atmel, Microchips, Intel) with reduced cost. The main features of DTP/DIA are: simple realization, reliability, ability to resolve various sources of information, support up to 2^{24} unique devices. Due to implementation of TCP procedures and utilization of world communication channels sources and receivers may be far distanced. Practical realization of DTP/DIA was introduced in net of online air temperature sensors in North-west Russia (http://thermo.karelia.ru/eng/). Also there is an ability to construct measurement and data acquisition nets for any physical quantity including mixed nets (for example for pressure, humidity and temperature sensors).*

Index Terms — data transfer protocol, distributed information acquisition, embedded microcontrollers, online air temperature, sensor net.

INTRODUCTION

The Data Transfer Protocol for Distributed Information Acquisition (DTP/DIA) was developed for application in distributed information measurement systems (IMS). DTP/DIA provides the functionality of the presentation and application layers of the OSI Reference Model for the specified purposes.

IMS stands for a bundle of software and hardware which performs acquisition, processing, storing, and presentation of measured data. The systems with control function are out of scope. The simplest IMS consists of measuring device, connected to computer by means of some instrument interface (such as IEEE 488 (GPIB) or EIA/RS 232). Typical measuring device contains a sensor and a microcontroller, which performs initial data acquisition and processing. In such a system the majority of IMS functions are given to computer.

More complicated systems can be developed on the basis of CAMAC or VXI. But projects with large amount of investigated objects at far distances from each other require to install distributed IMS. Some nodes of distributed IMS should perform data transmission to nodes which process and store data. Sometimes this communication can be done by measuring device itself if it is rather sophisticated, or this function may be performed by a computer. That is we deal with two kinds of data channels: local (1) and network (2) (Fig.1).

In description of IMS we use the term "data source" for the object, which transmits measured data, and "data collector" - for the node which receives measured data. If the node performs both reception and retransmission, this type of nodes will be named "retranslator". Obviously, in this terminology measuring devices are "data sources", but a single computer could be either "end-point data collector" or "retranslator".

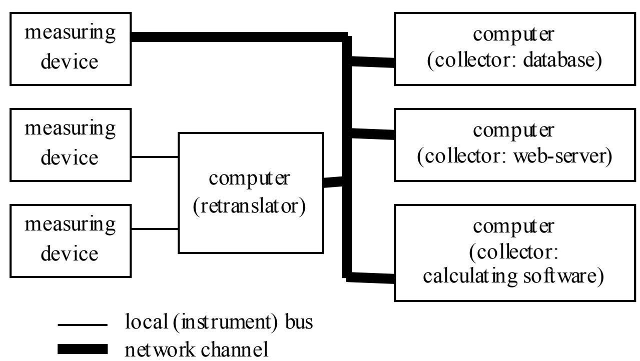

FIGURE. 1
A TYPICAL STRUCTURE OF DISTRIBUTED IMS.

In most cases the nodes of distributed IMS are considered to be the components of the open systems. So OSI Reference Model can be applied to their communication channels. The upper layers of such systems are poorly standardized due to the wide range of IMS's applications. The most of existing standards are vendor-specific. That's

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why it's necessary to introduce a simple protocol, suitable for both kinds of data channel. DTP/DIA matches these requirements.

DTP/DIA was implemented in both embedded firmware (for Atmel microcontrollers) and personal computer software (Distributed Information Acquisition software – DIA).

MAIN FEATURES OF THE DTP/DIA

The protocol describes data transmission in small stand-alone packets. This feature allows using DTP/DIA over both streamed (connection-oriented) and message-oriented channels. DTP/DIA packet consists of three logical blocks: *Header*, *Measured Data* and *Special Data*. *Header* and *Measured Data* are required. They have a fixed size. *Special Data* block is recommended and its size is variable. The maximal size of DTP/DIA packet is 60 bytes. A simple measuring device must produce packets, contained at least *Header* and one of the forms of *Measured Data* block. More sophisticated device should include *Special Data* block as well.

DTP/DIA provides few data presentation forms. Each form corresponds to a specific packet type. Some of the forms help to avoid the implementation of floating point arithmetic in device firmware.

DTP/DIA allows transmission of measured data accompanied with information about measurement error and its unit measure.

In distributed IMS it is very important to distinguish measuring devices from each other at the application layer. So the protocol includes identification mechanism. This feature helps to transmit data from several data sources over a single communication channel. For example, one can use a device with several sensors (such device is represented as multiple data sources). To distinguish data from various data sources DTP/DIA packet contains Data Source Identifier. To introduce a bit of structurization in distributed IMS the Identifier was divided into two parts. They correspond to high and low levels of 2-level hierarchy. Developer of IMS may use the first part to specify the group of units in distributed IMS and the second part to appoint a device number in this group. The protocol supports up to 16 millions (2^{24}) data sources.

Another important part of the DTP/DIA identification mechanism is an optional feature called the *Data Source Identification Procedure,* which helps sharing a single transport layer connection for data transmission from several data sources. This feature is not supposed to be applied to connectionless (message-oriented) channels. So data source can distinguish every collector by a certain transport layer connection. This mechanism consists of two events: "Offer To Identify" and "Device Request". They represent a some kind of handshaking. Also *Data Source Identification Procedure* may be applied for assigning identifiers.

We suppose to apply DTP/DIA for both network and local channels. Few types of local channels don't provide reliable data delivery. To avoid unreliability of local interfaces DTP/DIA has the following primitive features: detection of packet start (packet leading sequence), check sum and time stamp.

DTP/DIA provides neither authentication mechanism, nor security issues. To produce security based applications developer of IMS should provide authentication and data protection on the transport layer (by means of SSL [2] or TLS [1]).

DIA SOFTWARE

Distributed Information Acquisition Software fully implements the described protocol. It was developed and tested on several platforms: Windows 95/98/Me, Windows NT/2000/XP and Linux. The program was also tested on FreeBSD in Linux-emulator. Linux version can be linked statically and placed with the Linux kernel on a floppy disk. So it can be used in diskless low-performance systems (floppy required only). The main part of the program is provided with open sources under the terms of the GNU Lesser General Public License.

The program deals with objects of two kinds: *Device* and *Channel*. *Device* objects represent a particular data source and store current measuring information (date of measurement, measurement result, accuracy, units etc). *Channel* objects hides the method of data receiving and transmitting from other parts of the program. Such object implements input/output procedures for a specific communication resource (serial port, TCP-socket, UDP-socket, file, database, etc). Although it is not limited by the protocol, the current release of the DIA software doesn't support bidirectional *Channel* objects, i.e. any *Channel* object must either transmit data or receive it. Each *Device* object may be connected with few transmitting or receiving channels. Transmitting channels implements the "retranslator" function in the terms of DTP/DIA. Moreover the data storing function is the transmitting function as well. That is when we suppose to store measuring information in a file or database we assign a certain transmitting channel to corresponding object, which "transmits" data to file or database.

The open-source interface of objects interconnection and the modular structure of the program allow developing a module for any communication resource. The program can use new modules without recompiling. At the moment we have implemented the following communication modules:

- RS232 module performs communication via serial line.
- FILE module allows receiving of data from file. It is supposed that new data arrives when file modification time is changed. This module can be flexibly configured to support different file formats.
- MYSQL module provides the opportunity to store data in MySql database.

- TCP/UDP module supports receiving and transmitting of data over Internet/Intranet channels ([5], [6]). When the program transmits data by means of this module it acts as retranslator in the terms of DTP/DIA. This module can be configured to use SOCKS5 proxy [3].
- SSL module performs secure receiving and transmitting of measuring information. It provides some kind of authentication. At the stage of SSL handshaking both communicating sides should provide certificates, which are signed by trusted certification authority. Otherwise the connection establishment won't be authorized and SSL handshaking will fail.
- CTRL module implements some control interface, which allows creation and removing of both kinds of objects in the run-time. This feature provides the opportunity to configure the distributed IMS dynamically. By means of this module the operator may watch the state of all the objects in the running program.
- SMTP module implements a simple SMTP client according to [4]. It is supposed to inform the operator about long network time-outs. Because of various SMTP gates this information may be delivered to SMS, pager or ICQ.

DTP/DIA IN MICROCONTROLLER FIRMWARE

The realization of DTP/DIA in microcontroller built-in software is rather unsophisticated due to simplicity of the protocol. Binary code of packet formation and transmission procedure does not exceed 100 bytes in case of hardware UART in MCU (microcontroller unit).

One of the examples of DTP/DIA implementation is temperature sensor, based on Atmel MCU AT90S2313, which has the following useful features:

- 2K bytes of in-system programmable flash memory;
- 128 bytes of SRAM;
- programmable watchdog timer;
- full duplex UART;
- low power consumption.

Block scheme of device is presented in Fig.2.

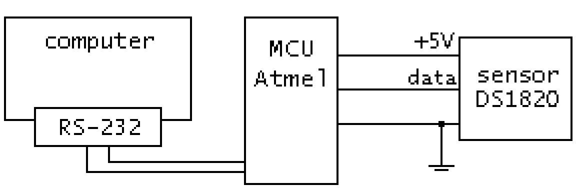

FIGURE. 2
BLOCK SCHEME OF DIGITAL TEMPERATURE SENSOR.

Digital sensor DS1820 (Dallas Semiconductors) is connected to MCU through 1-wire interface in slave mode. MCU puts various commands on data line and sensor replies. The whole cycle of data acquisition includes: sensor reset, temperature registering procedure, another sensor reset, temperature read procedure, processing read data, transmitting the data and sleep period (aimed at power saving). The stage of processing is necessary when digital format of obtained data does not comply with the certain field specification in DTP/DIA. For example, the most common format of DTP/DIA packet assumes the transmitting real physical value multiplied by 10 to escape fractional part (usually, it is sufficient to know value with accuracy of ±0.1).

Lets suppose that we read 19 from scratchpad of sensor (that means temperature of 19°C). Decimal X=19 in binary form is expresses as 00010011. This value should be multiplied by 10 and then be transmitted to computer-collector or retranslator (all calculation must be performed by MCU having no such direct instruction). Multiplication by 10 is appeared to be produced as 8*X+2*X=10*X. Multiplication by 2 and 8 carries out by simple instruction LSL (logical shift left). Once applied, new value in MCU's register is two times greater than previous. Let R0 to be a 8-bit register, then…

command	R0-register (00010011 - initial)	decimal expression in R0-register	action
lsl	00100110	38	*2
lsl	01001100	76	*2
lsl	10011000	152	*2

If the values in the first and third strings are summed the result will be 190.

Each DS1820 has unique 64-bit hardware number. They are partially used in forming Data Source Identifier field in DPT/DIA packets. Due to this feature few sensors may be connected on the 1-wire interface to one MCU. Microcontroller distinguishes various sources, so any distributed network of sensors may be constructed both with use of local and network channels (Fig.1).

ONLINE AIR TEMPERATURE SENSORS NET

On the basis of described protocol the online net of air temperature sensors was created (web version see at http://thermo.karelia.ru/eng/). It covers the territory of Republic of Karelia (North-west Russia). Also one of the sensors is distanced at several thousand kilometers from Petrozavodsk and is situated in Mezhdurechensk (Kemerovsky region). Geographical scheme of Karelian region is presented in Fig.3.

Three letter abbreviations on the map stands for different towns in Karelia. PAA – Paanayarvi, LOU – Louhi, SEG – Segezha, PTZ – Petrozavodsk, SOR – Sortavala. Arrows near the names of towns designate the current rise or fall of air temperature in respect to previous hour value.

All sensors yield data every 5 minutes and transmit them through Internet channels to the collector server situated in Petrozavodsk. Collector, database and web-server software is running on one computer. The main difference between various sensors is the way of data transfer and physical connection of sensors to data transfer devices.

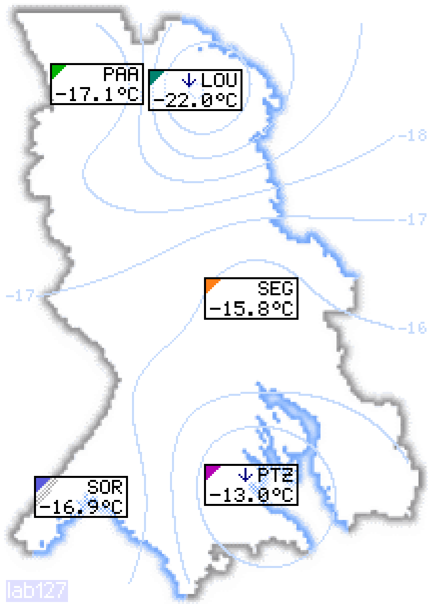

FIGURE. 3
KARELIAN MAP MARKED WITH TEMPERATURE MEASUREMENT POINTS.

Graphs (3-day, 3-week, 3-month and 1-year periods) with time dependence of air temperature are renewed every half hour.

Almost all temperature sensors are connected to network in various ways. LOU sensor is connected to COM port of computer running under Windows NT, SEG – Windows 98. Both are hidden behind firewall. Sortavala's is connected to gate's COM port, which is mapped to certain TCP port (feature of Cisco Systems hardware). All computers except PTZ and Mezhdurechensk (MER) sensors have Internet accessible IP addresses. PTZ and MER have local IP addresses and are translated by NATs (network address translation services). Moreover, PTZ sensor is constructed on not DS1820, but on MAX6577. So data transmission is carried out through FILE channels. To establish more security SSL connection with authentication and certifications was implemented between retranslator and collector computers. PTZ computer runs under Linux, and MER computer runs under FreeBSD.

Collector software stores temperature data from various town in corresponding log files. Web-server software and additional scripts build graphs, banners, and other required for certain web-design objects in HTML-pages.

Due to universality of DTP/DIA the same network channels may be used for transmission of various types of physical quantities. Any packet may include fields for quantity identification, unit measure (for example, °C), confidence interval and accuracy. It is up to collector software to determine each source and physical quantity sent.

ACKNOWLEDGMENT

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GLOSSARY OF ACRONYMS

CAMAC	Computer Automated Measurement And Control
EIA/RS	Electronic Industries Association Recommended Standard
GPIB	General Purpose Interface Bus
HTML	HyperText Mark-up Language
IANA	Internet Assigned Numbers Authority
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IMS	Information Measurement System
OSI/RM	Open Systems Interconnection Reference Model
SMTP	Simple Mail Transfer Protocol
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
TLS	Transport Layer Security
UART	Universal Asynchronous Receiver and Transmitter
UDP	User Datagram Protocol
VXI	VME bus eXtension for Instruments

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PROJETO E CONSTRUÇÃO DE UM POLARISCÓPIO MODELO PARA DISSEMINAÇÃO DA TÉCNICA FOTOELÁSTICA EM ENGENHARIA E EM CURSOS BIOMÉDICOS

Prof.Dr.Perrin Smith Neto and Prof.MsC José Luiz Silva Ribeiro

Resumo- O presente trabalho trata do projeto e construção de um polariscópio modelo, para disseminação da técnica fotoelástica, tanto nas engenharias, como nas áreas biomédicas, com informes sobre sua construção e utilização.
Para fins de projeto, foram feitos estudos sobre os conceitos básicos da Fotoelasticidade, com relação aos elementos constituintes de um polariscópio plano-circular de transmissão, com mobilidade de placas para compensações (principalmente Tardy), instrumento fundamental na área, e sobre a utilização destes conceitos na análise de peças / fatias fotoelásticas. Foram ainda realizadas visitas a várias instituições de renome, que trabalham com polariscópios, levantando-se dados sobre seus equipamentos, a utilização dos mesmos, e as necessidades de um polariscópio na prática da Fotoelasticidade.
O projeto final escolhido foi um polariscópio de construção relativamente simples, para execução em oficina mecânica de usinagem convencional, de pequeno a médio porte, com necessidades mínimas de construção e manutenção. Visou-se, mais do que detalhes mecânicos, a popularização do instrumento e, conseqüentemente, da técnica, no entanto sem perder a flexibilidade do instrumento e a qualidade da imagem. Os materiais utilizados, alumínio, plástico, metalon, bem como os detalhes construtivos, são caracteristicamente atuais, produzindo um instrumento leve, funcional, portátil, de baixíssimo custo e ainda atraente. Embora sua usinagem e montagem tenham sido simplificadas, o equipamento pode ser utilizado, segundo a metodologia de uso indicada, sem nada perder na qualidade de suas análises e em suas principais aplicações

Introdução

A proposta de projeto e construção de um polariscópio modelo, juntamente com a fundamentação da fotoelasticidade, surgiu da necessidade de um polariscópio de transmissão, atualizado, de baixo custo, para a análise experimental de tensões no Laboratório de Análise Experimental de Tensões do Instituto Politécnico da Pontifícia Universidade Católica de Minas Gerais. O estudo do polariscópio, foi voltado para o projeto e construção de umpolariscópio modelo com simplicidade de construção, baixo custo de fabricação, baixo custo de manutenção e flexibilidade de utilização. A técnica fotoelástica é de fundamental importância na solução de problemas relativos à obtenção da distribuição real de tensões em peças e equipamentos,com emprego em várias áreas da engenharia, com ênfase na mecânica dossólidos, na engenharia civil, mecânica, mecatrônica e também em bioengenharia, na área biomédica, em vários campos da odontologia emedicina. Um polariscópio de transmissão básico, não produzido no Brasil, tem um custo aproximado de US$ 18.000,00. O custo do equipamento modelo, construído nas oficinas do Instituto Politécnico da PUC Minas situa-se na faixa de US$ 3.000,00. Este custo é perfeitamente acessível às instituições de ensino do país. A sua usinagem e montagem foram simplificadas para facilidade de construção, sem, entretanto, prejudicar a qualidade das análises efetuadas, podendo o equipamento ser utilizado com eficiência, seguindo-se os procedimentos de utilização desenvolvidos. Para projeto, construção e experimentação, foram desenvolvidos estudos para a fundamentação dos conhecimentos da técnica fotoelástica, sintetizados nesta dissertação, como uma referência básica para aplicação no desenvolvimento de pesquisas no Mestrado e na Graduação. Foram realizadas visitas a várias instituições de pesquisa e ensino, que trabalham com polariscópios, levantando-se dados sobre seus equipamentos, a utilização dos mesmos, e as necessidades de um polariscópio na prática da Fotoelasticidade. Voltadas para a utilização desta técnica, em trabalhos relacionados à mecânica e automobilística, muitas aplicações já se encontram em andamento, estando assim o equipamento subsidiando pesquisas em peças bidimensionais e tridimensionais. A divulgação do presente trabalho, deverá incrementar os estudos relativos ao assunto, nas pesquisas científicas dos cursos de Graduação e nos trabalhos de pesquisa do Mestrado, alguns destes, já em franco andamento, bem como possibilitar o intercâmbio de conhecimento entre outros pesquisadores, em outras instituições que queiram se desenvolver ou iniciar seus trabalhos de pesquisa por este fértil campo.

Tipos de Polariscópios

Utilizando-se arranjos entre os elementos óticos anteriormente descritos, podese obter várias possibilidades de montagem e construção de polariscópios, para diversas aplicações. Como, para cada aplicação, pode-se obter melhor performance com este ou aquele tipo de polariscópio, descrever-se-á sobre os modelos de maior aplicabilidade.

Disposição dos Elementos Óticos em um Polariscópio O Polariscópio Plano

O polariscópio plano é o mais simples dos sistemas óticos usados em fotoelasticidade; consiste em dois polarizadores lineares e uma fonte de luz.cruzados, conforme figura 1.

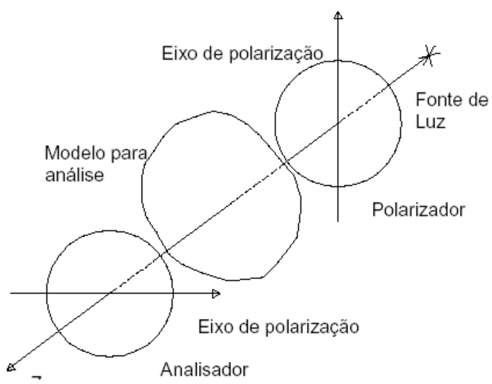

Figura 1- Polariscópio Plano

O linearizador mais próximo da fonte de luz é denominado polarizador e o mais afastado analisador. Neste tipo de polariscópio, se os eixos de polarização são cruzados, nenhuma luz é transmitida através do analisador e esta montagem produz o chamado campo escuro. Em operação, um modelo fotoelástico é posicionado entre os dois elementos e observado através do analisador.

O Polariscópio Circular

O polariscópio circular emprega a luz circularmente polarizada. O equipamentodispõe então, de quatro elementos óticos e uma fonte de luz.

O primeiro elemento a partir da fonte de luz é o polarizador. Ele converte a luz comum em luz plana polarizada. O segundo elemento é uma placa de quarto de onda posicionada em ângulo b = p / 4 em relação ao eixo de polarização.

Esta placa de quarto de onda converte a luz plana polarizada em luz circularmente polarizada. O terceiro elemento, a segunda placa de quarto de onda, é posicionada com o seu eixo rápido paralelo ao eixo lento da primeira. O motivo da presença deste elemento é converter a luz circularmente polarizada em plana polarizada novamente, vibrando no plano vertical. O último elemento é o analisador, com o seu eixo de polarização posicionado na horizontal, com o objetivo de extinguir a luz.

Esta série de elementos óticos constitui a disposição padrão de um polariscópio circular, produzindo um campo escuro. Mais três arranjos destes elementos óticos são possíveis, dependendo tanto do posicionamento dos polarizadores como das placas de quarto de onda. A Tabela 1 descreve estes arranjos:

Tabela 3.1 Quatro disposições de elementos óticos num polariscópio circular.

Arranjo	Placas de ¼de onda	Polarizador e Analisador	Campo
A	Cruzadas	Cruzados	Escuro
B	Cruzadas	Paralelos	Claro
C	Paralelas	Cruzados	Claro
D	Paralelas	Paralelos	Escuro

Tabela 1 Quatro disposições de elementos óticos num polariscópio circular.

Polariscópio de Reflexão

Trata-se de técnica que permite uma visualização global do campo de tensões e deformações a que se submete a peça ou conjunto analisado, não requerendo confecção de modelos, uma vez que a obtenção dos parâmetros se dá diretamente nestas peças, conjuntos ou estruturas, quando estes se encontram submetidos à seus carregamentos reais. O componente ou conjunto a ser analisado necessita ser, primeiramente, limpo, retirando-se qualquer resíduo de tinta, graxa ou sujeira, que possa comprometer a análise. Consiste em aplicar fina camada de tinta reflexiva que, após seca, será recoberta com uma camada de material fotoelástico, utilizando-se de uma cola apropriada, de forma a produzir uma interface entre o corpo a se analisar e a camada, para que, ao se submeter o corpo a um dado carregamento, esta deformação seja transmitida para esta camada fotoelástica. Assim permite-se que as imagens geradas pelos meios óticos, descritos anteriormente, sejam analisadas.

Polariscópio Com Uso de Lentes

Os polariscópios com uso de lentes são empregados somente onde se faz necessário o uso de luz paralela sobre todo o campo de estudo. É também utilizado nas situações onde a luz paralela é importante, incluindo-se aí aplicações onde uma definição bastante precisa de todo o limite do modelo é necessária. Nestas aplicações os reflexos parciais são usados em toda a área fotoelástica, na multiplicação e apuração das franjas. Muitas variações de sistemas de lentes são possíveis.

O Projeto

Para o início do projeto do polariscópio, foram estudados os vários modelos existentes, como polariscópios de luz difusa por transmissão e por reflexão e polariscópios de transmissão com o uso de lentes. Foram feitas visitas técnicas conceituadas instituições como o Departamento de Engenharia Mecânica da Universidade Federal de

Figura 2 Polariscópio de transmissão modelo, construído nas oficinas do Instituto Politécnico da Pontifícia Universidade Católica de Minas Gerais.

Uberlândia; Departamento de Engenharia Mecânica da Pontifícia Universidade Católica do Rio de Janeiro e Centro de Desenvolvimento da Tecnologia Nuclear, CDTN, em Belo Horizonte, Minas Gerais, este último, órgão técnico da Comissão Nacional de Energia Nuclear, CNEN.

Os Componentes do Polariscópio Modelo

A Base do Conjunto

Para a construção da base do polariscópio foi utilizado o perfil retangular em aço ABNT 1020, de dimensões 30 x 50 mm, com espessura de parede de 1,26 mm, cortado e soldado de forma a prover uma base retangular de 400 x 1400 mm. Esta base é diretamente apoiada em mesa ou bancada, tendo como função suportar o conjunto dos sistemas óticos, o sistema de carga, a fonte de luz e o pino de travamento e referência, para a fixação dos dispositivos de registro das imagens geradas. Ao longo da maior dimensão da base, foram usinados furos com diâmetro de 5 mm, para a fixação dos citados conjuntos e do sistema de carga, permitindo ajustes no sentido longitudinal ao eixo do instrumento, possibilitando a inclusão ou retirada de acessórios e fornecendo variadas configurações em função dos objetivos esperados.

.A Fonte de Luz

Para abrigar a fonte de luz do sistema, foi projetada uma caixa fechada, pintada internamente em branco liso, contendo apenas uma saída para o feixe de luz, por meio da fixação de uma chapa de alumínio vazada com a forma circular, onde se fixou externamente uma placa de acrílico branco, denominada placa difusora. Foi também incluída uma placa de acrílico de cor vermelha, para possibilitar o estudo de franjas isocromáticas mais definidas, com o uso de filtro monocromático, conforme descrito anteriormente. Na Fig. 3 tem-se uma vista da fonte de luz montada sobre a base do conjunto sem a placa difusora. Na parte posterior da fonte, foi acrescentada uma veneziana, para permitir a ventilação, evitando o superaquecimento das lâmpadas e das placas difusoras de acrílico. No fundo da fonte de luz foi incluído um ventilador para forçar o fluxo de ar e provocar uma troca de calor eficiente. Vários tipos de lâmpadas foram pesquisados.

Figura 3. Detalhe da fonte de luz e sua montagem sobre as guias de fixação da base do conjunto, observando-se, na parte superior, a veneziana de ventilação.

Em princípio procurou-se no mercado a lâmpada de vapor de sódio de baixa pressão, uma vez que Neto (1980) cita que, este tipo de lâmpada, produz uma luz monocromática, o que poderia ser uma das opções para a fonte. Entretanto, esta lâmpada não é encontrada no Brasil, segundo informações de fornecedores. Também foram estudadas as lâmpadas fluorescentes do tipo Branca Natural, com potência de 20 W, neste caso, ao contrário da lâmpada anteriormente citada, possui excelente espectro de freqüência luminosa, permitindo ótima reprodução de cores. Como fornece somente 650 lúmens de fluxo luminoso e necessita de reatores e outros acessórios, foi inicialmente descartado o seu uso. Outras lâmpadas foram estudadas, tipo incandescentes e fluorescentes compactas, sem melhores resultados, tendo sido escolhidas, então, as lâmpadas de filamento de tungstênio de 300 W, halógenas palito, tipo HA 300 da Philips, podendo ser utilizada outra similar, permitindo assim uma fonte de luz branca e de alta intensidade, emitindo um fluxo luminoso de 5100 lúmens cada, não sendo necessário o uso de reatores ou outros acessórios alem dos suportes das lâmpadas e fiação.

Os Conjuntos Óticos

Os principais componentes do polariscópio são, seguramente, os conjuntos óticos, pois as placas polarizadoras e de quarto de onda são a essência de seu funcionamento. Como um dos maiores fabricantes de sistemas de análise experimental de tensões, o grupo norte-americano Measurements Group, fabricante dos produtos Vishay, foi escolhido para o fornecimento destes componentes não fabricados no Brasil. Foram escolhidas placas polarizadoras lineares nas dimensões de 304,8 x 304,8 mm (12 x 12 pol.), com espessura de 0,762 mm (0,03 pol.), código do fabricante nº 100 -011991, e placas de quarto de onda, código nº 100 -011985, nas mesmas dimensões, sendo todas posteriormente cortadas na forma de disco, com o diâmetro de 300 mm.

Figura 4. Anéis graduados, pré-montados com os anéis retentores das placas de onda e polarizadores.

Para alojar estas placas nos conjuntos óticos, foram construídos quatro anéis graduados em aço inoxidável, com diâmetro interno de 300 mm, contendo marcações de 360 graus (resolução = 1 grau), onde as placas ficam protegidas externamente por meio de lâminas de vidro de 2 mm de espessura, com o mesmo diâmetro das placas óticas, sendo fixadas por meio de um anel retentor, conforme se observa na Fig. 4.Os anéis graduados foram montados em placas de alumínio com a espessura de 4 mm, contendo guias de referência angular de cada lado do conjunto, permitindo a movimentação dos mesmos para a leitura dos ângulos. Cada conjunto ótico é composto de uma placa polarizadora e uma placa de quarto de onda, cada uma com giro livre em relação à outra. Para permitir sustentação e perpendicularismo destes conjuntos em relação à base do equipamento, estas placas de alumínio foram parafusadas em uma estrutura retangular construída em perfis de alumínio e esta, parafusadas à base.

O Sistema de Carga

Nos estudos fotoelásticos, os modelos a serem analisados são submetidos a variados tipos de esforços, para que se analise o seu comportamento em função da aplicação destas cargas na estrutura real ou em desenvolvimento. Para tal, faz-se necessário a utilização de vários tipos de sistemas de carga, contendo diversos tipos de acessórios, entre eles células de carga, que permitem manter o modelo submetido a determinados valores de tensão, enquanto são feitas as leituras de ordens de franja. Na Fig. 5 tem-se a configuração para ensaios em barras submetidas à flexão pura.

Figura 5. Acessórios do sistema de carga, com a configuração para ensaiosde flexão pura

O sistema proposto permite efetuar ensaios de flexão pura, com a utilização de alguns acessórios e ainda de tração ou compressão. Observa-se na montagem a célula de carga e os dispositivos de fixação dos modelos.

Acessórios

Para fixação de uma câmera de vídeo CCD e de outras câmeras (fotográficas ou digitais) utilizadas para a captação das imagens geradas no polariscópio, foi disponibilizada uma haste regulável (nos sentidos longitudinal, transversal e vertical), com as dimensões idênticas às de outros equipamentos disponíveis no laboratório de análise experimental de tensões, permitindo ampla intercambiabilidade destes equipamentos e dispositivos.

Figura 6. Detalhe da montagem do sistema de cargas, com o suporte superior com rolamento. Oficinas da PUC – MG.

Figura 8.Montagem de uma câmera CCD, com seus dispositivos eacessórios, na haste regulável do polariscópio

Discussão e Conclusão

Embora cada componente do polariscópio tenha sido desenhado em AutoCAD 2000 e discutido com a equipe de construção durante o seu projeto, ao longo do processo de construção, algumas alterações tornaram-se necessárias, em função de variados fatores. Alguns componentes em alumínio, por exemplo, foram alterados devido ao fato de que, embora tivesse sido tomado o cuidado de escolher as dimensões dos componentes em catálogos de fabricantes durante a fase inicial, no momento da aquisição, estes não eram facilmente encontrados ou então os fornecedores somente se dispunham a vender quantidades muito elevadas. Para atender aos padrões de comercialização de perfis e chapas no mercado local, foram feitas algumas alterações dimensionais, que não comprometeram a proposta inicial e, em alguns casos, até facilitaram, pois permitiram aquisições de componentes em tamanhos próximos aos da usinagem final, agilizando os trabalhos da oficina.

Embora a maioria dos componentes usados não necessitassem de usinagens complexas, a construção dos anéis graduados tomou, da equipe de idealização e construção, tempo e seguidas discussões. Previsto inicialmente para ser construído em alumínio, logo de início foi alterado para aço inoxidável, para melhor resistir aos esforços de torneamento, sem empenamentos. Também foi este componente que necessitou de mais estudos, junto às empresas que fazem gravação de letras e números, uma vez que normalmente trabalham com uso de fotolito para corrosão por ácido. Ao final, optou-se por termoimpressão, com uso de um padrão em papel vegetal especial, impresso em copiadora de alta resolução, com base em desenho em AutoCAD 2000. Para fixação da tinta nas chapas e demais componentes de alumínio, foram utilizadas tintas e bases especiais para tal, permitindo um acabamento de ótima qualidade. Os componentes mais caros foram as placas polarizadoras lineares nas dimensões de 304,8 x 304,8 mm (12 x 12 pol.), com espessura de 0,762 mm
(0,03 pol.) e as placas de quarto de onda nas mesmas dimensões, em torno de US$ 600,00 (incluindo-se impostos de importação e despesas de transporte). Esta escolha, de tamanho das placas polarizadoras e das placas de quarto de onda, permitiu a obtenção de um campo de ótimo tamanho, possibilitando a
visualização completa de conjuntos mecânicos, que possam ocupar até os 290,00 mm de diâmetro. Vigas com entalhes e componentes mecânicos, por exemplo. Para trabalhos onde é necessária uma ampliação da imagem, ou o estudo de detalhes de uma dada parte de uma peça ou fatia (no caso da técnica do congelamento), pode-se acoplar lentes ao conjunto, ajustando as placas em variadas posições ao longo da base de apoio. Também, podem ser utilizadas câmaras fotográficas reflex, digitais com zoom, câmaras de vídeo e em especial as câmaras CCD, que produzem imagens ampliadas e permitem análises detalhadas de pontos mais críticos do modelo. Os demais materiais utilizados na construção custaram em torno de US$ 2.000,00. A mão de

obra da oficina foi estimada em 100 horas de tornearia e outras 100 em fresadora, plaina e furadeira radial, além de 80 horas de artífices mecânicos e pintura. Levando-se em consideração o custo de aquisição de um equipamento novo, importado, e ainda que este equipamento possua inúmeros recursos e acessórios, será de aquisição muito difícil para uma universidade que tem tantas prioridades de investimento, necessitando de linhas especiais de financiamento junto aos órgãos de incentivo à pesquisa ou empresas que trabalhem ou venham a trabalhar em parceria com a instituição. Só para se ter uma noção de valores, o polariscópio do Centro de Desenvolvimento da Tecnologia Nuclear, CDTN, recentemente adquirido por aquela instituição e, ao qual, alunos e professores tiveram acesso para seus estudos, por meio de convênio, foi avaliado por seus técnicos em torno de US$ 45.000,00. Sem os citados acessórios seu preço de custo diminui para aproximadamente US$ 18.000,00, portanto, um polariscópio básico, de custo em torno de US$ 3.000,00, torna-se uma alternativa simples e extremamente econômica para a realidade brasileira. Ainda durante a construção, diversos cuidados foram tomados para o alinhamento do sistema de fixação dos conjuntos óticos sobre a base. Foram executados furos contíguos, ao longo da base do conjunto, com distanciamento de 50 mm, para permitir que o sistema de cargas e as placas pudessem ser movimentados longitudinalmente, sem que se comprometesse o paralelismo do conjunto, podendo ser, por exemplo, utilizado externamente a fornos / estufas, realizando trabalhos com peças aquecidas. Na pesquisa de tipos de lâmpadas foram estudadas várias possibilidades, sendo escolhida a de filamento de tungstênio de 300 W, halógena tipo palito, permitindo uma fonte de luz branca e de alta intensidade, que emite um fluxo luminoso de 5100 lúmens, não sendo necessário o uso de reatores ou outros acessórios. Para possibilitar análises em materiais modelados com a técnica de congelamento, para fotoelasticidade tridimensional, foram instaladas duas destas lâmpadas, permitindo um feixe de luz mais intenso. Embora tenha sido instalado um ventilador, para evitar o excessivo aquecimento da fonte de luz e, principalmente das placas difusoras branca e vermelha, após alguns minutos de utilização, estas placas de acrílico se dilatavam, dificultando a troca de uma pela outra, quando aquecidas. Uma pequena diminuição na largura das citadas placas resolveu este problema. Com relação aos filtros vermelhos utilizados, tanto na fonte quanto na câmara fotográfica, ainda que os mesmos possam auxiliar a leitura de ordens de franja, não produzem um efeito monocromático perfeito. Foi utilizado, também, um filtro de cor amarela na câmara fotográfica, sem resultados positivos na avaliação de franjas, uma vez que várias tonalidades de cor foram observadas com seu uso, sem uma definição tão boa quanto a obtida com o filtro vermelho. Os padrões de franja apresentados nos modelos carregados, são ricos em informações, podendo sugerir os pontos onde se pode obter atenuações de tensões apresentadas, com pequenas alterações na geometria da peça e outras medidas, permitindo, em alguns casos, a diminuição de espessura ou quantidade de material empregado, reduzindo assim custos em toda a escala produtiva. Este é um dos mais importantes usos do polariscópio, podendo fornecer aplicações didáticas para várias disciplinas, tanto de cursos de engenharia (mecânica, mecatrônica, civil, etc.) como Resistência dos Materiais, Elementos de Máquinas, etc., como para odontologia (próteses, implantes dentários, brocas e ferramental), entre outras, onde se estudem os efeitos de tensões. O fato do polariscópio não possuir giro sincronizado das placas polarizadoras e de quarto de onda diminui a produtividade dos trabalhos de análise. Entretanto, tal fato não diminui a qualidade das medições efetuadas e, à medida em que o usuário se familiariza com seu uso, adquire uma prática que acelera a leitura necessária. A utilização de marcações prévias sobre os anéis graduados, com números impressos com rotuladores, também é outro fator de agilização e confiabilidade de que os ângulos de rotação estão mantendo as placas em sincronia e que o mesmo se mantém plano ou circular, em função do que se pretende avaliar. Quando se utilizam dois operadores, um girando as placas e o outro observando a imagem, as análises são otimizadas, principalmente quando se utiliza o método de leitura ponto a ponto, que exige a mudança de configuração plana e circular a cada leitura. Na utilização prática do polariscópio, observou-se que estas mudanças são normalmente feitas em incrementos angulares de 5º em 5º ou 10º em 10º, para que se encontre o ponto correto de leitura. O uso de papéis adesivados coloridos, tipo "Post-it", para fixar a referência do zero relativo é outra alternativa que foi utilizada com ótimos resultados, permitindo a leitura ponto a ponto nas marcações efetuadas no modelo. Em suma, com alguns recursos de marcação e prática na utilização, pode-se perfeitamente realizar análises fotoelásticas eficientes, sem a obrigatoriedade de mecanismos de sincronização. O uso de imagens dos modelos tensionados pode, também, ser obtida por fotografias, em especial quando se quer analisar as direções das tensões principais, quando pode-se observar toda a peça ou fatia completa. Após fotografarem-se o modelo com as franjas isoclínicas, pode-se, opcionalmente,
digitalizá-las para os estudos que se pretende fazer. Pode-se ainda transcrevêlas em uma folha de papel contendo o desenho do modelo e, a partir delas, traçar as curvas isostáticas. No caso das franjas isocromáticas pode-se estimar os valores das diferenças de tensão principal por interpolação. Dentre os materiais utilizados na construção do polariscópio destacam-se, em primeiro lugar, o uso intenso do alumínio, permitindo que o mesmo ficasse bastante leve, sem perder a

rigidez necessária para manter as formas originais, seja durante seu uso ou por pequenos esforços que possa sofrer. Também foi utilizado o nylon, na construção dos anéis internos, cuja finalidade é permitir um giro suave dos anéis graduados e prender as placas óticas entre dois discos de vidro de espessura de *2 mm* para cada uma delas. O uso de acrílico leitoso para as placas difusoras, nas cores branco e vermelho, apresentaram, também, resultados muito bons, permitindo a geração de um feixe de luz difusa sobre todo o campo visual. Com o emprego destes materiais, o equipamento ficou leve, compacto, portátil e assim pode ser facilmente transportado em função dos trabalhos que serão realizados com ele. Embora simples, trata-se de um polariscópio completo, tratando-se portanto de um equipamento atual eútil para a pesquisa e docência na Universidade. Na fase de projeto, foi prevista a possibilidade de se efetuarem algumas melhorias que incrementassem o uso do polariscópio. Uma opção, comumente encontrada em polariscópios mais sofisticados, refere à inclusão de mecanismos que efetuem o giro sincronizado das placas óticas. Para tal, modificação faz-se necessária a mudança da espessura dos anéis internos (que fixam as placas óticas nos anéis graduados externos), passando os mesmos a servir como polias, e ainda a instalação de eixos longitudinalmente ao equipamento, contendo polias menores para afixação de cintas, feitas com finos cabos de aço, permitindo o citado giro sincronizado. Para tal, é preciso ainda realizar a remodelação da estrutura de fixação das placas óticas, com aumento do distanciamento entre elas, para conter tais anéis internos. Uma segunda opção, caso se obtenha nova fonte de recursos, é a possibilidade de instalação de uma ou mais fontes monocromáticas. Neste caso, geralmente necessita-se desmontar a fonte difusa e montar umapequena fonte monocromática, com reatores acoplados ou em separado (no caso de fontes realmente monocromáticas). Tratando-se somente do uso de lâmpadas com melhor definição monocromática, as mesmas podem ser adaptadas à fonte existente, tal se repetindo com o uso de lâmpadas incandescentes ou fluorescentes comuns.

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Abstract

Studies were performed on the basic concepts of Photoelasticity, regarding the constitutive parts of a transmission plane-circular polariscope, with mobility of the lenses for compensations (mainly Tardy), which is a fundamental tool for the technique, and on the use of these concepts in the analysis of photoelastic parts/slices. Several wellknown institutions, which work with polariscopes, were also visited to obtain information about their equipment, its use, an the need of a polariscope in the practice of photoelasticity.

The chosen final project is a polariscope with a relatively simple construction, to be executed in a small to medium large machining workshop, with minimal construction and maintenance needs. Rather than detailing the mechanisms, the project aimed widespreading the use of the device, and therefore of the technique, without loos of device flexibility or image quality. The materials used -aluminum, plastic, steel profiles- as well as the constructive details are characteristic of up-to-date techniques, producing a device which is light, effective, portable, of very low cost and also attractive. Although its machining, construction and assemblage have been simplified, the equipment can be used, following the indicated methodology, without any lose in the quality of the analysis or in its main applications

DEVELOPMENT OF A SOFTWARE TO BIDIMENSIONAL STRESS ANALYSIS USING PHOTOELASTIC FRINGES

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Abstract- The work has as objective the development of a software of bidimensional stress analysis, capable to process and to analyze images of patterns of photoelastic fringes, obtained of plane polariscops in an automatic way, using a minimum amount of information supplied by the operator. The processing includes the obtaining of the difference between the maximum and minimun normal stress, maximum shear stress ;directions of the maximum normal stresses,isocromatics fringes and isoclinics.This software will allow studies of stress distribution in bodies of complex geometries submitted to several loading and to verify for instance, areas of high stress gradient. The method presented satisfactory results in photoelastic images generated by simulation, however it was not shown satisfactory in treatment of real experimental images. That is probably due to the fact that the methods of phase shifting, thoroughly published in the literature, are based on source of monochrome light, while the equipments used in the measurements used white light, in other words several wavelengths. In the development of phase shifting methods for white light - same that the camera is monochrome - the spectrum of the luminous source, and the answer should be known from the camera ccd to the luminous excitements of different spectra. . Concerning the analysis of monochrome images (that were generated by simulation), the processing presented satisfactory results, as described in the literature.

Introduction

Photoelasticity is a whole field technique that allows one to obtain principal stress directions and principal stress differences in the model. Photoelastic fringe interpretation, in the classical approach is made manually in a punctual form. Modern techniques that uses digital image processing for automatic fringe counting are based in some phase shifting methods.

Many authors proposed the use of more than one wavelength to produce a phase shift in photoelastic patterns. The RGB photoelasticity uses this principle, acquiring the image using a RGB video camera and then separating the red, green and blue images.

Others suggested the half fringe photoelasticity, where only one fringe in permitted in isochromatic pattern. Using this approach, one can obtain isochromatic parameters easily, but with less resolution.

Recent approaches are based in load stepping, where one increases (or decreases) the system of loads acting in the model, making the phase shifting. This approach is not so generic, because in tree-dimensional photoelasticity, one cannot change the loads acting on the slices.

Finally, one can change the photoelastic phase modifying some polariscope arrangements, such as quarter wave plate positions or analyzer positions. This approach seems to be the most simple, because has not restrictions in static applications and does not require RGB cameras or different light filters, although the phase-processing may not be the most simple.

In this work one uses the four image phase shifting method proposed by N. Plouzennec and others, because of the fact that the experimental arrangement is simple, using only a plane polariscope and image recording devices.

Phase shifting

The light emerging from a plane polariscope has the intensity given by

$$I = \frac{I_0}{2}\left[1 + \cos(2\beta - 2\alpha)\cos(2\alpha) - \sin(2\alpha)\sin(2\beta - 2\alpha)\cos(2\pi N)\right] \quad (1)$$

where α is the direction of principal stresses, β is angle between analyzer and polarizer, N is the fringe order and I_0 is the image contrast.

To obtain photoelastic parameters α and N from a plane polariscope, one must introduce a phase shifting. Using four phase shifts, one obtain four different expressions from equation 1, so that this system can be solved for the wrapped (discontinuous) parameters.

The first image is collected when β is taken equal to zero and the polarizer axis is placed at +45º from the reference axis. The equation 1 then turns:

$$I_1 = \frac{I_0}{2}\left[1 - \cos^2(2\alpha)\sin^2(\pi N)\right] \quad (2)$$

Now placing the polarizer axis parallel to the reference axis and making the angle β equal to +45º, 0º and 90º, equation 1 turns, respectively:

$$I_2 = I_0\left[0.5 + \sin(2\alpha)\cos(2\alpha)\sin^2(\pi N)\right] \quad (3)$$

$$I_3 = I_0\left[1 - \sin^2(2\alpha)\sin^2(\pi N)\right] \quad (4)$$

$$I_4 = I_0 \sin^2(2\alpha)\sin^2(\pi N) \quad (5)$$

Parameters determination

The solution of the system of equations 2 trough 5 is:

$$\tan(2\alpha) = \frac{2I_4}{2I_2 - I_3 - I_4} \qquad (6)$$

$$\cos(2\pi N) = \frac{2I_1 + 2I_3 - 3I_0}{I_3 + I_4} \qquad (7)$$

If one take the atan of expression 6, will obtain a discontinuous (wrapped) phase. This happens because atan function has image between -π/2 and + π/2. So, one must do the phase unwrapping. Many researchers have been working in phase unwrapping algorithms, mainly in radar SAR processing. The most simple method is based in the detection of discontinuities and add + π/2 or -π/2 in these points.

Another widely used method in noisy data is the unweighted least squares method, based in the minimization of the total phase discontinuities. Treating this problem through variational analysis, one reaches a partial differential equation problem, the solution of the poisson equation. In rectangular regions the homogeneous poisson problem has a fast explicit solution based in discrete cosine transforms.

Another method, more simple then the least squares approach, is based in the detection of discontinuities of the phase derivatives. When these discontinuous points are detected, in these points one make an interpolation from it's neighborhood. Then these phase derivatives are integrated again. This algorithm was used for this work.

It is important to note that equation 6 is not defined when $2I_2 - I_3 - I_4$ is equal to zero. In some cases, there are regions where it happens, for example, when the isochromatic fringes are too thick, and the term $\sin^2(\pi N)$ is equal to zero not just in the center of the fringe, but in a region around the its center. So, it is important to use image processing routines to make interpolation or to blurr these regions.

To obtain the correct fringe number, one must unwrap from the acos of equation 7. This task is more complicated, since the discontinuous points in this case are not so apparent, the kind of discontinuity is different from those of atan function. To illustrate this problem, in figure 1 one can see an example of a continuous phase φ, and the wrapped from atan(tan(φ)) and from acos(cos(φ)). The algorithm to treat the acos discontinuous phase is based in the detection of places where the derivatives change the sign suddenly.

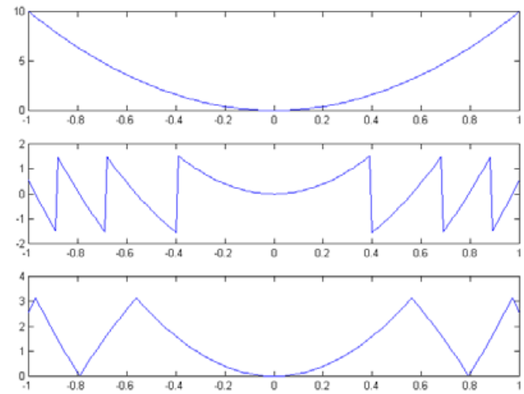

Figure 1. Different kinds of discontinuity. a) An example of continuous phase φ. b) The wrapped phase from atan(tan(φ)). c) The wrapped phase from acos(cos(φ)).

Application

A software were developed for photoelastic analysis using the methods described in this work. Some image processing routines were implemented, such as filters and region of interest processing. Also were implemented phase filters, specially designed for discontinuous data, and a masking routine, to eliminate regions of where the phase is not defined, based in harmonic methods.

The model is a disc under compression. The disc thickness is 5mm, the radius is 60mm, the applied load is 355 N, and the photoelastic constant is 13 KN/m. The images used in this application are shown in figure 2. The rectangular area marked in the images is defining the region used for the processing. The filtered wrapped isoclinic angle is shown in figure 3, and the unwrapped can be viewed in figure 4. In figure 5 one can see the wrapped fringe order, and in figure 6 the unwrapped fringe order.

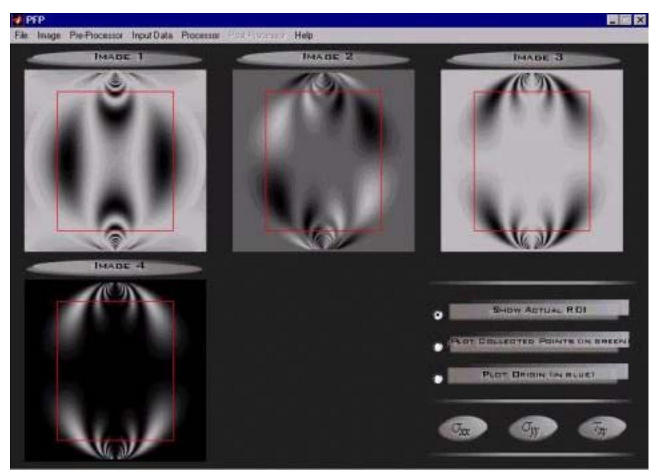

Figure 2. Four images used

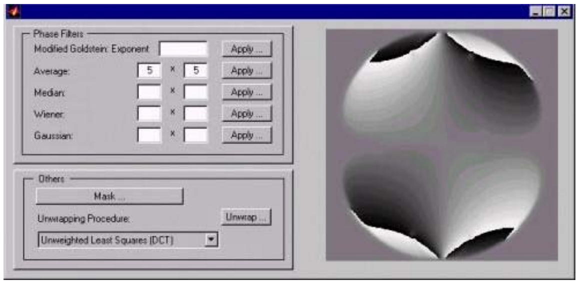

Figure 3. Filtered wrapped α

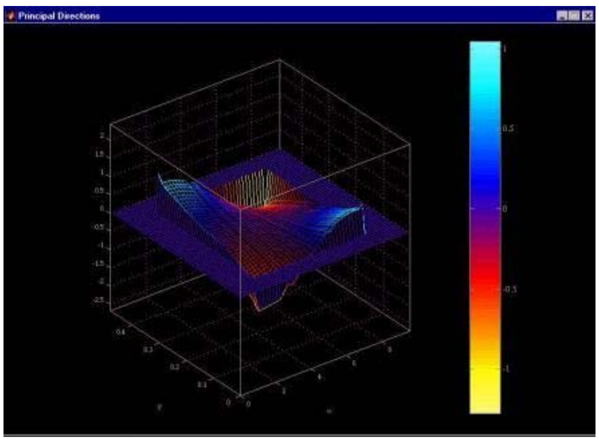

Figure 4. Unwrapped α

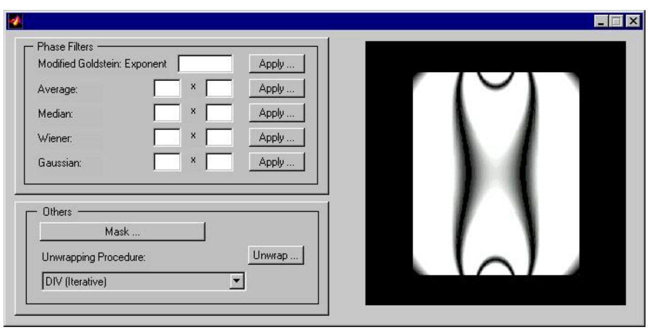

Figure 5. Fringe order wrapped phase

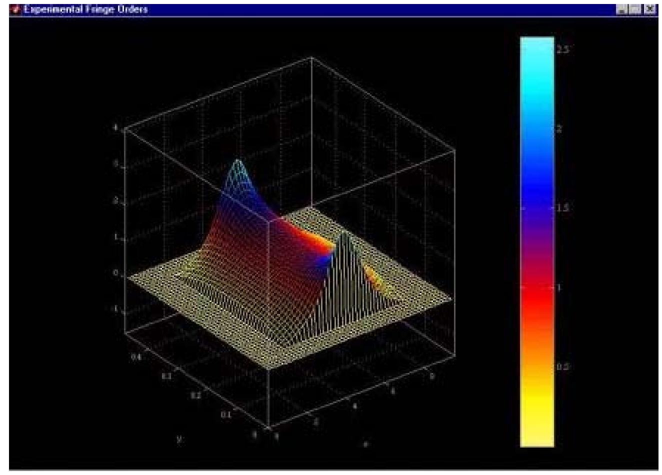

Figure 6. Fringe order unwrapped

Conclusion

Phase shifting in photoelasticity is an important tool in whole field analysis. Different ways to shift a photoelastic phase were proposed by many authors. The change in polariscope parameters has been shown to be the simplest form to do it. In this work were used a four images method, applied with image processing routines, such as blurr functions, region of interest processing, and filtering routines. Different phase unwraping algorithms were used to obtain the continuous photoelastic parameters, the direction of principal stresses and the fringe order for the whole field. An application to a disc under compression were made.

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IMPACTOS DA TECNOLOGIA DA INFORMAÇÃO NA PRODUÇÃO DE PUBLICAÇÕES CIENTÍFICAS ELETRÔNICAS

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Abstract *— This paper is a result of an academic research. A study that identifies and tracks the impacts caused by Information Technology (IT) to routines and abilities of productions and use of scientific publication, on a community of Science and Technology (C&T). It is also related to technical literature productivity, as well as, institutional visibility. This research has been developed through a study case. An auto-managed electronic questionnaire and semi-structured interviews had been used for data field collection. The e-mail was elected as the main medium of communication with the participants. Therefore, the "electronic reply behaviour" was also object of investigation. The conclusions indicate that the community assumed and legitimised the electronic communication mediated by computers. They perceive IT as a differential of autonomy, optimisation of processes, time saving and a mean of institutional visibility. Significant alterations had been identified in internal and external communication flows. They were also observed on relationships among invisible colleges and peers, on increase on the real work produced and on productivity. The scientific community recognise the benefits of remote access to bibliographical databases and to digital full texts.*

Index Terms — Information Technology Impacts, Electronic Scientific Publications, Scientific Communication

CONTEXTUALIZAÇÃO DA PESQUISA E APORTE METODOLÓGICO

O conhecimento humano é um componente fundamental na agregação de valor aos ativos de produção - tecnologia, matéria-prima, recursos humanos, informações e capital financeiro - ao potencializar competências e sustentar a competitividade de pessoas, grupos e nações. De maneira geral, toda e qualquer organização social transaciona com informação, conhecimento e saber para impulsionar suas atividades caraterísticas. Entretanto, algumas delas têm, naturalmente, vocação ao uso e geração intensivos desses recursos como as universidades, os institutos públicos de pesquisa (IPPs), as sociedades científicas e os centros industriais de pesquisas, desenvolvimento e inovação (P&D&I).

Este trabalho pretende contribuir para o conhecimento das mudanças ocorridas no processo de uso e geração de publicações científicas percebidas por uma comunidade de pesquisa em Ciência e Tecnologia (C&T), exposta às inovações da TI. As análises e reflexões aqui registradas são oriundas de pesquisa desenvolvida em tese de doutorado. O foco de observação e questionamento foi colocado nas modificações positivas e negativas que a comunicação online provocou comportamento de uso e produção de publicações científicas eletrônicas, entre pesquisadores de um Instituto Público de Pesquisa em Tecnologia Nuclear.

A pesquisa foi desenvolvida como um estudo de caso por tratar-se de um método adequado à abordagem de fenômenos sociais complexos, relativos a sujeitos com características ou natureza semelhantes. Através dele, é possível apreender a dinâmica de relacionamento entre as organizações e os indivíduos que as integram, assim como as relações que estabelecem com o meio ambiente (Marshall e Rosnam, 1995; Pereira, 1999).

Foram utilizadas diferentes fontes bibliográficas e testemunhais de dados, visando compor o cenário da situação, a partir de diferentes olhares: autores, pesquisadores, usuários, gerentes institucionais e de informação, agentes de fomento e editores científicos. Foram enviados 417 questionários eletrônicos aos pesquisadores de carreira da instituição. Os entrevistados (17) foram escolhidos por indicação interna e externa (pesquisadores e executivos da casa, agentes de fomento e editores cientifico). Os dados foram tratados estatisticamente e as entrevistas gravadas foram submetidas, após transcrição, à análise de conteúdo (discurso) e análise estatística como resume a Tabela 1.

Com essa "triangulação" pretendeu-se ressaltar os aspectos positivos e negativos que, na opinião dos todos os envolvidos, transformados em sujeitos da pesquisa, ressaltam a passagem do uso da publicação em papel para a eletrônica.
Tabela 1

Tabela 1 - Instrumentos de pesquisa

	Contato	Uso	%	Tratamento
Entrevista	17 pessoas	17 utilizados	100,0	Análise de conteúdo e estatística
Questionário	417 enviados	127 utilizados	27,0	Análise estatística

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AS TECNOLOGIAS DE COMUNICAÇÃO E INFORMAÇÃO ELETRÔNICAS NO AMBIENTE DE PESQUISA

Resultado de longo e complexo fluxo de observações controladas, o conhecimento em Ciência e Tecnologia (C&T) está intrinsecamente associado à dinâmica dos processos de comunicação. A disseminação de novas idéias é parte integrante das práticas de pesquisa e promovem trocas de informação entre indivíduos e grupos de interesse, através de meios especializados (Levy, 1993).

A Ciência propicia reordenações sociais e, ao mesmo tempo, recebe da sociedade respostas que iniciam novas demandas. Nesta linha, as inovações à Tecnologia da Informação (TI) e aos processos de comunicação eletrônica provocam reações variadas nas esferas sociais que sensibilizam. São ferramentas inéditas de acesso e divulgação de conhecimentos de toda ordem. Utilizam recursos tecnológicos de informática e telecomunicações para registrar e disseminar informações via redes eletrônicas de computadores (Van Der Kam et al., 2000).

Têm provocado mudanças irreversíveis não só aos processos de troca de informações como também às condições de inclusão de pessoas e organizações no mundo digital. Em particular, transforma processos e relações estáveis entre segmentos sociais específicos, dos quais recebe aprovação e/ou desprezo (Castells, 2000; Webber e Johnston, 2000).

Especialistas de diferentes áreas do conhecimento buscam identificar causas e efeitos desse complexo jogo entre as estruturas e as relações sociais, onde tecnologia é focalizada com destaque (Harnard, 1995; Dervin, 1998, Orlikowski, 1992; Friedlander, 2001). As tecnologias da informação e da comunicação modificam os processos e relações de produção na medida em que pressionam a sociedade a adotar formas inéditas de operação. O conhecimento e a informação substituem, em grande parte, o capital e o trabalho enquanto variáveis econômicas de agregação de valor. A informação emerge como força produtiva dominante, modificando a lógica da economia e do regime tradicional de acumulação de riquezas. Também amplia e estimula os investimentos desmaterializados como P&D, licenças e registros de patentes e treinamento especializado (Dantas, 1999).

As vantagens competitivas baseadas em atributos materiais deslocam-se para características como valor de mercado, tecnologia, design, formação profissional, marcas e grifes. A relativização do tempo e do espaço nos ambientes digitais e cibernéticos também são fatores de impacto ao descaracterizar os esquemas e processos de vigentes de organização do trabalho e da produção (Herkert e Nielsen, 1998; Stanworth, 1998).

Não é possível afirmar que uma nova tecnologia, quando introduzida em um ambiente organizacional, é benéfica por si. É necessário que ela se integre ao sistema social vigente através de mecanismos particulares e únicos de assimilação. Nesta ótica, a incorporação de novas de tecnologias é, em maior ou menor grau, modelada e apropriada pelos grupos sociais, através de conceitos e abordagens próprias (Rosenbaum, 1997). Avaliações pragmáticas e empíricas sobre impactos das inovações tecnológicas dão conta de que, no curto e médio prazos, as vantagens à elas associadas desestabilizam os padrões sócio-econômico-culturais vigentes (McMurdo, 1996). No entanto, por sua origem e função, a tecnologia também está exposta às pressões e reações da sociedade.

Ambas as posições visam antecipar que mudanças nos cenário social, econômico e político podem ser esperadas à medida que a TI é difundida entre as várias dimensões sociais. Assim sendo, é importante observar como as comunidades científicas reagem às pressões para adoção de novos modelos de registro e difusão do conhecimento, fundamentais `a produtividade e visibilidade no seu meio ambiente.

As pressões de mudança imprimidas pela TI estão presentes em todas as atividades P&D&I, inclusive na produção e divulgação de registros do conhecimento acumulado, representadas pela publicação científica. Assim sendo, os modelos tradicionais (não eletrônicos) de criação, arbitragem, edição e disseminação do conhecimento em C&T, também estão sendo estruturalmente modificados pelas inovações aos processos de comunicação (Ubell, 1997; Gomes e Meadows, 1998; Sabbatini, 1999; Costa e Meadows, 2000). Neste novo cenário, Maculan e Soares (2000); Costa (2000) e Hurd (1996 e 2000), afirmam que o processo de produção de publicações científicas eletrônicas está buscando uma identidade própria.

MODIFICAÇÕES À LÓGICA DE PRODUÇÃO DE PUBLICAÇÕES CIENTÍFICAS: DO ACERVO AO ACESSO

A comunicação eletrônica fez com que a lógica do acervos bibliográficos baseados na garantia literária dos documentos impressos fosse substituída, em parte, pela lógica do acesso, ou seja, pela gestão de conteúdos multimídia. Gradativamente, as práticas orientadas por um modelo analógico migram para outro, de natureza digital (Min e Rada, 1994). Da mesma forma, os processos de organização e tratamento dos dados deverão alterar, sobremaneira, os procedimentos clássicos de concepção (projeto) e geração (produção) de produtos de conteúdo digital (Cox, 1998).

Nesse momento, é perceptível o caráter ambíguo das facilidades e restrições na oferta de produtos eletrônicos do conhecimento e, em particular, da publicação científica eletrônica. Na busca de uma identidade própria, haverá um momento de ruptura nos conceitos e na lógica de operação de ambos os modelos (Lancaster, 1995; Costa et al., 2001; Friedlander, 2001)

Até meados dos anos 80, o trabalho baseado no conhecimento era orientado à provisão de serviços e produtos de informação baseados em papel (registro, armazenamento e recuperação).

A passagem da "economia industrial" para a "economia digital" promoveu a evolução de conceitos, tecnologias, formatos, suportes e mídias. O novo foco amplia, evolui e diversifica o escopo da atividade. Apesar de modificações aos processos vigentes, não é possível afirmar que as práticas tradicionais da "era industrial" foram ou mesmo que serão abandonadas no futuro. O foco está sendo deslocado:

- do suporte material, recipiente ou embalagem para o conteúdo e a mensagem;

- do texto impresso, linear e estático para a dinâmica de navegação por hipertextos;
- da pesquisa e acesso locais para pesquisa e acesso remotos;
- da postura reativa (suprimento da demanda explicitada) para a proativa (provimento da demanda potencial);
- da linguagem controlada para a linguagem livre;
- de acervos físico-materiais para acervos ótico-digitais;
- de sistemas isolados para redes integradas;
- de processos pré-concebidos (produtos de prateleira e customizados de massa) para produção sob encomenda, diferenciada ou pós-formatada;
- da garantia de permanência dos registros (longa vida útil do papel) à incerteza dos suportes magnéticos e eletrônicos;
- da gestão da informação para a gestão do conhecimento;
- de grandes volumes de papel para pequenos e diversificados lotes de produtos de informação.

Como qualquer atividade produtiva, os processos de geração e entrega de bens do conhecimento (produtos de informação) envolvem:

- a geração (criação de dados e fatos inéditos e/ou captação no meio ambiente);
- o processamento (reelaboração, ou seja análise e codificação da "matéria-prima" para sua melhor utilização);
- o armazenamento (estocagem de produtos acabados ou semi-prontos até que possam ser distribuídos); e
- a distribuição (entrega de bens em formato, meio, volume e tempo determinados pelo cliente). Podem ser desenvolvidos por uma única pessoa ou empresa ou por um conjunto de parceiros (Zack, 1996; Loges e Jung, 2001).

O conceito mais recente de produto de conteúdo vincula-o, em definitivo, ao ambiente digital WWW. Pode ser definido como unidades ou conjuntos de dados, textos, sons, imagens e suas combinações multimídia, apresentados em formato analógico ou digital e registrados em memória magnética ou óptica (SOCINFO, 2000).

Atributos como precisão, atualização, oportunidade, flexibilidade e customização são características esperadas de produtos de conteúdo ditos, de qualidade. Como aspectos positivos para sua produção e consumo podem ser lembrados:

- possibilidade de entrega eletrônica, em diferentes formatos e tamanhos;
- desenvolvimento de novos tipos de demanda e clientes; e
- modelos inéditos de agregação de valor (autor - editor - publicador - distribuidor - agentes de intermediação - usuário).

Quanto às restrições e os desafios, são representados por:

- relação com parceiros ou com clientes;
- criação e manutenção de infra-estrutura de produção e veiculação;
- políticas de investimentos, de preços e de promoção; e
- defesa de propriedade intelectual.

A nova ordem digital apresenta situações onde as facilidades e restrições do mundo eletrônico misturam-se às referências e rotinas do mundo analógico. Apesar das vantagens que apresenta, ainda existem questões complexas a serem equacionadas. Referem-se à política de preços, versões gratuitas, propriedade intelectual, dificuldades ergonômicas, barreiras culturais, conteúdos arbitrados, entre outras (Harnard, 1995).

Para Kling e McKim (1999, p. 891), a publicação eletrônica "é um documento primariamente distribuído através de meio eletrônico. O meio de distribuição é o fator que define sua natureza pois uma publicação eletrônica pode ser impressa, a posteriori, para leitura e circulação". A elaboração e formatação do texto através de computadores e softwares especializados também reforçam sua natureza eletrônica.

As transformações radicais estão concentradas na logística do processo pois a conectividade e a acessibilidade permitidas pela tecnologia e pelos canais, meios e equipamentos de transmissão, alteram os padrões tradicionais de entrega do produto e seus desdobramentos. Referem-se ao acesso a textos integrais, interseção de textos, seleção e elaboração de perfis de interesse, bancos de endereços eletrônicos, remessas e cobranças automáticas, suporte ao cliente. Trata-se de mais um diferencial no processo de agregação de valor (Harnard, 1995; Harter e Park, 2000).

A conquista definitiva de confiança dos usuários de publicações científicas eletrônicas está diretamente ligada à garantia de que os atributos de acessibilidade, confiabilidade e publicidade, centrais nos modelos baseados no papel, sejam preservados e consolidados no suporte eletrônico.

A portabilidade do meio permite eficiência no acesso e na transferência, seleção e organização em bancos de dados, reordenação de formatos, uso de partes do texto sem necessidade de redigitação.

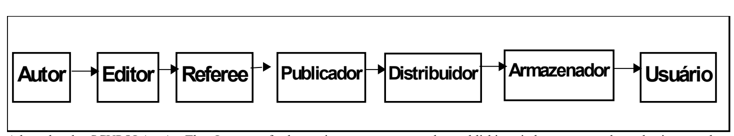
Em contrapartida e apesar das questões ecológicas, o papel tem seu lugar garantido na facilidade de manuseio, portabilidade e possibilidade de contato, visão do todo, forte padrão cultural e barreiras tecnológicas menos restritivas - falhas técnicas, inoperância e incompatibilidade eventual entre sistemas e redes (Wurman, 1992).

MODELO DE PRODUÇÃO DE PUBLICAÇÕES CIENTÍFICAS ELETRÔNICAS

Nos modelos econômicos globalizados crescem as exigências por condutas adequadas aos processos não poluentes, baixa escala e/ou diversificação da produção, baixo consumo de matérias-primas e energia, uso intensivo da tecnologia de informação e ênfase nas habilidades e qualificações humanas.

A Figura 1 demonstra as possibilidades de relação e acesso entre os diversos elos da cadeia de produção de bens e de agregação de valores. Cada combinação supõe uma forma específica de arranjo técnico e acesso eletrônico.

Figura 1: Atores da cadeia produtiva de publicações científicas



Adaptado de SCUPOLA, A. The Impact of electronic commerce on the publishing industry: towards a business value complementaring framework of electronic publishing. *Journal of Information Science*, v.25, n.2, p.135, 1999.

A modificação estrutural da informação contida nos relatos científicos e acadêmicos, não mais circunscritos à lógica linear de um texto impresso, proporcionam interação direta e multidirecional ao conteúdo (Barreto, 1999). Kling e McKim, (1999) indicam que apesar de reestruturados, os movimentos de produção permaneceram inalteradas. O que muda é a relação tecnologia - suporte - veiculação.

Os aspectos ligados à cultura da confiabilidade das publicações, devem e precisam continuar os mesmos. É necessário acessibilidade, confiabilidade e publicidade independentemente do seu meio de geração, distribuição e acesso.

COMPETÊNCIAS PARA A PRODUÇÃO DE PUBLICAÇÕES CIENTÍFICAS ELETRÔNICAS

As tecnologias de base eletrônica criaram demandas por novas competências de produção. A consolidação do setor será validada pela capacidade de resposta de seus profissionais aos desafios que se apresentam (Harnard, 1995; Rowley, 2000).

A gestão do conhecimento propicia a adaptação e a adequação de aspectos organizacionais críticos à sobrevivência e à soberania das empresas, face às instabilidades ambientais. Não obstante às facilidades e à precisão conseguidas através de técnicas avançadas, os processos de combinação e sinergia nos ativos de informação têm como característica-chave a inclusão das pessoas que agregam valor à informação (Sviokla, 1996).

A questão cultural da mudança é a variável mais difícil de ser entendida e controlada. Os profissionais de informação, como bibliotecários e jornalistas são, potencialmente, os principais agentes na modificação de atitudes e comportamentos relativos à mesma (Davenport, 2000). Ainda segundo o autor, corroborado por Bock (1999), pela natureza da função e do conjunto de instrumentos e estratégias de abordagem dos segmentos usuários, esses profissionais podem influenciar as mudanças e a remoção de preconceitos sobre ambiente eletrônico e seus produtos (Hickey, 1995; Mahroum, 2000).

Também está fortemente condicionada ao estabelecimento de relações saudáveis consistentes entre consumidores, provedores e promotores de informação. Trata-se de uma área de negócios em expansão, para a qual os IPPs poderão ser beneficiados, através de parceiras. Diferentes segmentos sociais poderão associar-se às comunidades científicas, para provimento de conteúdo avaliado e reconhecido para portais temáticos de C&T, bases de dados especializadas, aplicações educacionais e multimídia (Stephenson, 1998).

Outro desafio para o setor e seus profissionais está na complexidade de recuperação de registros não inscritos em tecnologias digitais, assim como os "ruídos" na busca de publicações ou páginas eletrônicas sem a chancela do conteúdo avaliado. Devem ser consideradas as questões éticas, legais, financeiras e de credibilidade relacionadas à veiculação e à exploração de direitos autorais de conteúdos em ambientes como a Internet.

Com base nos trabalhos de Hietink (1997) e Borgman (2001), recomenda-se a criação de programas de orientação aos autores e usuários de publicações científicas eletrônicas. Devem abordar os pontos-chave do produto, em seus aspectos fortes e fracos, pautando-se por considerações quanto à:

Acessibilidade

- garantia de permanência do documento na Web, por um longo período e, principalmente, se foi efetuada alguma publicidade ou divulgação da obra.
- Registro da publicação em algum meio eletrônico eficiente e durável (permanente) de registro magnético.
- Acessibilidade garantida por um meio ou endereço eletrônico confiável e disponível online a qualquer tempo ou período.
- Disponibilidade a qualquer cidadão ou membro da comunidade de acordo com as regras estabelecidas para acesso (gratuito, pago, senha).
- URL - Unified Related Locator (endereço eletrônico) estável e permanente.

Confiabilidade

- Conteúdos não podem ser modificados, indiscriminadamente.
- Diferentes versões de um mesmo documento devem ser claramente identificadas.
- Confiabilidade baseada em padrões institucionalizados e reconhecidos de credenciamento como um sistema de arbitragem e o própria credibilidade do autor.
- Deve possuir autoria explicitada com, pelo menos, um autor devidamente identificado (nome, instituição, endereço).

Publicidade

- O público ou os usuários potenciais devem ser informados, de alguma maneira, da existência da publicação.
- A publicação necessita gerar ou possuir uma quantidade suficiente de metadados e outras informações que a identifiquem e que possibilite sua recuperação direta ou através de metabuscadores.

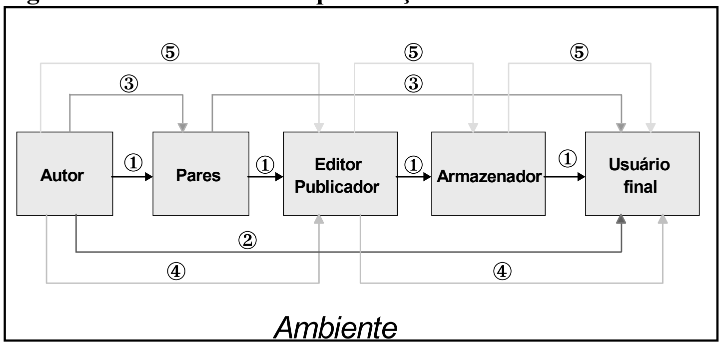
A Figura 2 mostra as várias possibilidade de se publicar na Web. O esquema clássico e modular ①inclui todos os atores e movimentos herdados do processo em papel. É perfeitamente transferível para ambientes eletrônicos e, para alguns casos, é o mais indicado.

No entanto, outras combinações podem ser efetuadas. O autor pode disponibilizar seu texto/publicação na Web e sensibilizar diretamente o usuário final ②.

Pode ainda, em uma terceira variante, submeter seus conteúdos ao processo de avaliação e referagem e, em seguida disponibilizá-lo na rede, através de sites pessoais e/ou temáticos ③.

Outra chance ④está na passagem da origem (autor) `a produção gráfico-editorial para então chegar aos leitores. A última forma ⑤, inclui o autor, o editor/publicador, o armazenador e o usuário final.

Figura 2: Possibilidades de publicação em ambiente eletrônico



① Do autor para os pares, para o editor, para o publicador, para o armazenador, para o usuário final

② Do autor para o usuário final

③ Do autor para os pares e para o usuário final

④ Do autor para o editor/publicadores, para o usuário final

⑤ Do autor para o editor/publicador, para o armazenador, para usuário final

As bases teórico-conceituais tratadas nesta parte, encaminham esse relato `a sumarização dos resultados aferidos no processo de pesquisa.

OS RESULTADOS: MUDANÇAS E DESAFIOS

De maneira geral é possível afirmar que a acordo com o modelo da estruturação de Giddens (1989), a comunidade científica pesquisada percebe claramente que as inovações tecnológicas na comunicação eletrônica modificaram suas rotinas e processos de trabalho.

Ao alterar o acesso e a difusão do conhecimento (comunicação, normas e significação), a TI alcança e modifica as competências profissionais dos sujeitos, da concepção à operação e gerenciamento do processo produtivo (poder, procedimento e dominação). Os parâmetros de avaliação de resultados e produtividade (sanção, condutas e legitimação) também foram reconsiderados. Porém, são perceptíveis e ativos os filtros de aceitação e rejeição criados pela comunidade, frente àquelas pressões.

Os ambientes de pesquisa possuem, naturalmente, predisposição em avaliar e assumir inovações. Na coleta de dados e, principalmente nas entrevistas, foi possível registrar depoimentos de pesquisadores que estão à frente do "tempo digital" da maioria das pessoas. Talvez por isso mesmo tenham sido indicados para o contato.

No geral, o grupo estudado está em fase de conhecimento, experimentação e eleição das facilidades proporcionadas pela TI. Usando o depoimento de um entrevistado "eu sinto que estão surpresos: ao mesmo tempo eufóricos e assustados".

As transformações são encaradas como fator de desenvolvimento que pressiona e remove antigos padrões de conduta. Percebe-se que alguns foram rapidamente substituídos e assimilados, como os referentes aos meios de comunicação. Outras mudanças, como a atividade de publicação científica, seguem um pouco mais devagar.

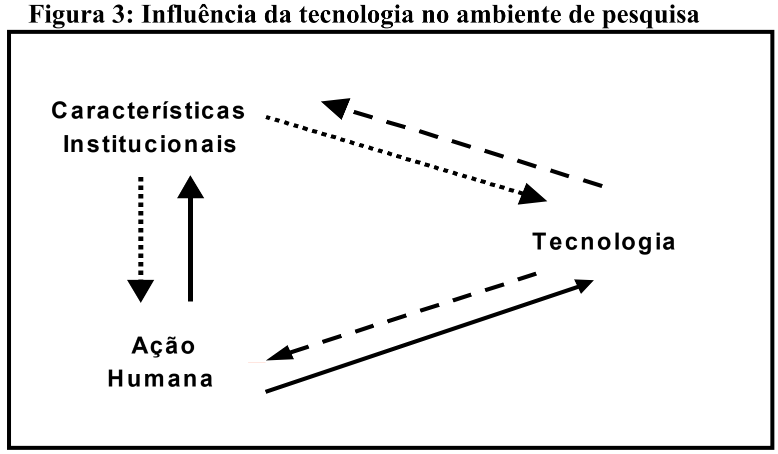
O fato talvez se relacione, diretamente, com a urgência e a necessidade primeira e constante de comunicação. É a base para que todos os outros componentes possam ser utilizados e, necessário, modificados.

Ficou claro que as pessoas estão se integrando ao novo modo de operação. É um processo que demanda tempo e trabalho pela existência de componentes culturais fortemente incorporados (como o uso de documentos impressos) e diferenciados no comportamento de cada grupo (hábitos, motivação e valores para publicação).

Os aspectos de segurança, confiança e autonomia estão privilegiados nas falas da população pesquisada. Através delas foi possível inferir que possuem capacidade de ação, interação e intervenção em processos e rotinas que envolvam tecnologia de informação. Com alguma criatividade e reforço externo, sua condição natural de "puxar e proagir" pode ser aproveitada e estendida aos membros menos ativos da comunidade.

A informática foi criada e se ampliou, integrando a TI por ação humana. Agora e mais uma vez, modifica as rotinas humanas em função de facilidades e condições de uso que apresenta. Essa é a característica básica da recursividade ou dualidade da tecnologia, como está colocado na Figura 3, ‘a página anterior. Ela indica que em ambientes de Ciência a Tecnologia também é fonte de pressão. Estrutura-se e amolda-se de acordo com as reações e tempos de assunção de cada comunidade, em particular (ações humanas).

Figura 3: Influência da tecnologia no ambiente de pesquisa



Processo interno e externo de comunicação

Na comunidade estudada, a Web já é central como estratégia e veículo de comunicação. Reforça e suprime outros canais de comunicação, modifica posturas e procedimentos de trabalho e tem graus de aceitação maiores ou menores, mais rápidos e mais lentos.

Especificamente para a comunicação, as mudanças foram muito bem aceitas e incorporadas pela comunidade. Na pesquisa, todas as perguntas que envolviam comunicação eletrônica foram maciçamente indicadas como primeira fonte ou primeiro recurso.

É perceptível que as organizações em geral e, em particular, as instituições de pesquisa em C&T, estão transferindo seus fluxos de comunicação e informação baseados em papel pelos registros digitais. A característica principal da primeira é a estabilidade e permanência. Porém, traz como herança, volumoso legado em papel. A maleabilidade e a flexibilidade dos aportes digitais trazem consigo a ambigüidade e instabilidade que podem gerar desconfiança. Seu processo de apropriação deve envolver todos os participantes pois a tecnologia é flexível e a interação dos diferentes contextos sócio-históricos se faz através da interseção de relações e comprometimento.

Da análise dos dados recolhidos, foi possível concluir que as mudanças referentes à comunicação foram bem aceitas. A comunidade reconhece e valoriza o esforço institucional de atualização tecnológica, tanto na modernização de processos (acesso à Internet/Intranet) como na melhoria da infra-estrutura (expansão da rede física e outras instalações).

Também espera que a comunicação organizacional seja exteriorizada através de estratégias de organização eletrônica do conhecimento (sítios, bases e páginas Web) e em processos específicos de gestão do conhecimento (técnico, científico e organizacional).

Comportamento de busca, uso e credibilidade de publicações científicas eletrônicas

Constatou-se o comprometimento e o envolvimento do grupo pesquisado quanto aos novos modelos eletrônicos de comunicação - mas não, necessariamente, com aqueles de publicação científica. A ausência de um programa instituído de publicação científica foi citada de várias formas e em vários depoimentos. Parece urgente e estratégico que sejam efetuadas ações que corrijam esta disfunção.

No esforço da formação de consumidores e produtores de documentos eletrônicos, são necessários procedimentos mercadológicos e campanhas de esclarecimento sobre as reais possibilidades e limites do novo meio.

Quanto ao processo de publicação eletrônica, como um todo, percebeu-se que alertas válidos e significativos convivem com alguns mitos sem fundamento. O que para alguns é apenas mudança de formato, por outros já é percebida como profunda e irreversível transformação. Características aparentemente físicas e externas da publicação, seu suporte material, agora sensibilizam as esferas ideológicas da questão. Todas as estruturas (recursos) dessa cadeia produtiva estão sendo transformadas: dos aspectos mais evidentes aos mais teleológicos.

Através dos depoimentos e das entrevistas foi possível identificar que cada ator não sabe, exatamente, o que incomoda mais pois o transtorno está diluído por todo o processo. Autores, editores, publicadores, bibliotecários, gestores e usuários buscam explicações e soluções ao seu universo imediato. No entanto, além de um fórum ampliado e permanente de discussões que privilegie todos os elos dessa cadeia, é necessário um certo período de tempo para identificação e observação dos fenômenos.

Algumas referências podem ser potencializadas nesse processo. O sistema de arbitragem por pares é central em sua escala de valores e exigências. É central na atividade baseada em papel e assim deve permanecer na digital. Esse pode ser o lastro mais significativo na credibilidade e difusão das publicações eletrônicas.

Da mesma forma, as normas e legislação existentes não se adequam ao novos suportes por basearem-se na materialidade do papel. É preciso urgência na reorganização desse referencial. Até os processos de aquisição de material bibliográfico estão sendo afetados. Nas instituições públicas, por exemplo, à cada compra ou empenho aprovado é atribuído um lote de patrimônio, um objeto físico que deverá ser cadastrado à sua entrega. Como se cadastra e se patrimonia uma transmissão online? Como guardá-la? Como registrá-la?

Atividades de editoração atingem, preferencialmente os editores. Porém, é importante que estes falem do seu trabalho, facilidades, crenças e verdades aos outros "elos" da cadeia. O problema é que fazem parte da mesma cadeia mas não são, necessariamente, parceiros. Portanto, o contato fica comprometido.

Comportamento de produção e disseminação de publicações eletrônicas

A adoção, pelos pesquisados, dos processos de comunicação eletrônica e das facilidades Web, podem ser aproveitados para capacitação paralela – para a geração de publicações eletrônicas - à medida em que se consolidam os hábitos e a confiança pelo uso da inovação. No caso, associando-lhes funções importantes e corriqueiras através da rede: busca e recuperação de dados e informações; envio de documentos únicos ou em lotes e produção de textos coletivos digitais. A criação de setores virtuais de inteligência e armazenamento coletivo de informações nos IPPs podem ajudar na "vascularização" dos fluxos internos e externos de informação.

Todavia, é preciso conhecer os perfis dos grupos envolvidos, sintonizando demanda, necessidade e oferta de soluções. A adesão e o reforço aos canais de comunicação eletrônicos faz transformar outros aspectos da vida dos cidadãos. Estar ligado 24 horas na Web e no e-mail é condição importante para uns. Outros, no entanto, se sentem invadidos pelo trabalho, pelo tempo e pela tecnologia.

Os periódicos científicos arbitrados continuam sendo os preferidos da maioria, principalmente agora que estão mais acessíveis (textos integrais). O trabalho de desmistificação - se for o caso - das publicações eletrônicas pode começar por eles!

A comunidade parece aberta à inovações desde que seja (ou esteja) convencida, segura ou se sentido livre, autônoma. A questão da autonomia na Web é ambígua, como a própria instabilidade digital. Qualquer modificação ou falha no sistema ou na rede física (externos, estruturais e poderosos) deixa a todos reféns da situação!

Capacitação para produção para publicação científica eletrônica

A habilidade de criar, armazenar e acessar informações e documentos digitais é fundamental à permanência e soberania das empresas e das pessoas. Nesse caso, a gestão do conhecimento enquanto um processo de monitoração ampliado, pode diferenciar as organizações

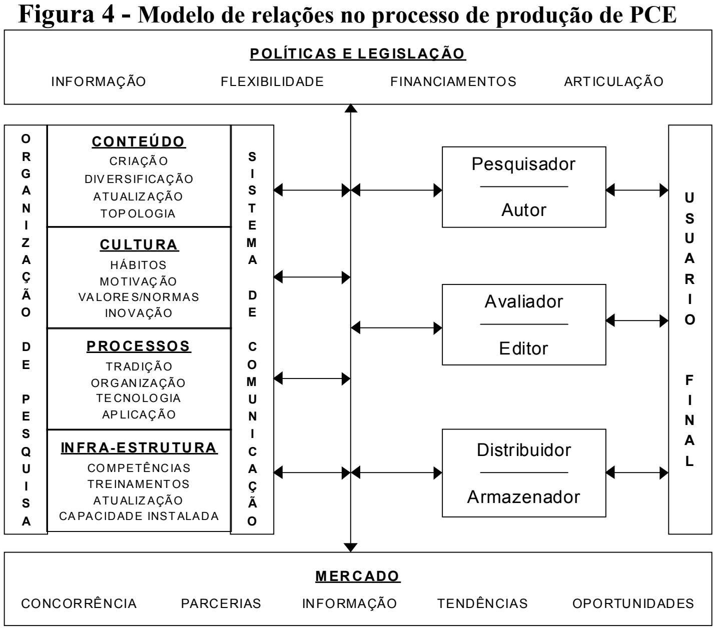
Ao organizar o fluxo contínuo (e eletrônico) da informação preserva a memória, a história e o futuro da organização. É propício à implementação de Programas Institucionais de Comunicação e de Publicação e de Sistemas de Gestão do Conhecimento. Velocidade de processamento, capacidade de reunir maior número de dados é o que têm feito diferença. No entanto, em respostas às pressões da TI, a comunidade estudada tem assumido apenas o que lhe parece seguro e adequado.

Estratégias políticas e mercadológicas poderiam ser introduzidas ao seu ambiente principal: Programas de Incentivo à Publicação Eletrônica, Clube de Autores Virtuais, Programas de Formação de Editores Científicos Web, e treinamentos que otimizem os recursos Web. E ainda, palestras de esclarecimento sobre as publicações científicas eletrônicas em que os autores, as instituições de pesquisa, as agências de fomento, as editoras e os prestadores de serviços pudessem ser envolvidos e associados.

Modelo de relações estruturais para a produção de publicações científicas eletrônicas

Na Figura 4 está proposto um modelo de relações e organização dos aspectos estruturais que integram o processo de produção e disseminação de registros eletrônicos do conhecimento. Basicamente, as relações devem ser ampliadas e espelhadas ao longo da cadeia produtiva, aproveitando-se as posssibilidades de comunicação dirigida e múltipla. Facilitam o entendimento, a cooperação e as transações dentro da mesma cadeia.

Figura 4 - Modelo de relações no processo de produção de PCE



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PRODUCING DISTANCE COURSES WITH XML

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Abstract

To take advantage of the asynchronous telelearning, documents representing courses must fit appropriate characteristics. The most important of these characteristics is the ability of the courses to adapt itself to the learner profile. The courses must also be interactive, structured, multimedia, web compatible, etc.
The purpose of this paper is to show how using XML and its associated tools is the way to fit all of these characteristics. It also describes the manner these characteristics are integrated.

Keywords

Tele-learning, distance courses, XML, adaptativity

1 Introduction

This study is a part of the SMART-Learning (System for Multimedia Adaptative and coopeRative TeleLearning) project at the RIM research unit (Réseaux Informatiques et Multimédia) at EMI. The goal of this project is to provide courses to distant learners without any space or time constraint, including the possibility of having synchronous sessions (real time) for the conversation between the various actors intervening in the process of learning (learners, trainers...). In addition, the fundamental goal is the adaptability of the courses to the learner according to pedagogical requirements and learner capabilities [1].

Generally, courses that are available on the Internet are hypertext documents. The structure of the hypertext and the reading modes it leads to are opposed to some educational principles. A learner can access any pedagogical sequence of a course without order constraints of these sequences and without having the preliminary knowledge. Consequently, the teaching objectives (specialty, type of training...) aimed by the access to the course will not be reached. In our view and to ensure a pedagogical learning, the course must take account of the learner profile (capacities of training, previous knowledge, language,...) and the learner evolution (prerequisite, speed of knowledge acquisition...)[2].
Another limitation of the hypertext is that the course has no structure and its content is mixed with presentation markers, which makes it impossible to automatically process the course.

In order to meet the courses needs in telelearning, it is necessary that the course document fits the following characteristics:

(i) The course must be a hypermedia or at least a hypertext document, in order to guarantee the interactive aspect of the course,
(ii) It must moreover be written in a syntax allowing it to be put on the Web,
(iii) The course document must be able to reproduce the course structure and contents,
(iv) It must also be modular. A course part can be added or updated without changing the whole structure,
(v) The document must be structured so that its manual or automatic processing is easy,
(vi) The course document must respect a course model previously defined on pedagogical bases,
(vii) The structure as well as the content must be independent of the presentation aspect of the course in order to allow the modification of the document style in a global and content independent manner,
(viii) The course is a hypermedia document that must be able to guarantee the synchronization (or scenarization) of the media it contains,
(ix) Finally and overall, to guarantee the adaptability of the courses which is a very important feature allowed by the telelearning.

We will show, in the continuation of this paper, how XML and its associated tools make it possible to guarantee, to the documents which represent our courses, the characteristics that we have just listed. We applied and tested these methods in our SMART-Learning system.

2 Course characteristics in SMART-Learning

SMART-Learning is mainly asynchronous. It provides courses to distant learners without any space or time constraint. The objectives of the SMART-Learning course structure is to fit the characteristics defined above and take advantage of the asynchronous telelearning.

The power of SMART-Learning appears in the ability of the courses to be adapted according to the learner profiles, as well as the ability of cooperating through the document.

We are mainly interested in presenting the model for structured and adaptative courses in the Internet (characteristic (ix)). The course structure is essential to satisfy the objectives listed above including the adaptability objective in SMART-Learning. It must allow the production of a generic course which will be used to generate a specific course at the moment of the training

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(figure 1). This model provides the general structure of a course in such way that the sequences presented to the learner are adapted to his profile and to the training level he wishes to reach.

Figure 1 shows how adaptability is processed in SMART-Learning. This schema will afterwards be realized using XML technology which is the only one that allows, in the same time, the adaptability and the other characteristics.

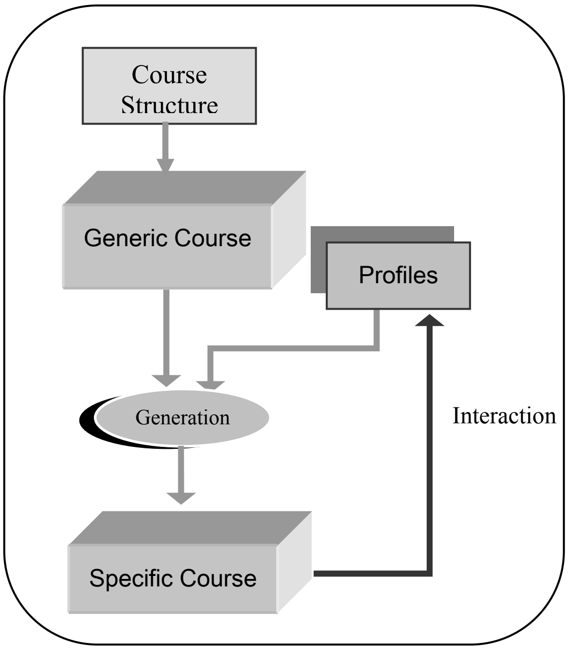

Fig. 1: Learning Process in SMART-Learning

The generic course is intended for all profiles. It is a document which contains, in addition to the learning material, the pedagogical expertise of the trainer. A generic course must take into account the various objectives pursued by the course and the various profile types of the learners who will have access to the course.
This approach makes it possible to generate for each learner, based on his profile, a specific course by using a generation system (figure 1) during the training while the learner is accessing the course. If, for example, the learner profile is modified following the result of an evaluation, the course will be automatically regenerated so as to consider the new knowledge obtained by the learner.

3 Course structure in SMART-Learning

In order to fit the above listed characteristics as well as the pedagogical process, we defined a structure for the course document of SMART-Learning which will be then represented in XML

The production of a course is based on an educational design, which is used to structure the contents in order to facilitate the learning. The course structure must take into account the following criteria [3]:

- To stratify information in order to take account of the complexity levels and to adjust it with the preliminary knowledge of the learner (characteristic (ix));
- To structure the presentation in media elements in order to facilitate the selection, the organization and the integration of information to be presented to the learner (iii, vii, ix);
- To produce the course in several languages in order to improve its deployment for a larger number of possible learners (ix);
- To consider the use of various media (text, audio, video...) which encourages the learner to take a telelearning course (i, ii, viii),
- To take in consideration all the details, even the optional sequences of the course (illustrations, reminders...). In a traditional teaching, the trainer is present at the time of the training and can add missing information or make a not initially considered reminder, whereas in a telelearning application, if the contents of the reminder are not initially considered, teaching will be then defective (i, iii),
- To have a hierarchical structure to represent the course document (iii, iv, v).

The generic course is then seen like a set of pedagogical sequences (PS) structured as a tree with a single root (figure 2). Each sequence constitutes a distinct whole. It can be a course, a chapter, an evaluation or other. A pedagogical sequence (PS) is then broken up into other pedagogical sequences or elementary pedagogical sequences of the lowest granularity. The leaves of the tree constitute the contents to be presented to the learner, they are the media elements (ME).

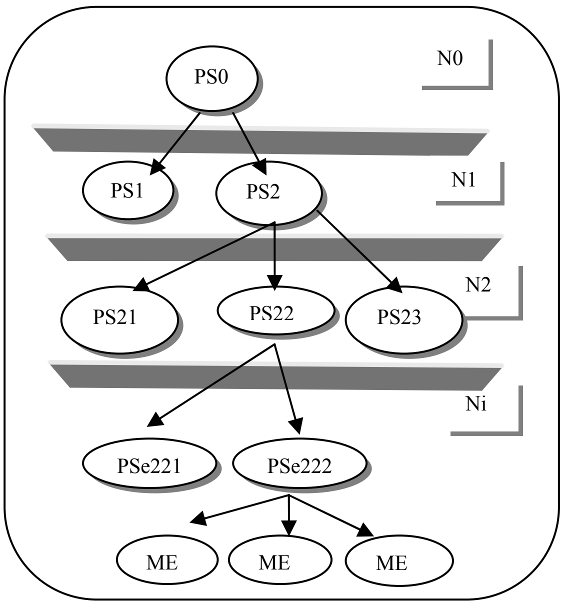

Fig. 2 : Course structure example

Moreover, this structure is valid for any courses whatever the teaching modes to which the designer is used (module, course, unit, etc) to conceive his course. All he has to do is to use the equivalence interface of SMART-Learning. This interface guarantees the equivalence between the terminology of our structure and that used by the course designer [4].

For adaptability reasons, each component (PS, PSe and ME) is annotated by a set of selection criteria which will be used by the learning process in order to generate or not the component according to the learner profile at a given moment. Thus, we defined four categories of selection criteria :

- Educational : this category describes the educational criteria that the course designer must define before the production for training needs. The most significant is "the pedagogical objective". For example, "engineer training" or "technician training";
- Psychological : this category describes all the psychological factors which determine the way of learning. For example, the understanding level;
- Localization: this category describes all the criteria which facilitate and improve the communication between the course author and the learners. For example, the course contents language and other regional characteristics;
- Technical : this category describes the technical needs (flow, hardware characteristics,…) to generate the components which will be presented to the learner according to his environment.

This structuring approach makes it possible to keep the same course structure and to change, for each profile, only the part of the contents which relates to it. It also makes it possible to avoid the errors which result of updating different course versions intended for different profiles. For example, the update of the contents of the PS1 (figure 3) is done only once for the two types of training (engineer and technician) instead of updating two different versions, one for the engineers and the other for the technicians, which could easily involve errors or omissions [2].

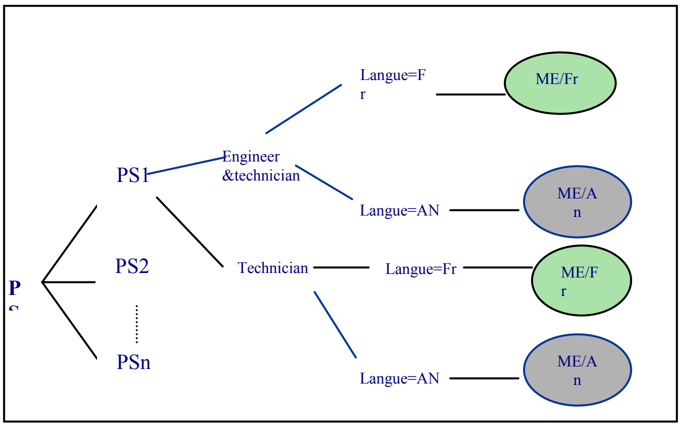

Fig. 3 : Example of relations between the criteria

4 XML AS A SOLUTION

HTML is, of course, the first solution which comes to mind for representing a course on the Internet. However, it fits only three of the characteristics we defined (i, ii and viii).

The XML language, reputed by its facility to exchange complex document on the Internet, is in fact the ideal solution to fit all SMART-Learning and telelearning courses characteristics we defined earlier. XML comes with a set of tools based on XSL, DTD-Schemas, CSS and parsers.

4.1 Hypermedia structured documents on the Web

The eXtensible Markup Language (XML) allows to write hypermedia course documents (i, ii) just like the HTML, but gives in addition the possibility of defining new personal tags contrary to the HTML which presents an extremely rigid and present tagging set.

The possibility of creating his own tags makes it possible to represent any type of document and thus the courses which we defined with adapted tags. The hierarchical structure of XML corresponds to the course structure of SMART-Learning (fig. 2) and thus fits the characteristics (iii and iv).

The automatic processing of course documents (v) is made possible by the XML associated parsers like XT of James Clarck [6], Xalan from Apache [7] or others. The tagging language also allows, by the means of name spaces, the use of several vocabularies in the same document. We can, in particular, represent the tags corresponding to the course structure and the tags corresponding to rules of time precedence between the elements. The synchronization language SMIL (Synchronized Multimedia Integration Language) integrates in this manner into any XML document and thus a course. It conforms, itself, to the XML syntax. In SMART-Learning, the media elements could thus be sequenced and scenarized (viii).

4.2 Definition of course types

It is important, in any telelearning system, to be able to define a course model which corresponds to a pedagogical or presentation method that all the courses must respect (vi).

XML allows it using the DTD (Document Type Definition) concept which is a model which makes it possible to define a document class for SMART-Learning courses. Each document corresponds then to an instanciation of the DTD. Schemas are even more flexible than DTDs to define more rigorous documents types.

3.3 Separation between content and presentation

The great drawback of HTML is the mixing of the content and the presentation instructions (format, style) in the same document. This makes the contents very difficult to locate and thus to update. It is also very delicate to apply the same presentation style on the same level of text, the section titles or the listings, for example.

These difficulties are overcome (vii) with XML and the associated tools. The structure and the contents of the document are described in an XML document whereas the presentation is defined in an associated document which can be described with several style definition languages depending on the desired presentation. We currently use the first version of CSS. CSS2 will allow much more possibilities when it is recognized by the various browsers. These possibilities will be more increased with the even more complete language XSL:fo.

Current browsers visualize XML documents. However, not all of them recognize the whole set of the XML associated tools functions. It is however always possible to transform an XML file into HTML using XSLT by associating formats described in XML to it. The transformation into HTML allows the document to be then visualized on any browser. This phase will be definitively abandoned when all the browsers are able to recognize XML and its tools.

4.4 Course adaptability

The adaptation of the course according to the user profile is made possible using XSLT. It will first of all be necessary to adopt a structure defining the relation between the course and the profile as in the case of SMART-Learning.

XSLT can transform an XML document into another XML document according to present selection criteria. In SMART-Learning, these criteria (educational, of localization) can be associated to any element of the course (PS, PSe, media). Thus, a generic course, containing all the possibilities, will be transformed into a specific course thanks to an XSLT document which includes specificities of the learner profile (figure 4). In fact, the general transformation parameters contained in the generic XSLT document are transformed using the profile values.

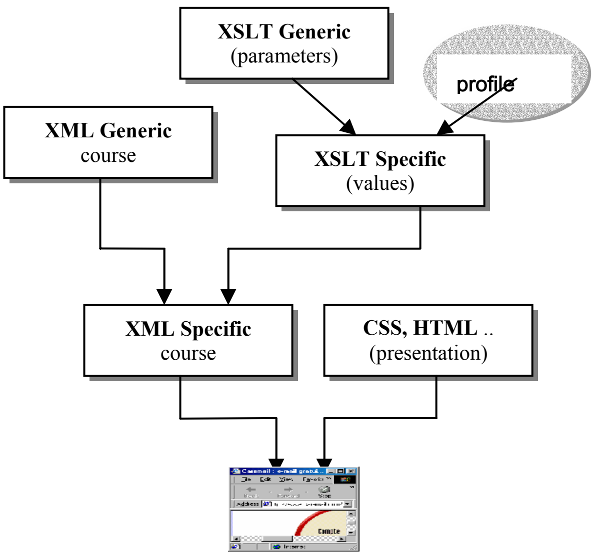

Figure 4: Successive transformations of a SMART-Learning course

Figure 4 also shows how is made the final transformation, using CSS and even XSLT to transform into HTML so that the course can be visualized on a Web browser.

4.5 The XML course transformation processes

This section details how the XML tools allow selecting a learner profile in order to prepare step by step the content that corresponds to a learner according to his profile.

A course or a part of it is represented by a pedagogical sequence. There will be only one generic XML document (see listing 1) to represent a PS, valid for all learner profiles(Engineer, technician, french, english ...). Thus, for each learner profile, it will be enough to apply the adequate XSLT transformation on this generic course.

Let's take the example of a simple course part:

P. XML generic course

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE EPS SYSTEM "course.dtd"
[
<-- media element reference -->
   <!ENTITY titrefr SYSTEM "titrefr.txt">
   <!ENTITY planfr1 SYSTEM "planfr1.txt">
            ---------------------------------------------
]>
<PSE id_PSE="ch1med2">
   <PSE_Obj_Pedag Val=" engineer+technician">
            <PSE_Language Val="french">
                        <Media type="text" url="" id_Style=""
                        niveau_Media="1">&titlefr;</Media>
                        --------------------------------------------
                        <Media type="text" url="" id_Style=""
                        niveau_Media="2">&planfr1;</Media
                        >
            </PSE_Language>
            <PSE_Language Val="english">
                        <Media type="text" url="" id_Style=""
                        niveau_Media="1">&titreen;</Media>
                        <Media type="text" url="" id_Style=""
                        niveau_Media="2">&planen1;</Media
                        >
                        ------------------------------------
            </PSE_Langue>
            </PSE_Obj_Pedag>
   <PSE_Obj_Pedag Val="technician">
            <PSE_Language Val="french">
            ---------------------------------------------
            </PSE_Language>
            <PSE_Language Val="english">
            ---------------------------------------------
            </PSE_Language>
   </PSE_Obj_Pedag>
</PSE>
```

Listing 1 : Generic XML course

Knowing that each learner has a given profile which is supposed to change constantly during all the learning process, it is impossible to predict all possible XSLT transformations that could be applied to the XML generic course. This led us to choose a solution with a generic

XSLT file (see listing 2) containing the parameters representing the profile.

Generic XSLT transformation

```
<xsl:transform
xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
version="1.0">

<xsl:variable name="PSE_Language" select="''"/>

<xsl:variable name="PSE_Obj_Pedag" select="''"/>

        <xsl:template match="/">
                <xsl:for-each select="PSE">
                <xsl:choose>
<-- instructions de transformation --------->
                        ---------------------------------
<xsl:when test="contains(@Val,$PSE_Obj_Pedag)">
                        ---------------------------------
                        </xsl:choose>
                </xsl:for-each>

        </xsl:template>
</xsl:transform>
```

Listing 2 : Generic XSLT transformation

Let's give the following values for a simplified profile:

Profile	
Pedagogical objective	Engineer
Language	French

Table 1 : Profile

Thus, the parameter setting of this generic XSLT by the profile elements will dynamically give an XSLT specific to this profile (see listing 3) containing the values corresponding to the profile(table 1):

Specific XSLT Transformation

```
<xsl:transform
xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
version="1.0">

<xsl:variable name="PSE_Language"
select="'french'"></xsl:variable>
<xsl:variable name="PSE_Obj_Pedag"
select="'engineer'"></xsl:variable>

        <xsl:template match="/">
                <xsl:for-each select="PSE">
                <xsl:choose>
<-- instructions de transformation --------->
                        ---------------------------------
<xsl:when test="contains(@Val,$PSE_Obj_Pedag)">
                        ---------------------------------
                        </xsl:choose>
                </xsl:for-each>
        </xsl:template>
</xsl:transform>
```

Listing 3 : Specific XSLT transformation

Thus, to generate the XML course specific to a profile, it is enough to apply to the XML generic course the XSLT transformation specific to this profile (see listing 4).

Specific XML course

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE PSE SYSTEM "course.dtd" [
        <!ENTITY titrefr SYSTEM "titrefr.txt">
        <!ENTITY planfr1 SYSTEM "planfr1.txt">
        ------------------------------------------------
]>
<PSE id_PSE="ch1med2">
  <PSE_Obj_Pedag Val=" engineer ">
        <PSE_Language Val="french">
        <Media type="text" url="" id_Style=""
niveau_Media="1">&titrefr;</Media>
        ----------------------------------------------
        <Media type="text" url="" id_Style=""
niveau_Media="2">&planfr1;</Media>
        ----------------------------------------------
        </PSE_Language>
        </PSE_Obj_Pedag>
  </PSE>
```

Listing 4 : Specific XML course

As the specific XML course is obtained, it is enough to apply on him an XSL or CSS stylesheet according to the wished visualization. Listings 5 and 6 show the use of an XSLT stylesheet that transforms the course into HTML incorporating a CSS stylesheet to be presented to the learner.

XSL transformation for the presentation

```
<xsl:transform
xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
version="1.0">
    <xsl:template match="/">
        <HTML>
            <head>
                <LINK REL="STYLESHEET"
TYPE="text/css" HREF="./course.css" TITLE=" smart
style "/>
            </head>
            <BODY>
                <xsl:for-each select="PSE">
            ---------------------------------------
                <xsl:if test="@type = 'text' and
@niveau_Media='0'">
            ----------------------------------------
                </xsl:for-each>
            </BODY>
        </HTML>
    </xsl:template>
</xsl:transform>
```

Listing 5 : XSL transformation for the presentation

```
External CSS for the presentation

*{background-image:url(..\Media\bg20.gif)},
.texte_niveau1{     font-size:20pt; color:blue;
                    border-style:double;
                    text-align:center
                    }
.texte_niveau2{     font-size:15pt;
                    color:black
                    }
.img_niveau3{       margin-left: 20
                    }
.img_niveau4{       margin-left: 45
                    }
```

Listing 6 : CSS for course presentation

XML and its tools allow thus, using a relatively simple representation, fitting the characteristics of a telelearning course and in particular the adaptative and structured courses of SMART-Learning

5 References

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[7] *http://xml.apache.org/xalan*

Set-in an interactive multimedia database of the French EEA association

Olivier BONNAUD[1], Yves DANTO[2],Christian GLAIZE[3], Jean-Paul LOUIS[4]

Abstract

In addition of the several virtual campus that are created in the world, the French EEA association composed of about one thousand members started the creation of a on-line data-base in the field of electrical and information engineering with the both goal to give an additional support for the students and to impulse the creation of new innovative pedagogical tools.

1. Introduction

In 2001, the French association of teachers and researchers in the field of electrical and information engineering, called "Club EEA" [1] gathered more than 1000 members and was structured as shown Figure 1. In addition of the executive board that includes the President, the General Secretary and the Treasurer, two main levels in the operational organization can be found. Thematic level that is constituted of four chapters gathering main domains (electronics / microelectronics / optoelectronics, signal processing, power electronics / power electrical engines, control automation.

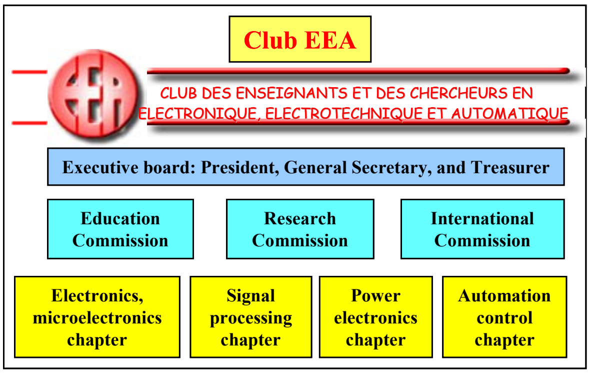

Figure 1: "Club EEA" Association structure. Two main levels in the operational organization: the scientific field chapters and the transversal commissions. The full board is constituted of the resident and secretary of chapters, presidents of commissions, and of the executive board.

1President of "Club EEA" Association, University of Rennes 1, Pôle CNFM de Rennes, CCMO, Campus de Beaulieu, 35042 Rennes Cedex, France University
2President of the Education Commission of "Club EEA" Association, University Bordeaux 1, Electrical Engineering Department, 351, cours de la Libération, 33405 Talence Cedex, France,
3 Responsible of Pilot Group of e-EEA Médiathèque, Laboratoire d'Électrotechnique de Montpellier - Université Montpellier II, CC079, Place Eugène Bataillon, 34095 Montpellier Cedex, France
7

The transversal level is composed of three commissions: academic's or education's, research's, and international's ones. From Education Commission, a specific group, called "Pilot Group" (PG) was created in order to set-in a database and new tools with the final goal to create a virtual campus. This was the result of an analysis of the evolution as well of the French Institutions in which some members are positioned, as International well-known institutions such as MIT, Stanford, etc. [2]. To improve the traditional presentations already available via Internet, we have decided at the level of the Education Commission to create a tool making easier the creation of new courses. This is the specificity of what we have called: "Médiathèque e-EEA™ " [3].

2. Reasons of such an approach

The fast increase of the new knowledge flow, the wide spectrum of knowledge, the evolution of the culture and the behavior of students lead to a permanent adaptation of our teaching approach.

It is clear that the video-image, Internet, and zapping, are new parameters to take into account to be attractive to students that are less and less excited by scientific studies.

In addition, more and more potential students can be interested to improve their knowledge without any live-lesson, but with some tools that give more than a book or a monograph, especially in the technology fields as in electronics, control automation, signal processing, electrical engineering, microelectronics, optoelectronics that constitute the main domains for which we are concerned. These domains are particularly adapted to dynamic presentations, schematic, and simulation approach [4]. Moreover, the pedagogical approach can be really different allowing as well classical French bottom-up approach as top-down one, as shown in Figure 2.

Indeed, the development of computer assisted education tools offers the possibilities to modify the classical teaching approach and maybe to make easier the harmonization in Europe of education in electrical and information engineering [5-6]. It is possible to begin the course on a system or application, and thanks to the permanent access to the links, to go back to basic and fundamental knowledge. In this situation the student understands or discovers the necessity to improve his fundamental knowledge and the course can be much more attractive; in fact it is generally appreciated by students. Figure 2 shows a sketch of the both approaches: bottom-up that corresponds to the usual education and top-down that is available in the new multimedia tools.

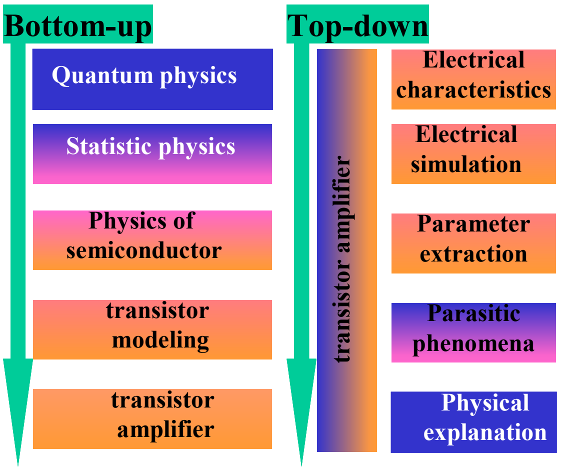

Fig. 2: Bottom-up and top-down approaches that are easier to set on with interactive tools (*After Bonnaud et al* [2]).

In such a context, we can admit that, alone, a teacher cannot easily modify and permanently improve his lessons, creates new interactive tools, new dynamic training, etc. The Club EEA is an organization establishing permanent links between its members and allows a common gathering of skills and resources that is today the need to highlight and valorize the individual approach. These documents are compiled in the Médiathèque e-EEA™" on-line available and reachable by everybody. To access to the associated site, the present address is: http://www.e-eea.org.

This behavior is a goal for our community, who considers that its contribution to the information world from its own skill and know-how in the knowledge world constitutes a main part of its mission. The diffusion of a part of its knowledge is the basement of university behavior in order to encourage contacts between people; this leads to an enhancement of the general knowledge and an increase of the knowledge need. At international level, an on-line Mediatheque e-EEA™ should encourage the cooperation between countries and should give access to new knowledge to undeveloped countries.

3. Principle

The Médiathèque e-EEA™ is an open on-line site giving access to teachers and students a set of scientific documents that gathers the pedagogical production of involved teachers. It is an exchange and diffusion tool with free access.

Copyright: The intellectual properties are the properties of the authors that keep the full rights. The Club EEA association diffuses the documents, and by this way, brings its notoriety.

The users are first the teachers that can judiciously use the on-line documents to built their own lessons but after signing a Charter". The students are the second type of users and can use this tool for learning and training as well in basic education as in life-long learning.

The documents are not, for a majority of them, in a first time, a self-consistent interactive course independently useable that needs a huge work (authors, software's, designers, etc..) that only one institution cannot produce easily. However, the Club EEA members constitute a huge potential of technical knowledge. Thus, the initial goal consists to produce scientific documents often resulting from traditional edited documents but with a few part, at least, of new information technologies in order to improve the information quality by the way of photographical illustrations, animations, interactive documents, integrated simulations, hypertext links, etc. Note that, some colleagues have already produced some interactive courses that can be immediately included in the Médiathèque e-EEA™, via links. That is the case of an interactive course on integrated microelectronic technology [4,7-8].

Following the advice of the PG, the scientific documents are generated and signed by their authors. After reviewing by the PG and selected colleagues who are member of adapted specialty chapter, an abstract is written in order to build a compact database easily consulted. Even if some books already exist in such or such field, this database can enlarge the spectrum.

This implies several effects:

- The various approaches in one specific field thanks to the contribution of several authors for which the sensitivity can be quite different,
- Heterogeneity of presentations, the authors using either some different animations or links. To minimize this heterogeneity, a coordinator chosen among the related authors has in charge a unified presentation in term of notations, symbols, et..,
- The concision of chapters that allows an involvement of numerous authors due to the minimization of their respective tasks,
- Only some compact modules can be selected in the whole document (or website) produced by colleagues, to be in agreement with copyrights or exclusivity.

4 Example of on-line tools

To give an idea of the beginning of this database, an example on the integrated microelectronic technology course, available on its own website [8] or from a link of the Médiathèque e-EEA™ site is presented in this part. Figure 3 shows an html page available on the web-site and in the English version that is in construction, the French one being achieved. Other foreign language versions are almost achieved, especially in Finish [9] and in Romanian [10].

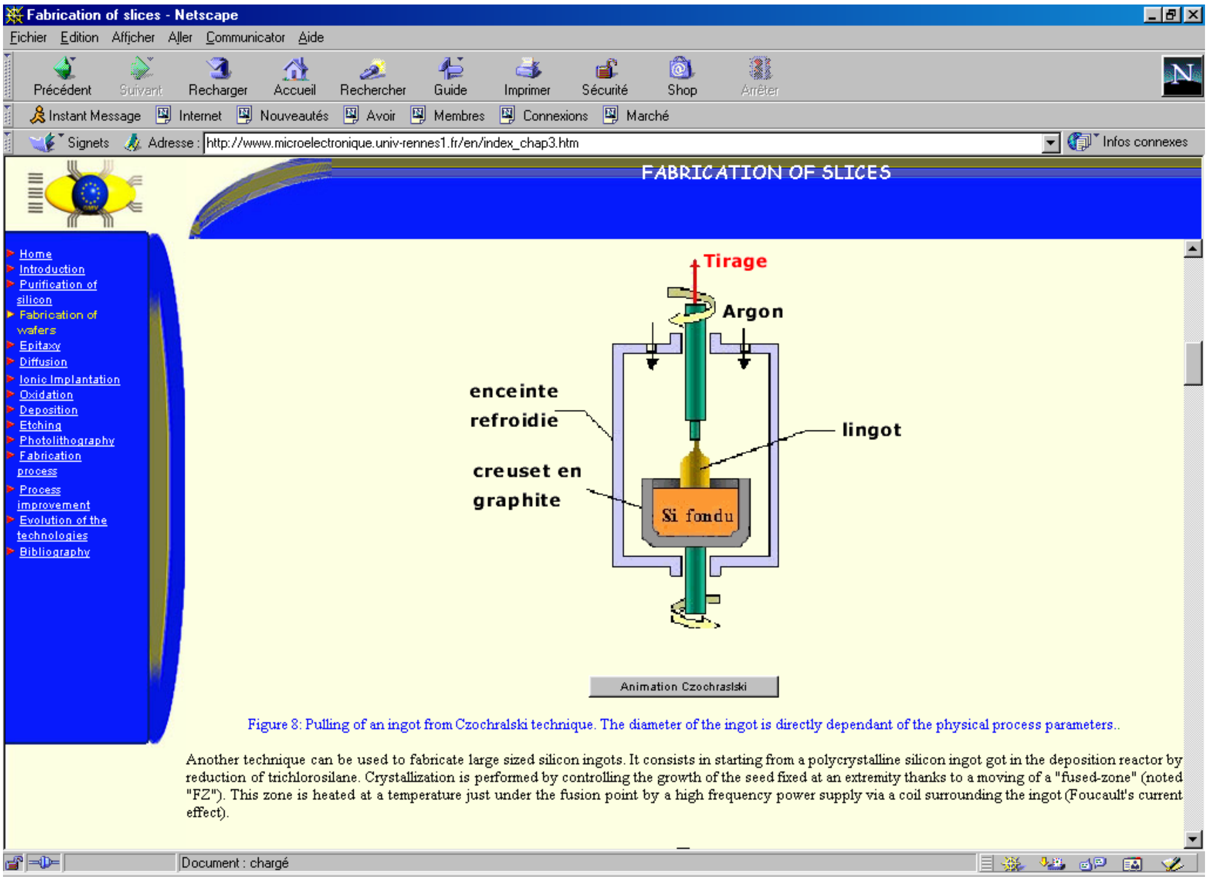

Fig. 3: Example of an html page of the integrated microelectronic technology course. This page corresponds to the English version of the document, which is in construction. The French, Finish and Romanian ones are almost achieved. Only, comments on figures are not yet translated in these last cases.

As shown on the figure 4, animations are included in the document that gives much more indications, especially in the field of technology for which a short animation describes much better an experimental technological step than a long text.

In this document, also simple simulations are available. Figure 4 gives an example of simulation that can be achieved to evaluate the growth rate of a thermal oxide. The user can change the data, and the simulation is performed through a Java applet, loaded in the personal computer or workstation of the user. In this case, the user saves some precious time of loading. Of course, the modeling is basic in this case to avoid too much long loading and calculation durations. The results are approximate but give a good idea of the basic phenomenon. As an example, the Grove’s model is used to simulate thermal oxidation in Figure 4.

Note that a lot of other examples can be given. Several colleagues have already set on the website of the Médiathèque e-EEA™ links to tools such as VHDL training, basic logic course, digital electronics, introduction to power electronics, electrical engine modeling, digital signal treatment, etc…[11]. In addition, the database can link to distance training developed by some colleagues. A good example is the Redwin long distance training developed in the frame of European collaboration [12] or a distance learning experience for IC test [13] set-up thanks to the French national committee for education in microelectronics (CNFM) [14].

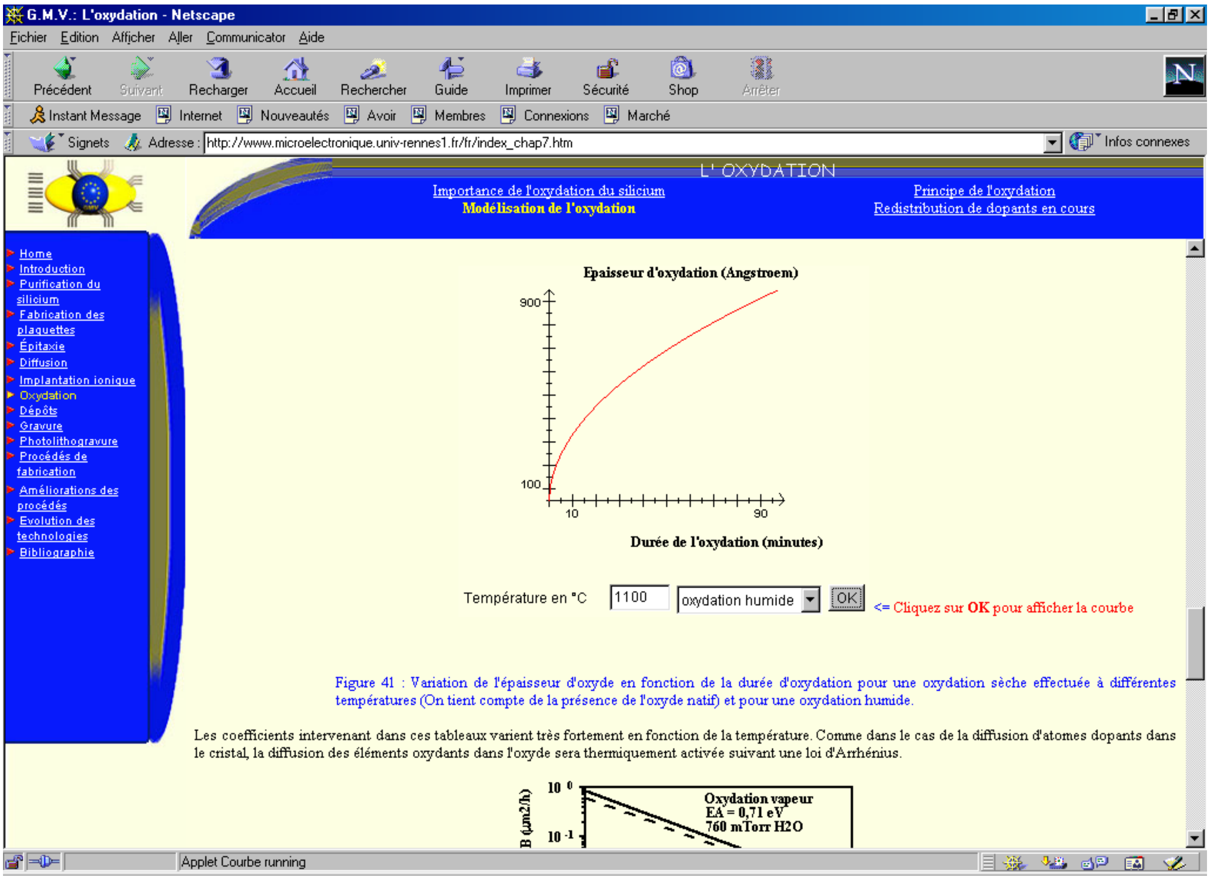

Fig. 4: Example of technological simulation included in the microelectronics module. The oxidation modeling is performed thanks to a Java applet loaded in the personal computer of the user. This procedure saves a lot of transfer time. The user has just to enter the data and activate the simulation. In this case, the modeling is simple to minimize the loading and transfer duration on the computer.

6 Conclusion

The Médiathèque e-EEA™ is potentially a huge tool able to spend knowledge as well to teachers as to students in the field of electrical and information engineering. It involves new educative technologies that allow making more attractive our fields to students and making much easier the learning of technological courses. The modern approach is in addition much more accepted by the students but also by teaching colleagues who can save a lot of time to prepare new courses in their own institutions.

This main objective is possible thanks to an active and well-organized structure built in the frame of teacher and researcher organization, the Club EEA. Diversity of approaches depending of different feelings of the scientific disciplines can enlarge the spectrum and enrich the global database. In its final form, this Médiathèque e-EEA™ should constitute a solid basement for a virtual campus.

Acknowledgments

The authors thanks all the members of the Pilot Group and all the colleagues who have contributed to set-in the database by loading their pedagogical products or establishing links to the website of Médiathèque e-EEA™.

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K12 INITIATIVES: A PATH TO THE FUTURE OF CITZENSHIP

Janete Molnar [1], Edvaldo Valle [2], Melany M. Ciampi[3] and Claudio da Rocha Brito[4]

Abstract —*This work shows the political and educational efforts of a project for K-12 that one of the main goals consists in the enhancement of young people to choose carriers like engineering. The social dimensions of it are clearly leading to a deep change in that particular society showed by the very positive feedback. Everything has been conceived to make it particularly attractive to young students of K-12 mainly the name "Let's go folks!" The project has been developed and applied by the City Hall education coordination in a joint venture with Supportnet, a private enterprise with the support of COPEC – Council of Researches in Education and Sciences. The overall results of "Let's go folks!" are highly encouraging and it could be seen as a paradigm for the other Brazilian education public institutions.*

Index Terms — *paradigm, pedagogy, policy, qualification, teamwork, technological illiterate.*

INTRODUCTION

Lately less and less young people are choosing engineering as a career. There are some reasons for this, among which two of them appear as of high relevance as the fall of social status and the low level basic sciences teaching in high school.

Certainly this issue has generated many discussions in academic and scientific communities in Brazil and some practical actions at governmental level have took place. And among them there is one that is the object of this work. It is the initiative of São Vicente City Hall that has decided to implement special programs for K12 in public schools in the city.

In order to attract more students into engineering, which is so necessary for the development of a country, an innovative approach was taken at the K-12 public schools in São Vicente city. The project has been developed and applied by the City Hall education coordination in a joint venture with Supportnet, a private institution with the support of COPEC – Council of Researches in Education and Sciences.

The chosen name Let's go folks! Is a slogan that speaks the language of young people and the Fortress of knowledge is the special space created in the schools where the students can spend some hours of the week enjoying the good time of learning in a complete new way. It has been dimensioned to make the students to feel special, a space to hold their interest and to get them excited about new technologies, informatics and so on.

It started in February of 2002; it has been planned to serve 10 thousand students per year, including the qualification of teachers and technical staff.

The creation of a public University in the town is the next step that will be accomplished in a medium to long period of time, which is the city demand due to the enlargement of population and the new mentality of the new politicians presently in charge. A new policy era has started in the country inspired in the new Presidency that express the Brazilian population hue and cry for the betterment of its society. It is time for changes and deep changes in education in order to combat the technological illiteracy.

BRAZIL'S ENGINEERING HISTORY

Colonization of Brazil plus the insurance aspect of Portugal made the royal government to recognize the necessity of forming the national engineer and so becoming it of crucial importance. It was made always attending the evolution of French Schools of Engineering also in 1641 in Lisbon born the Artillery and Square Classes becoming in 1647 the Special Class of Fortification and Architecture. The Portuguese engineer Luiz Serrão Pimentel (1579-1613) managed the school and it is considered the starting point of Lusitanian-Brazilian engineering [02].

Engineering schools still keeps the European schools style obviously because of the great influence of its countries along the colonization process. The evolution of engineering in Brazil follows very close the world trends. From the construction of Fortifications through electrical engineer to what is called today Mechatronic engineering in the country has developed in according to the necessities of promoting its development always seeking for the best applications of sciences achievement to the local resources.

Through the time many huge proportions accomplishments can be seen, not only public buildings and houses but also practical applications of electricity like telegraphy, telephony and lighting. Electrical energy conquests that were applied in Europe and USA shows that similarly the insertion of electrical energy in Brazil happened in the same historical moment of industrial expansion and development of developed countries.

Since the Fortification Classes and Military Architecture founded in Bahia, in 1699 until more than 200 engineering schools of present time, engineering education has had a

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history of success full of many conquests and accomplishments [03].

EDUCATION CONQUESTS THROUGH TIME

The Public Universities that raised in the many states of the country and that have worked very well for many years, made the country to achieve and built a solid reputation even abroad also creating generations of Brazilian scientists and educators [04]. These people fortunately have refused to accept the ominous and narrow-minded neo-liberal policies for education having started a fighting to keep up the achievements already gotten and actions that help to maintain and to enhance the researches in every field of science and technology [05].

For many years large discussions about national scientific and technological directions at national level took place and still take place in conferences, all communication medias like radio, TV and etc, despite it may seem to be a lonely fight once economical speculations seems to be more powerful with more sharp actions world wide.

Professionals and educators of every field of science and technology have been discussing the destiny of education in the country taking into account the historical moment of the world. Certainly some of these discussions have generated some practical actions at governmental level as a response to the society that see itself as the most interested part in the issue. In Brazil in engineering and technological fields the situation is very delicate. Although the proliferation of private universities all over the country expanding the number of 3rd grade students it does not assure the increase of students in engineering and technology areas. Looking through this perspective the K12 appears as one way to help students to develop skills to follow careers in these fields.

São Vicente City Hall management is one example of the new political mentality and so after some social conquests has decided to implement a special program for K12 in its public schools. Conscious of the importance of eradication of the so-called "technological illiterate" (that is now as important as the eradication of the "illiterate"), has been working hard to get the goal to enhance the number of students to choose the engineering and technology fields.

TECHNOLOGICAL EDUCATION: VALUABLE ASPECTS OF ITS INSERTION IN EDUCATION

Valuable workforce in a technology-based society of XXI century depends on an educational system that prepares students in mathematics, engineering and sciences. To accomplishment such task São Vicente City Hall is counting with the excellence of a national private enterprise located in the city, which is Supportnet that has been acting in the market for many years and that has a reputation of quality services and credibility. It is essentially the appliance of solutions for technological problems oriented to the clients/students necessities, in the several areas of knowledge.

Educational informatics in the development of students' cognitive potential is of great importance. The informatics knowledge is a powerful educational instrument to turn young people their own agents of learning process and in the building and acquisition of their knowledge; at last students more autonomous in the solving of problems using their logical - deductive reasoning in an effective way becoming them more capable to interact with people and the reality that surrounds them. Let's say that this is the technological literate citizen [06].

Technology high-speed advancement and globalization made essential the use of informatics in all human environments. The intelligent use of computers becomes effective when it is used in a way to make the student to explore her/his capabilities and to develop skills. It contributes to their further development and the seek for sustaining values, including a commitment with her/his own learning [07].

LET'S GO FOLKS! – A DESIGN STRATEGY FOR YOUTH

This special program is based in an integrated educational method using computers as the tools to increment the learning process aiming the betterment of fundamental education system, the K12.

Engineers, Pedagogues, Social Agents and others scientists and technicians involved with education have been working in the implementation and development of this project.

It encompasses top technologies with access to Internet and complete didactic material designed for this kind of proposal.

The project has been named "Let's go folks!" as a strategy to reach the young students. Another strategy of marketing to get the attention of them is the name of the labs, so called "Fortress of knowledge".

FORTRESS OF KNOWLEDGE – THE HISTORICAL ASPECT CONTRIBUTING TO THE STUDYING EFFECTIVENESS

Unfortunately, many K-12 students loose interest in subjects that are considered very difficult like mathematics, physics and others. The implementation of this new K-12 program aims essentially to generate the intellectual excitement among the students toward the acquisition of knowledge. The new approach with the computer as a powerful tool has showed to be effective to enhance the learning process.

It is a student-centered paradigm of education and with pedagogic proposal the Fortress of Knowledge is the special space created in the schools where the students can spend some hours of the week enjoying the good time of learning in a complete new way. It looks like the ancient fortresses that were built in the city in the XVI Century to protect it from the pirates and invaders. Nothing more charming! It contains in its space the computers around 20 (in each space) connected in a network, with Internet access.

The implementation of the program started in February of 2002; it has been dimensioned to serve 10 thousand students per year, including the qualification of teachers and technical staff for the next four years.

PROJECT BODY

Its physical infra structure contains 16 laboratories with 20 points of network each, in according to the international pattern EIA/TIA 568-A, where each lab contains one Rack with key and the local network active element (Switch 24 doors 10/100 MBITS).

The whole project is compounded by:

- 320 Celeron computers 800 MHZ/ Disk of 20GB and 128 MB RAM/ Colored monitor with 15"/ CD-Rom/ Stabilizer.
- Supply of 32 printers, 2 for each lab.
- Large band internet access

The laboratories dimensions are large enough to attend the necessities of the schools for present and they can be enlarged with the time and the new demands.

Internet access infra structure:

- The chosen technology for Internet access is the frame-Relay and 512Kbps speed.
- All labs have local and remote connection equipment (Switch, rotator and modem).

Supportnet offers a didactic material that has received special attention that provides the students all the necessary information for the correct use of computers.

PEDAGOGIC METHODS

Teaching Methodology:

- The proposal of teaching methodology in this program is based mostly in the interaction and real experience.
- The qualification is gotten by means of 25% of theory and 75% of practice [08].

The use of computer in education has been showing as an important agent in the promotion of closer and so important between adviser/instructor and pupil.

Evaluation Methodology is based on some methods, some orthodox and some non-orthodox. It depends on the teacher and they can be [09]:

- Presentation of works developed with the use of the computer developed during the course.
- Frequency of classes' presence, at least 75%.
- Lectures and practical exercises.
- At the end of the course the students have a test to evaluate the knowledge acquisition based in a minimum quantity required to be approved and get the certificate [10].

TIME STRATEGY

In order to accomplish the task the students have a schedule that has:

- 60 hours of Office package (Windows, Word, Excel and Internet);
- Professional certificate for 8^{th} year of Fundamental School;
- 45 hours of basic Windows, Word, Excel and Internet form the 5^{th} to the 7^{th} years of Fundamental School.

TEACHERS QUALIFICATION

Qualified teachers with knowledge in informatics are so important as good technical staff [11].

Teachers and students have a schedule to attend the necessary courses to improve their knowledge and also to help the students that will be as well transformed by the use of this new technology.

To get this goal the teachers have:

- 08 hours of typing;
- 80 hours of Office (Windows, Word, Excel, Power Point and Internet);
- 40 hours of informatics in Education.

Teachers and students have full time technical and pedagogical assistance and support of the staff for anything at all.

INNOVATIVE APPROACH

Presently one of the most important aspects to be taken into account is the challenge to make the program more attractive for the students so it should have a kind of content that is equally cultural and appealing. Bellow there are some examples of extra available topics plus the program content:

- Availability of Internet access;
- Virtual Bulletin;
- Web mail;
- *Let's go folks!* Journal;
- Best students of the month;
- Download areas (tutorials)
- Educational games;
- Chat;
- Know your City!
- Test your knowledge;
- Virtual Library;
- Internet Challenges;
- News;

These are some material available that are constantly updated to help students to develop a framework for understanding effective knowledge and cultural achievements [12].

ACCOMPLISHMENTS

The most important objective is to provide the public school students the possibility to develop the skills to choose careers in engineering and technology fields. It is done by:

- Training and qualification of public schools teachers in technology education and pedagogic design;
- To promote the betterment of its citizens qualifying them through the informatics specialization.

Social dimensions of this program for sure exceed the school borders and its first goal.

CONCLUSIONS

The history shows visibly that engineering in Brazil has started with the military engineering, which military actions at that time, in the country were basically the construction of fortifications and the seek for solutions of defense and attack evolving to what is today the civil engineer. Since its origin in Brazil, engineering has evolved altogether world's trends.

Presently Brazil has been facing the challenge of managing the effects of such rapid science and technology development achievements combating the technological illiteracy in order to provide its people a better quality of life. It is a fight for surviving the environmental problems, the wild economic war between the big enterprises among others. Problems that will become worse for developing countries in a near future if they do not find a way to over come the inner problems and start to build a true nation for its citizens.

The overall results of "Let's go folks!" project conceived and implemented in São Vicente public schools have got very good results so far and the students are very pleased with their performance and the feed back has been very positive.

The implementation of the project has been so good that it is going to be amplified to the qualification of poor communities citizens of the city.

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SIMPLE MATHEMATICAL MODELS WITH EXCEL

Traugott H. Schelker

Abstract — Maybe twenty or thirty years ago only physicists and engineers had any use for mathematical models. Today the situation has totally changed. Mathematical models have important applications in biology, medicine, economics, geography, psychology and many other disciplines. So a basi c understanding of mathematical modeling will be of benefit for everybody. In this workshop I will present some simple mathematical models using the program Excel. The aim is to show and develop simple, but typical and important examples of mathematical models. The participants will learn properties, possibilities and also limits of mathematical models. We will prepare and demonstrate a series of famous classical models and develop a model on our own. We will use only simple numerical methods with the Excel program. For this reason no further knowledge of mathematics, differential- or difference equations is required!

1. INTRODUCTION

"Mathematical models are almost as beautiful as models on the catwalk of a fashion house...!"

The most spectacular successes of mathematics in the last century have been in physical sciences. But over the last decades, mathematics have broken out into a whole new domain of applications in many different fields, social sciences, biology, medicine, agriculture, economy and others. In almost all fields of human endeavor mathematical tools became important. Today mathematical techniques and models play an important role in planning, decision making and also for prognosis. Without mathematical models we were left to manipulate real systems in order to understand the relationship of cause and effect. Manipulate real systems is often difficult, maybe impossible or too expensive. It may be possible for cars, but social and ecological systems are much more complicated! For these reasons mathematical models are now widely accepted as an appropriate tool for describing processes and matching them to our ideas and theories.

Furthermore modeling processes of dynamical systems, today have become a real possibility for each college student. Even without a long and significant preparation in mathematics, differential equations or computer programming, it is possible to prepare and study at least the main effects of simple models. Many programs exist, like Stella, Modus, Simulink or Mathematica etc., which allow to build such models. An easy and well known tool for studying simple mathematical models is the use of the Excel program.

The aim of this workshop is to give the participants an idea and appreciation of how simple mathematical models can be formulated, solved and applied. The main aspect is to show that simple ways of demonstrating and illustrating such models exist, without deeper knowledge of the theory of differential- and difference equations. I'm convinced it is more important to provide our students with an appreciation of mathematics and show them the important role of the discipline instead of frustrating students with an over emphasis of mathematical rigor!

In this workshop, we will use the Excel program to demonstrate a series of simple mathematical models. Excel is well known and most students have access to this program. And: our specific aim is to show that simple models can be prepared, studied and numerically solved without complicated special programs.

2. MATHEMATICAL MODELS: ITS ROLE AND LIMITATIONS

Mathematical modeling means the process of translating a real situation or problem from its original context into a mathematical description, called a model.

After that the mathematical model has to be solved and the results must be translated back into the original context.
We must emphasis the keyword "translation". The mathematical model is not the real situation, it's only a description in mathematical terms of the real situation.
Based on the results of the model we draw conclusions and maybe provide predictions about the events in the real situation. But then these predictions and conclusions have to be tested and compared to real events and then may lead to acceptance or falsification of the model or normally to its revision. So modeling in reality is a never ending process. We prepare, build, revise, build a new model, compare, revise and change it again. In any case, the model remains a partial view or description of the real situation. The model is not the real object, it's only an simplified image of the real thing! [4]

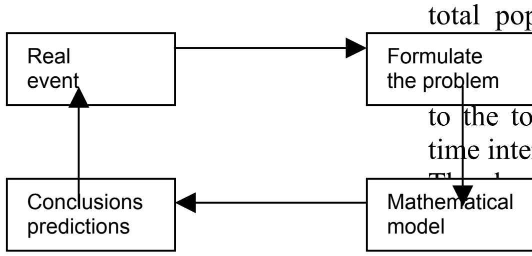


FIGURE 1
THE PROCESS OF MODELING

Some important components of the modeling process:

- Formulate the mathematical problem
- Solve the problem
- Interpret the solution
- Validate the model
- Explain, predict consequences
- Revise the model

3. HISTORICAL MATHEMATICAL MODELS

We start with some famous historical mathematical models, which played an important role in the history of sciences.

3.1 Malthusian population model

In 1798 Thomas Malthus, the famous American economist wrote the "Essay on the Principle of Population". At that time the industrial revolution and the related scientific discoveries caused a boom in the European population. So Malthus wrote like a prophet of doom. His essay with the phrase "Struggle for existence" probably influenced Darwin's theory about "natural selection for evolution". In fact Malthus formulated the first population model in history [1].
Definitions:

N = N(t) denotes the country's total population at time t
t = time in years
Δt = a small time interval
dN/dt = growth rate
a,b,c = parameters of proportionality

His assumptions:
For a short interval of time, say dt, Malthus assumed that both, birth- and death rate are proportional to the total population size and to the time interval. Or ... he considered the rate of growth of the ...n for a short time interval as proportional to the total population size and proportional to the time interval.
... formulated the differential equations:

birth rate = $a \cdot N \cdot \Delta t$
death rate = $b \cdot N \cdot \Delta t$
growth rate = $a \cdot N \cdot \Delta t - b \cdot N \cdot \Delta t = (a \cdot N - b \cdot N)\, \Delta t = c \cdot N \cdot \Delta t$

Taking the limit $\Delta t \rightarrow 0$ this equation leads to the differential equation:

$dN/dt = c \cdot N$
or $dN = c \cdot N \cdot dt$

This simple separable differential equation has the well known solution $N = N_0 \cdot e^{c \cdot t}$, where N_0 represents the population size at the beginning t = 0. As we will see, the behavior of the population depends very much on the constant c. We get exponential growth for c > 0, exponential decay for c < 0 and a constant population for c = 0.

Instead of solving this differential equation, we consider it as a difference equation and solve it numerically with an Excel sheet
Remark: In our equations we use the symbol dt although our calculations are based on a small discrete interval Δt

See model1

Malthus also considered food and land resources. He believed these resources would grow only linearly and so feared a human catastrophe in the future!
For the time period between 1500 and 1850 the real population growth in the USA reflects more or less the Malthusian model. Later on the errors of the model increase up to more than 30% and so the model is of little use! Malthus's model stands for unlimited growth ($c>0$) for all future time. And of course, this is very unlikely to occur, since there are many different limitations of growth. For these reasons, his model is not realistic for most situations.

3.2 Verhulst's population model

In 1845 Verhulst proposed a modification of the population model. He introduced a "crowding effect" for increasing populations. The assumption is, that the growth rate decreases when the total population size becomes too large for a given territory. This consideration reflects a certain "crowding effect". For the Verhulst's model there was a remarkable correlation between predicted population in the USA before 1900 and observed data.
Definitions:

N = the total population size
dt = a short time interval
a, b = two parameters of proportionality

Assumptions:
(1) The growth rate of the population for a short interval of time is again considered as proportional to the total population size, like in Malthus's model.
.
(2) But then the growth rate decreases when the population size becomes increasingly large. As a measure for large populations he used the product N^2
Thus he formulated the differential equations:

$dN = a \cdot N \cdot dt$
$dN = - b \cdot N^2 \cdot dt$ or finally
$dN = (a \cdot N – b \cdot N^2)\ dt$

This first order differential equation is not linear, because of the term N^2 , but it can be solved by a simple transformation. It results the famous formula of "sigmoid growth" or the so called "logistic growth". Again, instead of solving this differential equation analytically, we consider a numerical solution of the difference equation by Excel.

See model2

3.3 Mitcherlich's model

In the year 1909 Mitscherlich found out by experimenting with invitro cultures that production as a function of fertilizer does not increase unrestricted.
Assumptions: This fact urged him to consider the growth rate of production as proportional to the difference of production and a maximum possible production level. Mitscherlich also assumed, that there is an upper limit, say M to the production which can be sustained [2].
Definitions:

P = the actual production level of a plant for a certain area
M = maximum possible production level for this plant
a = factor of proportionality

His assumptions lead to the following differential equation:

$dP/dt = a \cdot (M – P)$
or $dP = a \cdot (M – P)\ dt$

For a numerical solution of the difference equation:
See model3

3.4 The Gompertz growth

This famous model has been introduced by Gompertz in 1825 for calculations of life assurances. After 1940 the model has been applied also as a basis for the extinction of animal populations in ecology and for the growth of tumors in medicine. The Gompertz growth is similar to the logistic growth and is encountered also in the study of growth of revenue in the sale of a commercial product.
We consider a closed two compartment model of plant growth [5].

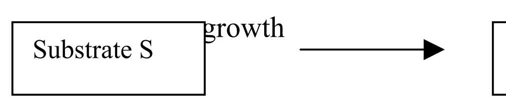


FIGURE 2
A two compartment model for growth

Definitions:

W = total dry weight of a plant or a substance in a growth process
S = substrate
dt = short time interval

a = parameter of proportionality of growth

c = a parameter describing the decay in the specific growth rate

Assumptions:

(1) The Gompertz growth can be derived by assuming that the substrate of the plant is not limiting the plant growth. So the growth machinery is always saturated with substrate. The growth rate is then again proportional to the dry weight

$dW/dt = a \cdot W$

(2) But we assume that the effectiveness of growth decays with time. This decay may be considered as due to degradation of enzymes. So the specific growth rate parameter a is no longer constant, but is itself governed by

$da/dt = - c \cdot a$ where c is a parameter, describing the decay in the specific growth rate.

We finally get:

$dW = a \cdot W \cdot dt$

$da = - c \cdot a \cdot dt$

These equations could easily be integrated, but we solve them again numerically by Excel.

See model4

3.5 Systems of linear differential equations

In biological systems as well as in whole populations there are usually two or more functions of time (variables) which interact with each other. So we get systems of differential equations. Let's consider the disintegration of an organic substance in two steps.

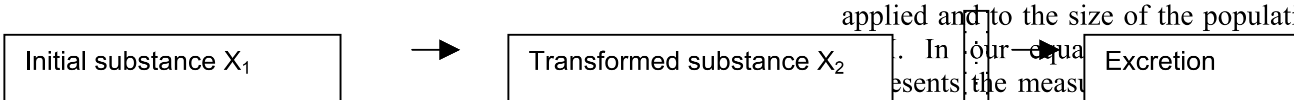


FIGURE 3
DISINTEGRATION OF AN ORGANIC SUBSTANCE

The original substance x_1 is first changed by enzymes in a transport form, called x_2. This second form of the substance finally is excreted through the cell membrane. The enzymatic reactions and elimination are considered as first order chemical reactions and so we assume that the rates of transformation are proportional to the quantities.

Definitions:

x_1 = original substance

x_2 = the substance transformed by enzymes, finally excreted

Assumptions:

(1) The rate of change is considered as proportional to the quantity x_1. The first equation expresses the disintegration of the original substance, which is transformed with the rate $k_1 \cdot x_1$ in the transport form x_2

$dx_1 = - k_1 \cdot x_1 \cdot dt$

(2) The transport form x_2 is created with the rate $k_1 x_1$ and excreted with the rate $k_2 x_2$

$dx_2 = (k_1 \cdot x_1 \cdot - k_2 \cdot x_2)\ dt$

The two linked equations describe the disintegration of an organic substance in two steps.

Example "Insecticide"

An other example of these kind of equations is found in the effectiveness of an insecticide. Here for instance we get a system of two non-linear linked equations.

Definitions:

I = quantity of insecticide used

P = population size of insects

dt = small interval of time

a, b, c = parameters of proportionality

Assumptions:

(1) The decrease of insecticide (disintegration) is proportional to the applied quantity of insecticide.
(2) The insecticide causes an increase of the death rate of an exponentially growing population of insects a·P, which is proportional to the amount of insecticide applied and to the size of the population ·- . In our equa t P·I esents the measu ce of insecticide..

$dI = - c \cdot I \cdot dt$

$dP = (a \cdot P \cdot - b \cdot P \cdot I)dt$

For a numerical solution of the example:

See model5

3.6 Population dynamics of salmons

Here we consider a simple model of Richter from 1974 [2]. This model has been applied on populations of salmons in the Pacific Ocean. We consider the cycle:

E----L----Y----A

Definitions:

E = eggs, L = larva, Y = young fish, A = adult fish

a, b = parameters of proportionality

p_1, p_2, p_3 = probabilities of survive

e = mean of the number of eggs per fish

Assumptions:
For many species of fish and for salmon as well, the larva will be eaten not only by predatory fish, but also by the adult fish of the same species. Therefore it is obvious to formulate the equation:

$$dL = (-a \cdot L - b \cdot L \cdot) \cdot dt$$

In this equation the first term is the death rate of larva because of other predatory fish. The second term is the prey rate of adult fish, which is indicated as a product of larva and adult fish (cannibalism!). Furthermore the number of larva L_0 at the beginning is equal to

Larva: $L_0 = e \cdot p_1 \cdot A$ where $\cdot p_1$= probability that larva hatch out,

A = number of adult fish

Young fish at time t: $Y_t = p_2\ L_t$ where p_2 = probability of survive of the larva

Adult fish at time t+1: $A_{t+1} = p_3\ Y_{t+1}$

We get a complicated dynamical behavior. Depending on the values of the variables, we even get a dynamical chaos!

For an illustration of the numerical solution :

See model6

3.7 Interacting species: Cassical Lotka and Volterra systems

The Italian biologist d'Ancona discovered in 1925 a drastic increase of predatory fish in the Adriatic Sea, as a consequence of limitations for fishing through World War I. His publication animated Volterra and at the same time Lotka in the USA to study ecological models. In 1925 Lotka published a famous book "Elements of physical Biology" with studies of different models. All these models are relatively simple and for this reason describe ecological systems insufficiently. Nevertheless they are still useful as a base in the understanding of the complex dynamics of biological systems.

As an illustration of an idealized case of such a model of interacting species, we consider foxes and rabbits living in a certain area, which has an abundance of food for the rabbits. On the other hand the foxes depend on eating the rabbits for their food. Let us define the prey and the predator populations in mathematical terms as X and Y. The two populations interact with each other.

Definitions:

x = predator population

y = prey population

a, b, c, d = parameters of proportionality

We can formulate the following assumptions:

(1) In the absence of predators, prey would grow unlimited, according to $dx/dt = a\ x$
(2) In the absence of prey, predators would decrease and finally die out, according to $dy/dt = -b\ y$
(3) The interaction of the two species we express by the product term $x \cdot y$, which is a measure for the interaction of the species. $x \cdot y$ is positive for predators and negative for prey.

So we get the model:

$$dx = (a \cdot x - b \cdot x \cdot y \cdot) \cdot dt \qquad x = \text{prey}$$

$$dy = (-c \cdot y + d \cdot x \cdot y \cdot) \cdot dt \qquad y = \text{predators}$$

For an illustration of the interacting of the two populations: See model7

3.8 Tourism and environment

Let's assume that a certain region is very famous for its beautiful natural environment. For this reason, the region attracts a lot of tourists. But the tourists on the other hand stress and pollute the environment. These effects reduce the attractiveness of the area and cause a reduction of tourism as a consequence and feed back effect.

But, of course a natural environment has the ability of self renewing its resources up to its maximum capacity.

Furthermore advertising influences and probably increases the number of tourists under the condition, that the environment is still attractive.

We could formulate the following system [3]:

Definitions:

T = number of tourists

E = conditions of the environment

a, b, c, d = parameters of proportionality

Assumptions:

(1) The attractiveness of the region depends on the conditions of the environment and can be enforced by advertising b·E
(2) The tourist stream is proportional to this attractiveness and this increases the tourist population
(3) The number of tourists is reduced by leaving tourists
(4) The strength of the environment by tourists depend on the number of tourists and also on the conditions of the environment and is for this reason proportional to the product T·E with a specific parameter d.
(5) Without future tourism a stressed environment would renew itself after a certain time up to its maximum capacity with a specific parameter c of regeneration

We could formulate the following equations:

dT = (-a·T + b·E·)·dt T = tourists

dE = (c·E·(M-E) - d·T·E·)·dt E = environment

For the numerical solution :

See model8

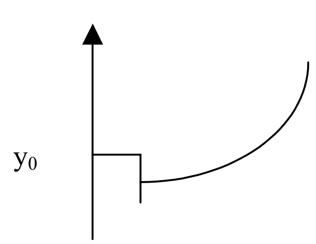
Appendix

"The method of Euler"

We can solve many differential equations created by such kind of models on the computer, using approximation techniques. The most simple of these techniques is the so called Euler's method. This method is based on a linear approximation using tangent lines.

To explain, let y' = f(t,y) a differential equation with initial condition $y = y_0$ when t = 0, that is at the beginning.

This means of course, that the solution of this equation is known only at the initial point (t_0,y_0) but that the derivative is known for all points (t,y) as shown in the figure.



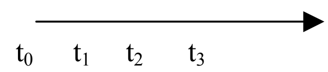


FIGURE 4
Euler's method

We consider now a time sequence t_0, t_1, t_2, t_3. Then the successive unknown values y_1,y_2,y_3 can be approximated by Euler's method, using tangent segments

$$\frac{y_1 - y_0}{t_1 - t_0} = f(t_0, y_0)$$

where $t_1 - t_0 = \Delta t$

$$y_1 - y_0 = f(t_0, y_0) \cdot \Delta t$$

$$y_1 = y_0 + y'(t_0) \cdot \Delta t$$

$$y_2 = y_1 + y'(t_1) \cdot \Delta t$$

and so on

$$y_{n+1} = y_n + y'(t_n) \cdot \Delta t$$

In this formulas, f(t,y) always represents the differential equation.

By using such numerical methods, we don't get exact values of the solution, because of all the small errors in the discrete time interval. But for the modeling of dynamical processes the exact values normally are not of high interest, but the typical course and development of the curves and their conditions.

The approximated values could be improved by using other approximation techniques in stead of the simple Euler method. For instance we could use the improved Euler-Cauchy method, the method of Heun or method of Runge-Kutta.

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DISTANCE LEARNING CHALLENGING PRESENT COMPUTER ENGINEERING PROGRAM

Alexandre Botari [1], Melany M. Ciampi[2] and Claudio da Rocha Brito[3]

Abstract — *This work shows one proposal that is basically the adoption of an online course in the curriculum of one of a traditional Computer Engineering Course of under graduation level. The course is Digital Systems and with its success another course may be introduced, the Communication Systems. It is a very simple process where the students have available the course with all the synchronous and asynchronous tools existent in the Institution. Through Internet it is possible to access the whole content of the course in individual modules and in sequence. The modules count with introductory elements, theory, and development through examples, interactive simulations and exercises. In a large country like Brazil, Distance Learning, is not only leaning as an alternative for the traditional teaching, but principally, as a need to provide quality education for a growing demand in a land geographically disperse.*

Index Terms — *Asynchronous, modules, synchronous, team work, tutorial, web-based education.*

INTRODUCTION

At under graduation level, distance learning faces some problems of partner-cultural character that represent obstacles more difficulties to be overcome. Educational and pedagogic models consecrated in Brazilian universities, above all in the private institutions of superior education, suffer a strong influence of the secondary school teaching way that education is centered in teacher's illustration and the pedagogic model is based on the European model of the century XIX, which is basically established on present and expositive classes. This reality is constantly fed by the academic-administrative structure that approaches of the secondary reality with graduation courses offered all together in blocks, or packages, with little or any academic mobility, that should be the gist of the university academy.

However, such reality has been modified and the Distance Education cannot and it should have preponderant role in the transformation for a modern educational paradigm.

This work consists in the description of an innovative engineering education approach, which is basically the introduction in a traditional engineering program of one course a hundred percent taught remotely.

OTHER ALTERNATIVE TO INCREMENT ENGINEERING EDUCATION

The proposal consists in the insertion, in a first moment, of Digital Systems course taught remotely and later with the introduction of Communication Systems course [1-3] in a Computer Engineering Program totally ministered in a traditional way They are both a hundred percent at distance, with practically a hundred percent of their content ministered remotely too [4].

For such, the content of the course has been adapted to be showed in individual modules, settling down among them a logical-progressive sequence or based on punctual subjects (topics).

The content of the existent Engineering Programs count with the following content, (basically) [5]:

- Important Preliminary Concepts: general aspects of the chronology of communication systems;
- Theory notions of the information: definition of Information, Message, and Sign;
- Communication Channels: phone channel, optic fiber, satellite, channel capacity, general vision of the systems of analogical communications and type;
- Usual Definitions of band width; concept of Basic Band; types of Communications Channels;
- Technical of Transmission of Analogical Signs for Analogical Carriers: General vision of the Modulation Systems in Width, Angle and Phase, Modulation AM;
- Ghastly Effects of Modulation AM; Temporary effects of the Modulation AM; Percentage of Modulation: Positive, Negative and Total; Efficiency of Modulation;
- The Problem of Over modulation; Modulation SSB and VSB; Modulation in Angle: in phase and in frequency;
- Concept of Lineal Modulation;
- Considerations about Distribution of Potency in the Spectrum of a Signal FM: Functions of Bessel; The rule of Carson; Graphic form of visualization of the difference between AM and FM; Comparison between AM and FM; More important methods of Generation and Detection FM: PLL, FM Stereo;
- Basic Beginnings of Antennas: Polarization, Diagrams of Radiation; Gain; Resistance of Radiation; Width of Bunch;

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- Introduction to the Usual Systems Communications: the. Phone Systems: The Evolution of the Telephone; Beginning of Operation;
- Telephones Cellular: main concepts; PX, PAX, PBX, PABX; Phone calls Local/Trunk; notions of cellular telephony b;
- Systems of Television: Initial concepts: square, Field, Persistence and Gleam, Resolution; The sign of Composed Video: synchronism H and V; equalization; Correction Gamma; Diagram in blocks of a TVC. General vision of NTSC, PAL Systems and EVAPORATE;
- Important initial concepts in digital transmission: synchronism types; acting calculation; systems CDMA4 - Communication for optic fibers;
- Types of fibers; propagation manners; characteristics of Transmission; examples of systems;
- Systems of Communication through Satellite Systems geostationary and of lower orbit;
- Transponder; Receiving stations; examples of connections;
- Basic Beginnings of Television Digital Differences of the analogical system; the digital code of the sign of Composed video. Diagram of the receiver; examples of systems;
- Codes brokers block Codes, recurrent and convolutions; interlacing; comparison of acting of coded systems and not coded;
- Notions of Digital Processing of Signs digital Sequences; transformed Z, decimation and interpolation; digital filters;
- Study of the Transformed of Fourier and its properties: linearity, areas in the domains t and f, duality, scale changes in t and f, translations in t and f, differentiation and integration, convolutions, correlation in the time and energy, ghastly density of energy. Functions of crossed correlation and of self-correlation for potency signs, ghastly density of potency, calculation examples;
- Behavior asymptotic of pulses. Pass-low filters without distortion. Representations of signs pass-strip, for components in squaring and for width-and-phase, wrapper; filters pass-strip without distortion. Relationship among them transformed of Laplace and of Fourier;
- Modulation: need to modulate and modulation types. Lineal or amplitude modulation. AM detection for wrapper. Modulators and detecting;
- Effects of synchronism lack. VSB, filters vestiges. Descriptions of TV system white-and-black and color. Examples of use of DSB and SSB;
- Exponential Modulation: FM and PM. Busy bands; tonal modulation, with one and two tones, spectra, phasor diagrams;
- Effects of no-linearity; generation methods and detection of FM. Analysis of PLL. Interference effects in the modulations AM, FM and PM; comparisons;
- Effect of the message spectrum;
- Representations of strip noise narrows: for components in squaring and wrapper-and-phase;
- Noise Effects in the lineal modulation; effect threshold;
- Noise in the exponential modulation. Effect threshold in FM; extension of the threshold.

And its basic and complementary Bibliography is the following elements:

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PROGRAM PECULIARITIES

In order to accomplish the effective implementation of this distance-learning course the students have all the existent computational tool of the Institution (Teleconference, Chat, e-mail, etc.) available, besides a tutorial through the page of the course in the link of the course in the portal of the Institution.

Through Internet, interactive examples and simulations have been showing as powerful tools for the teaching of the Communication Systems course. The sequence of the course is showed through modules that count with introductory elements, theory, development through examples, interactive simulations and exercises for delivery (everything available on-line and off-line through "downloads" and e-mail).

The software has been conceived in Java language. The students of the Communication Systems should create their own links associated to the main Link of the Computer Engineering Department.

To concept its sites studies begins in-group with the aid of monitors of Computer course of Computer Sciences Program using basic tools as Microsoft Front Page Express that is an editor in HTML language. The easiness of the use of its resources and the tutorial of the package allows a fast development of the students to the step that they get familiarized with the tools of Distance Learning.

Starting from certain point, after an evaluation it is very possible, to abolish the presence in class room, just limiting to monthly encounters with the monitors and teachers of the course for the evaluation and a correct feedback of the program [6].

Tutorial counts with synchronous and asynchronous resources offers the opportunity, so much for the monitors' students (of advanced years of the course) as for the students of the course. The subjects guided by the students of the course are under responsibility of the monitors, so that when they have to face subjects that are besides their knowledge, they go to the responsible teacher of the course that monitors and supervises the whole change of information [7-9].

Meetings that can be scheduled and/or sporadic are then combined among monitors, students and the teacher of the discipline, in order to accompany the pedagogic progress of the experience, once it not only a change of the communication means, but it is about a whole paradigm change, accompanied, evidently for the respective psycho-pedagogic impacts [10].

Table 1: Examples of the modules of teaching at Distance of the Communication Systems course, time of duration and used Electronic Means.

Subject of the module	Time foreseen	Exercises	Computer Tools.
Notions of theory of the information	2h30min	5 for delivery	Internet Explorer, Acrobat Reader, Outlook Express
Convolutions	2h30min	10 on line	Internet Explorer, Acrobat Reader, Outlook Express e Chat
Discussion	50 min	-	Chat
Need to modulate and types of modulation	2h30min	5 for delivery	Internet Explorer, Acrobat Reader, Outlook Express
Noise in the exponential modulation	2h30min	-	Teleconference
Discussion	50min	-	Chat

Communication Systems modules of the course (table 1, shows some examples of modules), have been divided so that it is possible the necessary time for the approach of the subject, completely, and it can't exceed week time determined for the hourly load of the course.

Inside of the program of availability of the modules of the course have made use of Hypermedia, with the support of videos, tables, photos and some simulations as support to the theory.

Tutorial indicates it is a powerful tool in the elimination of doubts, not only in the use of the software, as well as for the resolution of the own suggested problems, through links of help.

Electronic mail shows to be the most used electronic way to remove doubts as well as for the shipping of answers of the proposed problems.

Monitors team interfaces the communication between the educational of the course and the students, in the resolution of proposed problems and also in the elimination of doubts, having, however, the educational supervision in all the correspondents communications and received through the protocols generated at once of the shipping and of the greeting of the correspondences [11].

Evaluation of academic use can be made in presence classes with the application of individual tests and in-group tends. The score can be pondered by the remote participation of the students in case of a smooth implementation to avoid radical prejudice.

FUTURE ACHIEVEMENTS

The proposal intends to increment with an evaluation totally remote instead of a written questionnaire filled in class. The goal is to make it more interesting for the students. [12-14].

Students should answer to questionnaire about Communication Systems course, in which they could express their opinions about the methodology and pedagogic aspects, as well as regarding the computational tools available in the Institution for this unusual experience of Distance Education in a personal program. Programmed meetings with the students and monitors are part of the implementation of this system they should happen once a month, with the objective of evaluating the progress and to motivate the academics to the self-discipline in the study remotely ministered. These scheduled assisted meetings should happen also with the purpose of illuminating persistent doubts and/or for the resolution of proposed problems of larger level of difficulty.

CONCLUSION

This Innovative proposal is an opportunity to cultivate and grow the quality of engineer of this century.

The presented proposal is especially based in the modern paradigm that presupposes the need of a growing and incessant autonomy leading the student self-determination and responsibility in the construction of their knowledge. Some premises of the program are student commitment in dedicating certain number of week hours to study through diversified available computational tools.

The main preponderant factor that can be mentioned is that the psychological factor of "inhibition" doesn't exist with any physical presence, what propitiates a larger frankness in answering the questions and the possibility of more interactivity.

This proposal suggests a new " format " to the orthodox educational methods, since it presupposes the use of methodologies consecrated secularly, such as called them seminars, for example, with derivations and innovative aspects when inserting in this the whole available technological tools in the institution, as well as the insert of more flexible and modernized concepts to the usual proposals. Collaboration between monitors and students shows to be a powerful way of helping students to be more effective learners and help staff to be more effective teachers.

The accomplishment of the project for now presented demands a great commitment of the faculty, once this, in educator's exercise, will provide a fomentation atmosphere to the research, motivating the necessary deep studies, as well as potentializing the kinetic aspect usually existent in academic groups.

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Metodologia de Avaliação Usando Questionários com Escalas Não-numéricas: A Visão do Aluno e a Visão do Professor

Ronei Marcos de Moraes[1]

Resumo — *Este trabalho propõe uma nova metodologia de avaliação da qualidade do ensino ministrado em disciplinas de graduação. Nesta metodologia, alunos e também professores opinam através de questionários com escalas não-numéricas sobre a qualidade do ensino. Uma breve história da evolução desta metodologia é apresentada, bem como as dificuldades encontradas na sua aplicação. Um estudo de caso também é apresentado mostrando algumas das interessantes características deste tipo de questionário, como um alto índice de respostas válidas e o reduzido tempo de coleta dos dados. Neste estudo ficou constatado que alunos e professores tem visões similares das questões que envolvem uma disciplina, mesmo quando a variabilidade das opiniões individuais pareça indicar o contrário. A metodologia apresentada é genérica o bastante para poder ser aplicada também em outras situações de ensino que não o terceiro grau ou mesmo em avaliação da qualidade de um treinamento ministrado.*

Palavras-chave — Avaliação Docente e Discente, Questionários com Escalas Não-numéricas, Qualidade do Ensino, Ensino Superior.

INTRODUÇÃO

Há tempos a questão da avaliação da qualidade do ensino ministrado em sala de aula e a sua melhoria vem sendo analisada e questionada. Vários aspectos desse problema tem sido estudados, desde a proposta de novas formas de ensino de tópicos ou assuntos isolados [8, 10, 30], ou propostas de ementa [26], passando pela reforma de currículos inteiros [32].

Vários tipos de metodologias foram propostas para a modernização e melhoria da qualidade de ensino. Algumas delas são baseadas em participação ativa do aluno no processo ensino-aprendizado [33], ensino por projetos [36], ensino cooperativo [3], ensino assistido por computador [5], disponibilidade de material didático multimídia [17], video-conferência ou TV [34], ensino e avaliação via Web [9, 16], aprendizado com o auxílio de realidade virtual [35, 25], inteligência artificial [23] e até mesmo o uso de redes de computadores [24].

Apesar da sofisticação e da modernização digital do ensino provocar discussões [4], a avaliação de qualidade é o que realmente demonstra se houve melhorias de fato no ensino [28]. Várias formas de avaliação tem sido propostas, desde a avaliação pelos estudantes de uma disciplina [19], a avaliação em vários estágios na instituição [1, 32] até a avaliações em larga escala [6, 14]. Em vários estados no Brasil e outros países, diferentes tipos de avaliação da qualidade de ensino orientam reformas e ditam políticas educacionais [13] e até mesmo o intercâmbio educacional entre países [2].

Seguindo a mesma filosofia, a avaliação da qualidade do ensino pelos estudantes de um curso tem sido a base para muitas reformas curriculares, tanto de tópicos ou disciplinas isoladas como de cursos inteiros, visto que a melhoria do ensino, necessariamente passa pelo elemento fim deste elo: o aluno que recebe o ensinamento. No Brasil, essas reformas iniciaram-se a partir da nova Lei de Diretrizes e Bases da Educação Nacional (LDB) de 1996 (Lei número 9394/96).

Em particular, várias formas de avaliação através de questionários vem sendo tentadas e cada uma delas, em sua particularidade, vem contribuir em algum aspecto. Do ponto de vista estatístico, os questionários de avaliação tem como preocupação a objetividade e a qualidade dos dados a serem fornecidos [12] pelos alunos e devem cumprir pelo menos duas funções: descrever as características individuais e medir determinadas variáveis de um grupo em estudo [31]. Para atingir esses pontos é essencial a utilização de questões simples, preferencialmente fechadas, de múltipla resposta e em número reduzido [27]. O aspecto da confiabilidade dos dados pode ser "checados" com perguntas de teste, visando entender à realidade do "prestador da informação": o aluno e a qualidade da sua resposta [19, 20]. Com isso, busca-se vencer barreiras comuns nas atividades docentes como o receio por parte do professor da avaliação feita por parte dos alunos (quase sempre taxada como imatura) e obter respostas mais próximas à realidade, evitando alguns tipos de distorções. No entanto, entre o professor e o aluno, existem outros meios que podem atrapalhar o andamento do curso, como por exemplo, as condições do local de aula, greves, motivação, entre outras. Em Moraes e Melo, [20], além das formas habituais de cruzamento de informações, através de tabelas e gráficos, propõe-se quatro índices para avaliar a qualidade média do professor, qualidade média do aluno e motivação dos alunos. Cada índice procura mostrar a visão dos alunos a respeito do professor e de si mesmo, além de proporcionar um quinto índice sobre a colaboração média dos alunos naquela pesquisa, baseado na coerência das respostas obtidas.

Neste trabalho, procuramos aperfeiçoar a forma de avaliação que utiliza um tipo de questionário proposta por

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Moraes [19, 20], no qual uma mistura de ingredientes visa deixar o aluno mais à vontade para responder e ao mesmo tempo não deixar muitas questões discursivas para o aluno responder. Notadamente, esse último tipo de questão acarreta em um grande número de não-respostas. Assim, em substituição a questões com respostas de múltipla escolha, que nem sempre contempla todas as opções razoáveis para cada aluno em particular, utilizou-se uma escala. Essa escala não é uma escala numérica, como aquelas comumente utilizadas em pesquisas com perguntas subjetivas, mas sim uma escala contínua na forma de uma reta, com comprimento fixo para todas as questões e com indicações sobre o significado das extremidades direita e esquerda.

Pelo fato de nem todas as questões poderem ser colocadas desta forma, esse modelo é um híbrido com questões com respostas em escalas, múltiplas escolhas e também discursivas para sugestões ou respostas não contempladas entre as escolhas disponíveis.

Porém, mesmo com as vantagens oferecidas por esse método [19, 20] e dos bons resultados de sua aplicação [15], infelizmente a resistência por parte de alguns professores manteve-se. Para tentar vencê-la e ao mesmo tempo obter novas informações sobre a sala de aula, propomos uma metodologia de avaliação que dê vez também a expressão do professor. Este questionário foi empregado pela primeira vez com sucesso no primeiro semestre de 2000 em uma avaliação docente efetuada na UFPB. Neste trabalho, apresentamos a metodologia utilizada na confecção de ambos os questionários, bem como alguns resultados dessa primeira experiência.

HISTÓRICO METODOLÓGICO

O primeiro questionário para a avaliação da qualidade de ensino no Departamento de Estatística da UFPB foi proposto em 1992. Esse questionário sofreu modificações e aperfeiçoamentos [19, 20] e permaneceu em uso até 1998. Esse questionário era composto por questões que abrangiam a relação professor-aluno dentro e fora da sala de aula, bem como as condições das instalações, a forma de estudo, motivação, relação com os colegas de sala, etc.

Como a proposta de avaliação e o próprio questionário sempre estiveram abertos a críticas e sugestões dos alunos e professores, sentiu-se a necessidade de buscar uma alternativa para algumas questões de múltipla escolha que não contemplavam precisamente o desejo de expressão do aluno. A solução encontrada foi a adoção inicial de uma escala numérica do tipo *likert* (Pasquali, 1998). No entanto, essa escala sofreu críticas variadas por parte dos alunos, tanto por ser considerada insuficiente para alguns, como ser muito além do necessário para outros.

A solução final foi a adoção de uma escala desprovida de números: uma linha reta, com comprimento fixo para todas as questões e com indicações sobre o significado das extremidades direita e esquerda, sobre a qual o aluno pode colocar um ponto ou um círculo, conforme mostra a Figura 1 [22]. Este tipo de escala não-numérica elimina também a dúvida sobre a quantificação dos níveis entre um intervalo e outro observado, por exemplo, nas escalas do tipo *likert*.

|---|

Atitude Fortemente Positiva	Atitude Fortemente Negativa

FIGURA. 1
O TIPO DE ESCALA UTILIZADO, COM AS EXTREMIDADES DO SEGMENTO DE RETA IDENTIFICADOS RESPECTIVAMENTE, COMO UMA ATITUDE POSITIVA E ATITUDE NEGATIVA POR PARTE DO PROFESSOR.

Para medir a resposta do aluno atribui-se como o "zero" da escala a Atitude Fortemente Positiva e como a pontuação máxima a Atitude Fortemente Negativa (por exemplo, cinco, sete ou dez centímetros, dependendo do comprimento do segmento de reta). A partir dessa escala é possível quantificar a pontuação que o aluno está atribuindo ao professor, medindo-se o comprimento da reta até o ponto médio do círculo ou do ponto desenhado na reta. Essa solução teve uma aceitação bastante expressiva em sucessivas aplicações [15, 19]. A metodologia propôs o uso do questionário por duas vezes - na metade do período letivo e ao seu final - ou até mesmo três vezes aos alunos, quando sabido haver algum tipo de problema na disciplina.

Uma informação bastante interessante que pode ser obtida pela utilização deste tipo de questionário é a adequação do professor à disciplina, se comparado o seu desempenho entre as várias disciplinas que ministra naquele período. Essa informação pode levar a um aperfeiçoamento da distribuição de certas disciplinas a professores que realmente se dão bem em ministrá-las, levando os professores que não obtém bons resultados a ministrar outras disciplinas (nas quais obteve bons resultados), ou mesmo a uma reciclagem.

Porém, vários comentários maldosos por parte dos alunos para com alguns professores mais exigentes e comentários extremamente favoráveis a professores menos exigentes levantaram novamente a questão da maturidade do aluno que responde a esse tipo de questionário e se essa técnica de avaliação é realmente eficaz. Então, para buscar mais informações a respeito do que de fato acontece em um curso, seja na sala de aula ou fora dela, criamos um questionário similar ao primeiro direcionado ao professor. Esse novo questionário procura verificar a visão do professor sobre temas similares aos perguntados aos alunos. Em algumas questões, o professor é convidado a refletir sobre os seus próprios parâmetros de ensino; em outras, ele pode opinar sobre melhorias a serem realizadas no sentido de melhorar o desempenho da sala e o seu próprio.

OS QUESTIONÁRIOS

O questionário direcionado aos alunos levanta fatores importantes como, por exemplo, a qualidade do aluno que recebe o ensinamento, a sua metodologia de estudo, a sua preocupação com a ementa e com o seu futuro pós-escola. Enfim, o aluno avalia o desempenho do seu professor, o seu próprio, a ementa e os seus colegas. Pelo caráter dinâmico deste tipo de questionário, a partir de novas sugestões e críticas de alunos e professores, novas alterações poderão ser efetuadas. A composição básica desse questionário segue três linhas-mestras: a primeira visa conhecer as relações aluno-professor, vista por parte do aluno; a segunda visa estabelecer as relações entre o aluno e a disciplina que está sendo cursada; e a terceira visa conhecer o universo no qual o aluno está inserido e as suas relações com ele. Cada tópico está intimamente relacionado com o seguinte na tentativa de conhecer o ambiente da sala de aula sob a ótica do aluno e de certa forma tentando captar as contradições inerentes a este ambiente. Esse questionário possui ao todo 22 questões, sendo uma para sugestões e outras três para identificação do curso, período e se já cursou ou não a disciplina anteriormente. O aluno não é identificado, a menos que o faça por sua própria vontade.

O questionário direcionado ao professor levanta questões quanto à metodologia didática utilizada, qual o percentual da ementa foi cumprida (muito importante para disciplinas que são pré-requisitos de outras), horários de atendimento aos alunos, acesso à bibliografia, condições de sala de aula, assiduidade dos alunos e do próprio professor, dificuldades dos alunos que chegaram ao seu conhecimento, procura por monitores e pelo próprio professor fora da sala, etc. A estrutura deste questionário segue a mesma estrutura do questionário formulado para os alunos. Esse questionário possui ao todo 18 questões, sendo uma para sugestões e outras seis para identificação do curso, período, turma, número de vezes que já ministrou a disciplina, percentual da ementa cumprida e número de horas de atendimento extra-classe. Ao contrário do aluno, o professor é identificado.

ESTUDOS DE CASO

Usando os dados reais da experiência realizada em 2000, a seguir é dado um exemplo da análise dos dados provenientes deste tipo de questionário. Foram aplicados questionários em uma turma de Estatística IV (formada essencialmente por alunos da Psicologia), período diurno, no primeiro semestre de 2000, na Universidade Federal da Paraíba. A aplicação do questionário deu-se em uma data sorteada aleatoriamente entre a segunda e a terceira avaliação. Estavam presentes nesta data na sala de aula 25 alunos. O índice de respostas válidas nas questões (treze questões) com respostas nas escalas não numéricas foi de 100%. Nas questões de múltipla escolha (cinco questões), o índice também foi de também 100%. Das quatro perguntas abertas, apenas em uma (sugestões para melhoria do curso), o índice caiu para 68%. O tempo total utilizado pelos alunos para responder o questionário foi próximo dos dez minutos.

O professor, sem o conhecimento prévio das respostas dos alunos, respondeu ao questionário apenas ao final do semestre - essa defasagem no tempo é necessária, pois algumas perguntas referem-se ao rendimento final dos alunos da disciplina (no caso dos alunos, a pergunta equivalente refere-se a esperança de ser aprovado na mesma disciplina). Na aplicação do questionário do professor o índice de respostas válidas foi de 100% em todos os três tipos de pergunta. Esse questionário era composto por oito questões em escalas não-numéricas, quatro de múltipla escolha e seis abertas. O tempo utilizado pelo professor para responder o questionário foi cerca de sete minutos.

Como uma primeira ilustração, pode ser utilizada uma questão polêmica: "O nível das aulas é condizente com o de exercícios de avaliação", avaliada pelos alunos e "Avalie o nível dos exercícios (das listas e de sala de aula) com as provas e trabalhos", avaliada pelo professor. A escala para ambos foi apresentada com um comprimento total de 8 cm e o padrão de medida utilizado foi da esquerda para a direita. Portanto, valores muito próximos de zero (lado esquerdo do segmento de reta) significam a total coerência entre o nível dos exercícios apresentados em sala de aula e as provas e trabalhos. Valores próximos ao centro (quatro centímetros) indicam uma dúvida ou neutralidade do aluno ou do professor a respeito da sua avaliação. No sentido oposto (lado direito do segmento de reta), valores muito próximos de oito significam a total incoerência entre os exercícios.

Para essa questão, a resposta média dos alunos foi 1,249 com desvio-padrão de 1,003. O professor respondeu no ponto médio 0,6 com variação entre zero e 1,2. Podemos considerar próximas as visões dos alunos e a do professor no quesito compatibilidade entre as aulas e a avaliação, mesmo com a diferença dos pontos médios, visto que 76% dos alunos colocaram um ponto médio abaixo do comprimento de 2,0 cm e apenas dois alunos colocaram um ponto médio acima dos 3,0 cm. Essa questão ilustra a necessidade de se observar não apenas os pontos médios, mas também o percentual de alunos que concordam ou discordam com a visão do professor, dada pela amplitude de resposta do professor.

Como uma segunda ilustração, pode ser utilizada a questão: "Você acha que a ementa dessa disciplina vem de encontro ao seu curso?", avaliada pelos alunos e "A ementa dessa disciplina é razoável para a formação dos futuros profissionais nessa área?", avaliada pelo professor. A escala para ambos foi novamente a de 8 cm, com padrão de medida da esquerda para a direita. Valores muito próximos de zero (lado esquerdo do segmento de reta) significam a total concordância com a adequação da ementa ao curso. Valores próximos ao centro (quatro centímetros) indicam uma dúvida ou neutralidade e valores assinalados no lado direito do segmento de reta, (próximos de oito) significam a total discordância com a adequação da ementa ao curso.

Nesse caso, a resposta média dos alunos foi 2,667 com desvio de 2,065. O professor respondeu no ponto médio 1,95 com variação entre 1,4 e 2,5. Novamente, podemos observar a grande intersecção entre as respostas dos alunos e a do professor. Nesse caso, 60% dos alunos responderam com valores semelhantes ao do professor no segmento de reta, demonstrando a intersecção nas respostas. Apenas três alunos assinalaram um ponto médio acima dos 4,0 cm. É interessante notar que apesar das diferenças aparentes entre as opiniões, o professor assinalou um comentário interessante a respeito da sua resposta: "Os alunos utilizarão métodos estatísticos até mais sofisticados do que estes, porém, a base matemática deficiente complica o ensino dos tópicos".

É também digno de nota que 40% dos alunos declararam que a sua principal dificuldade no estudo da disciplina é a base matemática deficiente. No questionário do professor uma questão similar é colocada e as respostas são: base matemática deficiente e os atrasos freqüentes dos alunos.

CONCLUSÕES FINAIS

Este artigo apresenta uma metodologia para avaliação docente e discente, na qual alunos e professores opinam sobre várias questões envolvendo uma disciplina. Estas questões abrangem a metodologia de ensino, estrutura escolar, forma de estudo, atendimentos extra-classe, etc. Também é apresentado um estudo de caso envolvendo uma disciplina ministrada na Universidade Federal da Paraíba.

Pelos dados, pode-se notar que a utilização das escalas não-numéricas simplificou a coleta de dados com um índice de respostas válidas próximo a 100%, também nas questões de múltipla escolha e abertas. O número reduzido de questões também contribuiu para a obtenção desse índice. Percentuais similares de respostas válidas já tinham sido obtidos por essa metodologia em sucessivas aplicações anteriores [15, 20], ratificando a eficiência do método quando aplicado aos alunos.

No caso particular das respostas do professor, os índices de respostas também foram altos. É digno de nota que em boa parte das respostas, as visões de alunos e professores sobre o ensino coincidem. Naturalmente, houve algumas poucas divergências e uma maior dispersão de opiniões no alunado. Para verificar essas divergências, pode-se utilizar os índices propostos por Moraes e Melo [20].

Uma interessante característica dessa metodologia é ser suficientemente genérica para poder ser aplicada em outras situações de ensino ou treinamento. O método de análise apresentado, baseado nos percentuais das intersecções de respostas, apesar de simples é funcional, pois revela o grau de similaridade de pensamentos entre os alunos e professor. Nos casos analisados nesse trabalho, essa similaridade de pensamentos foi detectada e mostra a existência de uma sintonia entre a percepção dos alunos e do professor sobre o que ocorre na sala de aula.

É óbvio que se deve levar em consideração que existe uma diferença de óticas na resposta dos questionários dos alunos e professores, da a natureza dos papéis dentro da sala-de-aula. No entanto, a existência dessa similaridade de pensamentos se revela devido ao cuidado demonstrado na confecção dos questionários, buscando a avaliação dos pontos importantes da didática, do comportamento, dos pré-requisitos, da maturidade e da seriedade de professores e alunos na busca da melhoria da qualidade do ensino. Observando essas premissas, podemos minimizar as críticas dos docentes a respeito da tão propagada imaturidade dos alunos em seus julgamentos do que de fato ocorre na sala-de-aula, diminuindo alguns tipos de distorções e obtendo respostas mais próximas à realidade de ambos os lados.

Futuramente, com um modelo de questionário aperfeiçoado para o professor, esperamos reduzir ainda mais o número de questões abertas, transformando-as em escalas não-numéricas, facilitando ainda mais a coleta dos dados.

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IMPLEMENTAÇÃO EM TEMPO REAL DE UM SISTEMA DE RECONHECIMENTO DE FALA CONTÍNUA

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Resumo *— A popularização dos computadores pessoais e a generalização de aplicações computacionais na vida das pessoas exigem o desenvolvimento de interfaces homem-máquina mais amigáveis. Das formas de comunicação do ser humano, a mais natural é a fala. Assim, interfaces baseadas na fala que permitam a comunicação em tempo real com uma máquina apresentam várias possibilidades de aplicação. Entretanto, a construção de sistemas que operam em tempo real é uma tarefa bastante complexa, pois envolve análises de problemas que não são encontrados em protótipos que não operam deste modo. Neste trabalho é apresentado um software para reconhecimento de fala contínua, independente do locutor, e que opera em tempo real, usando a técnica de Modelos Ocultos de Markov.*

Palavras Chave — reconhecimento de fala, processamento de voz, sistemas em tempo real.

INTRODUÇÃO

Poder comunicar-se com computadores e outras máquinas através da fala é um sonho antigo, que motivou vários pesquisadores ao longo de várias décadas. Graças a esse esforço de pesquisa, iniciado na década de 50, atualmente já podem ser encontrados os primeiros sistemas de reconhecimento de fala de aplicação comercial. Contudo ainda existe muito a ser aperfeiçoado até que seja criado um sistema que permita a comunicação entre máquinas e pessoas através da fala de uma forma natural.

Uma interface baseada na fala é mais amigável e, dependendo de como é implementada, faz com que não sejam necessários conhecimentos específicos, facilitando a comunicação dos sistemas informatizados com as pessoas, reduzindo assim a exclusão social causada pela falta de domínio das novas tecnologias.

Outras possíveis aplicações para sistemas de reconhecimento de fala são:

- controle de máquinas via voz, deixando as mãos do operador livres para executarem outras tarefas;
- controle de funções de um automóvel (por exemplo, faróis, vidros, limpadores de pára-brisas e rádio), o que ajudaria a evitar acidentes;
- telefone para surdos: uma pessoa que deseja telefonar para uma pessoa com deficiência auditiva poderia falar normalmente. Na casa do deficiente, um sistema de reconhecimento poderia, por exemplo, escrever em uma tela o que a outra pessoa falasse, ou controlar uma cabeça artificial, que mexeria a boca conforme o que estivesse sendo falado para que o deficiente fizesse uma leitura labial;
- auxílio a pessoas deficientes: pessoas paraplégicas ou tetraplégicas poderiam controlar cadeiras de rodas e computadores através de comandos de voz;

Este artigo descreve um sistema de reconhecimento de fala contínua baseado em Modelos Ocultos de Markov contínuos, independente de locutor, para vocabulários pequenos, e que opera em tempo real.

RECONHECIMENTO DE FALA

O processo de reconhecimento de fala consiste em mapear um sinal acústico, capturado por um transdutor (usualmente um microfone ou um telefone) em um conjunto de palavras.

Os sistemas de reconhecimento de fala podem ser caracterizados por vários parâmetros sendo que alguns dos mais importantes se encontram resumidos na Tabela 1 [3].

Tabela 1: Parâmetros típicos usados para caracterizar a capacidade de sistemas de reconhecimento de fala.

Parâmetros	Faixa
Modo de Pronúncia	palavras isoladas a fala contínua
Estilo de pronúncia	leitura a fala espontânea
Treinamento	dependente de locutor a independente de locutor
Vocabulário	pequeno (< 20 palavras) a grande (> 20000 palavras)
Modelo de linguagem	estados finitos a sensível a contexto
Perplexidade	pequena (< 10) a grande (> 100)
SNR	alta (> 30 dB) a baixa (< 10 dB)
Transdutor	microfone com cancelamento de ruído a telefone

Um sistema de reconhecimento de palavras isoladas requer que o locutor efetue uma pequena pausa entre as palavras, enquanto que um sistema de reconhecimento de fala contínua não apresenta este inconveniente.

A fala quando gerada de modo espontâneo é mais relaxada, contém mais coarticulações, e portanto é muito mais difícil de reconhecer do que quando gerada através de leitura.

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Os sistemas dependentes de locutor necessitam de uma fase de treinamento para cada usuário antes de serem utilizados, o que não acontece com sistemas independentes do locutor, desde que estes já foram previamente treinados com vários locutores.

O reconhecimento torna-se mais difícil à medida em que o vocabulário cresce, ou apresenta palavras parecidas.

Quando a fala é produzida em seqüências de palavras, são usados modelos de linguagem para restringir as possibilidades de seqüências de palavras. O modelo mais simples pode ser definido como uma máquina de estados finita, onde são explicitadas as palavras que podem seguir uma dada palavra. Os modelos de linguagem mais gerais, que aproximam-se da linguagem natural, são definidos em termos de gramáticas sensíveis a contexto.

Uma medida popular da dificuldade da tarefa, que combina o tamanho do vocabulário e o modelo de linguagem, é a *perplexidade*, grosseiramente definida como a média do número de palavras que pode seguir uma palavra depois que o modelo de linguagem foi aplicado.

Existem também parâmetros externos que podem afetar o desempenho de um sistema de reconhecimento de fala, incluindo as características do ruído ambiente e o tipo e posição do microfone.

O reconhecimento de fala é um problema difícil devido às várias fontes de variabilidade associadas ao sinal de voz [3]:

- *variabilidades fonéticas* : as realizações acústicas dos fonemas, a menor unidade sonora das quais as palavras são compostas, são altamente dependentes do contexto em que aparecem [1]. Por exemplo o fonema /*t*/ em *tatu* tem uma articulação puramente oclusiva, e em *tia*, dependendo do locutor, pode ter uma articulação africada, onde à oclusão se segue um ruído fricativo semelhante ao do início da palavra "chuva". Além disso, nas fronteiras entre palavras, as variações contextuais podem tornar-se bem mais acentuadas fazendo, por exemplo, com que a frase '*a justiça é ...*' seja pronunciada como '*ajusticé...*'
- *variabilidades acústicas*: podem resultar de mudanças no ambiente assim como da posição e características do transdutor.
- *variabilidades intra-locutor*: podem resultar de mudanças do estado físico/emocional dos locutores, velocidade de pronúncia ou qualidade de voz.
- *variabilidades entre-locutores*: originam-se das diferenças na condição sócio - cultural, dialeto, tamanho e forma do trato vocal para cada uma das pessoas.

Os sistemas de reconhecimento tentam modelar as fontes de variabilidade descritas acima de várias maneiras:

- Em termos fonético acústicos, a variabilidade dos locutores é tipicamente modelada usando técnicas estatísticas aplicadas a grandes quantidades de dados de treinamento. Também têm sido desenvolvidos algoritmos de adaptação ao locutor que adaptam modelos acústicos independentes do locutor para os do locutor corrente durante o uso [14][17].
- As variações acústicas são tratadas com o uso de adaptação dinâmica de parâmetros [14], uso de múltiplos microfones [15] e processamento de sinal [3].
- Na parametrização dos sinais, os pesquisadores desenvolveram representações que enfatizam características independentes do locutor, e desprezam características dependentes do locutor [4][5].
- Os efeitos do contexto lingüistico em termos fonético-acústicos são tipicamente resolvidos treinando modelos fonéticos separados para fonemas em diferentes contextos; isto é chamado de modelamento acústico dependente de contexto [8].
- O problema da diferença de pronúncias das palavras pode ser tratado permitindo pronúncias alternativas de palavras em representações conhecidas como redes de pronúncia. As pronúncias alternativas mais comuns de cada palavra, assim como os efeitos de dialeto e sotaque são tratados ao se permitir aos algoritmos de busca encontrarem caminhos alternativos de fonemas através destas redes. Modelos estatísticos de linguagem, baseados na estimativa de ocorrência de seqüências de palavras, são geralmente utilizados para guiar a busca através da seqüência de palavras mais provável [6].

Atualmente, os algoritmos mais populares na área de reconhecimento de fala baseiam-se em métodos estatísticos. Dentre estes, dois métodos têm se destacado: as redes neurais artificiais (*Artificial Neural Networks*, ANN) [16] e os modelos ocultos de Markov (*Hidden Markov Models*, HMM) [7]. Mais recentemente, implementações híbridas que tentam utilizar as características mais favoráveis de cada um destes métodos também têm obtido bons resultados [13].

SISTEMA IMPLEMENTADO

A rigor, um sistema que opera em tempo real deve ser capaz de efetuar todas as operações a uma taxa maior ou igual à taxa com que o sinal de entrada chega. Devido às verificações efetuadas pelo modelo de linguagem, não é possível atender a este critério. Entretanto, do ponto de vista do usuário, para que se tenha a impressão de operação em tempo real, basta que o tempo de resposta seja tal que o atraso devido ao processamento não seja perceptível (ou demasiadamente longo), e foi baseado nesta premissa que este sistema foi implementado.

Como tecnologia básica, foi escolhido o método baseado em modelos ocultos de Markov contínuos com modelamento por subunidades fonéticas. Para estas foram escolhidos os fones independentes de contexto[6]. Na Figura 1 tem-se um diagrama em blocos do sistema implementado.

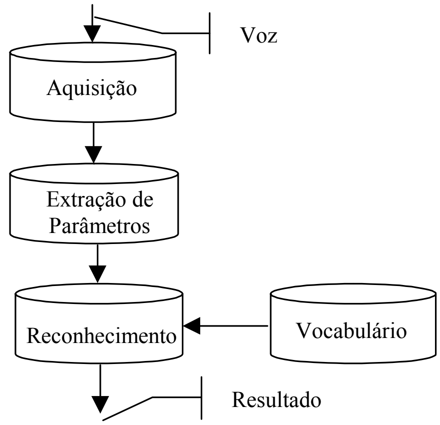

FIGURA 1
DIAGRAMA EM BLOCOS DE UM SISTEMA DE RECONHECIMENTO DE FALA.

Neste diagrama, podemos identificar os seguintes módulos:

1. **Módulo de aquisição de dados**: responsável por converter um sinal analógico, proveniente de um microfone, para um sinal digital em formato PCM.
2. **Módulo de extração de parâmetros**: tem por função converter o sinal de voz em uma seqüência de vetores de parâmetros. Isto é feito com o objetivo de representar os eventos acústicos relevantes do sinal de fala em termos de um conjunto compacto e eficiente de parâmetros.
3. **Módulo de reconhecimento**: por fim, a locução parametrizada é inserida no módulo de reconhecimento, que tem por função comparar a seqüência de parâmetros da locução a ser reconhecida com os modelos nele armazenados. A palavra cujo modelo que apresentar a maior similaridade com a locução de entrada vai ser a palavra reconhecida.

A seguir, cada um destes itens será mostrado em maiores detalhes:

Módulo de aquisição

Como dito anteriormente, este módulo é a interface do sistema com o usuário: coleta os sinais acústicos provenientes de um microfone e os apresenta para serem processados. Entretanto, como os algoritmos de reconhecimento apresentam um alto custo computacional, seria interessante que este só entrasse em ação quando houvesse um sinal de voz presente, deixando os recursos do sistema livres para outros aplicativos enquanto o locutor não estiver falando.

Analisando um sinal típico de a fala, nota-se que grande parte do tempo de uma conversação é ocupado por silêncio, como pode ser observado na Figura 2. Desta forma, para otimizar a utilização do sistema de reconhecimento, os intervalos de silêncio devem ser descartados, sendo processada somente a fala válida. Neste trabalho foi desenvolvido um algoritmo baseado em níveis de energia, uma adaptação do método proposto no artigo clássico de Rabiner & Sambur [11].

A identificação da presença de fala válida no sinal adquirido pode ser feita de várias formas, e a dificuldade em fazê-la depende do ambiente onde se encontra o locutor, pois a ausência de fala não significa silêncio absoluto. De fato, na maioria das aplicações práticas sempre haverá um ruído de fundo. Em ambientes demasiadamente ruidosos serão encontradas dificuldades para distinguir a fala do ruído não só na aquisição como também na etapa de reconhecimento.

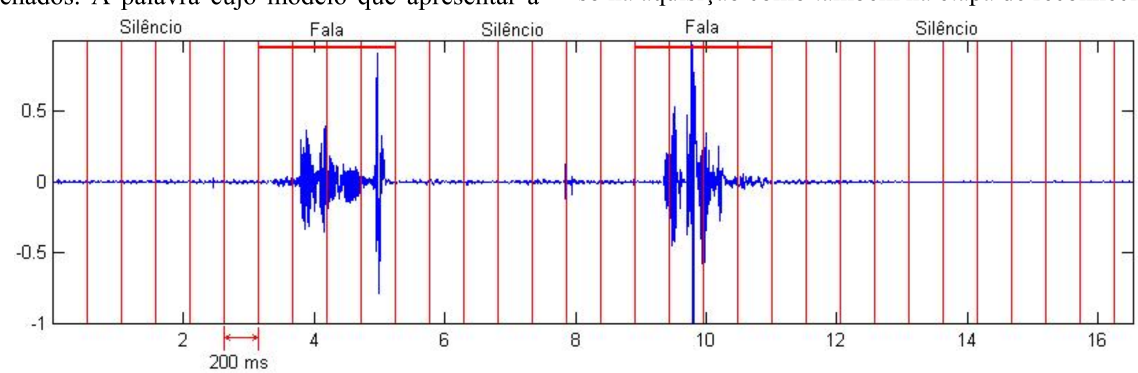

FIGURA 2
DIAGRAMA DO SISTEMA DE RECONHECIMENRO DE FALA

Para ambientes com uma relação sinal-ruído razoável uma técnica que apresenta bons resultados é a análise do nível de energia do sinal. Considerando que o sinal de voz do locutor possui um nível de energia notavelmente superior ao nível do sinal de energia do ruído, é possível identificar os intervalos que possuem fala.

Para isto, inicialmente é necessário medir o nível de sinal quando não se tem sinal de voz presente, isto é, o nível de energia do ruído ambiente. Depois, quando em operação, o sistema verifica se a entrada ultrapassa um determinado limiar acima do nível do ruído, e quando isto acontece, o sinal é enviado ao sistema de reconhecimento.

A aplicação do algoritmo de detecção de início e fim pode ser exemplificado pela

Figura 3, que apresenta a forma de onda de uma palavra, seus níveis de energia e as marcações de inicio e fim.

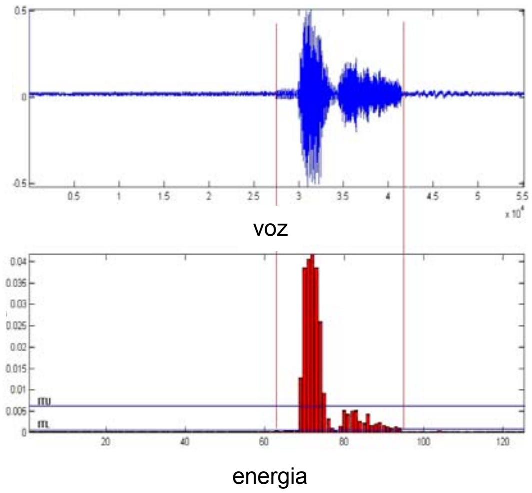

FIGURA 3
APLICAÇÃO DO ALGORITMO DE DETECÇÃO DE INICIO E FIM NA PALAVRA 'DOIS'.

Módulo de extração de parâmetros

A próxima etapa consiste na extração de parâmetros do sinal de voz. Para este trabalho foram escolhidos os parâmetros mel-cepstrais [4], amplamente utilizados na maioria dos sistemas de reconhecimento de fala atuais.

O processo de obtenção dos parâmetros acústicos da fala envolve 3 etapas: a pré-ênfase, o janelamento e a análise espectral, representadas conforme a Figura 4.

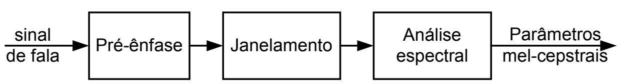

FIGURA 4
DIAGRAMA DE BLOCOS DO PROCESSO DE EXTRAÇÃO DOS PARÂMETROS MEL-CEPSTRAIS

A pré-ênfase, realizada por um filtro passa altas ($1 - 0,95z^{-1}$), tem como função compensar a atenuação de 6dB/oitava nas altas freqüências. Esta atenuação é ocasionada pelo efeito combinado do espectro decrescente dos pulsos glotais (-12dB/oitava) e pelo efeito de radiação dos lábios (+6dB/oitava) [10].

Os parâmetros do sinal de fala são atualizados a cada 10 ms, sendo o janelamento do sinal calculado através da janela de Hamming de 20 ms. Este janelamento tem como função produzir suavização da amplitude do sinal amostrado, nos extremos do segmento de análise, dando maior ênfase às amostras localizadas no centro da janela. Desta forma, tem-se uma superposição entre os dados de análise de 2 janelas adjacentes. Este processo pode ser observado na Figura 5.

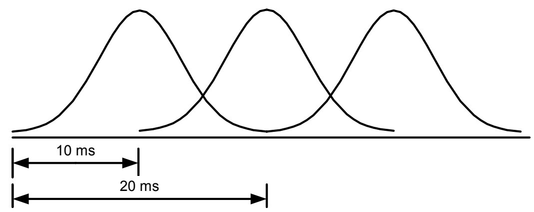

FIGURA 5
PROCESSO DE SUPERPOSIÇÃO DE JANELAS PARA O CÁLCULO DOS PARÂMETROS MEL-CEPSTRAIS

Como finalização do processo, têm-se a análise espectral, onde é realizada a conversão da representação temporal do sinal analisado, para alguma forma de representação espectral. Basicamente dois métodos de análise espectral predominam nos sistemas de reconhecimento de fala: o método de análise espectral LPC (Linear Predictive Coding) e o método de análise espectral por banco de filtros, obtido a partir da Transformada Rápida de Fourier (FFT). Para este trabalho, optou-se pelo segundo método, por ser mais eficiente na obtenção dos parâmetros mel-cepstrais.

Tanto o espectro resultante da FFT quanto o espectro resultante da predição linear são representações bem mais relacionadas ao processo de audição e percepção humana do que os métodos de representação temporal (taxa de cruzamentos por zero, perfil de energia, log-energia, entre outros), utilizados na caracterização da fala. Isto justifica a ampla utilização de parâmetros extraídos a partir da representação espectral do sinal acústico, em relação aos parâmetros de representação temporal.

Além dos parâmetros cepstrais (mel-cepstrais), foram utilizados também os parâmetros diferenciais (delta-mel-cepstrais, delta-delta-mel-cepstrais), com o intuito de uma melhor caracterização das variações temporais do sinal de fala.

Módulo de reconhecimento

O módulo de reconhecimento é o responsável pelo mapeamento dos parâmetros acústicos correspondentes à locução de entrada em sua transcrição ortográfica. Foram implementados três algoritmos de busca para o reconhecimento de fala contínua: o *Level Building* [11], o *One Step* [9] e o Herrman-Ney [2]. Para melhorar o desempenho do sistema em termos de taxa de acertos foram incluídos o modelo de duração de palavras [12] e o modelo de linguagem bigrama [6]. Também foi implementada a estratégia Viterbi *Beam Search* [12] de poda de caminhos. para diminuição do custo computacional e consequentemente do tempo de processamento. Um diagrama de blocos para este sistema é mostrado na Figura 6.

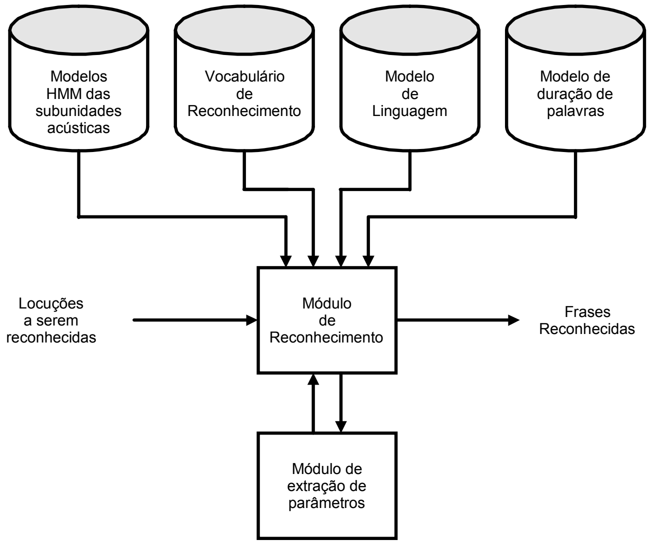

FIGURA 6
DIAGRAMA DE BLOCOS DO MÓDULO DE RECONHECIMENTO.

Estes algoritmos são extremamente complexos, e a descrição detalhada dos mesmos foge do escopo deste trabalho. Em [12] tem-se uma boa referência para o estudo dos mesmos.

Uma consideração importante a ser feita é sobre o tamanho do vocabulário, ou seja, o número de palavras que o sistema pode reconhecer. Quanto maior o vocabulário, maior será o tempo necessário para que uma palavra seja reconhecida. Com estes algoritmos, temos conseguido, para este sistema, operação em tempo real para vocabulários de algumas dezenas de palavras. Outros algoritmos de reconhecimento, mais eficientes estão sendo estudados para permitir operação em tempo real para vocabulários maiores.

CONCLUSÃO

Neste artigo foi apresentado um breve resumo da tecnologia de reconhecimento de fala e suas aplicações, bem como a descrição da implementação em tempo real de um sistema de reconhecimento de fala contínua independente de locutor baseado em modelos ocultos de Markov, para um vocabulário pequeno.

A implementação de um sistema para operação em tempo real apresenta dificuldades que não são encontradas em protótipos de laboratório que não operam em tempo real, levando a considerações e a soluções próprias deste tipo de sistema. Ainda, do ponto de vista da pesquisa, é possível testar novas idéias e soluções em um sistema real, verificando o ganho obtido e mesmo a viabilidade das idéias concebidas.

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A Evolução da Alfabetização Brasileira na Última Década: Uma Análise Espacial e Temporal

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Resumo *— O Brasil divulgou recentemente parte dos resultados do Censo Brasileiro de 2000. Entre os dados divulgados estão os índices de alfabetização por estado brasileiro. As primeiras informações davam conta que o índice de analfabetismo brasileiro caiu significativamente. Porém, ficou sem resposta a questão da verdadeira mudança estrutural do analfabetismo brasileiro. As políticas implementadas e experimentadas ao longo da última década foram suficientes para alterar o grave quadro do analfabetismo brasileiro do Censo de 1991? Para responder a essa questão, utilizamos técnicas estatísticas de Análise Espacial para detectar a presença de padrões espaciais existentes no Censo de 1991 e no Censo de 2000, verificar as suas possíveis variações e confrontá-las com os gastos governamentais em ensino fundamental nos últimos anos.*

Palavras-chave — Avaliação do Analfabetismo Brasileiro, Análise Espacial, Índices de Autocorrelação, Geoestatística.

INTRODUÇÃO

A revolução cultural iniciada no final do século XX com o avanço de novas tecnologias, como as telecomunicações e a informática, tem sérias limitações no chamado grupo de países "em desenvolvimento", incluindo o Brasil. A maior parte da população da maioria desses países sofre a exclusão da sociedade informatizada, pelo fato desses países não terem se dedicado a educação básica dos seus povos, ou seja, a alfabetização. As estatísticas oficiais brasileiras demonstram que o Brasil também não fez bem a sua lição de casa até o final da década de 80. Após o Censo Brasileiro de 1991 [6] sabia-se que apenas 66,43% da população brasileira era alfabetizada. Por conseqüência, 33,57% dos brasileiros não eram. Deve-se levar em consideração que em um Censo, a forma de se declarar uma pessoa analfabeta é quando a própria pessoa se declara sem condições de ler e escrever o seu próprio nome. Relembrando a realidade brasileira do final da década de 80, após choques econômicos e a hiper-inflação, o país não possuía elementos favoráveis para um grande salto na educação, ainda que necessitasse deste salto para o seu desenvolvimento. Segundo [8], a heterogeneidade predomina no mapa do Analfabetismo brasileiro em 1991.

A década de 90 foi benéfica no sentido educacional ao Brasil, com vários governantes investindo sistematicamente em grandes programas educacionais e o resultado começou a aparecer no recentemente divulgado Censo Brasileiro de 2000. Após quase uma década, apesar dos percalços econômicos, o Brasil recuou o seu índice de analfabetismo para 24,76% da população no Censo Brasileiro de 2000 [5]. Apesar das melhorias, significativas evidenciadas pelos índices, fica a questão: houve de fato grandes alterações nos quadros estaduais de analfabetismo da nação?

Esse trabalho procura acrescentar novos elementos a essa discussão, a partir de uma análise estatística dos dados governamentais fornecidos. Para realizar essa análise, lançamos mão de técnicas de Análise Espacial [3] para a verificação das reais diferenças ocorridas no Brasil, em termos espaciais, entre os anos de 1991 e 2000.

METODOLOGIA

A avaliação das alterações espaciais entre os Censos de 1991 e 2000 será efetuada através de uma análise espacial utilizando mapas coropléticos (nome dado pela Geografia aos mapas coloridos) [2] e a Associação Espacial de Moran [3]. Essa ferramenta estatística de análise é composta pelos Índices de Moran (Global e Local) e pelos diagramas e mapas de espalhamento. A seguir, os conceitos necessários estão formalizados.

Matriz de Proximidade Espacial

A matriz de proximidade espacial é uma matriz que relaciona n áreas $\{A_1,A_2,...,A_n\}$ de uma região. Essa matriz W é tal que cada um dos seus elementos w_{ij} representa uma medida de proximidade entre as áreas A_i e A_j, segundo um critério de proximidade [3]. Um critério possível é: w_{ij}=1 se A_i compartilha um lado comum com A_j; caso contrário w_{ij}=0.

Média Móvel Espacial

A média móvel espacial $\bar{y}_i$ explora a variabilidade espacial dos dados, procurando determinar variação das tendências. É dada por:

$$\bar{y}_i = (\Sigma^n_{j=1}\ w_{ij}\, y_j\,)\ /\ \Sigma^n_{i=1}\ w_{ij} \qquad (1)$$

onde y_j é o valor do atributo estudado em cada área A_j.

A análise pela média móvel tem a vantagem de produzir uma superfície menos descontínua nos dados originais e isso pode ser visto no mapa coroplético.

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Índice Autocorrelação Espacial

A média móvel é vista como uma primeira aproximação da variabilidade espacial, mostrando alguns padrões e tendências. Porém, também é importante verificar a dependência espacial dos dados, a fim de verificar a maneira pela qual os dados estão correlacionados no espaço. A autocorrelação espacial procura medir essa dependência espacial de uma área A_i e suas áreas vizinhas, segundo um atributo estudado. Então, Índice Global de Autocorrelação de Moran (I) mede a interdependência geográfica em uma região segundo um atributo e é dado por:

$$I = \left(\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} z_i z_j\right) / \left(\sum_{i=1}^{n} z_i^2\right) \quad (2)$$

onde z_i é a diferença entre o valor do atributo na região de estudo e a sua média.

O índice I verifica se as áreas conectadas apresentam algum afastamento de um esperado padrão aleatório. Em geral, seu valor fica limitado ao intervalo [-1, 1], embora em alguns casos possa assumir valores diferenciados. Assim, valores positivos do índice I quantificam correlação direta entre a área em questão e os seus vizinhos, segundo o atributo estudado e os valores negativos quantificam correlação inversa [4].

Segundo Anselin [1], os indicadores locais de autocorrelação devem atender a dois objetivos:

- permitir a identificação de padrões de associação espacial e,
- ser uma decomposição do índice global.

O Índice Local de Moran (I_i) é uma simplificação do índice global, computando a variação do atributo na área A_i pela variação do mesmo atributo em seus vizinhos.

$$I_i = \left(z_i \sum_{j=1}^{n} w_{ij} z_j\right) / \left(\sum_{i=1}^{n} z_i^2\right) \quad (3)$$

Diagrama de Espalhamento de Moran

Descrevendo a equação (2) em forma matricial, temos:

$$I = (Z^t W Z)/(Z^t Z), \quad (4)$$

o Diagrama de Espalhamento de Moran é uma forma gráfica adicional para visualizar o Índice de Moran. Procura-se visualizar espacialmente o relacionamento entre os valores observados Z e os valores das médias locais WZ. O diagrama é mostrado na Figura 1. O gráfico é dividido em quatro quadrantes: Q1, Q2, Q3 e Q4. Os pontos colocados nos quadrantes Q1 e Q2 indicam regiões que seguem o mesmo processo de dependência espacial das demais observações. Já os pontos colocados nos quadrantes Q3 e Q4 indicam diferentes processos de dependência espacial, ou seja, podem indicar regiões de transição entre regimes espaciais. Esse gráfico pode ser apresentado na forma de um mapa coroplético, indicando-se os quatro quadrantes com cores diferenciadas para facilitar a interpretação.

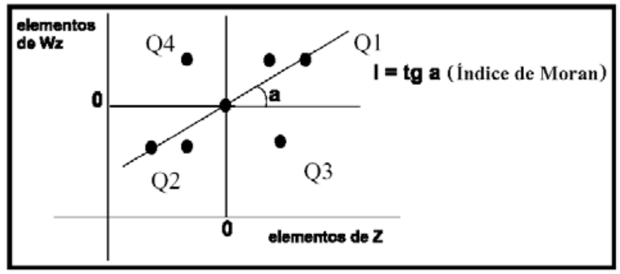

FIGURA. 1
DIAGRAMA DE ESPALHAMENTO DE MORAN.

Indicadores Locais de Associação Espacial (LISA)

Uma vez admitida a significância estatística do índice local de Moran, permite-se identificar agrupamentos de regiões com atributos semelhantes e áreas anômalas, contendo mais de um regime espacial, com significância estatística.

Para a visualização destes índices, pode ser gerado um mapa coroplético apresentando as regiões com correlação local significativamente diferente do resto das outras regiões. Normalmente, este mapa contém apenas quatro categorias, apresentando a não significância, significância em 5%, significância em 1% e significância em 0,5%.

RESULTADOS

No Censo Brasileiro de 1991 [6], o estado com o menor índice de analfabetismo era o Rio de Janeiro, com apenas 20,88%, seguido pelo Rio Grande do Sul com 21,88%. Do lado oposto, com o maior índice estava o estado de Alagoas com 57,95%, seguido pelo estado do Maranhão com 56,36%. Pode-se notar ainda que os estados das regiões norte e nordeste, com exceção de Roraima e Rondônia, estavam com percentuais de analfabetos maiores que o percentual do Brasil que era de 33,57% da população. Por outro lado, os estados das regiões Sul, Sudeste e Centro Oeste tiveram os menores percentuais de analfabetismo do país. O mapa apresentado na Figura 1 evidencia a heterogeneidade da população analfabeta como já constatado antes por Teles e Moraes [8].

No Censo Brasileiro de 2000 [5], os estados que tinham graus melhores de alfabetização continuam a possuir os melhores graus e os que possuíam os maiores graus, também continuam a tê-lo. Novamente, o Rio de Janeiro possui o mais baixo índice de analfabetismo do país com 16,97%, seguido pelo Rio Grande do Sul com 16,99%. Novamente, do lado oposto, com o maior índice continua com o estado de Alagoas com 44,08%, seguido pelo estado do Maranhão com 40,33% e as regiões Norte e Nordeste continuam com os maiores índices de analfabetismo do país, inclusive Roraima e Rondônia que apesar de terem diminuído o percentual de analfabetismo em, respectivamente, 8,20% e 10,12% ficaram com índices maiores que o do Brasil neste último Censo, que foi de 24,76%. No entanto as outras regiões permaneceram nas suas respectivas posições.

FIGURA. 2
MAPA DA POPULAÇÃO ANALFABETIZADA DO BRASIL, SEGUNDO DADOS DO CENSO BRASILEIRO DE 1991.

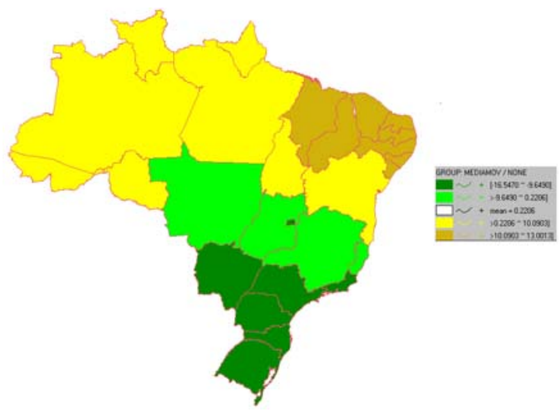

FIGURA. 3
MAPA DAS MÉDIAS MÓVEIS DA POPULAÇÃO ANALFABETIZADA DO BRASIL, SEGUNDO DADOS DO CENSO BRASILEIRO DE 1991.

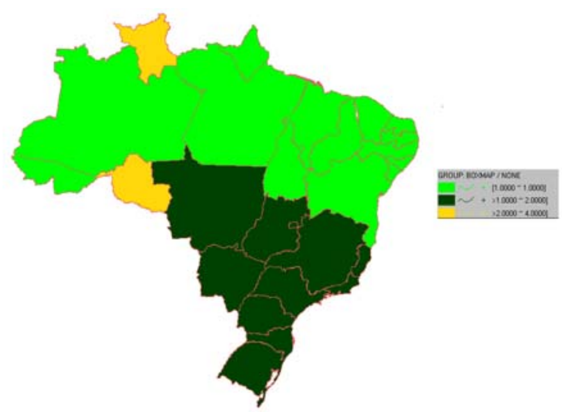

FIGURA. 4
MAPA DE ESPALHAMENTO DE MORAN PARA A POPULAÇÃO ANALFABETIZADA DO BRASIL, SEGUNDO DADOS DO CENSO BRASILEIRO DE 1991.

Analisando a variação percentual absoluta entre os Censos, constata-se que os estados que obtiveram os maiores percentuais de melhora foram os estados do Maranhão, Piauí, Paraíba e Bahia, respectivamente, com índices superiores a 15%. Por serem estados considerados em situação financeira difícil, provavelmente obtiveram apoio federal para esse salto qualitativo. Do lado oposto, os estados que obtiveram os menores percentuais de melhora foram os estados do Rio de Janeiro, São Paulo, Rio Grande do Sul, o Distrito Federal, respectivamente, com índices inferiores a 6%. Nota-se então, que os estados que estavam em melhor situação em 1991, não se empenharam tanto na solução do problema do analfabetismo na última década. Isso causa espanto, principalmente por serem os estados em melhor situação financeira no país.

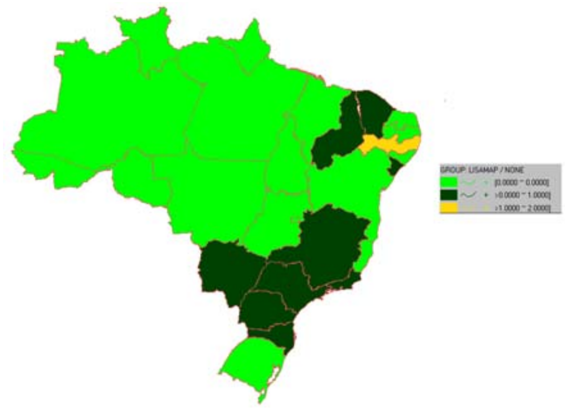

FIGURA. 5
MAPA DE INDICADORES LISA PARA A POPULAÇÃO ANALFABETIZADA DO BRASIL, SEGUNDO DADOS DO CENSO BRASILEIRO DE 1991.

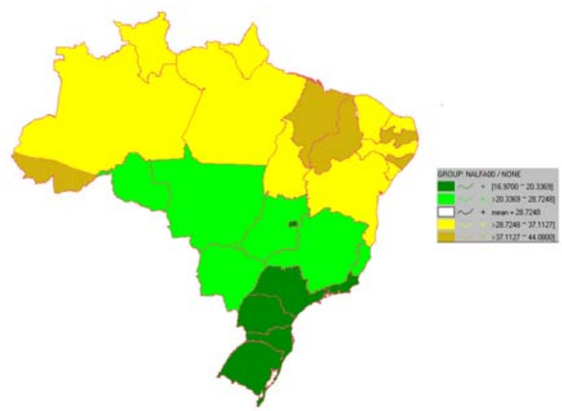

FIGURA. 6
MAPA DA POPULAÇÃO ANALFABETIZADA DO BRASIL, SEGUNDO DADOS DO CENSO BRASILEIRO DE 2000.

O Índice Global de Autocorrelação de Moran no ano de 1991 foi de 0,7282, indicando a existência de uma alta correlação espacial entre os estados do Brasil naquele ano. No ano 2000, o Índice de Moran passou a ser de 0,7151, mostrando uma pequena alteração da correlação existente.

O Mapa da Figura 2 mostra a distribuição do percentual de analfabetos do Brasil em relação ao percentual médio, no ano de 1991. Pode-se verificar que mais de 50% da população era composta por pessoas sem alfabetização, nos estados que estão em cor amarela escura. Esta área é composta pelos estados do Maranhão, Piauí, Paraíba e Alagoas. Na área em amarelo, composta pela quase totalidade da região Norte e boa parte do Nordeste, os índices de analfabetismo estão entre 39,12% e 50,90%. Observa-se também que os estados de Roraima e Rondônia possuem índices diferenciados de analfabetismo em relação à região Norte. Por outro lado os estados Rio de Janeiro, São Paulo e Distrito Federal juntamente com os estados da região Sul tiveram os menores porcentuais de analfabetos, entre 20,88% e 27,33%.

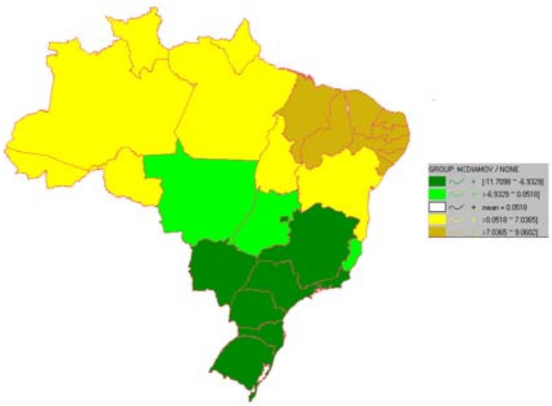

FIGURA. 7
MAPA DAS MÉDIAS MÓVEIS DA POPULAÇÃO ANALFABETIZADA DO BRASIL, SEGUNDO DADOS DO CENSO BRASILEIRO DE 2000.

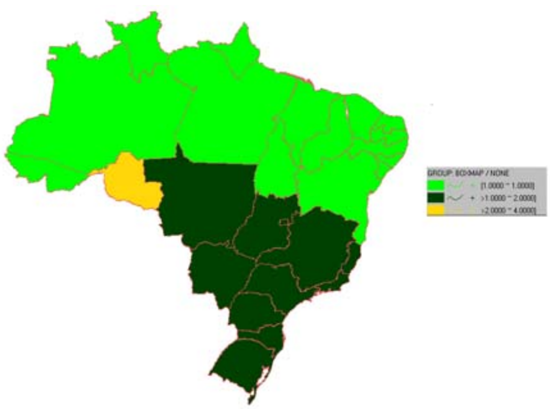

FIGURA. 8
MAPA DE ESPALHAMENTO DE MORAN PARA A POPULAÇÃO ANALFABETIZADA DO BRASIL, SEGUNDO DADOS DO CENSO BRASILEIRO DE 2000.

Utilizando-se da Média Espacial Móvel para analisar o percentual de analfabetos do Brasil, nota-se no Mapa da Figura 3, que a variação do percentual de analfabetos pode estar sendo influenciada pelas regiões políticas do Brasil. Vê-se claramente quatro regiões bem definidas. Conforme mencionado, a Média Móvel tem a vantagem de produzir uma superfície menos descontínua nos dados originais. Isso pode ser observado na Figura 3, onde os estados de Rondônia e Roraima não mais estão diferenciados em relação à região Norte. O mesmo acontece em parte da região Nordeste, com os estados do Ceará, Rio Grande do Norte, Pernambuco e Sergipe. Na região Centro-Oeste, o Mato Grosso do Sul agora se uniu ao grupo de estados do Sul e Sudeste com baixos índices de analfabetismo e o Distrito Federal encontra-se isolado em relação a essa região.

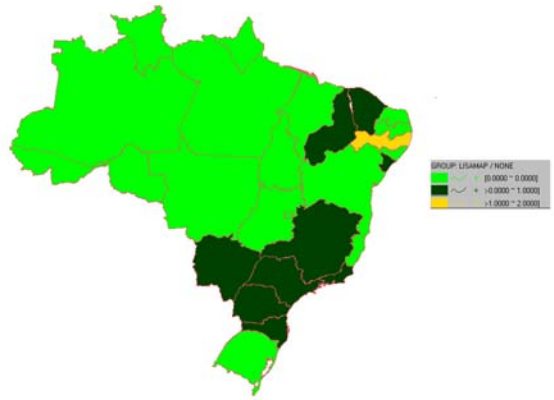

FIGURA. 9
MAPA DE INDICADORES LISA PARA A POPULAÇÃO ANALFABETIZADA DO BRASIL, SEGUNDO DADOS DO CENSO BRASILEIRO DE 2000.

O Mapa da Figura 4, Mapa do Espalhamento de Moran, onde os estados com as cores em verde claro e verde escuro estavam respectivamente no primeiro e no segundo quadrante do Diagrama de Espalhamento de Moran. Desta forma estes estados apresentaram uma associação espacial positiva. Já os estados em cor amarela, Roraima e Rondônia apresentavam uma associação espacial negativa, ou seja, não seguiam os mesmos processos de dependência espacial que os outros estados.

No Mapa da Figura 5 pode-se observar a distribuição dos Indicadores Locais de Associação Espacial para o percentual de analfabetos dos estados brasileiros em 1991. Os estados da região Norte não apresentam diferenças significativas entre si. Entre os estados do Nordeste, áreas de transição são observadas entre o Ceará e Rio Grande, Paraíba e Pernambuco, este último como transição com Alagoas. Sergipe também aparece como uma área de transição entre Alagoas e Bahia. O mapa apresenta uma área de fronteira entre os entre duas regiões definidas pelos estados do Espírito Santo, Minas Gerais e Mato Grosso do Sul. Pode-se notar o isolamento do estado do Rio Grande do Sul em relação a sua região.

No Mapa da Figura 6, tem-se a distribuição do percentual de analfabetos do Brasil em relação ao percentual médio, no ano 2000. Observa-se que os estados do Maranhão, Piauí, Paraíba, Alagoas e Acre apresentaram os maiores percentuais de analfabetos do país, entre 37,11% e 40,08%. Do lado oposto, os estados do Rio de Janeiro, São Paulo e o Distrito Federal e os estados da região Sul apresentaram os menores percentuais de analfabetos, entre 16,97% e 20,34%. Além disso, quase a totalidade da região Centro Oeste e os estados de Mina Gerais, Espírito Santo e Rondônia estavam com o percentual de analfabetos um pouco menor que o percentual médio, que foi de 28,72%.

No Mapa da Figura 7 observa-se novamente que a Média Espacial Móvel produziu uma superfície menos descontínua nos dados originais. Nota-se que os estados do Rio Grande do Norte, Ceará, Pernambuco e Sergipe não mais apresentam diferença em relação a região Nordeste, apenas com a Bahia. O mesmo ocorreu com os estados de Rondônia e Acre na região Norte. Os estados de Minas Gerais e Mato Grosso do Sul passaram a fazer parte do grupo de estados compostos por São Paulo, Rio de Janeiro, os estados da região Sul e o Distrito Federal.

Ao observar o Mapa do Espalhamento de Moran (Figura 8) para o percentual de analfabetos do Brasil, no ano 2000 verificou-se que os estados da região Nordeste e Norte, com exceção de Roraima, estão no primeiro quadrante do Diagrama de Espalhamento de Moran e os estados das regiões Centro Oeste, Sul e Sudeste estão no segundo quadrante. Com isso esses estados possuem uma associação espacial positiva, o que indica que esses estados seguem um processo de dependência espacial. O estado de Rondônia pode ser considerado como um extremo, por não estar associado espacialmente a nenhum de seus vizinhos.

A distribuição dos LISAs para o percentual de analfabetos dos estados brasileiros em 2000 pode ser observada no Mapa da Figura 9. Nota-se no mapa as seguintes áreas de transição: Santa Catarina com relação ao Rio Grande do Sul; Mato Grosso do Sul com os estados da sua região; Piauí com o Maranhão e a Bahia; Ceará com a Paraíba, Rio Grande do Norte e Pernambuco; este último como transição com Alagoas e Sergipe como transição com Alagoas e Bahia. Os estados da região Norte não apresentam diferenças significativas entre si.

Em termos comparativos, observando a evolução dos índices de Autocorrelação de Moran e a evolução dos percentuais de analfabetismo evidenciadas pelos Mapas das Figuras 2 e 6, pode-se notar que não houve uma mudança conjuntural nos quadros estaduais de analfabetismo no Brasil. Ressalvas devem ser feitas aos estados do Acre e Roraima. Ambos não acompanharam a evolução percentual dos demais estados brasileiros e se encontram diferenciados com respeito aos respectivos estados vizinhos.

Apesar dessas conclusões serem aparentemente conflitantes com a melhoria dos índices percentuais divulgados, outras informações oficiais podem vir à tona para esclarecê-las. Ribeiro [7] analisa os gastos e fontes financiadoras do Ministério da Educação (MEC) e mostra certas distorções nos investimentos do ministério. Por exemplo, em termos gerais, a partir de 1994, o governo não aplicou mais que 1,44% do PIB em educação, o que se traduz em R$ 89,31 per capita por ano. O gasto médio anual do MEC com o Ensino Fundamental entre 1993 e 1999 ficou em R$ 2.100,13 milhões com um desvio-padrão de R$ 558,25 milhões. Ao longo deste período os valores estavam em queda desde 1994 até 1997. Em 1998 os recursos aumentaram para novamente serem reduzidos em 1999. Como os valores investidos pelo MEC podem ser considerados tímidos para a gravidade do problema do analfabetismo no Brasil, fica claro que a melhoria nos índices deveu-se a uma redistribuição de recursos e não a um aumento dos investimentos em educação.

Conclusões Finais

Neste trabalho foi apresentada uma análise estatística do analfabetismo brasileiro entre os Censos de 1991 e 2000. Observou-se a diminuição significativa dos índices percentuais nacionais do analfabetismo. Porém, com a utilização de técnicas de Análise Espacial ficou evidente a permanência da estrutura do analfabetismo por estados entre os Censos.

Portanto, apesar da melhoria evidenciada pelos índices globais, o Brasil apresenta a mesma distribuição espacial no analfabetismo, preservando as desigualdades regionais que deveriam ter sido amenizadas. De um modo geral, alguns estados não melhoraram seus índices na proporção de seus vizinhos, como o Rio de Janeiro, São Paulo, Rio Grande do Sul e o Distrito Federal. Isso provavelmente se deve a uma redistribuição dos recursos do MEC entre os estados, visto que o volume de recursos total sofreu bruscas reduções durante o período e fecharam em 1999 em patamar inferior ao de 1994. Essa redistribuição foi suficiente para diminuir os índices do analfabetismo brasileiro, ainda que não tenha sido suficiente para alterar a distribuição espacial do mesmo.

Segundo o Banco Interamericano de Desenvolvimento (BIRD), mantendo-se constante os fatores de capital, terra e trabalho, o aumento de um ano na média educacional da população economicamente ativa determina um incremento de 5,5% na taxa de crescimento do PIB [9]. Para melhorar a baixa média educacional brasileira, obviamente valores compatíveis devem ser investidos em educação.

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SESHET-S: Um Sistema de Monitoria Virtual para o Ensino a Distância de Estatística

Hérico Gouveia de Souza[1], e Ronei Marcos de Moraes[2]

Resumo *— Este artigo descreve a plataforma de monitoria virtual denominada SESHET-S e a implementação de um módulo adicional para o ensino de Amostragem. Esse sistema modela o conhecimento em módulos independentes de conhecimento usando regras "fuzzy". A resposta a uma dada consulta ao sistema é fornecida levando-se em consideração todas as possíveis respostas e também apontando o valor percentual das suas possibilidades. O novo módulo de Amostragem contém o conhecimento dos diversos tipos clássicos de amostragem e inclui também o cálculo do tamanho da amostra para a amostragem aleatória simples usando uma média ou uma proporção*

Palavras-chave — Monitoria Virtual, Sistemas Especialistas, Ensino a Distância, Ensino de Estatística.

INTRODUÇÃO

A profusão de análises estatísticas inadequadas no meio científico mostra a falta de um cuidado maior na manipulação de dados de pesquisa. Vários trabalhos publicados em periódicos de renome ou não, trazem a falta patente de um pesquisador da área de estatística, com suas análises insuficientes e conclusões seriamente prejudicadas. No meio comercial e empresarial, tal fato também ocorre e pesquisas de opinião no Brasil e em outros países trazem vícios de concepção que levam a conclusões no mínimo não-convencionais. Estas deficiências originam-se no aprendizado deficiente da estatística ministrada no ensino médio e superior, tanto pelo fato das ementas destas disciplinas não atenderem a cada curso especificamente, quanto pela falta de uma estrutura de apoio ao ensino que leve o aluno a um aprendizado mais profundo das técnicas estatísticas. Desta forma, a maioria dos profissionais sabe da existência da ciência, porém não a conhecem na profundidade suficiente para que ela lhes seja útil realmente. [12].

Dada esta realidade e com o advento do Ensino à Distância, onde ensinamos nossos alunos por correio, televisão e recentemente através de redes de computadores (notadamente pela Internet), observamos um sério problema: se o aprendizado nas disciplinas de estatística já é insuficiente no ensino presencial, como resolver as dúvidas de um estudante à distância? Na maioria das vezes, não é possível colocar um professor em contato direto com o aluno.

No futuro, o ensino à distância reduzirá as limitações geográficas e os cursos atenderão a um grande número de estudantes. Esses estudantes necessitarão de orientadores e monitores para responder às suas questões e dúvidas [15]. Dentro desta ótica, um sistema especialista acoplado a um sistema de análise seria bem-vindo no sentido de orientar o correto uso das suas ferramentas, bem como no ensino delas, como Coob [3] sugere. Também seria interessante que esse sistema possa ensinar ao usuário os passos de uma análise e guiá-lo na sua execução, seguindo a tendência de Giraud [5].

Em várias áreas do conhecimento humano, os sistemas especialistas são utilizados para o auxílio em tomada de decisões: seja na medicina, economia, indústria, etc. As regras são usadas para expressar o conhecimento humano sobre um assunto e essas regras podem ser tratadas por vários tipos de lógica, como a lógica clássica, a lógica modal, a lógica *fuzzy*, etc de acordo com o tipo de aplicação [17].

Sob o ponto de vista didático e estatístico, não existe uma ferramenta de ensino que una um sistema especialista dedicado ao ensino a um "software" estatístico. Nem mesmo os "softwares" comerciais mais utilizados como SAS®, SPSS®, Statistica® ou SPlus®, têm um sistema especialista para auxiliar o usuário na decisão sobre qual método é adequado ao seu problema. Estes sistemas estatísticos são capazes de análises complexas, mas não limitam ou guiam os usuários nas suas ações. Assim, esses "softwares" não podem auxiliar o usuário no uso de uma técnica em detrimento de outra e nem mesmo podem guiá-lo a não utilizar uma técnica equivocada em sua análise.

Uma possível solução para este problema seria a construção de um sistema especialista com conhecimento específico sobre "como ensinar" um determinado assunto. Assim, o estudante poderia interagir com este sistema para aprender e solucionar suas dúvidas. No entanto, esse sistema não pode ser apenas um sistema especialista para tomada de decisões, como os mencionados anteriormente; ele deve possuir características especiais para simplificar o seu uso e ser amigável, já que a sua utilização será feita por pessoas inexperientes na área.

Moraes e Zuffo [12] propuseram uma arquitetura inteligente, usando lógica *fuzzy* para aplicações em Ensino à Distância com características específicas para atender a área

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de ensino, como: possibilidade para interpretar respostas vagas e imprecisas (como por exemplo: “Eu não sei”, ou “Deve ser...”); possibilidade para apresentar várias possíveis soluções para uma dúvida e apontar deficiências do conhecimento do estudante. Esta arquitetura foi denominada: *Monitor Virtual* dada a sua similaridade com a função exercida pelos monitores no ensino tradicional [12]. Foi proposta também uma aplicação desta arquitetura na construção de um sistema de apoio ao ensino à distância de Estatística, denominado SESHET-S [11].

A partir da implementação desta arquitetura o SESHET-S, em sua versão original, cobria os tópicos de Análise Exploratória de Dados [16], Noções de Probabilidade [8], Inferência Estatística Paramétrica [9], Inferência Estatística Não-paramétrica [7], Análise de Regressão e Análise de Variâncias [14].

Com este leque de assuntos o *software* se apresenta como uma ferramenta bastante útil para o esclarecimento de dúvidas pertinentes aos mesmos. Embora estes assuntos cubram uma quantidade significativa de análises, vários tópicos avançados ainda não foram implementados, como a Amostragem que é a base para os procedimentos de coleta de dados. Este trabalho propõe o aperfeiçoamento do SESHET-S e a implementação de um módulo que trate deste tema com o seguinte conteúdo: Amostragem Aleatória Simples, Amostragem Estratificada, Amostragem Sistemática, Amostragem por Conglomerados e Determinação do Tamanho de Amostra [2]. Com esse conteúdo, o sistema SESHET-S poderá se útil para um número maior de disciplinas e estudantes.

Este artigo está assim disposto: na próxima seção apresenta-se uma revisão da metodologia empregada na construção do SESHET-S, a qual está sendo utilizada novamente para a adição deste novo módulo. Na seção posterior, alguns resultados serão apresentados e por fim, a última seção apresenta as conclusões finais.

METODOLOGIA

Os sistemas especialistas tratam problemas que são usualmente resolvidos por especialistas humanos [13]. Estes sistemas trabalham sobre o conhecimento de um determinado domínio, de modo similar ao ser humano, conhecimento este que é codificado para ser tratado pelo computador. O conhecimento é geralmente caracterizado por um grupo de regras e fatos. As regras são a tradução do conhecimento de um especialista e os fatos podem ser adquiridos inicialmente ou posteriormente, durante o processo de dedução [1]. Usando regras e fatos, novos fatos são obtidos. Para obter novos fatos, uma ou mais formas de raciocínio podem ser usadas. Em geral, os sistemas especialistas podem mostrar ao usuário como deduzir algo no processo de decisão e como novos conhecimentos podem ser inseridos na base de conhecimento. Além disso, podem checar se um novo conhecimento pode gerar conflito com a base de conhecimento previamente armazenada.

Usualmente, os sistemas especialistas respondem a melhor solução lógica possível para a consulta do usuário e sistemas especialistas na área de estatística não são diferentes. Como a principal aplicação é o ensino, a base de conhecimento deste sistema deve ser capaz de tratar informação incompleta ou vaga. O usuário será um estudante e ele poderá não conhecer bem o assunto e por essa razão, utiliza-se a lógica *fuzzy* [6, 20]. Essa lógica combina regras e fatos usando um modo de raciocínio denominado raciocínio aproximado [4], podendo tratar respostas incompletas e apontar várias soluções lógicas para um problema e quantificá-las [10]. Para cada resposta, o sistema deverá mostrar as condições para sua aplicação e uma medida de possibilidade [19] para ela no contexto apresentado. Dependendo da qualidade da consulta processada pelo usuário, o sistema pode concluir que o mesmo deve estudar alguns fundamentos teóricos, apontando tópicos e sugerindo bibliografia correspondente, sem lhe dar uma resposta final a sua consulta, como faria um professor tradicional.

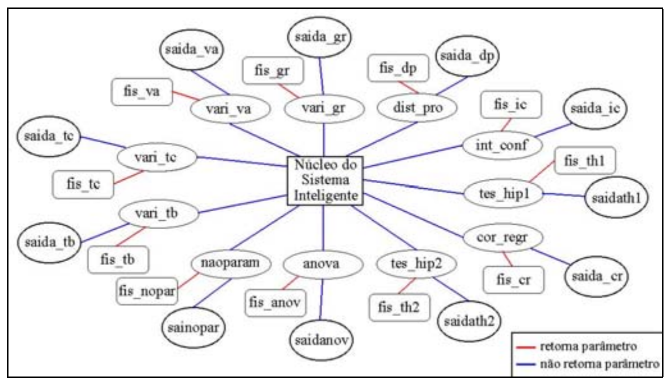

FIGURA. 1
ESTRUTURA MODULAR DO SISTEMA ESPECIALISTA SESHET-S.

Para combinar três propriedades importantes da Engenharia de Software que são: modularidade, facilidade de manutenção e facilidade de implementação de novas rotinas, o sistema foi implementado de acordo com a estrutura modular mostrada na Figura 1. O núcleo do sistema contém apenas as chamadas para sub-rotinas que implementam cada um dos tópicos abordados pelo sistema e uma parte da interface de comunicação com o usuário. Dentro das sub-rotinas (vari_va, vari_tc, dist_pro, etc), uma segunda parte da interface de comunicação com o usuário atua na coleta das informações relevantes e as transfere para uma rotina de manipulação do conhecimento. Essas rotinas de manipulação (fis_va, fis_tc, fis_dp, etc) apenas verificam a compatibilidade de cada possível resposta com os dados de entrada e retorna um vetor de possibilidades à rotina que a iniciou. Esta comunicação que retorna um parâmetro está denotada no diagrama pelas ligações em vermelho. Esta arquitetura possibilita um acesso rápido ao conjunto de regras envolvidas em cada módulo evitando assim, interações desnecessárias do sistema. Outra vantagem é a possibilidade de evitar que problemas de manutenção em um dado módulo venham a se propagar pelo sistema.

Para implementar essa arquitetura, foi utilizado o *software* Matlab que possui uma *toolbox* para o manuseio do conhecimento dado por regras *fuzzy*, as quais manipulam o conhecimento modelando conjuntos *fuzzy* [18]. Além disso, o Matlab também possui uma *toolbox* de estatística que embora não tenha sido utilizada na construção do sistema foi um dos atrativos para a sua utilização em futuras versões.

O conjunto de regras e funções de pertinência necessárias à implementação do conhecimento foi fornecido por um especialista humano. Esse conjunto de regras e seus respectivos assuntos estão descritos na Tabela 1, onde também podem ser visualizadas as disciplinas oferecidas pela UFPB que poderão utilizar o sistema.

TABELA 1
MÓDULOS DO SISTEMA SESHET-S COM SEUS RESPECTIVOS NÚMEROS DE REGRAS, ASSUNTO E A QUE DISCIPLINA SE DESTINA.

Disciplinas a que se destina	Assunto	Módulos implementados	Número de regras
Cálculo das Probabilidades e Estatística I	- Tabelas de Freqüência	vari_tb	22
	- Medidas de Tendência Central	vari_tc	46
	- Med. de Variabilidade	vari_va	45
Estatística Vital	- Gráficos	vari_gr	15
	- Distribuição de Probabilidade	dist_pro	23
Estatística III	- Intervalo de Confiança	int_conf	36
	- Testes de Hipóteses	tes_hip1	48
	- Correlação e Regressão	cor_regr	32
Estatística IV	- Testes de Hipóteses	tes_hip2	80
	- Análise de Variâncias	Anova	32
	- Métodos Não-paramétricos	Naoparam	35
		Total	414

FONTE: DADOS DO SISTEMA SESHET-S NA SUA VERSÃO ATUAL.

Atualmente, as disciplinas apresentadas na Tabela 1 e suas variações (disciplinas específicas com ementa ligeiramente menor) cobrem cerca de 40% das disciplinas oferecidas pelo Departamento de Estatística da UFPB, ou seja, cerca de 1000 alunos podem se beneficiar deste sistema a cada semestre letivo.

Com a implementação do novo módulo, duas novas disciplinas e cerca de 200 novos alunos irão se somar a esses potenciais usuários, elevando o percentual a valores próximos a 50% das disciplinas oferecidas pelo Departamento. O módulo sobre Amostragem segue essa arquitetura e traz um conteúdo sobre [2]:

- Amostragem Aleatória Simples - é o processo de amostragem em que as combinações de *n* diferentes elementos, dos *N* que compõem a população, possuem igual probabilidade de vir a ser a amostra efetivamente sorteada;
- Amostragem Estratificada - é o processo de amostragem no qual a população constituída por *N* elementos é previamente dividida em grupos distintos ou mutuamente exclusivos, que são denominados estratos, daí o seu nome. Dentro de cada extrato podemos extrair as amostras segundo os critérios da amostragem aleatória simples.
- Amostragem Sistemática - é o processo de amostragem no qual se considera os *N* elementos da população numerados de 1 até *N*, em alguma ordem. Para selecionar uma amostra de *n* unidades, tomamos uma unidade aleatoriamente das primeiras *k* unidades e a partir desta, a cada *k* unidades sucessivamente.
- Amostragem por Conglomerados - é o processo de amostragem em que, os elementos da população fazendo parte de grupos, são sorteados alguns desses grupos para comporem a amostra.
- Determinação do Tamanho de Amostra - Mostrar a metodologia de cálculo do tamanho da amostra para a amostragem aleatória simples nos casos de se estimar uma média ou uma proporção [2]. No caso da média, temos dois casos a se considerar: o primeiro, quando se conhece a variância populacional e o segundo, quando ela não é conhecida. No caso da proporção, o cálculo depende do próprio parâmetro a ser estimado [2] e por isso também temos dois casos a considerar: o primeiro quando temos alguma informação sobre a proporção a ser pesquisada e o segundo, quando nenhuma informação é disponível.

A limitação do novo módulo a esse escopo específico é devido às ementas das disciplinas a serem atendidas. É sabido que outros tópicos poderiam também ser abordados, como por exemplo, o sorteio das amostras, os estimadores e seus diferentes tipos, a determinação do tamanho da amostra para os outros tipos de amostragem, os diferentes tipos de conglomerados e a correção para populações finitas, entre outras, porém estes tópicos pertencem a disciplinas mais avançadas no estudo da Amostragem. Futuramente, pretendemos ampliar o módulo de amostragem para atender a essas disciplinas mais avançadas, tanto para atender melhor aos alunos de graduação, como aos de pós-graduação.

RESULTADOS

Da concepção original do sistema a versão atual, o mesmo passou por várias melhorias e acréscimos no conjunto de regras que foram dando origem a novas versões. Estas melhorias permitiram chegar aperfeiçoar o conjunto de regras para melhor tratar formas específicas de dúvidas e também a interface, onde são utilizadas janelas com perguntas de múltipla resposta, como pode ser visto na Figura 2. Atualmente o sistema está na versão pré-release SESHET-S versão 0.4 e está em fase de testes de utilização por algumas turmas. Estes testes visam a evolução do sistema, correções de problemas e imperfeições e ainda a adaptações gráficas para facilitar a sua utilização e torná-lo mais amigável ao usuário. Ao mesmo tempo, novos conhecimentos e módulos estão sendo inseridos, aprimorando o sistema e tornando-o mais útil para os alunos e professores das disciplinas mencionadas anteriormente.

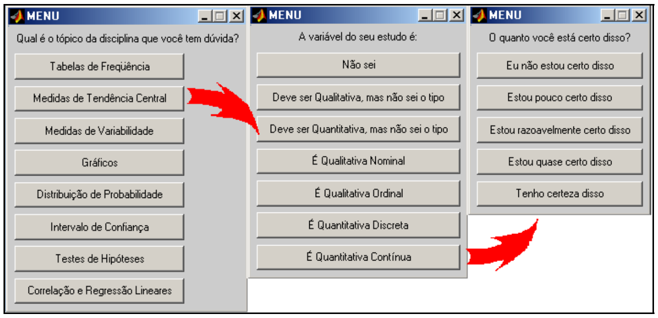

FIGURA. 2
MENU PARA ENTRADA DE INFORMAÇÕES NO SISTEMA SESHET-S.

O usuário passa as informações sobre a sua dúvida através de um sistema de menus. Esses menus direcionam o sistema para um dos módulos de conhecimento específico do SESHET-S. O sistema quantifica a certeza do aluno em cada uma das suas informações e ao final coloca todas as possíveis respostas em uma nova janela, bem como as possibilidades de ocorrência de cada uma delas, como pode ser observado na Figura 3. Devemos notar que a medida de possibilidade [19], diferentemente da medida de probabilidade [8], não precisa ter uma soma total fechada em 100%.

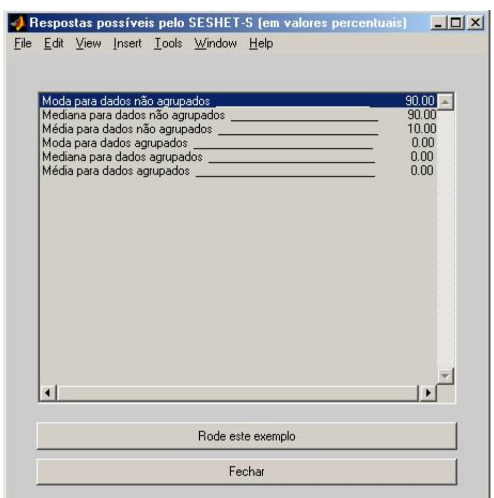

FIGURA. 3
RESPOSTAS POSSÍVEIS PARA UMA DADA CONSULTA NO SISTEMA SESHET-S.

Para ilustrar o processo de consulta, tomemos como exemplo seqüência dada pelas Figuras 2 e 3. Na Figura 2, no primeiro Menu, o aluno selecionou uma dúvida no tópico "Medidas de Tendência Central". No segundo Menu, a variável do estudo é declarada como "É Qualitativa Ordinal" e no terceiro Menu, ele responde que "Estou quase certo disso". O sistema continua a questionar o aluno através de Menus, análogos ao da Figura 2 para definir melhor o escopo da resposta e as possibilidades de cada uma delas. Ao final dessas interações com o aluno, o sistema exibe todas as respostas possíveis para o tipo de questão e as possibilidades de cada resposta, inclusive as respostas não possíveis. O objetivo na menção das respostas não possíveis é mostrar ao aluno também os caminhos que não devem ser seguidos. Na Figura 3, o aluno receberia como resposta a sua consulta que a possibilidade para a resposta "Moda para dados não agrupados" é de 90%, bem como a da "Mediana para dados não agrupados". A "Média para dados não agrupados" possui uma possibilidade de apenas 10%. As demais respostas para as mesmas medidas para dados agrupados possuem possibilidade zero. Então o aluno pode perceber que as Medidas de Tendência Central: Moda e Mediana podem se aplicar ao seu caso com alta possibilidade. Com uma baixa possibilidade, a Média também poderia se aplicar a esse caso. A imprecisão da resposta deve-se a imprecisão do questionamento do aluno, dado que ele não tem certeza sobre o tipo da variável, ainda que aponte que ela possa ser Qualitativa, em um primeiro momento. O sistema nesse caso aponta direções para o aluno, mas não esclarece definitivamente a dúvida do aluno, assim como um professor real também não poderia fazê-lo. Um professor real necessariamente diria: "Você precisa saber qual é o tipo de variável para que eu possa esclarecer quais tipos de Medidas de Tendência Central se aplicam ao seu caso".

CONCLUSÕES FINAIS E TRABALHOS FUTUROS

Este trabalho descreve a plataforma de monitoria virtual denominada SESHET-S e a implementação de um módulo adicional para o ensino de Amostragem. O conteúdo deste módulo inclui as técnicas clássicas de Amostragem, e a forma de se calcular o tamanho da amostra para a amostragem aleatória simples.

Esse sistema pode apoiar o ensino à distância e também pode ser aplicado como um reforço no ensino presencial. Auxiliado pelo sistema especialista *fuzzy*, o usuário pode ser treinado em várias situações a encontrar a melhor resposta para a sua consulta ou confrontar suas conclusões com as conclusões apresentadas pelo sistema especialista. Este sistema pode também verificar o conhecimento do estudante sobre algum assunto específico e assuntos correlatos.

Vale notar que em termos de arquitetura, esta é suficientemente genérica para ser aplicada ao ensino à distância de outros tópicos, relacionados ou não com a Estatística.

O sistema SESHET-S estará brevemente disponível para *download* via Internet a todos os alunos, em uma versão compilada independente do *software* Matlab. O próprio Matlab permite a compilação em separado de sistemas criados em sua plataforma. Assim, os alunos não necessitarão de ter uma licença desse *software* instalado para poder utilizar o SESHET-S. Além da facilidade de utilização para os alunos, essa solução também permite que o sistema continue sendo desenvolvido sob a plataforma Matlab. Estuda-se também uma possível versão em linguagem Java que poderia ser operada pela Web, diretamente do servidor do Departamento de Estatística da UFPB.

Futuramente, pretendemos analisar a contribuição desse sistema ao ensino de estatística, comparando-se turmas que utilizem o sistema e que não o façam. Várias outras particularidades no estudo da amostragem poderão também ser abordadas, para tornar esse módulo um subsistema maior, dedicado ao estudo de técnicas mais avançadas dos processos de Amostragem.

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O SISTEMA DE COTAS NO INGRESSO DOS CURSOS DE ENGENHARIA DA UERJ

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Resumo — A UERJ (Universidade do Estado do Rio de Janeiro) está reservando para o ingresso nos cursos de graduação 50% de suas vagas a estudantes de origem de escolas mantidas pelo poder público e até 40% para os negros e pardos. Neste sistema de cotas, que está sendo implantado no vestibular deste ano para todos os *campi*, envolve também os cursos das Engenharias da UERJ que estão distribuídos em três *campi*: na cidade do Rio de Janeiro-a Faculdade de Engenharia, no médio Paraíba-a Faculdade de Tecnologia e na região serrana de Nova Friburgo-o Instituto Politécnico. Como exemplo do volume de estudantes envolvidos, pode-se citar o número de inscritos no vestibular de 2001, quando ainda não existia o sistema de cotas, em que o campus da UERJ do Rio de Janeiro teve 5.316 candidatos para um total de 460 vagas nos cursos de engenharia Elétrica, Cartografia, Civil, Mecânica, Química e Produção. Sendo a UERJ uma instituição com um grande contigente de estudantes, este sistema de cotas se torna impactante para todo o sistema universitário. Assim, o objetivo deste trabalho é expor as leis que instituíram este sistema de cotas e suas repercussões no ensino de Engenharia na UERJ.

Termos Índice — Minorias em Engenharia, Ensino de Engenharia, Educação Superior.

I-INTRODUÇÃO

O presente trabalho apresenta alguns resultados parciais dos concursos de seleção para a graduação da UERJ. Estes resultados podem contribuir como subsídios no delineamento do perfil do estudante que ingressará na UERJ no primeiro e segundo semestres de 2003. Nesses concursos há uma cota de vagas específica para estudantes de escolas públicas e/ou autodeclarados negros ou pardos.

Os estudantes oriundos de escolas mantidas pelo poder público podem optar entre o vestibular SADE/2003 e o vestibular Estadual/2003 para ingressar nos cursos de graduação da UERJ. No Sistema de Acompanhamento do Desempenho dos Estudantes do Ensino Médio (SADE) somente estudantes que cursaram integralmente os ensinos fundamental e médio em instituições mantidas pelo poder público localizadas no Estado do Rio de Janeiro podem fazer este concurso, conforme disposto na Lei Estadual nº 3.524, de 28 de dezembro de 2000 . Já o vestibular Estadual/2003 é aberto para estudantes de escolas públicas e particulares.

Nesses concursos há uma parcela de 2.485 vagas para UERJ reservadas ao vestibular SADE e 2.485 vagas para o vestibular Estadual. Do total de vagas destes concursos há uma reserva de 40% de vagas destinadas ao candidatos que se declararem negros ou pardos no momento da inscrição [3].

A classificação será feita obedecendo a ordem descrente do total de pontos. Para o cálculo do percentual de 40% dos candidatos autodeclarados negros e pardos será considerado, inicialmente, os candidatos do vestibular SADE. Se este percentual não for alcançado sua complementação será feita com os candidatos do vestibular Estadual [1].

II - SADE – SISTEMA DE ACOMPANHAMENTO DO DESEMPENO DOS ESTUDANTES

O SADE é um concurso realizado em duas etapas. A primeira, denominada de Exame de Qualificação, é uma prova objetiva e de múltipla escolha em que se procura avaliar as competências e habilidades de avaliação, análise, interpretação e observação do candidato. Neste exame será considerado aprovado e poderá fazer o Exame Discursivo, quem se enquadrar entre os conceitos A, B, C e D. O conceito A representa um número de acertos maior do que 70% das questões. O conceito B significa um número de acertos maior do que 60% e igual ou menor do que 70% das questões. Para o conceito C, o número de acertos deve ser maior do que 50% e igual ou menor do que 60% das questões. No conceito D, o número de acertos deve ser maior do que 40% e igual ou menor do que 50% das questões. Serão considerados reprovados os candidatos que tiverem um número de acertos igual ou menor do que 40% das questões.

A segunda avaliação é o Exame Discursivo que é formado por uma prova de língua portuguesa com redação para todos e mais três provas de disciplinas específicas por grupo de carreiras afins. Esse exame procura avaliar as competências e habilidades já avaliadas no Exame de Qualificação acrescida da capacidade de criação. Este exame é igual tanto para os candidatos do vestibular SADE/2003 quanto para o vestibular Estadual/2003.

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III – RELAÇÃO CANDIDATO/VAGA

No processo de seleção aos cursos de graduação da UERJ, houve um número maior de candidatos no vestibular Estadual/2003 para as engenharias do que no SADE/2003. Estes dados podem ser observados na TABELA I, que mostra o número de inscritos e a relação candidato vaga para o SADE e o vestibular Estadual dos cursos de Engenharia.

Um caso interessante extraído da tabela, é a relação candidato/vaga de 0,75 para engenharia cartográfica no SADE e de 5,9 no vestibular Estadual. No SADE, para esta habilitação, o candidato cumprindo os requisitos mínimos de aprovação ele terá, praticamente, uma vaga no curso de Engenharia .

TABELA I
RELAÇÃO CANDIDO/VAGA ESTADUAL E SADE 2003

	Estadual			SADE		
	Total Inscritos	Vagas	Rela. C/V	Total Inscritos	Vagas	Rela. C/V
Eng. Cartográfica	118	20	5,9	15	20	0,75
Eng. Civil	552	60	9,2	118	60	1,97
Eng. Produção	373	30	12,43	33	30	1,1
Eng. Elétrica	1.188	110	10,8	257	110	2,34
Eng. Mecânica	355	30	11,83	63	30	2,1
Eng. Química	614	40	15,35	94	40	2,35

Outra diferença acentuada na relação candidato/vaga é no curso de engenharia de produção que possui 373 candidatos concorrendo a 30 vagas no vestibular Estadual e no SADE são 33 candidatos para o mesmo número de vagas.

IV – NEGROS E PARDOS

A porcentagem de candidatos a engenharia da UERJ que se declararam negros ou pardos é maior no vestibular SADE 2003 que no Estadual 2003 como se pode ver na TABELA II.

TABELA II
PERCENTAGEM DE NEGROS/PARDOS AUTODECLARADOS

	Estadual			SADE		
	Tot. Insc.	Auto Declara-do	% Negros/ pardos	Tot. Insc.	Auto Declarado	% Negros/ pardos
Eng. Cartográfica	118	31	26,27%	15	6	40%
Eng. Civil	552	87	15,76%	118	47	39,83%
Eng. Produção	373	50	13,40%	33	12	36,36%
Eng. Elétrica	1.188	229	19,28%	257	137	53,31%
Eng. Mecânica	355	57	16,06%	63	29	46,03%
Eng. Química	614	116	18,86%	94	37	39,36%

V – RESULTADO DO EXAME DE QUALIFICAÇÃO

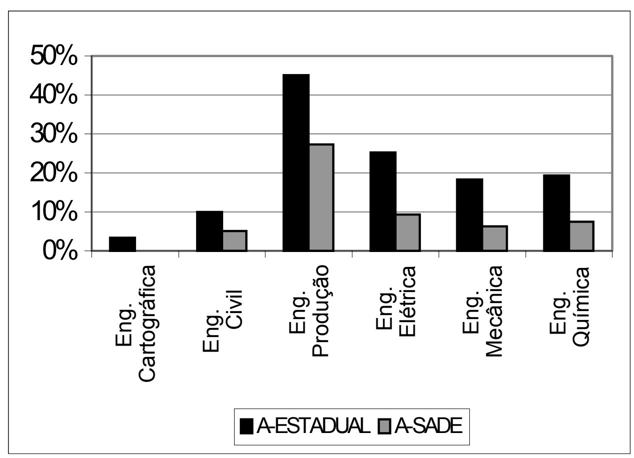
O resultado geral do Exame de Qualificação mostrou que os candidatos do vestibular Estadual apresentaram melhor desempenho quando comparados aos do SADE. Esta constatação pode ser observada na Tabela III, que mostra o resultado do Exame de Qualificação para o vestibular SADE/2003 e Estadual/2003.

TABELA III
RESULTADOS DO EXAME DE QUALIFICAÇÃO

	ESTATUAL 2003	SADE 2003
Conceito	%	%
A	6,39%	2,27%
B	13,68%	6,01%
C	22,31%	14,46%
D	30,90%	33,04%
E	26,72%	44,21%
TOTAL	100%	100%

No caso específico dos cursos de engenharia, os candidatos tiveram desempenho semelhante ao resultado geral. Esses resultados podem ser observados nos gráficos I, II, III e IV que apresentam a porcentagem de aprovados com conceitos A, B, C e D para os cursos de Engenharia Cartográfica, Civil, Produção, Elétrica, Mecânica e Química.

GRÁFICO I
PORCENTAGEM DE APROVADOS COM COMCEITO A



Analisando os gráficos se constata que é maior a porcentagem de candidatos do vestibular Estadual aprovados com A e B quando comparado ao vestibular SADE. O SADE tem um porcentagem maior de aprovados com conceito D. Com conceito C há algumas habilitações das engenharias em que existem uma porcentagem maior de aprovados do SADE.

GRÁFICO II

PORCENTAGEM DE APROVADOS COM COMCEITO B

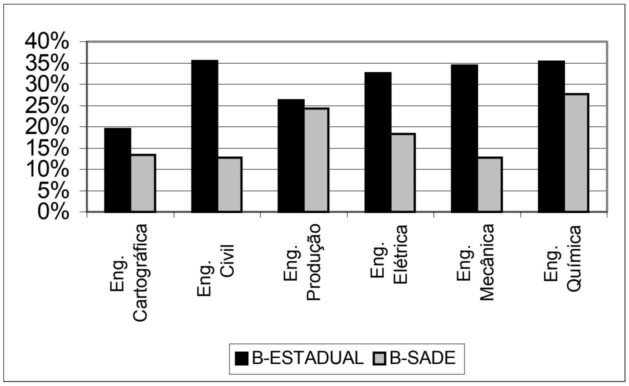


GRÁFICO III

PORCENTAGEM DE APROVADOS COM COMCEITO C

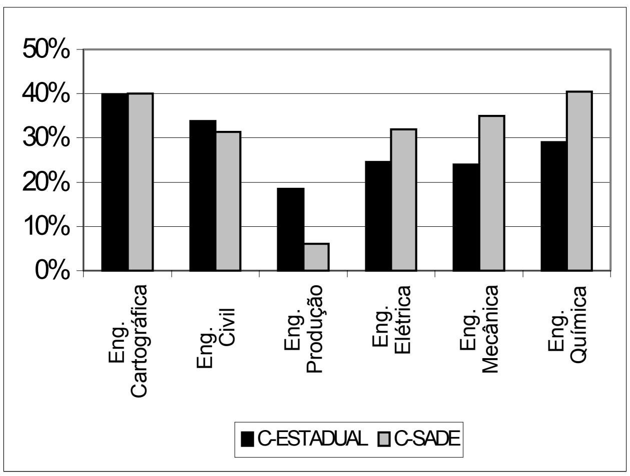
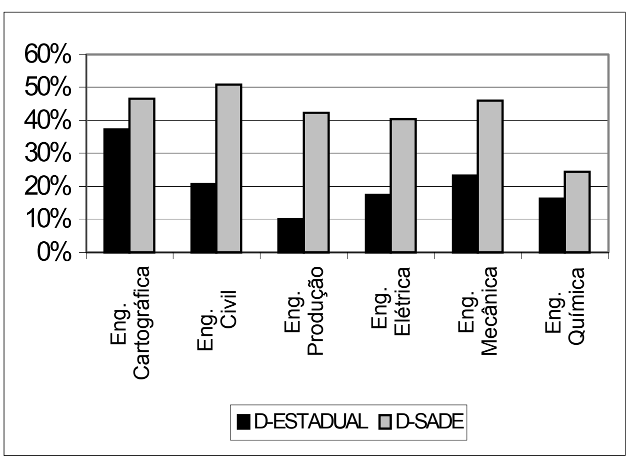


GRÁFICO IV

PORCENTAGEM DE APROVADOS COM COMCEITO D



VI – CONSIDERAÇÕES FINAIS

Comparando a relação candidato vaga dos concursos de acesso aos cursos de graduação da UERJ com os resultados do Exame de Qualificação, observa-se que os candidatos do concurso menos disputado, que é o SADE, apresentaram um desempenho menor que os candidatos do vestibular Estadual.

Até o presente momento, não temos os resultados do Exame de Discursivo. No entanto, considerando que esses resultados possam refletir nos resultados das provas discursivas, no ano de 2003, os cursos de engenharia poderão ter alunos com níveis diferentes de capacidades e habilidades. Umas das preocupações dos autores é que essa diferença possa implicar em desempenhos diferentes dos estudantes após a entrada na universidade. Por exemplo, se estes universitários forem tratados sem distinção é possível que aumente a evasão escolar.

Com relação a evasão, tradicionalmente na UERJ, os alunos ficam desmotivados com o considerável índice de reprovação nas disciplinas da parte comum do curso, como os cálculos e as físicas. Essas reprovações contribuem no índice de desistência dos estudantes.

Assim, para não aumentar a evasão, os autores concordam que é importante que a UERJ se prepare para receber os novos universitários, principalmente os oriundos do SADE, criando condições que melhorem a relação ensino-arprendizagem durando sua permanência na universidade.

Com esse objetivo de melhorar essa relação, há atualmente uma comissão da Sub-Reitoria de Graduação desenvolvendo um projeto que permitirá a aquisição de mais livros para as bibliotecas e apoio ao estudante. Isto se dará tanto do ponto de vista pedagógico quanto financeiro. Como exemplo, está sendo analisada a possibilidade de fornecer bolsas aos alunos carentes.

Sendo objetivo do legislador democratizar o acesso às instituições públicas estaduais de ensino superior, o SADE realmente aumenta as chances dos estudantes das escolas públicas. Porém, cabe a Universidade do Estado do Rio de Janeiro atualizar o projeto pedagógico para motivar todos os alunos que ingressarão em seus cursos. Assim, a UERJ estará contribuindo com a sua permanência na instituição.

REFERÊNCIAS

[1] Página eletrônica do vestibular da Universidade do Estado do Rio de Janeiro. http://www.vestibular.uerj.br/

[2] Lei Estadual N^{o} 3.524, de 28 de dezembro de 2000.

[3] Decreto Estadual N^{o} 30.766, de 4 de março de 2002.

Laboratório Virtual Colaborativo para Experiências em Eletrônica

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Abstract: *The aim of this article is to present the multi-user version of LVEE (Virtual Laboratory for Electronic Experiences), that it is a three-dimensional environment for simulation of electronic experience. The changes, not only make possible the users to share the same environment, but they also include innovations in the interface to increase the scene realism. The virtual world of LVEE was inspired in electric engineering laboratories of UFPA. The LVEE interface allows the construction of circuits using 3D components and permits local or remote circuit simulation. It makes use of the Virtual Reality Modeling Language (VRML), External Authoring Interface (EAI), JAVA language, SPICE (Simulation Program with Integrated Circuit Emphasis) and Microsoft Access 2000.*

Keyword: *Collaborative Virtual Environment of Teaching, Electrical Circuits, VRML, JAVA*

1. Introdução

A Realidade Virtual (RV), como tecnologia, tem fornecido novos meios para melhorar a interface e a interação com os sistemas computacionais, permitindo que os usuários se envolvam no ambiente através de seus sentidos, aumentando o realismo. Com isso, as experiências adquiridas na execução de alguma tarefa se tornam mais duradouras, como no mundo real [1] [2].

Contudo, a preocupação principal não é só melhorar a interação humano-computador, mas melhorar a interação humano-humano, usando o computador como meio de comunicação. A partir dessa premissa e utilizando o poder da RV, nasceram os Ambientes Virtuais Multiusuários (AVMU) [3], ambientes tridimensionais gerados por computador que permitem que os usuários possam se encontrar, compartilhar o ambiente e informações. A grande motivação para o desenvolvimento de AVMUs está no exponencial crescimento da área e no elevado potencial deste tipo de aplicação para qualquer área do conhecimento. Além disso, a grande maioria dos ambientes multiusuários se apresenta numa forma totalmente bidimensional, causando algumas restrições aos usuários, tais como: a falta da noção de presença de outros usuários, ou de um ambiente mais contextualizado para as tarefas, ou de um ambiente mais próximo do real para o desenvolvimento das tarefas, falta de novas formas de comunicação, entre outros.

Devido a essas características, os AVMUs são ferramentas excelentes para a realização de atividades colaborativas e cooperativas. As habilidades sociais dentro de um espaço tridimensional (mundo real) são inerentes ao ser humano quando inserido em uma comunidade, portanto, nada mais natural que cooperar ou colaborar em um ambiente com características semelhantes. Com isso, pode-se utilizar o conceito de Ambiente Virtual Colaborativo (AVC), que é um AVMU que permite que várias pessoas possam interagir através de ambiente virtual tridimensional para atingir um objetivo comum.

O projeto descrito por este artigo faz uso da tecnologia de RV não imersiva, para melhorar a interface e a interação computacional e atingir uma grande quantidade de usuários, uma vez que usa periféricos convencionais, e a própria Internet como meio de comunicação, em função dos avanços tecnológicos que vem sofrendo, permitindo assim maior qualidade e confiabilidade aos AVC.

Este projeto trata-se de uma adaptação feita no LVEE monousuário [4], contando com novas interfaces, tecnologias e funcionalidades.

A organização deste trabalho envolve considerações adicionais sobre AVC (seção 2), na seção 3 são apresentadas as características do projeto LVEE, finalmente, na seção 4 são discutidas algumas considerações sobre o desenvolvimento do projeto até o presente momento.

2. Ambientes Virtuais Colaborativos

O uso de ambientes virtuais multiusuário vem crescendo rapidamente, uma vez que permitem que diversos usuários possam interagir num ambiente virtual compartilhado, através de redes de computadores, solucionando o problema de usuários geograficamente dispersos e melhorando o desempenho coletivo através da troca de informações. O uso de ambientes virtuais multiusuário em sistemas cooperativos permite aos participantes interagirem com o mais alto grau de naturalidade, pois através do ambiente é possível comunicação por meio de imagem, vídeo, texto e áudio.

Segundo Sighal [5], um ambiente virtual multiusuário é distinguido pelos cinco fatores apresentados a seguir:

- Um senso de compartilhamento de espaço: todo o participante tem a sensação de estar sendo colocado no mesmo local, mesma sala, prédio ou terreno.
- Um senso de compartilhamento de presença: quando da entrada no ambiente virtual, cada participante deve ter uma identificação clara, normalmente é escolhida uma "identidade virtual", chamada *avatar*, a qual inclui uma representação

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gráfica, modelo de estrutura corporal, modelo de movimentação, modelo físico, e outras características.

- Senso de compartilhamento de tempo: participantes deveriam estar aptos a ver outros comportamentos, e como eles ocorrem em tempo real.
- Uma maneira de comunicação: embora a visualização forme a base eficaz de uma ambiente virtual multiusuário, a maioria deles deve também permitir a comunicação entre os participantes – por gestos, por texto ou por voz, por exemplo.
- Uma maneira para compartilhar: os elementos acima mencionados fornecem efetivamente um sistema de vídeo conferencia de alta qualidade. Contudo, o verdadeiro poder dos ambientes virtuais multiusuários está na habilidade de uma interação realística não somente com os outros usuários, mas também com o próprio ambiente virtual.

3. Laboratório virtual de Experiências de Eletrônica

A proposta é utilizar a Realidade Virtual como uma *interface* mais natural entre aluno-computador, para simulação de circuitos elétricos usando resistores, capacitores, indutores, fontes e fios. Contudo, o que deve ser ressaltado nesta etapa de desenvolvimento do LVEE e á possibilidade de compartilhamento do ambiente virtual tridimensional em tempo real, onde é feita a experiência com circuitos elétricos. Assim, o professor pode demonstrar ao aluno como ele deve proceder tanto na montagem do circuito, como na simulação do mesmo, e apesar do ambiente ser compartilhado por vários alunos, a impressão é que cada um está tendo a sua aula particular.

3.1 Aspectos Tecnológicos

Para o desenvolvimento deste protótipo, utilizaram-se VRML (Virtual Reality Modeling Language) [6], linguagem utilizada para a modelagem e construção de ambientes virtuais tridimensionais e JAVA [7]. Além disso, há necessidade de uma *interface*, chamada EAI (*External Authoring Interface*) [8], que permita a comunicação entre uma *applet* JAVA e um ambiente VRML. Além destas, foi utilizado também um simulador de circuitos elétricos, chamado SPICE (*Simulation Program with Integrated Circuit Emphasis*) [9]. O protótipo conta com um banco de dados e o SGBD utilizado é o Microsoft Access 2000. A arquitetura do sistema proposto é apresentada na Figura 1.

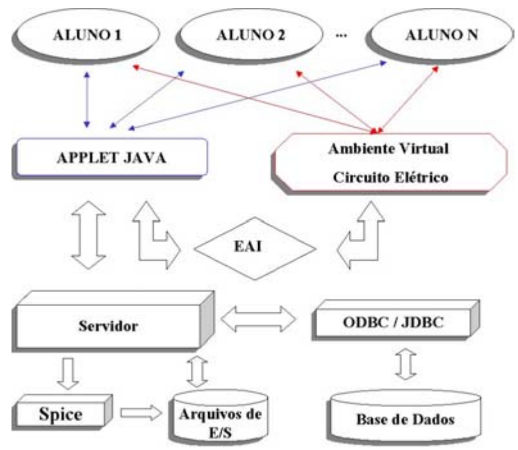

FIGURA 1:
VISÃO GERAL DA ARQUITETURA DO LVEE.

3.2 Modelo de Comunicação

A arquitetura de comunicação utiliza os conceitos do modelo de comunicação Cliente/Servidor (Figura 2). A idéia é simples: de um lado tem-se o sistema do usuário funcionando como o cliente, a qual faz requisições de serviços a uma outra aplicação denominada servidor [10]. A comunicação realizada no sistema ficou restrita à comunicação baseada em sockets (classes Socket e DatagramSocket) e threads, devido ao fato de possuírem interfaces de programação de baixo nível para comunicação em rede, em que o envio de dados entre as aplicações ocorrem através de streams.

O usuário através do *browser Web* envia um pedido de abertura de conexão a um servidor que é executado em determinado *host*. Uma mensagem de confirmação de conexão é enviada, em seguida a *applet* envia dados ao servidor para serem processados. Posteriormente, o servidor responde ao pedido da *applet* enviando os dados do pedido.

A maneira mais comum de implementar um servidor multiusuário é a implementação de servidores com *threads*. No momento que um cliente estabelece conexão com o servidor, uma nova *thread* é criada para atender esse cliente.

A Figura 2 mostra, ainda, o processo de mensagens entre os clientes conectados. Quando um usuário envia uma mensagem ao servidor, a mensagem é tratada pela *thread* associada ao usuário. A *thread* filtra e repassa aos outros clientes conectados. Assim, todos os clientes comunicam-se exclusivamente com a *thread* que os associa ao servidor.

Existem vários tipos de mensagens no LVEE, entre elas as mais importantes são: mensagens de mudança de posicionamento dos objetos, de *chat*, de inserção e remoção de componentes, de simulação do circuito e mensagem de resposta da simulação de circuitos. Cada mensagem é identificada por um campo ID.

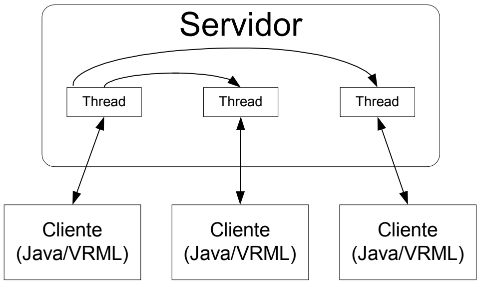

FIGURA 2:
ESTRUTURA DE COMUNICAÇÃO BASEADA EM *THREADS*.

3.3 Arquitetura do Protótipo

A seguir será mostrado o diagrama de classes do protótipo utilizando-se a notação UML [11], por se tratar de uma notação muito utilizada na representação de sistemas computacionais. E o modelo entidade-relacionamento do banco de dados.

3.3.1 Diagrama de Classes

O diagrama de classe UML do sistema é apresentado na Figura 3. A classe *Servidor* instancia a classe *Leitor* (subclasse de *Thread*) para cada usuário que se conecta no sistema.

Assim como a classe *Servidor*, a classe *Cliente* instancia a classe *Leitor* para receber as mensagens vindas do Servidor.

A classe *Gerenciador de BD* é responsável por manter a consistência do banco de dados que reflete o desenvolvimento da aula. Por exemplo, quando ocorre uma inserção de componente na aula, a representação deste componente é persistida no banco de dados.

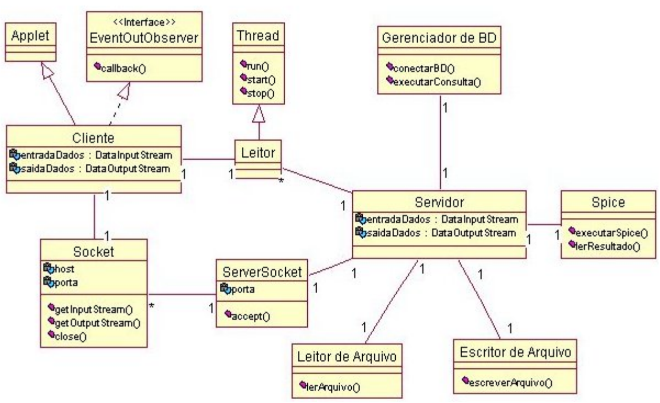

FIGURA 3:
DIAGRAMA DE CLASSES DO SISTEMA.

3.3.2 Modelo Entidade-Relacionamento

O modelo Entidade-Relacionamento gerado pelo Microsoft Access 2000 é apresentado na Figura 4. Como se trata de um modelo colaborativo, foi criado o conceito de grupo para controlar a aula, e os usuários são cadastrados no grupo.

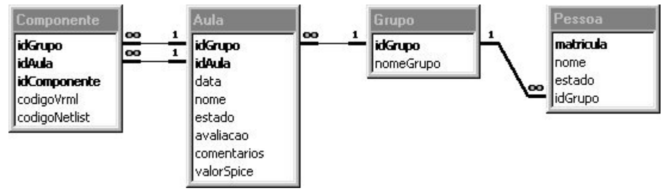

FIGURA 4:
MODELO ENTIDADE-RELACIONAMENTO.

De acordo com o modelo, um grupo pode criar várias aulas, estas, por sua vez, podem estar associadas a vários componentes.

3.3.3 Diagrama de Seqüência

Aqui nesta seção, são fornecidos alguns diagramas de seqüência que proporcionam uma visão abstrata de como se comportam os componentes do protótipo. Dentre as principais mensagens do sistema, estão representadas, aqui, a simulação (Figura 5), a inserção de objetos (Figura 6)e a conexão (Figura 7).

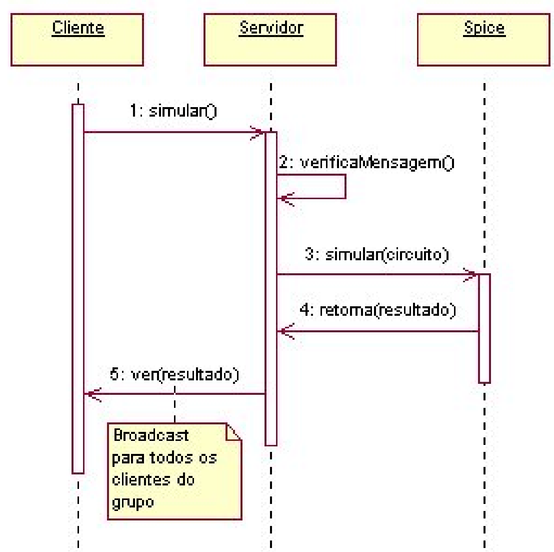

FIGURA 5:
DIAGRAMA DE SEQÜÊNCIA PARA A SIMULAÇÃO

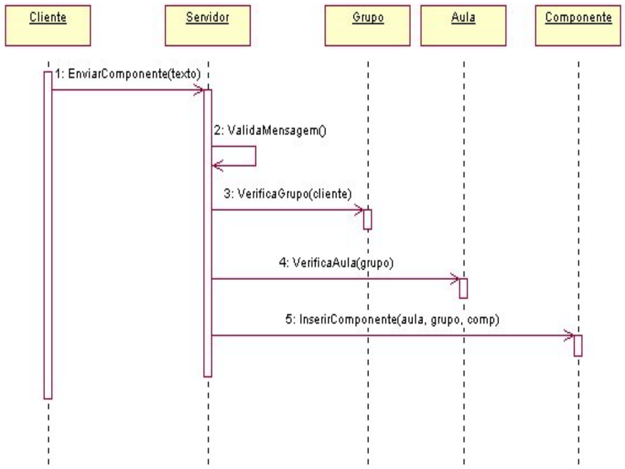

FIGURA 6:
DIAGRAMA DE SEQÜÊNCIA PARA A INSERÇÃO DE OBJETOS

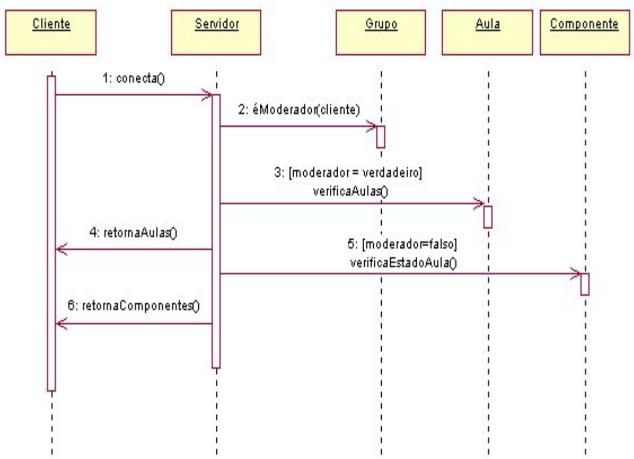

FIGURA 7:
DIAGRAMA DE SEQÜÊNCIA PARA A CONEXÃO DO USUÁRIO

3.4 O Ambiente Virtual

As experiências virtuais são de fácil criação, onde o usuário tem a total liberdade para montar e visualizar o circuito criado. E a simulação dos circuitos elétricos é feita através do PSPICE.

A *interface* do protótipo é composta de duas partes principais (Figura 8): a primeira é destinada à visualização e manipulação dos componentes, e a segunda é a *applet* que se divide em uma parte de chat, onde o usuário se conecta e realiza troca de mensagens com os outros usuários, e outra para a criação e simulação do circuito. Tanto o ambiente virtual quanto a *applet* fazem parte de uma página Web, assim o protótipo pode ser acessado de qualquer computador que tenha acesso a Internet.

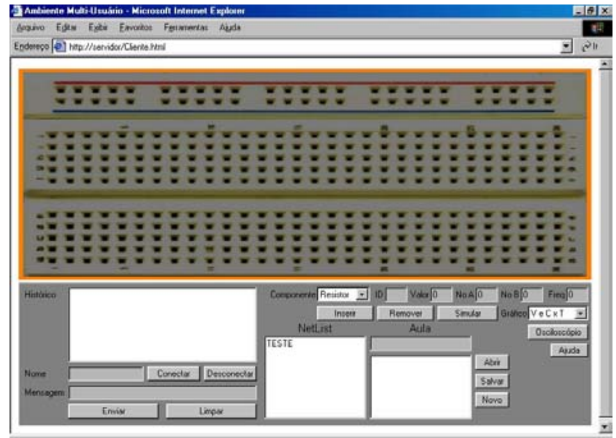

FIGURA 8:
VISUALIZAÇÃO DA PÁGINA DO PROTÓTIPO.

No experimento, ao inserir um componente (um resistor, um capacitor, uma fonte, um indutor ou um fio) seu modelo tridimensional é inserido na cena na posição especificada pelo usuário, seu código para o SPICE é inserido na caixa de texto do `netList` (arquivo que descreve o circuito e serve como parâmetro de entrada para o SPICE), e sua representação é armazenada no banco de dados.

Um exemplo de NetList é vista na figura 9.

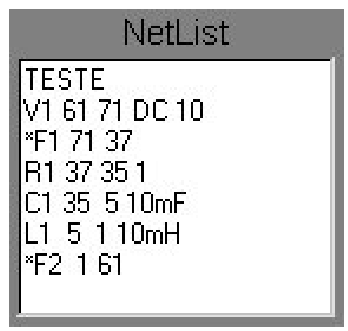

FIGURA 9:
NETLIST APÓS INSERÇÕES DE COMPONENTES.

Após inserir todos os componentes e montar a estrutura do arquivo para o SPICE, simula-se o resultado do experimento, clicando no botão `Simular`. O resultado gerado pelo SPICE é exibido em uma página HTML para análise pelo usuário. Qualquer mudança no circuito é prontamente percebida por todos os outros usuários que estão conectados ao servidor, seja ela de inserção, remoção ou simulação.

Além de simular, o usuário pode verificar o comportamento do circuito através de um gráfico de osciloscópio (Figura 10).

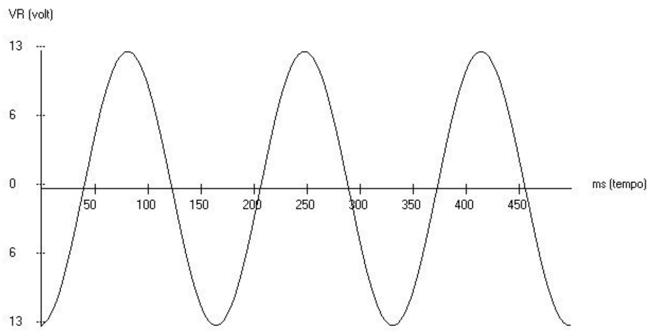

FIGURA 10:
GRÁFICO DO CIRCUITO.

O gráfico da Figura 10 mostra a tensão no resistor variando no tempo.

4. Considerações finais e trabalhos futuros

Neste trabalho foram apresentadas extensões ao LVEE (Laboratório Virtual de Experiências de Eletrônica), de modo a torná-lo multiusuário e colaborativo. Acredita-se que tais extensões de fato tornaram o LVEE ainda mais propício ao emprego como ferramenta auxiliar no ensino de engenharia elétrica.

Como futuros trabalhos, pretende-se desenvolver um simulador de circuitos elétricos escrito em JAVA, de modo a não se necessitar mais do SPICE. Isto tornará o LVEE plenamente portável para as diversas plataformas computacionais existentes, além de facilitar em muito futuras atualizações. Por fim, pretende-se investigar a utilização do LVEE em maior escala, de modo a se avaliar na prática o grau de benefício oriundo de seu uso.

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Uso da Linguagem Natural para Manipulação e Interação de Ambientes Tridimensionais Educacionais para Engenharia Elétrica

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Abstract: *The aim of this article is to make possible that users can have a better interaction in the manipulation of a three-dimensional environment using the natural language, for that, we propose an integration among VRML (Virtual Reality Modeling Language), JAVA and PROLOG (Programming in Logic). As case study we have used the tool to support the learning of electric circuits, namely LVEE (Virtual Laboratory for Electronic Experiences), that it is a three-dimensional environment for simulation of electronic experience. The LVEE interface allows the construction of circuits using 3D components, as well as simulations local or remote of the created circuits.*

Keywords*: Java, LVEE, Prolog, VRML.*

Resumo: *O objetivo deste artigo é possibilitar que usuários possam ter uma melhor interação na manipulação de uma ambiente tridimensional utilizando a linguagem natural, para isso propõe-se uma integração entre VRML (Virtual Reality Modeling Language), JAVA e PROLOG. Como estudo de caso propõe-se o uso de uma ferramenta de auxílio ao aprendizado de circuitos elétricos, chamado LVEE (Laboratório Virtual de Experiências de Eletrônica), que é um ambiente virtual tridimensional para simulação de experiências de circuitos elétricos. A interface do LVEE permite a construção de circuitos elétricos usando componentes 3D, bem como simulações locais ou remotas dos circuitos criados.*

Palavras-chaves: *Java, LVEE, Prolog, VRML.*

1. Introdução:

Com a evolução constante das tecnologias aplicadas a interfaces do usuário, uma nova geração de interfaces vem se estabelecendo. Dentre as novas tecnologias de interface surge com destaque a Realidade Virtual (RV) facilitando a visualização, manipulação e interação de usuários com ambientes computacionais tridimensionais (3D). Além da RV, a Inteligência Artificial (IA) também vem para melhorar a interação do usuário com o ambiente, e que juntas se torna uma grande e poderosa combinação tecnológica para o desenvolvimento de ambientes tridimensionais inteligentes, que é o próximo passo evolucionário para o desenvolvimento de interface humano-computador [1] [2].

Foi com o objetivo de utilizar as características disponibilizadas pela Realidade Virtual à Educação que o Laboratório Virtual de Experiências de Eletrônica (LVEE) foi concebido [3]. O LVEE é um ambiente virtual que propicia ao aluno criar de forma tridimensional, circuitos elétricos e em seguida simulá-los, obtendo resultados, como por exemplo, de correntes e tensões nos componentes do circuito criado. Contudo, devido à interface do protótipo conter vários campos e botões a serem preenchidos ou acionados, pensou-se em uma forma de melhorar a usabilidade de interação com a interface, tornando-a mais simples e intuitiva. Esta melhora se deu através do uso de um Processador de Linguagem Natural (PLN), que proporciona ao usuário a possibilidade de trabalhar ou interagir com o protótipo através de sua língua natural. As simulações podem ser feitas local ou remotamente, através da Internet, estendendo as possibilidades citadas do uso da Realidade Virtual para Educação a Distância (EAD).

Esta ferramenta, denominada de LVEE com PLN, faz uso das seguintes tecnologias (Figura1):

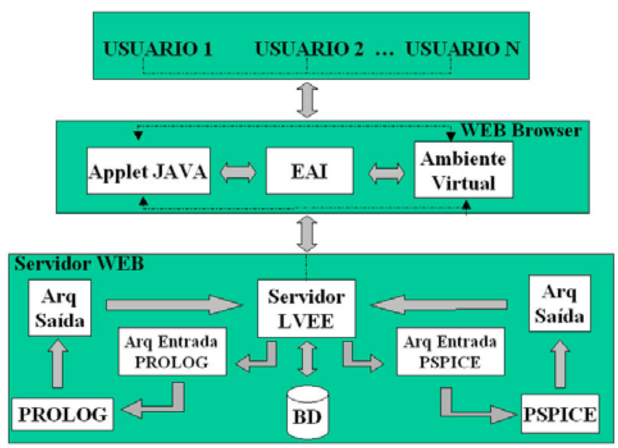

FIGURA 1:
RELACIONAMENTO ENTRE AS PRINCIPAIS TECNOLOGIAS DO PROTÓTIPO.

- **VRML** é um padrão internacional para a descrição de ambientes virtuais através de primitivas tridimensionais

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como: cubo, esfera, cilindro e outras formas mais complexas utilizando polígonos ou deformações.

- **EAI** (*Extherinal Authoring Interface*) [5] foi projetada para que um programa externo, como *applet* Java, envie mensagens para os objetos existentes no ambiente VRML, realizando ações como a criação de outros objetos ou animações.
- **PROLOG:** responsável pelo processamento lingüístico das sentenças levando em consideração todas as características da língua portuguesa.
- **PSPICE** SPICE é um acrônimo para *Simulation Program with Integrated Circuit Emphasis*. Foi desenvolvido na Universidade da Califórnia em Berkeley, no início dos anos 70 e calcula o comportamento do circuito [4].

2. Laboratório Virtual de Experiências de Eletrônica

A proposta é utilizar a Realidade Virtual como uma interface mais natural entre aluno-computador, para simulação de circuitos elétricos com componentes passivos, ou seja, usando resistores, capacitores, fontes e indutores. Contudo, essas experiências não devem ficar restritas a circuitos elétricos, e ao conjunto dessas experiências deu-se o nome de Laboratório Virtual de Experiências de Eletrônica.

Devido às dificuldades de ensino/aprendizagem, para o curso de Engenharia Elétrica tradicional, é proposta a utilização de sistemas baseado em Realidade Virtual com o objetivo de minimizar os problemas citados ou resolvê-los por completo, sempre deixando claro que a Realidade Virtual deve ser usada como mais uma ferramenta para auxiliar o ensino presencial e não como substituta do mesmo.

A proposta do projeto LVEE tem como objetivos:

- Disponibilizar o conhecimento para aprendizado e revisões complementares das disciplinas envolvidas;
- Possibilitar maior tempo para a prática das experiências, levando em consideração o próprio ritmo do aluno;
- Facilitar o aprendizado, através de uma interface interativa que utiliza os conhecimentos já adquiridos no mundo real;
- Reduzir o custo de implantação de laboratórios, ao menos nas tarefas mais rotineiras e nas fases iniciais de aprendizado;
- Avaliar a potencialidade da RV na educação;
- Possibilitar fácil atualização do conjunto de experiências nos laboratórios virtuais e
- Avaliar a potencialidade e dificuldades na integração do VRML x Java.

3. Arquitetura de Comunicação

Apesar do LVEE ainda ser um ambiente virtual monousuário, ele permite que várias instâncias sejam executadas simultaneamente. Ou seja, há a possibilidade de dois ou mais alunos estarem simulando seus circuitos ao mesmo tempo, sem que um interfira no outro. O modelo cliente-servidor é utilizado, e é implementando através da programação em Java utilizando *threads* e *sockets*, onde cada *thread* gerencia a conexão, e cada conexão é feita por um par de *sockets* que ligam o computador do aluno (cliente) ao o servidor onde está instalado o LVEE (Figura 2).

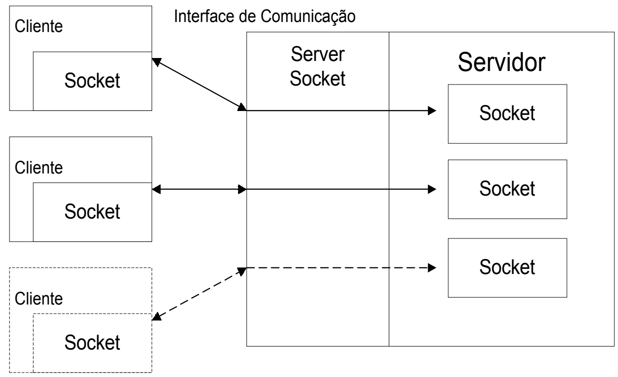

FIGURA 2:
ARQUITETURA DE COMUNICAÇÃO DO LVEE.

4. Protótipo.

O protótipo é carregado em uma página Web que é composto de duas partes. Uma para o AV e outra para a *applet*. O AV consiste de um protoboard onde o usuário poderá visualizar o circuito tridimensional montado. Um exemplo de AV com alguns componentes inseridos pode ser visto na Figura 3.

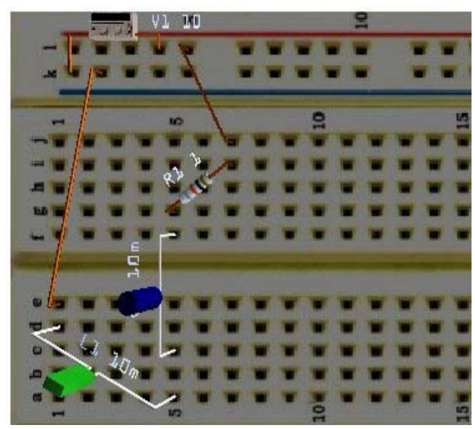

FIGURA 3:
EXEMPLO DE UM EXPERIMENTO INSERIDO NO AV PARA SIMULAÇÃO

É no AV que o usuário perceberá modificações decorrentes de sua interação com a applet. Nela pode-se inserir e remover componentes eletrônicos, como: fonte, fio, resistor, indutor e capacitor, para realizar simulações de circuitos eletrônicos. O usuário poderá “descrever” as ações a serem executadas no LVEE como um todo através do campo **Mensagem** na applet (Figura 5). A *applet* com vários botões possui uma usabilidade de interação para a interface bastante complexa para um usuário comum. Esta interface pode ser vista na Figura 4.

FIGURA 4:
TELA DE INTERAÇÃO ENTRE O USUÁRIO E O SISTEMA

Contudo com o objetivo de melhorar a usabilidade na interação homem-computador, foi desenvolvido um PLN para ser usado na composição da interface, possibilitando assim uma melhora bastante significativa na interface da *applet*, tornando-a mais simples, intuitiva e tão funcional quanto à da Figura 4. A interface da *applet* utilizando as técnicas de PLN pode ser vista na Figura 5.

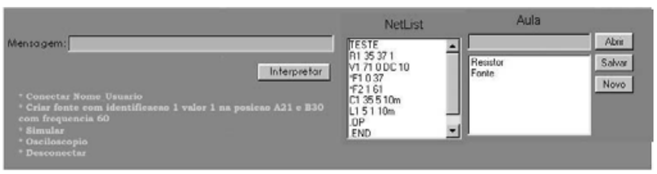

FIGURA 5:
TELA DE INTERAÇÃO ENTRE O USUÁRIO E O SISTEMA ATRAVÉS DE LINGUAGEM NATURAL

A interface da *applet* contém dicas de como utilizar os comandos básicos do protótipo descritos na cor cinza a baixo do campo **Mensagem**. Este campo fornece a principal forma de interação entre o usuário e o protótipo.

Quando o usuário descreve o que quer no campo reservado para esta ação e posteriormente clica no botão **Interpretar** o módulo SERVIDOR é acionado para criar/escrever um arquivo de entrada de parâmetros para em seguida chamar o módulo PROLOG a ser executado, pois ele é responsável pela interpretação da sentença que passa por analisadores léxico, sintático e semântico, na verdade para todas as ações pedidas pelo usuário são criadas mensagens e enviadas ao servidor, e especificamente para o PLN para que possam ser interpretadas. O léxico transforma as unidades significativas das palavras, em identificadores (tokens); o sintático verifica se os tokens estão corretos de acordo com as regras gramaticais pré-definidas; o semântico implica atribuições de significado as estruturas geradas pela análise sintática [5] [6]. Com o término do processo de interpretação o PROLOG gerará um arquivo de saída que servira de entrada para o módulo SERVIDOR que ficou a espera dos parâmetros para retornar uma resposta ao usuário, que pode ser um retorno de erro como na Figura 6 ou resposta correta do pedido do usuário, como inserção de um objeto no ambiente virtual.

FIGURA 6:
RESULTADO GERADO PELO PLN

A primeira tarefa que o usuário deve executar no LVEE é Conectar. Para esta operação o frase usada é "Conectar Nome_Usuário". Após a descrição desta sentença, o usuário clicará no botão **Interpretar** para realizar o *login* do usuário no servidor, para que este possa se beneficiar de todos os serviços disponíveis pelo mesmo. Caso haja aulas específicas salvas pelo aluno da autenticação, seus nomes serão carregados para uma caixa de texto, para posterior seleção e carregamento das mesmas. As aulas estão armazenadas em um Banco de Dados (BD) no servidor.

Após a conexão o usuário poderá iniciar as suas experiências ou reeditar as que estiverem salvas.

Outro exemplo é quando o usuário desejar inserir no protoboard um resistor com valor 2 (dois) nas posições A21 e B30, neste caso, terá que se construir uma frase da seguinte forma: "Criar um resistor com identificação 9 valor 2 no A21 e no B30" ou "Criar R9 valor 2 no A21 e no B30".

Ao término da interpretação tem-se um resultado com alguns parâmetros gerados como mostrada Figura 7.

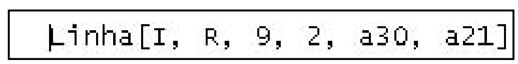

FIGURA 7:
RESULTADO GERADO PELO PLN

Ao término do processo de comunicação do módulo SERVIDOR com o arquivo de saída do PROLOG, o servidor repassará para a Applet JAVA os parâmetros obtidos, que atualizará o ambiente virtual com o componente especificado.

O usuário ainda poderá solicitar através da *applet* que o protótipo disponibilize a simulação dos circuitos elétricos construídos, e em seguida os gráficos de um osciloscópio.

Quando o usuário descreve na applet a ação de simular experimento, o SERVIDOR aciona o módulo SPICE, que por sua vez fará toda a simulação do experimento através de cálculos matemáticos retornando um resultado que será repassado ao usuário em uma nova página em formato HTML para sua análise. Um resultado de simulação pode ser visto na Figura 8 logo abaixo.

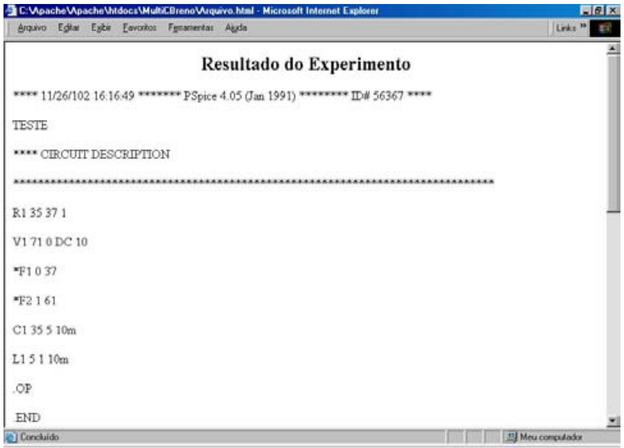

FIGURA 8:
RESULTADO DA SIMULAÇÃO DA EXPERIÊNCIA.

Após a simulação, se tudo estiver de acordo, ou seja, o experimento estiver de acordo com as regras pré-definidas para o funcionamento do circuito o usuário ainda poderá solicitar através da *applet* a geração dos gráficos de um osciloscópio. Utilizando o campo **Mensagem** com "gráfico osciloscópio", um dos resultados pode ser visto na Figura 9.

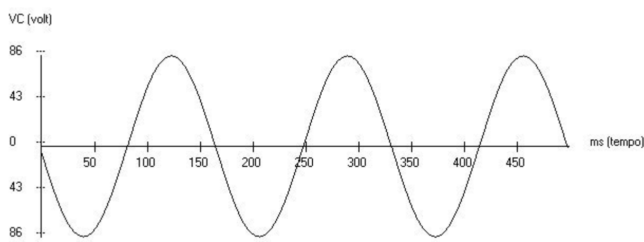

FIGURA 9:
RESULTADO DA GERAÇÃO DE UM GRÁFICO OSCILOSCÓPIO

O campo descrito como Netlist é o campo reservado para mostrar ao usuário qual o resultado obtido depois da interpretação do PLN em forma de códigos parametrizados de acordo com a experiência dos circuitos elétricos inseridos no ambiente. Um exemplo do Netlist com componentes pode ser visto na Figura 10.

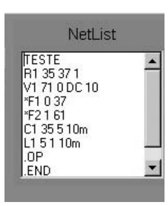

FIGURA 10:
CAMPO NETLIST COM OS PARÂMETROS

Os campos a baixo do texto onde está descrito **Aula** têm por finalidade realizar as seguintes ações: a segunda caixa de texto localizada a baixo da palavra **Aula** é utilizada para disponibilizar para o usuário as aulas salvas pelo mesmo, caso o usuário queira abrir uma aula salva anteriormente basta o mesmo clicar em cima da aula desejada e clicar em cima do botão **Abrir**, podendo assim continuar a execução ou o estudo de uma aula interrompida por algum motivo anteriormente. O botão **Salvar** é utilizado para salvar a experiência atual no ambiente sendo que para isto é necessário adicionar algum nome significativo para esta aula na primeira caixa de texto ao lado do botão "Novo". Por fim, o botão **Novo** é utilizado para disponibilizar um novo ambiente com o protoboard totalmente vazio apto para novas simulações de experiências. Um exemplo de algumas aulas salvas mostradas na caixa de texto pode ser visto na Figura 11.

FIGURA 11:
VISUALIZAÇÃO DO CAMPO AULA

Além de o usuário ter todas estas possibilidades descritas acima, o mesmo ainda poderá usar a opção de ajuda descrevendo no campo Mensagem "ajuda". Serão fornecidos exemplos e explicações de como agir para que o funcionamento do protótipo ocorra de acordo com as suas necessidades, esse conteúdo será mostrado em uma página HTML (Figura 12). Por fim, quando o usuário terminar a utilização do protótipo o mesmo terá de solicitar a desconexão com o módulo SERVIDOR através da mensagem "Desconectar".

FIGURA 12:
TELA DE AJUDA

5. Considerações finais

O processamento de linguagem natural usado para melhorar a usabilidade na interação homem-computador em sistemas que possuem AV parece ser bastante promissor, uma vez que, a interação pode ser bastante difícil para determinados usuários que não possuam muita afinidade com o domínio da aplicação, e a informática num segundo momento, facilitando assim a utilização do LVEE. Contudo, vale ressaltar que o PLN foi desenvolvido em PROLOG com o auxílio da gramática de cláusulas definidas e está sujeito a ambigüidades de sintaxe que são ocasionadas pelos limites da mesma.

Além disso, o uso do LVEE poderia ser empregado de forma multiusuário, que é o próximo passo a ser seguido. Contudo, foi necessária primeira a consolidação do ambiente monousuário.

Também, há necessidade de aumentar o domínio da gramática, o que permitiria que o LVEE, por exemplo, pudesse realizar movimentos de visões, tais como: rotacionar e transladar o experimento.

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Realidade Virtual Aplicada ao Ensino e Aprendizagem da Cinemática

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Abstract. The aim of this article is to present a tool for the simulation of three-dimensional objects, which gives support for the students to learning in physics course, in the kinematics area. This tool, namely SEVC (Simulator of Virtual Experiences in Kinematics), it makes possible the student to simulate situations of the objects in movements with speeds, accelerations and varied initial positions.
Keywords: Kinematics, Java, Virtual Reality in Education, VRML

Resumo. O objetivo deste artigo é apresentar uma ferramenta de simulação de objetos tridimensionais, voltada a auxiliar a aprendizagem de alunos no curso de física, na área de cinemática. Essa ferramenta, chamada de SEVC (Simulador de Experiências Virtuais de Cinemática), possibilita ao aluno simular situações objetos em movimentos com velocidades, acelerações e posições iniciais variadas.

Palavras-chave: Cinemática, Java, Realidade Virtual na Educação, VRML.

1. Introdução

O uso da informática como ferramenta de ensino nas escolas de 1º e 2º graus tornou-se importante nos últimos anos no processo de aprendizagem dos alunos, e o resultado disso é a existência de milhares de softwares voltados para educação, muitos deles com características tecnologicamente avançados como som, animação, cores e uma grande variedade de recursos disponíveis no mercado. Atualmente pode-se classificar certas modalidades de produtos de software educacional, tais como: produtos de exercício e prática, com as perguntas e respostas que se esta habituado a encontrar, há os tutoriais que funcionam como uma espécie de guia, programas de simulação e modelagem, os hipertextos e hipermídias, e os jogos educacionais. Além disso, há, ainda, as grandes bases de conhecimento, os chamados sistemas especialistas, neste caso, encontra-se sistemas dirigidos à área de treinamento e atendimento de necessidades eventuais e os tutores inteligentes produzidos para fins educacionais. Na verdade, esta classificação nos é interessante apenas para uma exposição didática.

Na prática, nenhumas destas modalidades de produtos de software educacionais funcionam isoladamente. Atualmente, os sistemas procuram ser híbridos e o que se busca cada vez mais é navegar por todos eles o tanto quanto possível.

Em particular, na modalidade de simuladores, a Realidade Virtual (RV) pode ser uma ferramenta bastante útil na área de educação. Principalmente, pelo fato da RV disponibilizar uma variedade de maneiras à interação humano-computador, utilizando uma combinação de tecnologias cujas interfaces com o aluno podem estimular seus sentidos, novas percepções e uma nova maneira de aprendizagem através da interação com mundos virtuais.

Este artigo tem como objetivo apresentar uma ferramenta de simulação baseada nos conceitos de RV voltada a auxiliar o ensino e a aprendizagem de alunos no curso de física, na área de cinemática [11], como tecnologias de apoio têm-se VRML *(Virtual Reality Modeling Language)*, linguagem Java, e EAI *(External Authoring Interface)*. Essa ferramenta chama-se SEVC (Simulador de Experiências Virtuais de Cinemática), possibilitando o aluno simular situações de movimento de objetos com velocidade, aceleração e posições iniciais variadas, apresentando simultaneamente a simulação vos gráficos relacionados ao movimento escolhido.

De maneira geral, neste trabalho, serão comentadas o uso da RV em Educação e ferramentas que possibilitem o desenvolvimento de protótipos com os benefícios da RV, bem como a apresentação do protótipo construído.Na seção 2 são discutidos usos de RV na educação. Na seção 3 é apresentado o protótipo SEVC, incluindo a motivação, suporte tecnológico e funcionamento. E por fim, na seção 4, são apresentados as considerações finais e trabalhos futuros.

2. Realidade Virtual

A RV pode ser definida como avançadas técnicas de interface, permitindo ao usuário realizar imersão, navegação e interação em tempo real num ambiente sintético tridimensional gerado por computador [1] [3]. Uma das grandes vantagens das tecnologias de RV é possibilitar que todo o conhecimento intuitivo do usuário possa ser deslocado a um outro contexto de manipulação do ambiente virtual.

Os ambientes virtuais estão classificados em ambiente imersivos e não-imersivos. A idéia de imersão está ligada com o sentimento de se estar dentro do ambiente.

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Geralmente, um sistema imersivo é obtido com o uso de periféricos não-convencionais, tais como capacete de visualização, luvas especiais de manipulação, ou até mesmo o uso de sala de projeções. O valor ainda bastante elevado da aquisição desses dispositivos especiais acaba por restringir o seu uso, principalmente para usuários comuns. Entretanto, como alternativa, tem-se a realidade não-imersiva, baseada em periféricos convencionais, tais como: teclado, *mouse* e monitor, muito mais acessível em termos de custo para os usuários. A evolução dos PCs e do aperfeiçoamento das interfaces dos atuais softwares de RV, possibilitando um maior grau de imersão em ambientes tridimensionais, mesmo para ambientes considerados não-imersivos.

3. A Realidade Virtual na Educação

A criação de mundos virtuais, onde o participante pode se movimentar, ver e manipular objetos, como no mundo físico, poderá constituir um importante recurso no ensino, uma vez que, os alunos poderão descobrir, de uma forma ativa e perspicaz, os conhecimentos anteriormente transmitidos unicamente pelo professor.

Permitindo a experimentação de novos e diferentes ambientes, similar ou não ao mundo real, cujas características e regras serão delineadas de acordo com os objetivos pretendidos para o processo de aprendizagem, assim, os mundos virtuais poderão vir a constituírem locais de pesquisa e investigação que permitam aos professores não só a transmissão pura e simples de conhecimentos, mas a disponibilização de uma ampla e variada informação que permitirá aos alunos, através da experimentação, análise, investigação e crítica, serem os agentes principais da construção de seus conhecimentos, tarefa que deve ser realizada com a cooperação do professor, que assume agora um novo papel, o de facilitador da construção do conhecimento [7] [12].

A interatividade e a manipulação desempenham também, na experiência virtual, um papel educativo importante, permitindo o "aprender fazendo" que se poderá agora generalizar para "aprender manipulando". Se as experiências científicas, exigindo manipulação, não são, em geral, realizadas por falta de meios ou devido a perigos que delas possam ocasionar, no mundo virtual esses problemas inexistem, sendo possível a criação, sem riscos, de qualquer experiência, pela qual os alunos, manipulando os objetos que antes apenas ouviram falar ou viram em fotografia ou vídeo, alcançam novos conhecimentos sobre os mesmos. [6]

Segundo a Doutora Verônica Pantelides da East Carolina University [6] há diversas razões para usar a Realidade Virtual na educação, entre elas destacam-se:

- Maior motivação do estudante;
- O poder de ilustração da Realidade Virtual para alguns processos e objetos é muito maior do que outras mídias;
- Permite uma análise de muito perto ou de muito longe;
- Dá oportunidades para experiências;
- Permite que o aprendiz desenvolva o trabalho no seu próprio ritmo;
- Não restringe o prosseguimento de experiências ao período da aula regular;
- Permite a que haja interação, e desta forma estimula a participação ativa do estudante.

4. O Protótipo SEVC (Simulador de Experiências Virtuais de Cinemática)

4.1 Motivação

O protótipo é uma ferramenta de simulação tridimensional para o estudo da cinemática, mas especificamente para movimento retilíneo uniforme e movimento retilíneo uniformemente variado.

Uma das razões para a concepção do SEVC é a possibilidade de visualizar resultados práticos de teorias das leis da física que antes se restringiam somente a anotações no quadro. Estimulando o aluno a explorar novas situações e novos resultados através de simples manipulações dos objetos virtuais presentes no ambiente simulado.

O SEVC é uma ferramenta que complementa, através de visualizações práticas, a teoria estudada e analisada pelo professor em sala de aula, tornando o conteúdo mais atrativo para o aprendizado.

A proposta deste protótipo tem como objetivos:

- Disponibilizar o conhecimento para aprendizado e revisões complementares das disciplinas envolvidas;
- Possibilitar maior tempo para a prática das experiências, levando em consideração o próprio ritmo do aluno;
- Facilitar o aprendizado, através de uma interface interativa que utiliza os conhecimentos já adquiridos no mundo real;
- Avaliar a potencialidade da RV na educação;
- Possibilitar fácil atualização do conjunto de experiências.

4.2 Suporte Tecnológico

4.2.1 VRML, EAI e JAVA

VRML é uma linguagem de programação que permite a construções de objetos e cenários tridimensionais, e tem vasta aplicabilidade, incluindo entretenimento, interfaces 3D para usuários que usam recursos remotos da Web, ambientes 3D colaborativos, simulações de interatividade para educação, etc.

JAVA é uma linguagem orientada a objetos que possui uma API robusta voltada para construção de aplicações em rede e o desenvolvimento de interface próprio para Internet com o uso de applet [2].

EAI (*External Authoring Interface*) [4] foi projetada para permitir que um programa externo, como *applet* Java, acesse *nodes* (geralmente objetos) em um cenário VRML, usando o modelo de eventos existente no VRML. Neste modelo, um evento de saída de um dado *node* pode ser roteado para um evento de entrada de um outro *node*. Quando o evento de saída gera um evento, o evento de entrada é notificado e seu *node* processa aquele evento.

Scripts são executados dentro de um *browser* VRML. Apesar de usar recursos de rede, não há maneira de um *script* interagir com um código externo Java, tal como um *applet* Java. Por outro lado, a única maneira de usar EAI é como parte de um *applet* Java, como pode ser visto na Figura 1 [5].

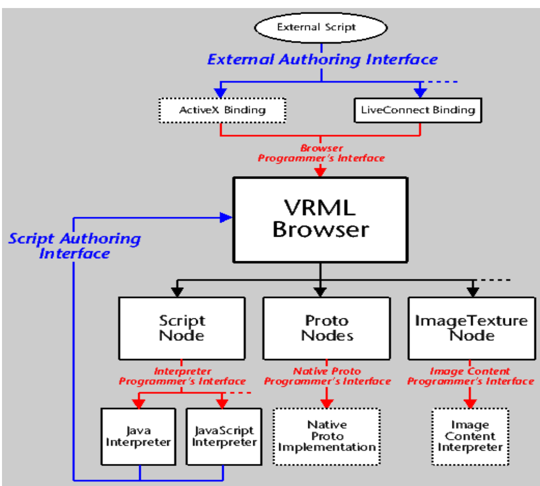

FIGURA 1:
A COMUNICAÇÃO ENTRE AS TECNOLOGIAS VRML, JAVA E EAI [9]

4.3 Funcionamento do SEVC

O protótipo é apresentado em uma página Web que contém uma ambiente virtual tridimensional e uma applet, utilizada para configurar o ambiente virtual e seus objetos. O protótipo carrega um ambiente inicial, simulando uma cidade, o aspecto principal é uma rua com marcações de distância, onde o aluno poderá realizar experiências utilizando um ou dois veículos (Figura 2 e Figura 3).

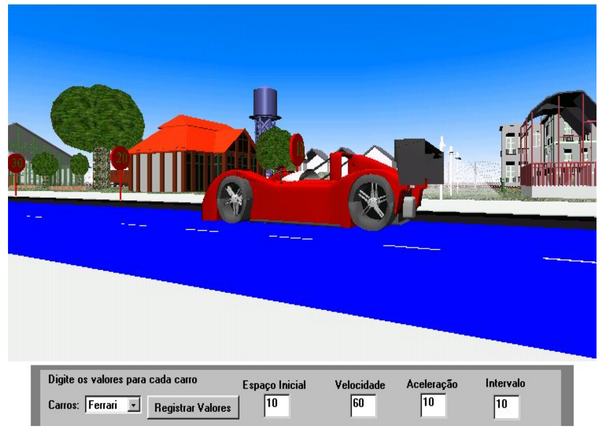

FIGURA 2:
ALUNO INTERAGINDO COM APENAS UM CARRO

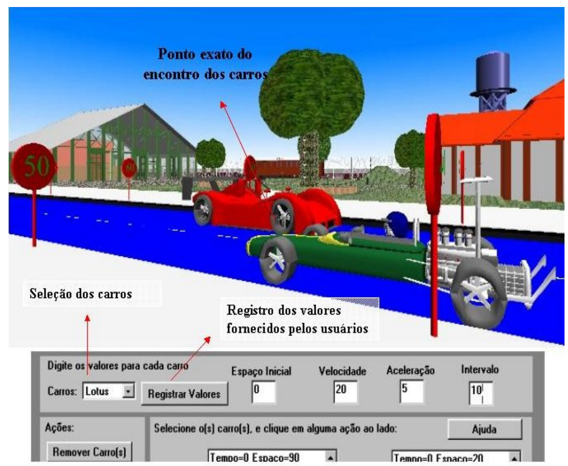

FIGURA 3:
ALUNO INTERAGINDO COM DOIS CARROS EM DIREÇÕES OPOSTAS

O aluno pode interagir com o protótipo através de uma applet, nesta o aluno pode escolher o tipo de carro, entre uma Lotus e uma Ferrari, escolher seu espaço inicial, velocidade inicial e aceleração (Figura 3).

Na parte inferior da applet o aluno pode avaliar o deslocamento do veículo segundo a segundo, e ao final, se a simulação for feita com dois carros terá o tempo e a posição de encontro entre os dois veículos (Figura 4).

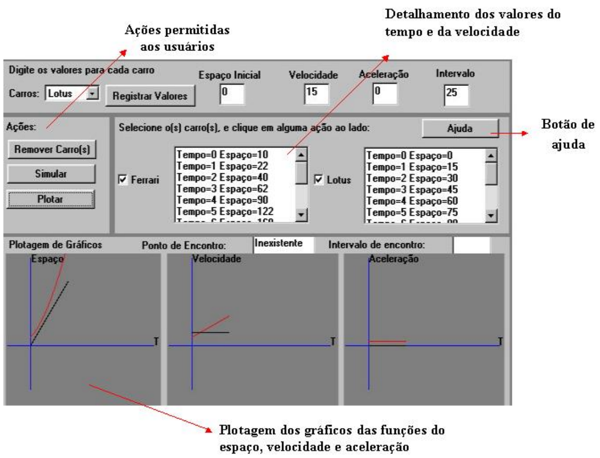

FIGURA 4:
APPLET DE INTERAÇÃO DOS VEÍCULOS

Para determinar o calculo do espaço percorrido é usada a seguinte fórmula da física, $S = So + Vo * T + (A * T^2)/2$, onde: **S**, é o espaço final a ser determinado, **So** é o espaço inicial onde o veículo vai estar, **Vo** é a velocidade inicial do veículo, **A** é a aceleração e **T** é o tempo para a simulação.

Após a configuração dos parâmetros e simular o movimento dos veículos, através do botão simular, ficará disponível a opção *plotar* gráficos, entre eles: espaço x tempo, velocidade x tempo e aceleração x tempo.

O ambiente pode ser observado de diversos ângulos, atividade que poderia ser impossível de realizar dentro de uma sala de aula comum, na RV ela se torna trivial, isso torna o aprendizado mais enriquecedor (Figura 5).

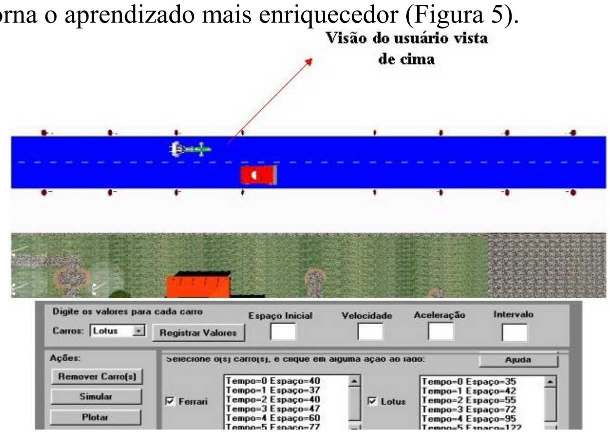

FIGURA 5
MÚLTIPLAS VISÕES DO AMBIENTE

E toda dúvida do aluno em relação às funcionalidades do simulador, ou das próprias teorias da física, especificamente na cinemática, poderá ser solucionada com o auxílio por um tutorial presente no sistema. Nele, há trechos relacionados a conceitos do estudo dos movimentos dos corpos, movimentos com velocidade escalar variável e movimento uniformemente variado. Todo tutorial está estruturado em hipertextos, contendo exemplos de vídeos demostrando as funcionalidades do simulador direcionado as dúvidas do aluno.

5. Considerações Finais e Trabalhos Futuros

As razões para utilizar ambientes virtuais no meio educacional são várias: facilita a motivação, a criatividade, experiências em primeira pessoa, ensino-aprendizagem pela descoberta, controle do tempo e do espaço, desenvolvimento de capacidades e superação de dificuldades, entre outras [6, 8]

A utilização da RV em contexto educativo pressupõe uma concepção de ensino diferente da tradicional, colocando a disposição de educadores e alunos uma nova ferramenta para esta prática de ensino, que tem como principal agente da construção do conhecimento o próprio aluno.

É importante frisar que não é pretensão desta ferramenta a eliminação das tradicionais formas de ensino-aprendizagem, tais como leituras em livros, interação professor-aluno e aluno-aluno. Pretende-se elaborar uma ferramenta que seja aliada ao processo, que possa se tornar parte integrante do mesmo.

Como trabalhos futuros, pretende-se:

- Ampliação dos domínios de aplicação desta ferramenta, não se restringindo somente a cinemática, mas também a outras disciplinas da Física;
- Melhoramentos no ambiente virtual conforme *feedback* dos alunos em relação ao seu uso, interface, funcionalidade, etc.
- Buscar maior grau de imersão do sistema, através da adaptação do simulador ao uso de alguns periféricos, ditos não-convencionais, tais como luvas e óculos 3D.
- Tornar o SEVC um ambiente colaborativo, permitindo a troca de conhecimento entre aluno-aluno ou professor-aluno via *Internet*, em um ambiente tridimensional compartilhado.

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UM NOVO SISTEMA DE CONTROLE DE ACESSO PARA LABORATÓRIOS INTERDISCIPLINARES

João Marcos Salvi Sakamoto[1], Alexandre César Rodrigues da Silva [2] e Luis Carlos Origa de Oliveira[3]

Resumo *— A implantação de laboratórios abertos para o ensino interdisciplinar nas áreas tecnológicas tem sido muito discutida. Muitas instituições estão adotando esta sistemática como forma de motivação dos alunos no desenvolvimento de projetos multidisciplinares. Estes laboratórios estariam à disposição dos alunos diuturnamente para que possa haver uma melhor utilização dos recursos disponíveis e maior flexibilidade de horários. No entanto, devido à limitação de funcionários, muitos estão funcionando nos moldes tradicionais. Apresenta-se neste trabalho um sistema para controle de acesso utilizando iButton, para permitir que alunos possam circular livremente em qualquer horário sem a supervisão de funcionários. Este sistema possui vantagens em relação aos outros sistemas, ditos convencionais, como, por exemplo, cartões magnéticos, códigos de barras, etc, pois os iButtons são baratos, podem armazenar uma grande variedade de informações que, quando necessário, podem ser alteradas rapidamente, além do que a comunicação com o sistema hospedeiro é feita através de um simples contato.*

Palavras chave — iButton, controle eletrônico de acesso, projetos multidisciplinares, laboratórios interdisciplinares.

INTRODUÇÃO

Muitos dos componentes sensores de sistemas de controle estão familiarizados no idioma digital universal de 0s e 1s. Recentemente os *iButtons*, com mais de 27 milhões em circulação [15], têm tido emprego em muitos segmentos produtivos do mundo todo como uma extensão dos computadores. Este fato, sem precedentes, fez com que alguns hábitos culturais e econômicos fossem mudados. Os *iButtons* estão sendo usados intensamente como elemento para identificação e ou autenticação, como sensores de temperatura, selo de dados, guarda de propriedade e muitos outros. Alguns casos interessantes de empresas que estão utilizando esta tecnologia de ponta são narrados na literatura [1]. Uma dessas histórias refere-se a uma escola na Flórida que acreditava estar promovendo educação com uma alta dose de tecnologia a seus alunos. Neste espírito, a administração adotou a tecnologia de cartão inteligente como um modo para agilizar rotinas diárias, como destrancar salas de aula, controlar acesso aos computadores, compras na lanchonete escolar ou qualquer outra transação que necessitasse armazenamento de informações. No final de um determinado período o sistema implementado foi desativado pois os frágeis cartões não sobreviviam às manipulações dos estudantes.

Com o advento dos *iButtons*, a escola começou a empregá-los como chaves personalizadas. Dessa forma, qualquer estudante poderia ser facilmente identificado podendo entrar em edifícios, salas de aula, computadores e páginas da Web. Com o formato de um anel metálico, foi emitido para cada estudante um *iButton* contendo as identificações necessárias e que poderia ser usado de acordo com a preferência do indivíduo, ou seja, como um anel de dedo, um relógio de pulso ou um adorno qualquer. Receptores (*Blue Dot*) conectados a computadores permitiram que os estudantes, pelo simples gesto de apertar o botão neste receptor, entrassem na sala de aula, ou registrassem os livros retirados na biblioteca, ou até registrassem os gastos na lanchonete. Um sistema automatizado com essa tecnologia permite que uma escola mantenha um ambiente físico aberto e seguro para cada estudante, que possui acesso a um determinado ambiente, sendo identificado por um símbolo visível e pessoal.

Os *iButtons* vêm sendo empregados em muitas outras atividades como em hospitais, para identificação de pacientes; no registro de temperaturas; em fazendas, para controle da lida com as criações; em equipamentos de alta tecnologia, como um selo de garantia; enfim, o limite para o emprego dos *iButtons* é a criatividade.

Em uma instituição de ensino, como uma universidade, muitas vezes é necessário utilizar laboratórios, computadores ou equipamentos fora do horário normal de funcionamento, a fim de se realizar trabalhos e pesquisas. Como nesses horários não há funcionários para supervisionar o trabalho, é necessário utilizar um meio de supervisão automática ou eletrônica.

Para esse fim, uma solução imediata seria fornecer chaves convencionais aos alunos, porém pode não haver um controle de cópias de chaves.

Pensando nisso, desenvolveu-se, neste trabalho, um sistema de chave eletrônica controlado por um computador, no qual a chave é um *iButton*. Com este sistema, pode-se permitir ou não que alunos tenham acesso a certas áreas da

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universidade, visando melhorar o controle de entrada dos prédios e laboratórios.

O QUE É E COMO FUNCIONA UM *IBUTTON*

O *iButton* é uma pastilha (*chip*) de silício armazenada em uma cápsula de aço inoxidável com um diâmetro menor que uma moeda. Seu encapsulamento serve tanto para proteger o *chip* como para prover contato elétrico com o sistema de comunicação. O *iButton* é altamente resistente, podendo sofrer quedas, arranhões e até molhar. Devido a isso, pode ser utilizado diariamente como um acessório digital, em um chaveiro, crachá, anel, entre outros. A Figura 1, extraída de [15], mostra um *iButton* e seu encapsulamento.

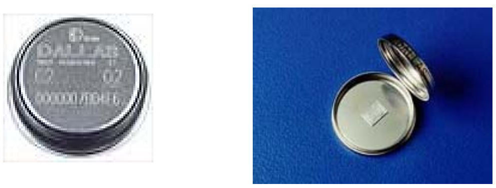

FIGURA. 1
IBUTTON E CÁPSULA ABERTA.

A referência [11] enumera várias especificações técnicas, algumas das quais, citadas a seguir. A cápsula do *iButton* tem 16mm de diâmetro, podendo ter 3.1mm ou 5.9mm de espessura, designados por F3 e F5, respectivamente. A versão F5 é padrão para todos os dispositivos que contém uma fonte de energia interna. Os dispositivos que são energizados pelo mestre podem estar disponíveis também na versão F3. A espessura do aço é de 0.254mm. O material isolante entre a parte inferior e o contato superior é de polipropileno preto, que inibe raios ultra violeta. Este desenho proporciona uma excelente estabilidade mecânica e é resistente à corrosão. Todas as cápsulas resistem a choques mecânicos de 500g (1g = $9.81 m/s^2$) em todas as direções. Uma queda de 1.5m de altura em uma superfície de concreto não danifica o encapsulamento nem seu conteúdo. A Figura 2, extraída de [14], mostra as especificações físicas do *iButton*.

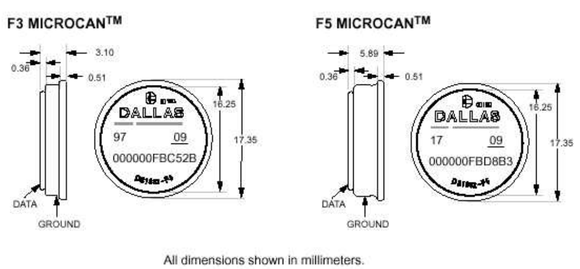

FIGURA. 2
ESPECIFICAÇÕES DOS *IBUTTONS*

No encapsulamento dos *iButtons* há várias informações gravadas, como o número de série, o tipo de *iButton*, etc. A Figura 3, extraída de [11], mostra o significado das informações gravadas.

A comunicação dos *iButtons* com o sistema hospedeiro é realizada serialmente através do protocolo 1-Wire [2], onde é necessário apenas um fio de dados e um retorno (terra). O próprio encapsulamento fornece os contatos para a comunicação, onde o topo é o contato de dados e a base é o terra.

Há diferentes tipos de *iButtons* disponíveis, sendo que cada tipo possui funções específicas, como termômetro, calendário com relógio, memória reprogramável, etc. Todos os *iButtons* possuem um número de série único gravado em uma memória de 64 bits, sendo que os 8 primeiros bits são o código que identifica a família do *iButton*, os próximos 48 bits são o número de série único, e nos últimos 8 bits é implementado um algoritmo de checagem dos 56 bits anteriores. Além das características citadas anteriormente, todos possuem as seguintes características comuns [14]:

- Identificação digital e informações através de contato momentâneo;
- Armazenamento informações de maneira compacta;
- Os dados podem ser acessados enquanto estiverem fixados em algum objeto;
- Comunicam-se com o barramento com um simples sinal digital a 16.3 kbits por segundo;
- Tamanho padrão e protocolo padrão asseguram compatibilidade com a família *iButton*;
- A superfície do *iButton* se encaixa na superfície do hospedeiro;
- Encapsulamento de aço inoxidável resistente a ambientes severos;
- Podem ser fixados facilmente com adesivos ou anéis de fixação;
- Detector de presença que reconhece quando o leitor aplica uma tensão.

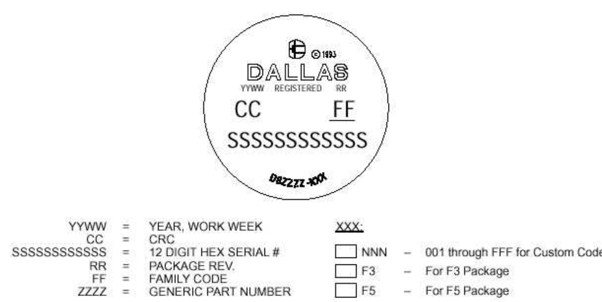

FIGURA. 3
INFORMAÇÕES GRAVADAS NOS *IBUTTONS*

O *iButton* não necessita de fonte de alimentação, pois ele retira energia da própria linha de dados no momento do contato.

Pode-se operar com vários *iButtons* simultaneamente através de uma rede para comunicação digital. Há diversos meios de comunicação, como o *Blue Dot* (serial ou paralelo), caneta para leitura, adaptador serial ou paralelo, apresentados na Figura 4, respectivamente, extraída de [15].

FIGURA. 4
BLUE DOT, CANETA DE LEITURA E ADAPTADOR SERIAL

O *iButton* possui vários acessórios de fixação e de uso pessoal. Os acessórios de fixação são usados para colar o *iButton* na superfície de um objeto qualquer, através de adesivos ou anéis de fixação, ou soldar em uma placa de circuito impresso. Entre os acessórios de uso pessoal, estão chaveiros, carteiras, anéis, pulseiras de relógio, entre outros.

IBUTTON PARA CONTROLE DE ACESSO

O *iButton* para controle de acesso mais simples é designado pelo número DS1990A e possui o número de série como característica principal. No entanto, pode-se usar qualquer tipo de *iButton* para controle de acesso, pois todos possuem um número de série. O DS1990A consiste em uma memória ROM de 64 bits e possui também as seguintes características [14]:

- Vários DS1990A podem coexistir em um mesmo barramento;
- Chave eletrônica de baixo custo;
- Pode ser lido em menos de 5 ms;
- Temperatura de operação de -40^{o}C a $+85^{o}$C;

UM NOVO SISTEMA DE CONTROLE DE ACESSO PARA LABORATÓRIOS

A proposta do sistema foi substituir a chave convencional e trabalhar de modo semelhante aos cartões magnéticos ou códigos de barras, ou seja, deve haver um leitor na porta e um computador para controlar a entrada do usuário. Assim, desenvolveu-se um novo sistema de controle de acesso utilizando *iButtons* como chaves, um *Blue Dot* como leitor e um computador para verificação da permissão de entrada dos usuários e auditoria.

Desenvolveu-se, então, um programa em Linguagem C para controlar o sistema, ou seja, ler o *iButton*, verificar se este está autorizado e, em caso afirmativo, abrir a porta através de uma trava eletrônica.

Utilizou-se um ambiente denominado *TMEX* [12] para utilizar rotinas de comunicação com o *iButton*. O ambiente *TMEX* é um conjunto de drivers e programas utilitários que permitem a comunicação dos *iButtons* e acessórios utilizando um microcomputador.

A ferramenta utilizada para desenvolver o programa foi o *Professional Software Developer's Kit* (DS0621-SDK) [10], que contém os códigos fonte de todos os aplicativos *TMEX* e os arquivos necessários para que as funções *TMEX* sejam compiladas. Para utilizar o software desenvolvido é necessário que o *TMEX* esteja instalado e configurado no microcomputador.

A partir do estudo das funções *TMEX* e de alguns aplicativos prontos, pode-se desenvolver o programa de controle de acesso. O sistema operacional escolhido foi o *MS-DOS* devido ao fato de ser um sistema simples e qualquer microcomputador padrão *IBM-PC* pode executá-lo facilmente. Isso é uma vantagem, pois pode-se utilizar computadores ultrapassados e ociosos sem custo adicional.

O programa executa os seguintes passos: inicializa os drivers e testa se as configurações estão corretas. Em seguida, fica em espera e quando um *iButton* toca o *Blue Dot*, lê o seu número de série e compara com os números de série autorizados em um arquivo. Se o *iButton* não estiver autorizado, o programa emite um ruído, registra no arquivo de auditoria que um *iButton* não autorizado tentou acessar o sistema e volta ao estado de espera. Se o *iButton* for autorizado, o programa registra no arquivo de auditoria o nome do usuário, a data e o horário de acesso e, em seguida, abre a trava eletrônica.

Após vários testes obteve-se êxito com o programa, que funcionou corretamente. Com isso, testou-se o sistema como um todo, ou seja, implementou-se o sistema com o microcomputador, *Blue Dot*, adaptador serial, transformador (220-12V), circuito de potência e trava de porta eletrônica, como mostra a Figura 5 e, em detalhes, a Figura 6.

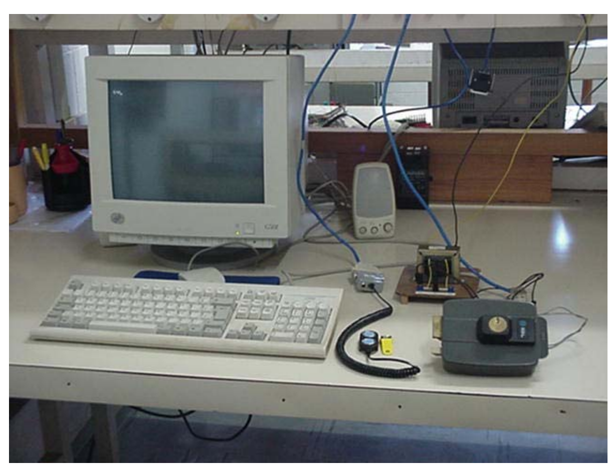

FIGURA. 5
SISTEMA DE CHAVE ELETRÔNICA.

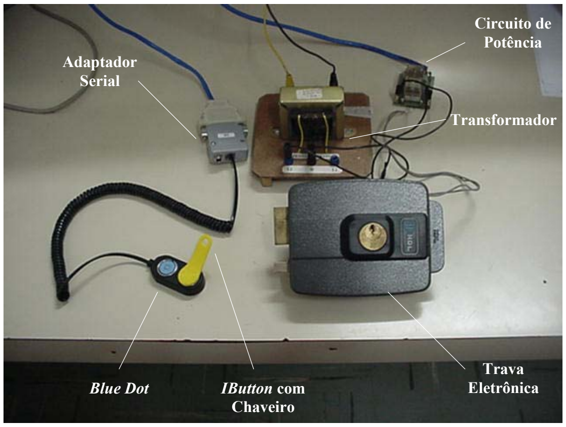

FIGURA. 6
SISTEMA EM DETALHES.

O teste foi realizado no Laboratório de Processamento de Sinais e Sistemas Digitais da Faculdade de Engenharia de Ilha Solteira e obteve-se sucesso, ou seja, os *iButtons* cadastrados abriram a trava e os não cadastrados não abriram. Deve-se salientar que se utilizou *iButtons* de vários tipos, pois todos possuem um número de série único.

Uma parte importante do projeto é a auditoria, que neste primeiro momento foi realizada gravando o nome do usuário, a data e o horário de entrada. Porém, de acordo com certas necessidades podem ser implementadas rotinas de auditoria mais complexas.

CONCLUSÃO

O sistema de chave eletrônica apresentou um resultado altamente satisfatório, mostrando que o *iButton* pode substituir o cartão magnético ou o código de barras na identificação de pessoas, pois é barato, extremamente resistente, pode entrar em contato com a água, e pode ser utilizado como um chaveiro, crachá ou anel. A instalação é simples, barata e pode-se usar computadores obsoletos para o controle, pois o programa foi desenvolvido em MS-DOS. Este sistema pode ser instalado em locais que necessitem de um certo controle de acesso, mas não disponham de funcionários para supervisão de pessoal. Este sistema poderá ser instalado em qualquer sala de nossa unidade universitária. Como exemplo, o PROIN-DEE que é um laboratório que dispõe de vários computadores e os alunos poderão acessá-lo em horários noturnos, quando não há funcionários disponíveis para controlar a entrada e saída do laboratório.

O sistema de chave eletrônica com o *iButton*, mostrou-se melhor que o de chave convencional, pois pode-se desabilitar um usuário se for necessário, pode-se usar um mesmo *iButton* para abrir várias portas diferentes e é possível criar várias rotinas de auditoria como o registro do horário de entrada, etc.

Os *iButtons* como um todo possuem inúmeras utilidades, pois cada um possui funções características, sendo que a chave eletrônica é apenas uma aplicação destas. A execução de projetos utilizando os *iButtons* depende apenas das necessidades do usuário e da criatividade do projetista.

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BRANCH AND BOUND APLICADO NO PROBLEMA DE COBERTURA DE FUNÇÕES BOOLEANAS

Tercio Alberto dos Santos[1], Alexandre César Rodrigues da Silva[2] e Carlos Eduardo da Silva Santos[3]

Resumo *— Este trabalho apresenta um método para a obtenção de cobertura mínima para uma função booleana empregando o algoritmo Branch and Bound modificado. A partir da formulação do problema de cobertura de funções booleanas como um problema de programação linear inteira 0 e 1, cuja formulação é apresentada a seguir, a solução ótima global é obtida.*

MIN CT. X de modo que

$$AX \geq b$$
$$X \geq 0$$

Onde: $X \in Rn$; $C \in Rn$; $b \in Rn$ e $A \in R^{n.n}$ *com posto completo. Vários métodos para a geração de implicantes primos podem ser utilizados para a geração da formulação da cobertura. Empregou-se neste trabalho o algoritmo Expander que utiliza-se do método de expansão de Shannon. Uma grande variedades de funções booleanas foram estudadas, cujos resultados comprovaram a eficiência computacional deste tipo de abordagem. O algoritmo implementado em linguagem de programação está sendo comparado com outros algoritmos já implementados.*

Palavras chave — Programação Matemática, Otimização de Funções Booleanas, Branch and Bound, Plano de Corte, Dual Simplex.

INTRODUÇÃO

A otimização lógica a dois níveis tem suas raízes há muitas décadas atras e está baseada na teoria clássica sobre álgebra de chaveamento. Vários textos tratam do assunto [1], [2], [3]. Os primeiros algoritmos para a minimização exata foram propostos por Quine [4] e por McCluskey [2]. Uma grande variedade de métodos foram propostos ao longo dos anos como, por exemplo, o método de Rudell e Sangiovanni [5] denominado Espresso-Exact, o método de Dagenais et ali [6] denominado de McBoole, o método de Coudert e Madre [7] e muitos outros.

Com o aumento da complexidade dos circuitos digitais a minimização lógica exata tornou-se impraticável até algumas décadas atrás. Com o aumento da velocidade e da capacidade de memória das estações de trabalho, aliado ao desenvolvimento de eficientes métodos de cobertura para uma solução exata, revitalizou-se o interesse por essa área de pesquisa.

Atualmente, tem-se como um dos mais eficientes algoritmos de minimização de funções booleana o programa denominado BOOM (A Heuristic Boolean Minimizer) [8], cuja principal característica é a combinação da geração dos implicantes primos em conjunto com a solução do problema de cobertura, o que leva a uma redução no número de implicantes primos gerados.

Este trabalho trata sobre a resolução do problema de cobertura de funções booleanas formulada como um problema de programação matemática. Implementou-se três algoritmos descritos na literatura com o objetivo de avaliar o que melhor soluciona o problema de cobertura. Foram implementados o algoritmo Branch and Bound, o Plano de Corte de Gomory e o Dual Simplex. Utilizou-se como critério de eficiência a quantidade de memória utilizada, o tempo de execução, a quantidade de iterações e a solução obtida.

PROBLEMA DE COBERTURA

Toda cobertura mínima de uma função booleana é solução de um problema de programação linear inteira 0 e 1, dessa forma todos os avanços da área da programação matemática podem ser utilizados com o objetivo de solucioná-la. Muitos métodos clássicos podem ser empregados, porém nesse trabalho implementou-se três métodos, o Branch and Bound, o Plano de Corte de Gomory e o Dual Simplex Canalizado [9].

O método Simplex é a base para o Plano de Corte de Gomory e para o Branch and Bound. O Dual Simplex Canalizado é uma forma alternativa para solucionar o problema de cobertura sem a necessidade de se utilizar o método Simplex.

Resolver o problema de cobertura consiste em encontrar uma solução que satisfaça todas as restrições do problema e que o custo da função objetivo, que representa o custo de implementação da função booleana, seja o menor possível.

Na grande maioria dos exemplos tratados neste trabalho obteve-se solução inteira no conjunto binário 0 e 1. Contudo, em alguns casos encontrou-se uma solução otimista (casos cíclicos). A identificação de casos cíclicos tornou-se possível, pois a solução é fracionária. Para esses casos empregou-se o método Branch and Bound ou Plano de Corte

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de Gomory para encontrar a solução ótima global do problema.

O algoritmo de Branch and Bound é um algoritmo enumerativo, cuja estrutura de resolução baseia-se na construção de uma árvore onde os nós representam os problemas candidatos e os ramos representam as novas restrições que devem ser consideradas. Por intermédio dessa árvore, todas as soluções inteiras da região viável do problema são enumeradas de modo implícito ou explicito o que garante que todas as soluções ótimas serão encontradas.

O algoritmo de Plano de Corte [10] é um dos principais algoritmos de programação linear inteira, o seu uso é pós otimização de PL internamente. Nesse algoritmo de uma iteração para outra resolve-se um PL com uma restrição adicional. Assim, os PL's sucessivos são diferentes em uma restrição adicional. Portanto, a estratégia mais evidente é usar dual simplex que aproveita o quadro ótimo de um PL para resolver o PL seguinte com a simples adição no quadro da nova restrição corretamente atualizada para a base atual.

O algoritmo dual simplex canalizado é o mais adequado para reotimizar subproblemas de programação linear (PL) gerados pelos algoritmos de Branch and Bound na resolução de um problema de programação linear inteira.

No algoritmo de Branch and Bound cada problema (PL) é diferente de seu antecessor em uma restrição adicional da seguinte forma:

$$x_j \geq k + 1 \qquad (\beta_1)$$

ou

$$x_j \leq k \qquad (\beta_2)$$

Sendo k um número inteiro.

Embora as restrições do tipo β_1 e β_2 podem ser adicionadas como uma restrição padrão e usar um algoritmo dual simplex padrão, essa estratégia aumenta sem necessidade o tamanho do quadro e da base. Como as restrições β_1 e β_2 são restrições sobre uma única variável então a melhor estratégia é usar um algoritmo dual simplex canalizado que leva em conta esse tipo de restrições somente de maneira implícita.

Vários métodos podem ser empregados para a formulação do problema de cobertura. Neste trabalho utilizou-se o algoritmo Expander [11] que implementa Método de Expansão de Shannon.

O Método de Expansão de Shannon

A geração de implicantes primos pelo Método de Expansão de Shannon é uma técnica iterativa que permite obter implicantes primos de uma dada função boolena através de simples operações sobre o conjunto de mintermos e/ou estados "don't care", representados em notação decimal, que descreve a função original. Tal método pode ser empregado em função com um grande número de variáveis. Todos ou, quase todos os implicantes primos que não estariam no conjunto solução são eliminados, simplificando, desse modo, a busca pela solução mínima.

Como exemplo considere a função booleana f(A,B,C,D) = $\Sigma m(0, 6, 8, 10, 15) + d(1, 2, 7, 9, 11, 14)$. Para a formulação do problema de cobertura utilizou-se o algoritmo Expander cujo arquivo de entrada e de saída estão apresentados na Figura 1 e na Figura 2, respectivamente. A tabela de cobertura proposta por McCluskey, consiste de colunas contendo todos os mintermos da função e de linhas que representam todos os implicantes primos gerados. A Tabela I apresenta a tabela de cobertura de McCluskey cujos implicantes primos foram gerados pelo algoritmo Expander.

Com o auxílio da Tabela I, o problema de cobertura dos mintermos transforma-se em um problema de programação linear inteiro binário 0 e 1.

FIGURA. 1
TELA DO ARQUIVO DE ENTRADA DO PROGRAMA EXPANDER.

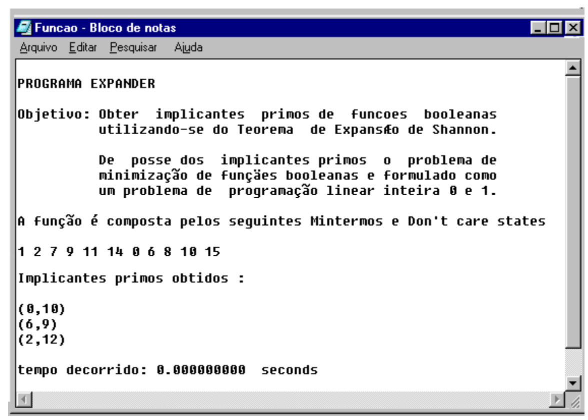

FIGURA. 2
TELA DO ARQUIVO DE SAÍDA DO PROGRAMA EXPANDER.

TABELA I
TABELA DE COBERTURA DE MCCLUSKLEY CUJOS IMPLICANTES PRIMOS FORAM GERADOS PELO ALGORITMO EXPANDER

	Mintermos				
Implicantes	0	6	8	10	15
XX10		x		x	
1X1X				x	x
X11X		x			x
X00X	x		x		

Optou-se por tratar o problema de cobertura como um problema matemático. Dessa forma, empregou-se uma notação matemática mais simples.

Fazendo-se: x_1 = XX10 , x_2 = 1X1X, x_3 = X11X e x_4 = X00X o problema apresentado na Tabela I é formulado como um problema de programação linear inteira 0 e 1 como descrito a seguir [12]:

$$
\begin{aligned}
&\min x_0 = 3x_1 + 3x_2 + 3x_3 + 3x_4 \\
&\text{s.a.} \\
&x_1 + x_2 \geq 1 \\
&x_1 + x_3 \geq 1 \\
&x_2 + x_3 \geq 1 \\
&x_4 \geq 1 \\
&x_1, x_2, x_3, x_4 \in \{0, 1\}
\end{aligned}
$$

Na resolução deste problema de programação linear usou-se uma linguagem de programação [13] MATLAB 5.3, que foi implementado em duas etapas:

a) Fez-se um programa para resolver o problema pelo método Simplex e obteve-se uma solução otimista, apresentado na Tabela II.

TABELA II
SOLUÇÃO OTIMISTA PELO MÉTODO SIMPLEX

7.5000	-1.5000	-1.5000	-1.5000	-3.0000
0.5000	-0.5000	-0.5000	0.5000	0
0.5000	-0.5000	0.5000	-0.5000	0
0.5000	0.5000	-0.5000	-0.5000	0
1.0000	0	0	0	-1.0000

O valor da função objetivo é igual a 7.5000, os valores da coluna abaixo do valor da função objetivo são os valores das variáveis, ou seja, {(0.5000, 0.5000, 0.5000, 1.0000)};

b) A solução da primeira etapa é otimista, então, implementou-se o programa (Branch2) empregando o dual simplex canalizado, assim, dando seqüência na resolução do método Branch and Bound.

No desenvolvimento do problema tem-se dois subproblemas P_1 e P_2.

Resolução do subproblema P_1

Para resolver o subproblema P_1 acrescentou-se uma restrição representado na Tabela III.

TABELA III
SOLUÇÃO OTIMISTA COM ACRÉSCIMO DA RESTRIÇÃO

7.5000	-1.5000	-1.5000	-1.5000	-3.0000
0.5000	-0.5000	-0.5000	0.5000	0
0.5000	-0.5000	0.5000	-0.5000	0
0.5000	0.5000	-0.5000	-0.5000	0
1.0000	0	0	0	-1.0000
-0.5000	-0.5000	0.5000	0.5000	0

Implementou-se o programa Dual Simplex Canalizado e encontrou-se como solução ótima global da função booleana apresentada na Tabela IV.

O valor da função objetivo é igual a 9 e os valores da coluna abaixo do valor da função objetivo são os valores das variáveis, ou seja, o conjunto verdade {(1, 0, 1, 1, 1)}.

TABELA IV
SOLUÇÃO ÓTIMA DO SUBPROBLEMA P_1

9	0	-3	-3	-3
1	0	-1	0	0
0	-1	1	0	0
1	1	-1	-1	0
1	0	0	0	-1
1	1	-2	-1	0

Resolução do subproblema P_2

Para resolver o subproblema P_2 adicionou-se uma nova restrição e implementou-se o programa Dual Simplex Canalizado e obteve-se como solução ótima do problema de cobertura mínima da função booleana *f*(A,B,C,D) = Σm(0, 6, 8, 10, 15) + d(1, 2, 7, 9, 11, 14) representado na Tabela V.

TABELA V
SOLUÇÃO ÓTIMA DO SUBPROBLEMA P_2

9	-3	-3	-3	-3
0	0	0	1	0
1	-1	0	-1	0
1	0	-1	-1	0
1	0	0	0	-1
1	-1	-1	2	0

A solução ótima do subproblema P_2, é o valor da F.O = 9 (função objetivo) e os valores das variáveis é o conjunto verdade {(0, 1, 1, 1, 1)}.

Observa-se que em ambos os subproblemas P_1 e P_2 o custo da função booleana *f*(A,B,C,D) = Σm(0, 6, 8, 10,15) + d(1, 2, 7, 9, 11, 14) é F.O. = 9.

Outros algoritmos foram implementados neste Exemplo na linguagem de programação MATLAB 5.3 e o valor obtido em ambos os casos foi o mesmo para função booleana *f*(A,B,C,D) = Σm(0, 6, 8, 10, 15) + d(1, 2, 7, 9, 11, 14).

Implementação do Algoritmo Dual do Simplex

Partindo-se do quadro otimista implementa-se o algoritmo Dual Simplex na linguagem de programação (MATLAB 5.3), e obtém-se como resultado:

FO = 9, X2 = 1, X3 = 1, X7 = 1 e X4 = 1

Assim, a solução ótima global do problema de cobertura da função booleana *f*(A,B,C,D) = Σm(0, 6, 8, 10,15) + d(1, 2, 7, 9, 11, 14) é dada por: custo mínimo igual a 9, e o conjunto verdade {(0, 1, 1, 1, 0, 0, 1)}, embora em ambos casos os conjuntos verdades sejam diferentes, porém, o custo é o mesmo.

Implementação do Algoritmo Plano de Corte ou Algoritmo de Gomory.

Partindo-se do quadro otimista da Tabela II encontrado pelo algoritmo Simplex, e acrescenta-se uma restrição de corte tem-se a Tabela VI, para depois implementar o algoritmo de Gomory (Gomo2) na linguagem de programação MATLAB 5.3.

TABELA VI
ACRÉSCIMO DE UMA NOVA RESTRIÇÃO NO QUADRO OTIMISTA

7.5000	-1.5000	-1.5000	-1.5000	-3.0000
0.5000	-0.5000	-0.5000	0.5000	0
0.5000	-0.5000	0.5000	-0.5000	0
0.5000	0.5000	-0.5000	-0.5000	0
1.0000	0	0	0	-1.0000
-0.5000	0.5000	-0.5000	-0.5000	0

Implementando o algoritmo de Gomory (Gomo2) tem-se a apresentação da Tabela VII a qual apresenta a solução ótima do problema.

TABELA VII
SOLUÇÃO ÓTIMA PELO MÉTODO DE GOMORY

9	-3	0	0	-3
1	-1	0	1	0
1	-1	1	0	0
0	1	-1	-1	0
1	0	0	0	-1
1	-2	1	1	0

A função objetivo FO = 9 e os números que aparecem na coluna abaixo do número 9 são os valores das variáveis, ou seja, o conjunto verdade {(1, 1, 0, 1, 1)}.

Comparando-se as três implementações obteve-se o conjunto de soluções diferentes, porém com o mesmo custo, ou seja, em todos os casos a solução mínima global da função booleana $f(A,B,C,D) = \Sigma m(0, 6, 8, 10,15) + d(1, 2, 7, 9, 11, 14)$ tem o custo igual a 9. Assim, obteve-se parâmetros para os três algoritmos implementados para relacionar custos, números de iterações, tempo computacional e quantidades de memórias, apresentados na Tabela VIII. Os resultados obtidos são:

TABELA VIII
APRESENTAÇÃO DA ANÁLISE DOS ALGORITMOS BRANCH2, GOMO2 E DUAL

Program	Custo	Iteração	Tempo(seg)	Mem.(bytes)
Branch2	9	6	2,56	2.772
Gomo2	9	5	2,09	2.448
Dual	9	3	0,77	1.780

As Figuras 3, 4 e 5, respectivamente, apresentam a relação gráfica das iterações, tempo gasto em segundos e memória em bytes dos três algoritmos implementados.

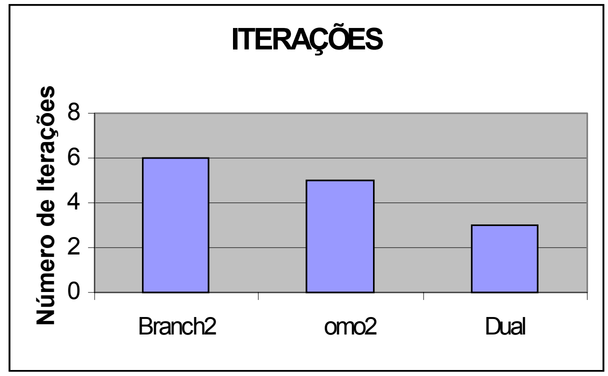

FIGURA. 3
APRESENTA AS ITERAÇÕES GASTAS PELOS PROGRAMAS BRANC2, GOMO2 E DUAL.

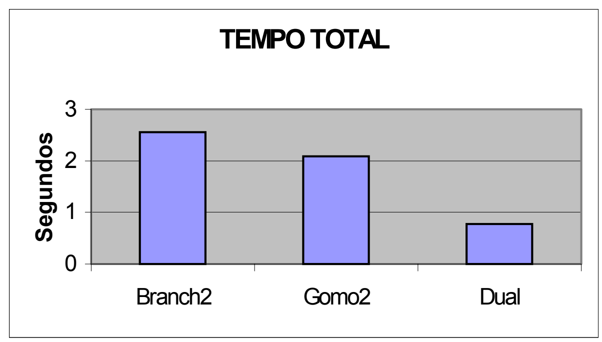

FIGURA. 4
APRESENTA O TEMPO GASTO PELOS PROGRAMAS BRANC2, GOMO2 E DUAL.

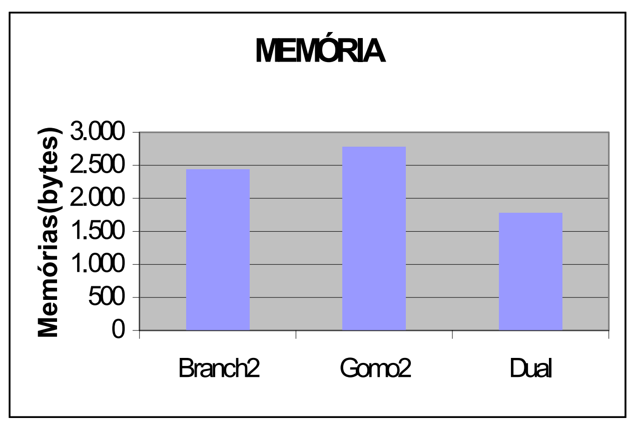

FIGURA. 5
APRESENTA A QUANTIDA DE MEMÓRIAS GASTA PELOS PROGRAMAS BRANC2, GOMO2 E DUAL.

CONCLUSÃO

Os circuitos elétricos são representados matematicamente pelas funções booleanas e neste trabalho revolveu-se a função booleana f(A,B,C,D) = Σm(0, 6, 8, 10,15) + d(1, 2, 7, 9, 11, 14) como exemplo. Através do algoritmo Expander, que utiliza-se do método de expansão de Shannon, gerou-se os implicantes primos as funções e o problema de cobertura foi modelado como um problema de programação matemática.

Visto que todo problema de cobertura mínima de uma função booleana é solução de um problema de programação linear inteira 0 e 1, implementou-se o algoritmo de Branch and Bound e encontrou-se a solução ótima global do problema de cobertura mínima.

Comparando-se com a implementação de outros algoritmos como Plano de Corte de Gomory e Dual Simplex observou-se que os três algoritmos implementados encontram o mesmo custo. A análise da Tabela II mostra os parâmetros entre os programas Branch2, Gomo2 e Dual quanto ao número de iterações, quantidade de memórias e o tempo em segundos gastos na execução de cada programa. Chega-se a conclusão que entre os três programas implementados o Dual leva uma ligeira vantagem, pois tem um número menor de iterações, o tempo gasto para executar o programa é menor comparando com os outros dois e a quantidade de memórias é bem menor.

Muito outros casos de cobertura estão sendo avaliados com o objetivo de validar os algoritmos implementados.

AGRADECIMENTOS

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SEQ2VHDL - Um Ambiente para Projeto de Sistemas Digitais

Leandro de Oliveira Tancredo[1], *Alexandre César Rodrigues da Silva* [2] *e Norian Marranghello* [3]

Resumo — *Este trabalho apresenta uma nova ferramenta de síntese para projetos de sistemas digitais denominada SEQ2VHDL. A partir da descrição em diagrama de transição de estados de uma máquina de estados finitos, representada no modelo de Mealy, é gerado uma descrição otimizada do sistema na linguagem de hardware VHDL. Elimina-se dessa forma a tarefa árdua com detalhes d projeto. A SEQ2VHDL foi comparada com duas outras ferramentas disponíveis comercialmente. Foram projetados diversos chip-set de códigos de transmissão digital utilizados no setor de telecomunicações. Os resultados comprovaram o desempenho satisfatório com relação ao custo de implementação, ao tempo de execução e uso de memória. A ferramenta trará grandes contribuições nas áreas educacionais da engenharia elétrica e computação, possibilitando além da criação de sistemas autômatos, o aprendizado da linguagem VHDL, pois trata-se de uma ferramenta de domínio público ao contrário das ferramentas comerciais.*

Palavras Chave: FPGA, VHDL, FSM, HDL, Síntese Lógica).

INTRODUÇÃO

Este artigo tem como proposta apresentar uma ferramenta de síntese de alto nível ou HLS (abreviatura do inglês *high-level synthesis*) denominada SEQ2VHDL (SEQUENCIAL TO VHDL) e, a partir, dela implementar vários circuitos integrados de códigos de linhas utilizados em transmissão de dados, no setor de telecomunicações, originados a partir do diagrama de estados, utilizando a linguagem VHDL [2] [8][9]. Criou-se, dessa forma, um ambiente compatível para a síntese de sistemas digitais que veio facilitar a tarefa do projetista, eliminando a descrição detalhada como no exemplo de uma metodologia de projetos digitais seqüenciais apresentada em [10].

Atualmente, dispõe-se de dois importantes tradutores disponíveis comercialmente que interpretam uma máquina de estado finito, descrita através de seu diagrama de estado. Estas ferramentas são denominadas: Statecad [11] da Actel e Active-HDL [4], da Cypress.

Esses *softwares* destacam-se pelo uso do diagrama de estados para descrever o comportamento de uma máquina de estados finitos, traduzindo-as para a sua representação em código VHDL. Nenhum processo de otimização é efetuado nesta etapa, deixando a cargo das ferramentas de síntese, ou seja, o MAX + Plus II [1] ou XILINX [12]. Estas ferramentas apresentam entradas gráficas que possibilitam expressar idéias em um modo natural, bem próximo da linguagem humana.

Como a descrição em VHDL independe da tecnologia, as ferramentas de síntese comerciais apropriadas levariam para o nível de implementação de estado no domínio físico.

Conforme GENOE [7] existem aproximadamente 6000 licenças para sintetizadores lógicos no mercado, entretanto, há uma carência de ferramentas que interpretem os níveis de abstração altos. Um tradutor de linguagem, foi proposto por BONATTI [3] e implementado em um pacote de domínio público, denominado Stoht. FUHRER et alli [6] descrevem uma solução para minimização de estados de uma FSM para circuitos lógicos.

Muitas outras ferramentas de síntese de Alto Nível são descritas na literatura, comprovando a importância deste tipo de abordagem.

Na próxima seção, descreve-se os programas TABELA e o SEQ2VHDL.

AMBIENTE TABELA E SEQ2VHDL

Descreve-se nesta seção um método sistemático para projetos que a partir de uma descrição textual de uma máquina de estados finitos síncronas, origina-se uma segunda descrição, onde os elementos de memória são claramente identificáveis (*flip-flops*) e, finalmente, uma última descrição em VHDL na qual está presente uma entrada particular, denominada relógio.

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Programa TABELA

O programa TABELA [5] resultado de trabalho de tese apresentado na UNICAMP possui as seguintes etapas do projeto conforme a Figura 1.

Na metodologia empregada parte-se do nível RTL do domínio comportamental e chega-se ao nível lógico do mesmo domínio, ou seja, parte-se do diagrama de estados e chega-se nas correspondentes funções booleanas e memórias em suas formas mínimas. Vários algoritmos de minimização de funções booleanas poderiam ser empregados nesta etapa do projeto, optou-se pelo método Quine-McCluskey [5].

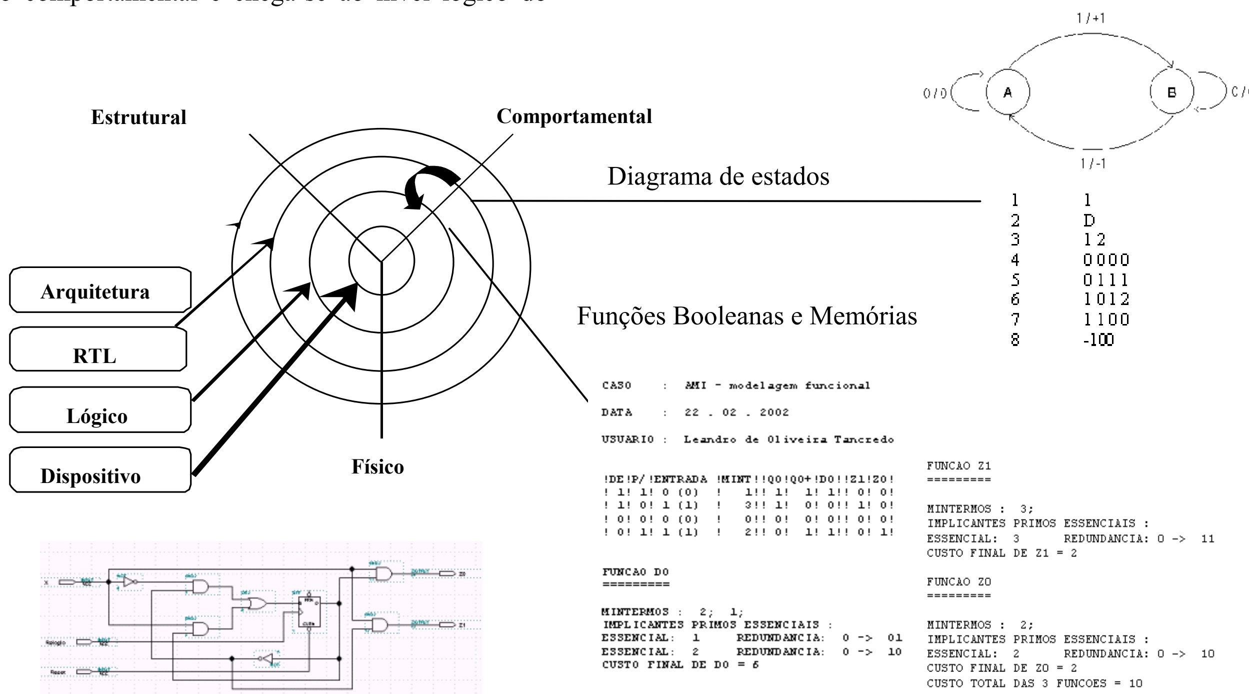

FIGURA. 1
DIAGRAMA Y APRESENTANDO A FERRAMENTA TABELA.

Programa SEQ2VHDL

Nesta seção descreve-se a ferramenta SEQ2VHDL, que recebe como entrada as funções booleanas (a saída gerada pelo programa TABELA) e cria um modelo funcional do circuito descrito na linguagem de descrição VHDL, conforme a figura 2 que apresenta o diagrama Y.

A listagem abaixo descreve o arquivo AMI.VHD gerado pelo programa SEQ2VHDL:

```
-- Ferramenta de Síntese Lógica
-- A ferramenta tem por objetivo transformar a descrição -
-- de uma máquina de estados finitos
-- sintetizada pelo programa TABELA para o seu modelo
-- RTL descrito em VHDL.
-- Programa: SEQ2VHDL.EXE
-- Programador: Leandro de Oliveira Tancredo
-- Versão: 9.0 de 3 de março de 2002
ENTITY AMI IS
    PORT(
-- CLK e CLR estão presentes em todos os modelos
    CLK, CLR : IN BIT;
-- Os parâmetros seguintes são definidos de acordo
-- com a descrição contida no programa tabela.
-- Xn representam as variáveis de entrada
-- Qn representam as variáveis de estado
-- Zn representam as funções de saída
    X0     : IN BIT;
    Q0     : OUT BIT;
    Z0, Z1 : OUT BIT );
END AMI;

-- RTL e a designação para todas as arquiteturas
ARCHITECTURE RTL OF AMI IS
-- VEn são sinais auxiliares que assumem os mesmos
-- valores das variáveis de estado. Eles são utilizados para
-- permitir
-- um melhor modelamento do sistema
SIGNAL  VE0: BIT;
--Jn, Kn e Dn representam as funções de controle e são
-- definidas
```

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```
-- no arquivo gerado pelo Programa TABELA
SIGNAL D0 : BIT;
 BEGIN
-- Nesta parte do modelo tem-se a descrição de cada um dos Flip-flops.
--Deve-se observar que os sinais auxiliares são utilizados,
-- sendo que no final de cada processo seus valores são
--transferidos para as variáveis de estados
-- Importante salientar que em relação ao software, existem duas procedures,
-- uma que implementa o flip-flop D e outra que
--implementa o JK e estas procedures recebem os índices
-- que representam o respectivo elemento de memória.
--Tais índices estão definidos no arquivo gerado pelo
 --programa TABELA
-- Inferindo flip-flop tipo D
PROCESS(CLK, CLR)

BEGIN
   IF CLR = '0' THEN
      VE0 <= '0';
   ELSIF CLK'EVENT and CLK = '1' THEN
      VE0 <= D0;
   END IF;
   Q0 <= VE0;
END PROCESS;
-- Processos que implementam as funções combinacionais de controle
-- dos Elementos de memória e de Saídas.
  D0 <=  ( NOT(X0) AND (VE0)) OR ((X0) AND NOT(VE0));
  Z1 <=  ( (X0) AND (VE0));
  Z0 <=  ( (X0) AND NOT(VE0));
END RTL;
```

Pode-se notar que na entidade do modelo apresentado foram definidos os portos de entrada e saída e os sinais de sincronismo (CLK e CLR). O porto denominado Q_0 não é necessário para o perfeito funcionamento do sistema. Este foi inserido para permitir que o projetista observe, através de simulação, os estados pelos quais a máquina está transitando. Cabe salientar que o TAB2VHDL foi desenvolvido para ser empregado no ensino de sistemas digitais. Se a avaliação das transições de estado não forem necessárias, as variáveis de estado podem ser omitidas.

São definidos sinais auxiliares denominados V_{En} cujo objetivo é evitar que se gerem vários *drivers* para um mesmo sinal, o que exigiria o desenvolvimento de uma função de resolução. Esta função define qual será o valor do sinal em caso de conflitos.

É criado um processo para cada um dos *flip-flops* utilizados. Dois tipos de processos foram criados, um para modelar *flip-flop* D, sensível a transição de subida, e o outro para modelar *flip-flop* JK, sensível a transição de subida. Vários outros modelos de *flip-flop* poderiam ser definidos na ferramenta SEQ2VHDL.

Por fim, são definidas as funções de controle dos elementos de memória, D_0, e de saída, Z_1 e Z_2.

Estas funções foram obtidas do arquivo gerado pelo programa TABELA.

Na simulação apresentada na figura 2, verifica-se o perfeito funcionamento do código AMI, cujo modelo foi gerado pelo programa SEQ2VHDL.

Vários códigos de linhas foram projetados, empregando três diferentes ambientes de projeto. Na próxima seção, ao implementar os códigos, compara-se o projeto gerado pelo SEQ2VHDL com outras ferramentas.

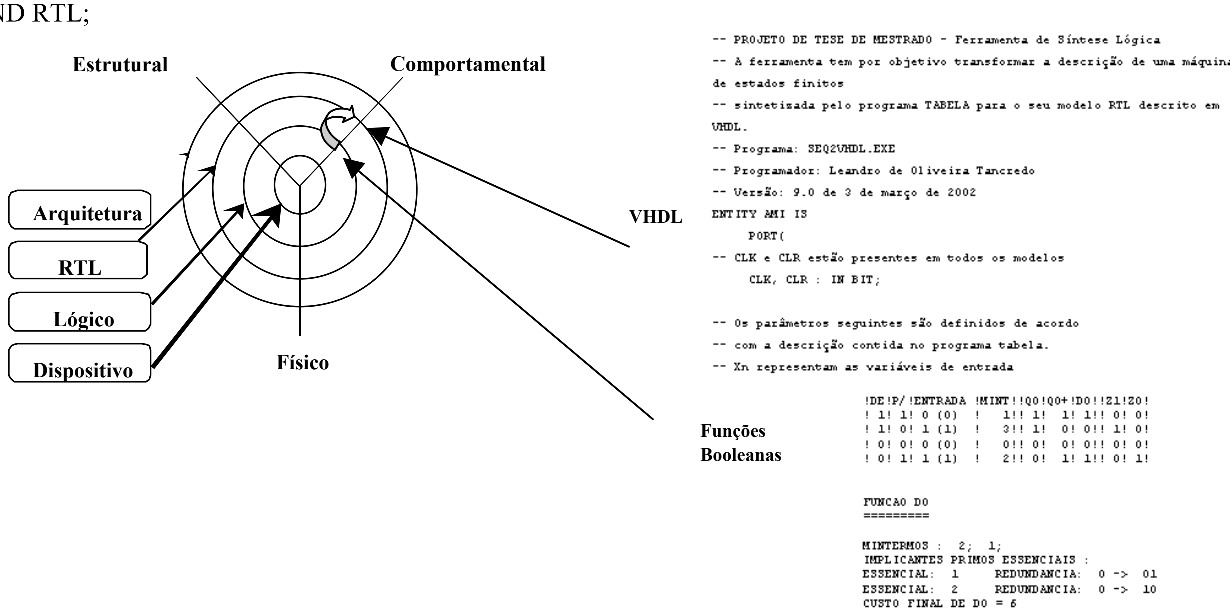

FIGURA. 2
DIAGRAMA Y QUE REPRESENTA A FERRAMENTA SEQ2VHDL.

ESTUDO DE CASOS

Escolheu-se para estudo de casos a implementação de alguns chip-sets de códigos de transmissão digitais, utilizando-se duas ferramentas e o ambiente TABELA + SEQ2VHDL. A maioria desses exemplos são padrões, todavia, com o passar do tempo surgem novos serviços, que obrigam a adaptação do código à nova tecnologia utilizada.

Logo, os projetos devem permitir uma maior flexibilidade de adaptação, sendo que uma solução adequada seria a implementação em *software*. Contrariamente, por estes códigos estarem localizados nas camadas inferiores da OSI/ISO, e, por isso, necessita-se de velocidade nas suas aplicações em tempo real, adotando-se a implementação em *hardware*.

O desenvolvimento de projetos eletrônicos tem impulsionado o setor de telecomunicações nos últimos anos, permitindo, assim, a criação de vários serviços digitais, como exemplo, temos várias tecnologias RDSI, HDSL, ADSL, VDSL e várias outras que estão surgindo no mercado. A utilização de componentes lógicos programáveis, como FPGAs para implementação de hardware, têm proporcionado uma melhoria no desempenho do circuito, ou seja, a redução de custos e uma integração física maior em relação aos projetos convencionais.

Os códigos de linha HDB3, HDB1, 2BQ1, 3B4B, MLT-3, AMI e algumas técnicas alternativas de detecção de sincronismo foram projetados utilizando-se as ferramentas comerciais, aqui denominadas simplesmente de SC e AC, e os resultados foram comparados com os obtidos pelo ambiente TAB2VHDL, conforme Tabela I.

TABELA I

RESULTADO COMPARATIVO DA FERRAMENTA IMPLEMENTADA COM AS COMERCIAIS

	HDB3			HDB1			2BQ1			3B4B		
	SC	AC	TAB	SC	AC	TAB	SC	AC	TAB	SC	AC	TAB
LC	7	15	7	6	4	4	7	5	5	12	7	7
% UTIL	21	46	21	18	12	12	21	15	15	37	21	21
FAN-IN	34	101	39	33	15	17	34	18	10	88	52	32
CUSTO	99	301	50	35	18	11	43	22	9	181	183	44
TEMPO (s)	11	6	3	2	3	6	3	8	3	8	10	2
MEMÓRIA (KB)	4,492	4,162	2,363	3,02	3,095	2,925	3,1	2,366	2,417	2,594	2,757	2,216

	MLT3			AMI			S10010			CCS		
	SC	AC	TAB	SC	AC	TAB	SC	AC	TAB	SC	AC	TAB
LC	6	4	4	3	3	3	8	4	4	8	4	4
% UTIL	18	12	12	9	4	9	25	12	12	25	12	12
FAN-IN	24	13	14	8	6	8	37	19	21	40	19	22
CUSTO	24	13	14	1	1	2	15	24	27	18	28	27
TEMPO (s)	3	2	2	1	4	2	1	0	1	0	4	1
MEMÓRIA (KB)	2,963	3,025	2,912	3,032	3,396	2,324	2,63	3,432	3,136	3,333	2,994	3,438

	KEMN			TRANSU		
	SC	AC	TAB	SC	AC	TAB
LC	14	5	5	9	4	4
% UTIL	43	15	15	28	12	12
FAN-IN	64	29	33	44	17	22
CUSTO	29	80	63	23	21	33
TEMPO (s)	1	6	1	1	6	1
MEMÓRIA (KB)	3,191	3,157	2,941	3,352	2,934	3,065

Pode-se concluir através da análise das tabelas apresentadas que o ambiente TABELA em conjunto com SEQ2VHDL obteve um desempenho notável comparado com as ferramentas avaliadas.

Outro resultado importante, foi obtido ao comparar o custo do código gerado pelo TAB2VHDL ao utilizar como elemento de memória flip-flop JK (TAB JK) ou D (TAB D), observa-se conforme Tabela II que em algumas situações o JK é a melhor solução como no 2BQ1, 3B4B e MLT3, e que em outras o D foi a melhor solução como na AMI, S10010 E CCS.

TABELA II
COMPARAÇÃO UTILIZANDO ELEMENTO DE MEMÓRIA JK E D NO TAB2VHDL

	HDB3		HDB1		2BQ1	
	TAB D	TAB JK	TAB D	TAB JK	TAB D	TAB JK
CUSTO	50	50	11	11	9	6

	3B4B		MLT3		AMI	
	TAB D	TAB JK	TAB D	TAB JK	TAB D	TAB JK
CUSTO	44	43	14	7	2	5

	S10010		CCS	
	TAB D	TAB JK	TAB D	TAB JK
CUSTO	24	29	27	28

CONCLUSÃO

Conclui-se que com o surgimento de novos serviços, que deverão em um curto espaço de tempo, serem projetados e adaptados, impulsionados pelos grandes resultados apresentados pelo desenvolvimento das tecnologias digitais, como exemplo, o HDSL que a partir de um único cabo de par trançado se compartilha 30 canais de voz em um link de 2 Mbps, substituindo um único canal de voz analógico como nas tecnologias passadas. Portanto, a necessidade de novas ferramentas de síntese como o TAB2VHDL, para otimizar *chip-sets* envolvidos nestes tipos de projetos, passa a ter fundamental importância.

Assim, o estudo mostrou que é impossível ter uma única ferramenta que substitua todas as outras, entretanto, se existisse, ficaria muito complicado trabalhar, tendo como causa o alto grau de complexidade que envolveria o projeto.

O projeto de sistemas digitais é uma área de pesquisa em constante evolução. O aumento contínuo da complexidade dos sistemas, cria a necessidade de se rever as técnicas de síntese e otimização já desenvolvidas.

O emprego cada vez maior das FPGAs tem motivado o desenvolvimento de ferramentas de síntese automatizada.

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VIABILIZANDO LABORATÓRIOS DE APOIO A PESQUISA NO PROGRAMA DE MESTRADO EM TELECOMUNICAÇÕES DO INATEL

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Resumo *— O objetivo deste artigo é poder comprovar a eficiência no aprendizado dos alunos de um programa de pós-graduação "stricto sensu" dependendo dos recursos laboratoriais implementados, e as conseqüências diretas na qualidade dos trabalhos de tese apresentados. Restringiu-se a apresentação de somente dois roteiros laboratoriais desenvolvidos pelos alunos relativos a conceitos de fundamental importância dentro da área de sistemas de comunicação. Este trabalho tem proporcionado uma melhor sedimentação por parte dos alunos dos conceitos teóricos apresentados nos cursos do programa. Entre os equipamentos mais importantes usados no laboratório pode-se destacar: modulador de sinais genéricos SMIQ, analisador vetorial de sinais FSIQ, analisador espectral e de redes e osciloscópios digitais de faixa larga. O laboratório conta também com rádios digitais Microstar 7,5GHz , 18 GHz e Aurora 2,4 GHz para ensaios com equipamentos em condições opera-cionais. Essa associação de instrumentos e equipamentos permite realizar testes nas mais diversas condições, possibilitando estudar novas configurações, determinar suas limitações e buscar inovações na área de sistemas de comunicações.*

Palavras Chave — Medidas Experimentais, Modulação de Sinais, Análise Espectral, e Análise de Sinais.

INTRODUÇÃO

Neste artigo serão abordados dois roteiros laboratoriais de extrema utilidade na análise dos sistemas de comunicações digitais. O primeiro deles trata dos diversos tipos de espalhamento espectral, sendo que em cada exemplo citado é apresentado um diagrama em blocos completo do hardware que está sendo estudado. Neste roteiro, o aluno realiza um levantamento do desempenho do sistema DS-SS (*Direct Sequence Spread Spectrum*) [1] perante a interferências propositais de faixa estreita e de faixa larga. O segundo roteiro apresenta um estudo minucioso do modulador complexo em fase e quadratura (IQ), abordando as influências do filtro cosseno elevado, do ruído AWGN (*Additive White Gaussian Noise*) [2], e dos múltiplos percursos [3] no sinal transmitido. Estas análises são realizadas tanto no domínio do tempo quanto no domínio da freqüência, abordando também uma análise do diagrama da constelação recebida e do diagrama de olho.

ESPALHAMENTO ESPECTRAL

A técnica de espalhamento espectral foi desenvolvida primordialmente para permitir comunicações militares com grande robustez a interferências propositais, prática muito comum em tempos de guerra. Porém, as características desta técnica de comunicação acabou por demonstrar uma grande vantagem para o uso comercial, pois permitiu um novo método de múltiplo acesso ao canal de comunicação: o múltiplo acesso por divisão por código (CDMA – *Code Division Multiple Access*) [1].

A literatura aborda a existência de três técnicas de espalhamento espectral, cabendo destacar: Espalhamento Espectral por Seqüência Direta, Espalhamento Espectral por Salto em Freqüência, e Espalhamento Espectral por Salto no Tempo.

Espalhamento Espectral por Seqüência Direta

A técnica de espalhamento espectral por seqüência direta representa um dos principais segmentos no estudo de espalhamento espectral, devido a sua aplicação no padrão de telefonia celular CDMA, padronizada pelo IS-95 [4]. Nesta técnica, os bits de dados são multiplicados por uma seqüência pseudo aleatória (*PN*) de comprimento *N*. A taxa da seqüência *PN* (taxa de *chip*, *Rc*) é muito maior do que a taxa de bit (*Rb*). Desta forma, o espectro do sinal de saída ocupa uma largura de faixa muito maior do que a largura de faixa ocupada pelo sinal original.

Após o canal, o sinal recebido deve ser multiplicado pela seqüência *PN* em fase, para que o sinal possa ser recuperado. Caso as seqüências estejam defasadas, o sinal não é recuperado sendo interpretado como ruído pelo circuito de decisão. A Figura 1 mostra o diagrama em blocos de um sistema *DS-SS* em banda básica. Utilizando os rádios digitais *DS-SS* em conjunto com o Modulador Digital SMIQ [5] é possível levantar o desempenho desta técnica perante interferências intencionais de faixa larga e de faixa estreita.

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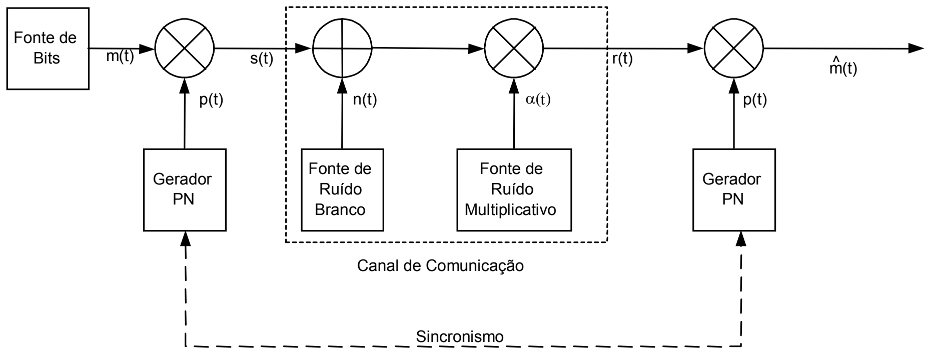

FIGURA 1
DIAGRAMA EM BLOCOS DE UM SISTEMA DE TRANSMISSÃO *DS-SS*

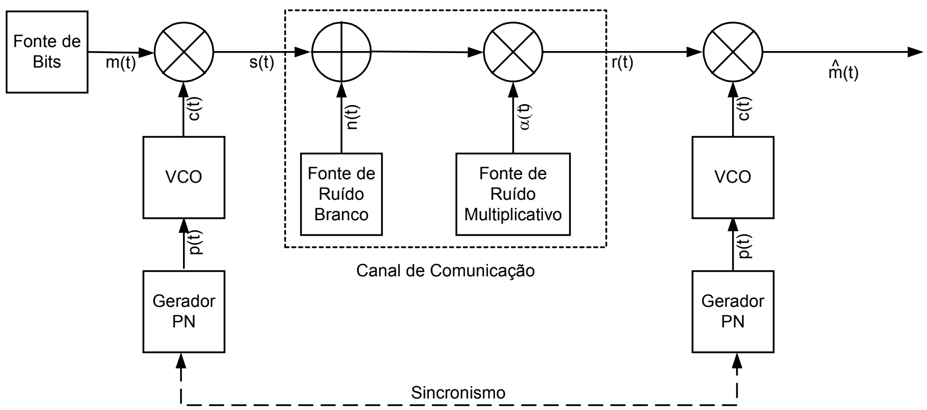

FIGURA 2
DIAGRAMA EM BLOCOS DE UM SISTEMA DE TRANSMISSÃO *FH-SS*

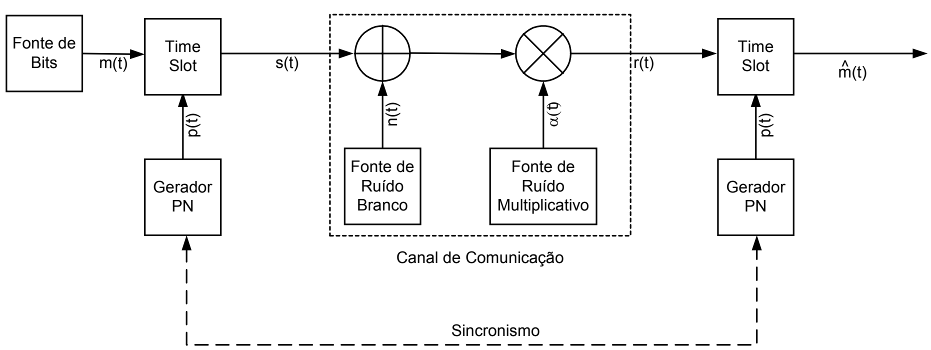

FIGURA 3
DIAGRAMA EM BLOCOS DE UM SISTEMA DE TRANSMISSÃO *TH-SS*

Espalhamento Espectral por Salto em Freqüência

O Espalhamento Espectral por Salto em Freqüência (*FH-SS Frequency Hope Spread Spectrum*) [1] representa outra técnica de espalhamento espectral que vem sendo bastante utilizada para transmissão de sinais digitais em meios perturbados. Neste caso, o Oscilador Controlado por Tensão (*VCO*) tem sua freqüência de operação definida por uma seqüência *PN*, ou seja, a cada instante de tempo, a freqüência utilizada para modular o sinal a ser transmitido é definida por uma seqüência *PN*. A Figura 2 mostra o diagrama básico para a transmissão e recepção de um sinal *FH-SS*.

Espalhamento Espectral por Salto no Tempo

O Espalhamento Espectral por Salto no Tempo (*SS-TH*) [1] é a ultima das técnicas de importância referenciada neste artigo. Neste tipo de sistema, o slot de tempo que o usuário ocupa em cada quadro é definido por uma seqüência *PN*. A Figura3 mostra um diagrama básico para este sistema.

Os sistemas de transmissão que utilizam técnicas de espalhamento espectral possuem um melhor desempenho referente a interferências propositais. Esta melhoria de desempenho é denominada de Ganho de Processamento (*Gp*). Utilizando os recursos do laboratório, os alunos podem co-rroborar os resultados teóricos com as medidas práticas realizadas. O objetivo com este experimento é explorar o sistema *DS-SS*, pois esta é a técnica utilizada por um dos rádios digitais que o laboratório possui. Com este sistema, vários usuários utilizam a mesma faixa espectral ao mesmo tempo. Isso é possível pois cada usuário possui um código de espalhamento único, ou seja, cada usuário utiliza uma seqüência de espalhamento conhecida apenas pelo transmissor e pelo receptor.

Uma das grandes vantagens que pode-se observar é que este tipo de analise das técnicas de espalhamento espectral pode ser adotado utilizando diferentes tipos arquiteturas de rádios digitais, além de verificar o desempenho contra interferências intencionais de faixa estreita e ruído de faixa larga.

MODULAÇÃO DIGITAL COMPLEXA

As técnicas de modulação digital que transportam os bits de informação na fase e/ou na amplitude de uma portadora podem ser representadas através de um diagrama vetorial chamado de Diagrama de Constelação ou simplesmente Constelação [2]. Este diagrama utiliza bases ortogonais para representar os símbolos da modulação em um plano vetorial. A base desse plano é constituída pelas funções seno e cosseno, pois estas funções respeitam o princípio de ortogonalidade, dado por :

$$\int_0^T \mathrm{sen}(\omega_o t)\cdot\cos(\omega_o t)dt = 0 \qquad (1)$$

onde ω_o é a freqüência angular da portadora e T é o período da portadora.

Desta forma, qualquer modulação que utilize variações de fase e de amplitude podem ser representadas neste plano. A Figura 4 mostra a constelação de um sinal *QPSK* (*Quadrature Phase Shift Keying*) [3].

Os vetores que terminam nos vértices do quadrado pontilhado representam os símbolos que compõe a modulação. A circunferência pontilhada possui raio $\sqrt{E_s}$, onde E_s é a energia do símbolo. Fazendo a projeção dos símbolos nos eixos, é possível perceber que cada símbolo da constelação pode ser representado por coordenadas cartesianas. Sendo assim, o sinal modulado pode ser obtido através de dois sinais; um modulando a portadora em fase e outro modulando a portadora defasada de 90° (*sinal em quadratura*). Desta forma, os sinais *I* (*In Phase*) e *Q* (*Quadrature*) definem quais são os símbolos transmitidos ao longo do tempo e representam o sinal modulado em banda-básica. A Figura 5 mostra como obter modulação *QPSK* utilizando a representação vetorial.

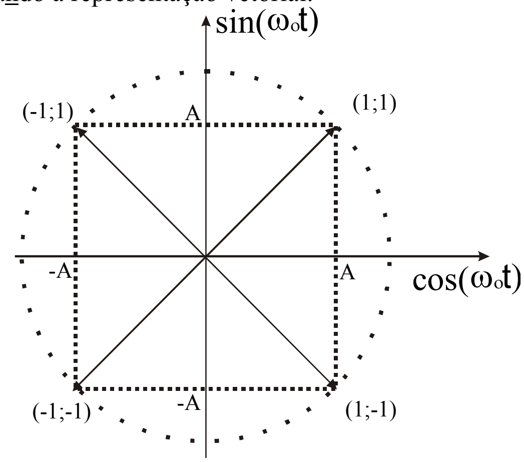

FIGURA 4
CONSTELAÇÃO QPSK

A Figura 5a mostra uma seqüência de bits à ser transmitida enquanto que a Figura 5b mostra os sinais *I* e *Q* obtidos a partir dos bits de entrada. Observando a projeção dos símbolos nos eixos na Figura 4, pode-se concluir que um sinal *QPSK* nada mais é do que a soma vetorial de dois sinais *BPSK*. Por este motivo, os sinais *I* e *Q* são sinais binários que assumem os valores +A ou –A. Como cada símbolo representa dois bits, o período dos sinais *I* e *Q* é duas vezes maior do que o período do sinal de entrada. De uma maneira geral, pode-se definir que o tempo de símbolo de um sistema *M-ário* como:

$$T_s = \log_2(M)\cdot T_b \qquad (2)$$

Onde T_s é o tempo de símbolo, M é a ordem da modulação em fase e quadratura e T_b é o tempo de bit do sinal a ser transmitido.

A Figura 5c mostra um modulador vetorial, onde o sinal *IQ* em banda-básica é translado para a freqüência de canal. O sinal *I* é modulado utilizando a função cosseno e o sinal *Q* é modulado utilizando a função seno. A soma vetorial desses sinais gera o sinal *QPSK*, representado através de uma portadora com quatro fases distintas. O princípio mostrado aqui pode ser extrapolado para gerar sinais *M-PSK* (M – *Phase Shift Keying*) e *M-QAM* (*M – Quadrature Amplitude Modulation*), alterando apenas a lei de formação do sinais *I* e *Q*. Desta forma é possível construir um modulador digital genérico, mudando apenas o mapeador *IQ*. No caso do *SMIQ* o mapeador *IQ* é implementado utilizando *DSP* com um programa que permite selecionar o tipo de modulação desejada.

Esta experiência permite ao aluno explorar os recursos do modulador digital genérico *SMIQ* e do analisador de sinais *FSIQ* [6] para verificar o princípio de funcionamento da

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modulação digital, além de estudar a influência dos filtros e do canal no sinal modulado.

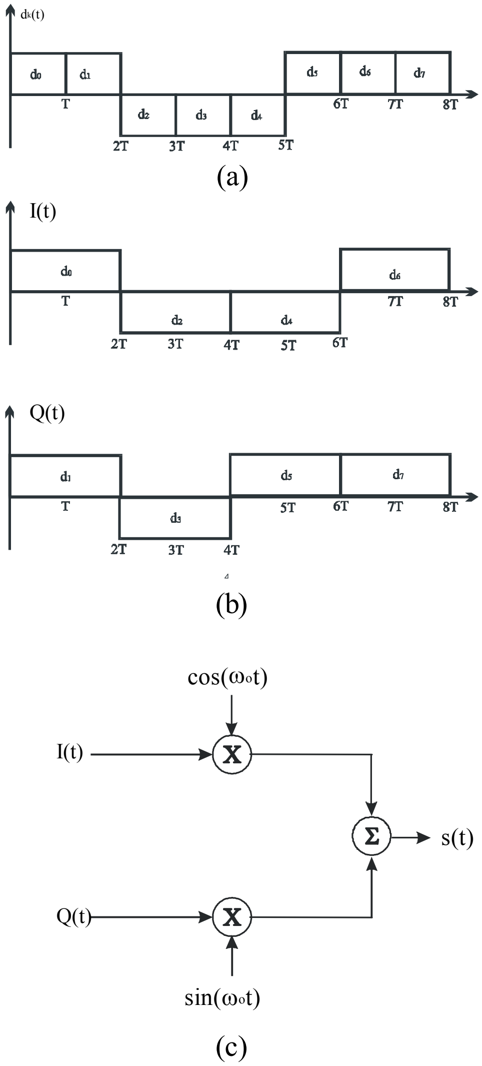

FIGURA 5
MODULAÇÃO EM FASE E QUADRATURA

Canal com Ruído Branco Aditivivo Gaussiano

Uma vez conhecida a lei de formação do sinal modulado, pode-se analisar a influência do ruído *AWGN* (*Aditive White Gaussian Noise*) [2] no sistema de comunicação. O ruído branco ou ruído térmico está sempre presente no canal de comunicação sendo um dos principais responsáveis pela causa de erros de recepção, se o mesmo não for bem analisado e dimensionado. O ruído branco pode ser modelado como uma variável aleatória (*VA.*) de média nula e variância σ^2 com distribuição Gaussiana. A média de uma *VA* representa o nível *DC* presente no sinal, enquanto que a variância representa a potência AC do sinal aleatório. Desta forma é possível determinar a relação sinal ruído através da potência do sinal desejado e da variância do sinal de ruído.

A Figura 6 mostra a constelação de um sistema *QPSK* transmitida através de um canal AWGN com relação sinal-ruído (*SNR*) de 4dB.

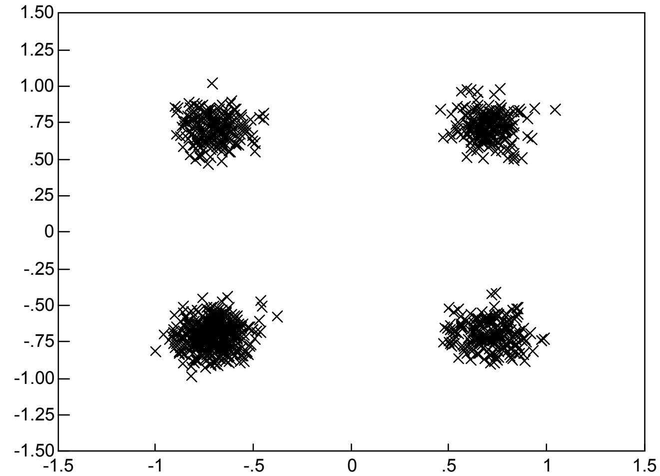

FIGURA 6
CONSTELAÇÃO QPSK

Canal com Desvanecimento Seletivo

Outro fator responsável pela degradação do desempenho dos sistemas digitais é a Interferência Intersimbólica (*ISI*) [3], introduzida por canais com múltiplos percursos. Esta interferência causa, no domínio da freqüência, nulos espectrais, denominado de desvanecimento seletivo. A resposta ao impulso de um canal com múltiplos percursos pode ser expressa por:

$$h(t) = A_0\delta(t) + A_1\delta(t-\tau_1) + ... + A_n\delta(t-\tau_n) \qquad (3)$$

Onde A_n e τ_n são a amplitude e o atraso de cada percurso, respectivamente.

Para um canal com apenas dois percursos, pode-se escrever a resposta impulsiva como:

$$h(t) = A_0\delta(t) + A_1\delta(t-\tau_1) \qquad (4)$$

A Resposta em Freqüência deste canal é obtida através da Transformada de Fourier de (4), conforme apresentado em (4).

$$H(j2\pi f) = \Im\{h(t)\} = A_0 + A_1 e^{j2\pi f\tau_1} \qquad (5)$$

A Figura 7 mostra a Resposta de Amplitude e Fase do canal modelado a partir de (4) e (5), com $A_0 = A_1 = 1$ e com τ_1=1s.

Pode-se perceber que a distâncias entre os nulos espectrais ocorrem a cada 1*Hz*, que representa o inverso do atraso sofrido pelo segundo canal. Deste modo pode-se definir a largura de faixa do canal, BW_{canal}, como sendo:

$$BW_{canal} = \frac{1}{\tau_1} \qquad (6)$$

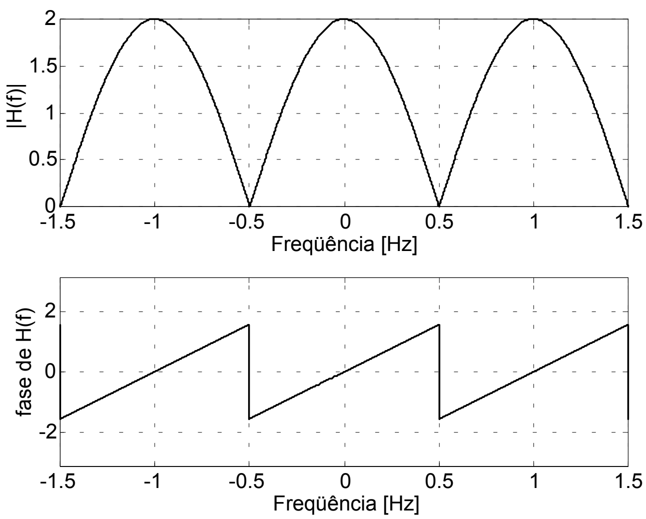

FIGURA 7
RESPOSTA EM FREQÜÊNCIA E EM FASE DO CANAL COM DESVANECIMENTO

A banda de coerência do canal, BW_c, é definida como a largura de faixa do canal no qual o mesmo pode ser considerado plano e pode ser expressada como:

$$BW_c = \frac{1}{5BW_{canal}} = \frac{1}{5BW_c} \qquad (7)$$

Deste modo, caso a largura de faixa do sinal a ser transmitido for menor do que a banda de coerência do canal, pode-se afirmar que o sinal sofre desvanecimento plano, ou seja, não ocorrem nulos espectrais dentro da faixa de interesse.

CONCLUSÕES

A necessidade de atualização e especialização exigida pelos alunos de Mestrado em Telecomunicações demanda a aprendizagem de um vasta gama de informações em um curto intervalo de tempo. Desta forma, se faz necessário utilizar abordagens diferentes técnicas de ensino para que este aprendizado se torne eficiente, como o uso de ferramentas computacionais e de laboratórios para simulações de sistemas de telecomunicações.

Este artigo apresentou duas experiências que facilitam o aprendizado de conceitos envolvidos em transmissão digital. A primeira experiência aborda a técnica de transmissão digital que utiliza espalhamento espectral. Nesta experiência, o aluno levanta o desempenho do sistema de comunicação *DS-SS* em canais que apresentam interferências intencionais de faixa larga ou faixa estreita, medindo o Ganho de Processamento efetivo do sistema. Já na segunda experiência, o aluno realiza um estudo sobre as modulações digitais em fase e quadratura, explorando a estrutura de geração de sinais digitais através de portadoras ortogonais. Realiza-se uma análise da influência do filtro cosseno elevado na modulação *QPSK*, bem como o desempenho do sistema em canais *AWGN* e com desvanecimento. Estas análises são realizadas tanto no domínio do tempo e da freqüência, além de apresentar o diagrama de constelação do sinal recebido.

Com isso, o aluno é capaz de corroborar os resultados apresentados na teoria com os dados obtidos nas medições práticas realizadas em laboratório, o que permite um aprendizado dinâmico e bem fundamentado.

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VERIFICAÇÃO DE CONCEITOS SOBRE AMPLIFICADORES DE RÁDIO FREQUÊNCIA ATRAVÉS DO USO DO GENESYS/HARBEC 2003

Laert Calil Junior[1], Wilton Ney do Amaral Pereira[2], Maurício Silveira[3], Carlos Nazareth Mota Marins[4]

Resumo *- Este artigo mostrará a utilidade do programa GENESYS/HARBEC, desenvolvido pela empresa Eagleware, como facilitador no ensino da engenharia, para a descrição e análise de dispositivos não-lineares e de técnicas de linearização de amplificadores de potência em RF. Desta forma, é apresentado como resultado, o desempenho de um amplificador sem a utilização de técnicas de linearização e o desempenho deste mesmo amplificador utilizando algumas técnicas de linearização. Os objetivos do uso do GENESYS/HARBEC são: modelagem dos sinais no circuito usando um número finito de raias espectrais e verificação da estabilidade do circuito.*

Abstract *– This paper will show the utility of software GENESYS/HARBEC, developed for Eagleware company, to facilitate the education in engineering, to describe the performance analysis of non-linear devices and linearization techniques of RF amplifiers. In this way, it´s shown like as a result, the performance of a amplifier without use of linearization techniques and using some linearization tecniques. The targets to use the GENESYS/HARBEC are: modeling of sinals in the circuit using a finite number of harmonics spectra and checking the stability of circuit.*

INTRODUÇÃO

Em circuitos analógicos, é costume definir sistema linear, como aquele que tendo um espectro na entrada, o coloca na saída com um determinado ganho e algum atraso de fase, sem acrescentar ou retirar nenhuma componente a esse espectro. Na verdade, isso não acontece com nenhum tipo de circuito ativo. Apenas os elementos passivos e circuitos baseados nestes, se podem considerar lineares.

As não-linearidades introduzem componentes indesejáveis no sinal, ou retiram componentes do sinal desejado. Estes fenômenos se resumem na distorção harmônica, compressão do ganho e intermodulação.

Na tentativa de corrigir estas não-linearidades existem quatro técnicas principais de linearização de dispositivos não-lineares: alimentação no sentido direto *("feedforward")*; realimentação negativa *("feedback")*; pré-distorção; técnicas envolvendo processamento digital de sinais. Como o interesse é a análise de dispositivos não-lineares, o programa GENESYS/HARBEC foi utilizado porque é capaz de efetuar a simulação de equilíbrio harmônico destes dispositivos e das técnicas de linearização.

TÉCNICAS DE LINEARIZAÇÃO

Alimentação no sentido direto *("feedforward")*

Esta técnica foi desenvolvida pelo engenheiro eletrônico Harold S. Black. Inicialmente ignorada, ressurgiu quando métodos alternativos de linearização foram necessários para projetar amplificadores com grande retardo temporal, onde considerações de estabilidade excluíram o uso da realimentação negativa.

Nesta técnica, o sinal de entrada é dividido em duas partes por um divisor de potência, conforme indica a Fig. 1, onde o ramo superior dirige-se ao amplificador principal não-linear, geralmente em classe *AB* ou em classe *C*, e o outro ramo, para o elemento de retardo. Uma amostra do sinal distorcido na saída do amplificador principal é separada por meio de um acoplador direcional. Essa amostra é atenuada, e subtraída do sinal da entrada, via elemento de atraso L1. O sinal de erro resultante, idealmente contendo apenas distorção, é reforçado pelo amplificador de erro (em

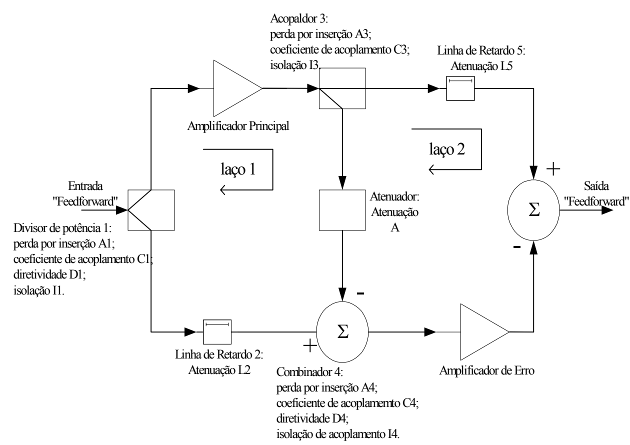

Figura 1 - Linearização por alimentação no sentido direto ("feedforward").

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classe A) antes de ser subtraído do sinal do amplificador principal com atraso devidamente ajustado, cancelando a distorção e entregando um sinal linearizado na saída.

Realimentação Negativa *("feedback")*

O modelo inicial deste tipo de sistema foi introduzido pelo engenheiro eletrônico Harold S. Black. A realimentação negativa permite trocar o ganho do modelo por alguma outra propriedade, como, por exemplo, a redução de distorção ou o aumento da largura de faixa.

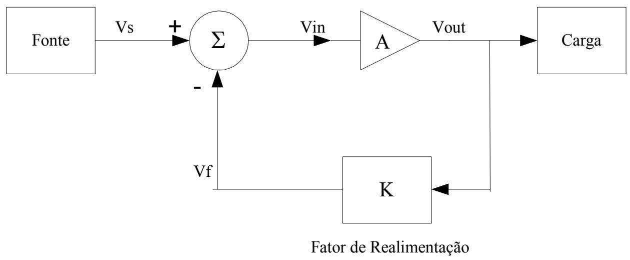

Figura 2 - Diagrama em blocos de um sistema realimentado.

A função de transferência do amplificador com realimentação é determinada por:

$$A_f = \frac{A}{1 + AK} \quad (1)$$

onde:
A: ganho do amplificador em malha aberta;
K: ganho do bloco de realimentação;
A_f : *ganho do sistema realimentado.*

Em geral, $A.K$ >>1, logo:

$$A_f = \frac{1}{K} \quad (2)$$

Nesta condição o ganho de um amplificador realimentado, A_f, é quase independente do ganho de malha aberta *A* e depende apenas da rede de realimentação.

A técnica de linearização por realimentação negativa se divide em quatro categorias: realimentação em RF, realimentação de envoltória, realimentação polar e realimentação cartesiana.

Pré-distorção

Este método cria uma distorção complementar à produzida pelo amplificador a ser linearizado. A saída de um amplificador não-linear pode ser representada pelo polinômio:

$$Vout = G_1 Vin(t) + G_2 Vin^2(t) + G_3 Vin^3(t) + ... + G_n Vin^n(t) \quad (3)$$

onde:
Vin: sinal de entrada;
Vout: sinal de saída;
$G_1, G_2, G_3, ..., G_n$: coeficientes do amplificador.

A distorção *AM-AM* e *AM-PM* introduzida pelo amplificador é função do nível do sinal de entrada e da contribuição dos coeficientes do amplificador. Se estes coeficientes são conhecidos (através de medidas e/ou simulações), a distorção do amplificador pode ser compensada pela introdução de uma característica que adicionada a não-linearidade permite um ganho linear do amplificador. A técnica de pré-distorção está dividida nas seguintes categorias: pré-distorção de RF; pré-distorção de FI; pré-distorção de banda básica.

Técnicas envolvendo processamento digital de sinais

Estas técnicas envolvem formas de processamento digital de sinais para alterar o sinal de entrada original em banda básica ou portadora modulada. Elas se baseiam na síntese da envoltória e fase de um sinal modulado em alta potência, com alta eficiência e usualmente não linear.

Todas as técnicas tem eficiência altas, se aproximando de 100% na maioria dos casos, o que as tornam atrativas e, consequentemente, muitas pesquisas tem sido direcionadas nesta área. Problemas práticos nas suas realizações e complexidade têm resultado em poucas aplicações comerciais até agora. Os principais métodos são: eliminação e restauração de envoltória (*EE&R*); amplificação linear usando componentes não-lineares (*LINC*); modulador universal analógico combinado de malha fechada (*CALLUM*); amplificação linear usando técnicas de amostragem (*LIST*).

SIMULAÇÃO

Introdução

Através do uso do programa GENESYS/HARBEC foi possível efetuar as simulações das seguintes técnicas: realimentação, pré-distorção e alimentação no sentido direto. As técnicas envolvendo processamento digital de sinais foram interpretadas como uma forma de pré-distorção.

Esta plataforma computacional possui um grande número de opções de componentes eletrônicos, passivos ou ativos, para vários tipos de simulações. Neste caso, para simular um amplificador não-linear, foi utilizado um componente que varia a tensão de saída conforme a tensão de entrada.

Para levantamento destes gráficos, foi utilizado um amplificador comercial com as seguintes características: ganho de potência: 20*dB*; ponto de compressão de 1dB: 8dBm; ponto de interceptação de 3*dB*: 18*dBm*. Após análise matemática foi possível determinar os coeficientes do polinômio apresentado como equação 3: $G1$ = 10; $G2$ = -5.83; $G3$ = -181,130656.

Os sinais aplicados no amplificador foram tons de 1,3 e 1,7MHz.

Os valores acima serão parte da função de transferência do dispositivo à ser utilizada na simulação.

Resultados

Utilizando os valores acima, os seguintes resultados foram obtidos para o dispositivo apresentado na Fig. 3, sem a utilização de técnicas de linearização.

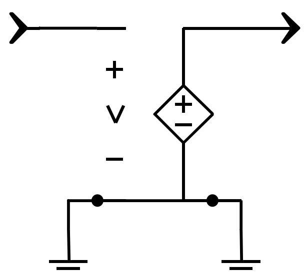

Figura 3 – Componente que simboliza o amplificador sem a utilização de técnicas de linearização.

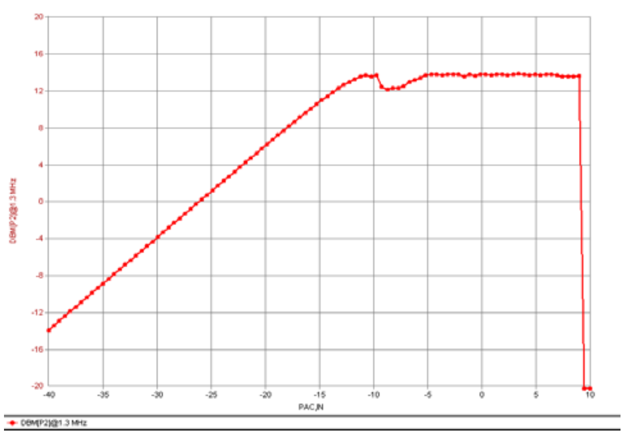

Figura 4 – Característica AM-AM.

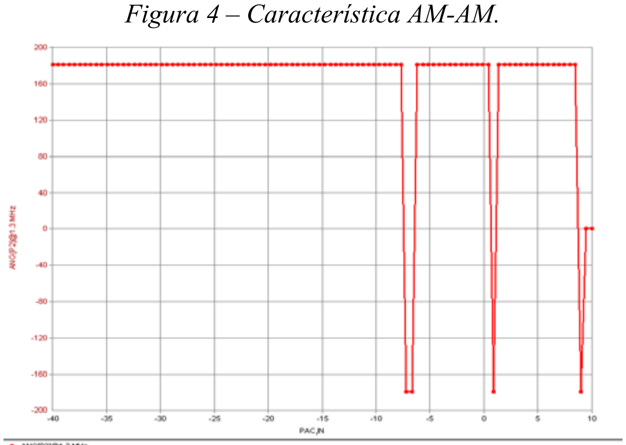

Figura 5 – Característica AM-PM.

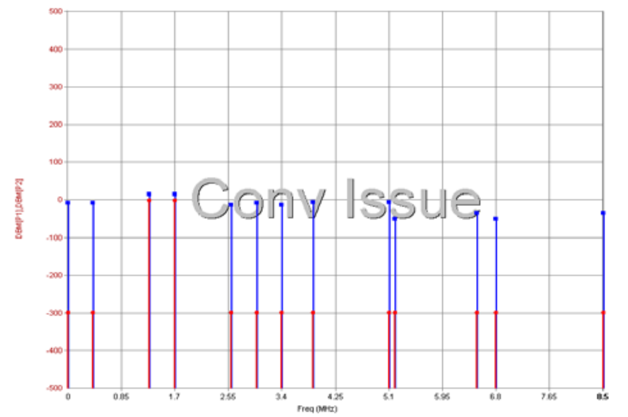

Figura 6 – Distorção de intermodulação.

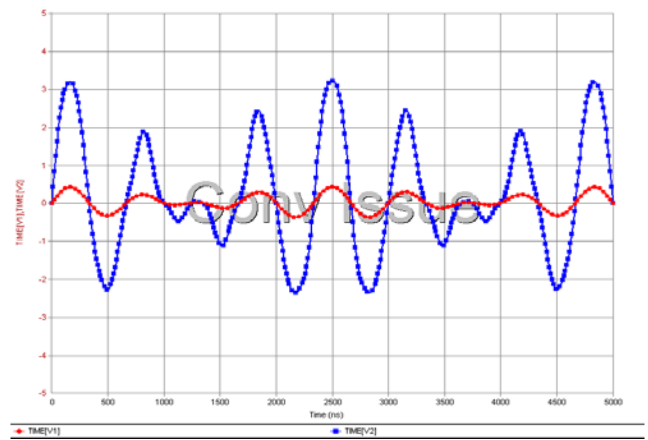

Figura 7 - Sinal de entrada e sinal de saída no domínio do tempo.

A Fig. 8 mostra o amplificador utilizando a técnica de realimentação onde foram obtidos os resultados mostrados nas Figs. 9, 10, 11 e 12 que representam as características *AM-AM*, *AM-PM*, distorção de intermodulação e sinais de tensão de entrada e saída no domínio do tempo, respectivamente:

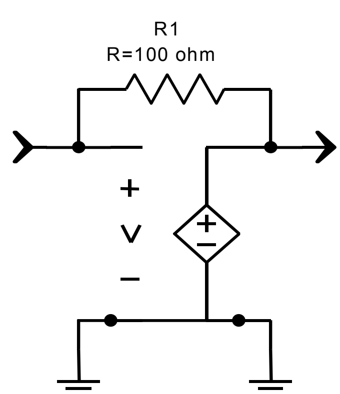

Figura 8 – Amplificador utilizando a técnica de linearização por realimentação.

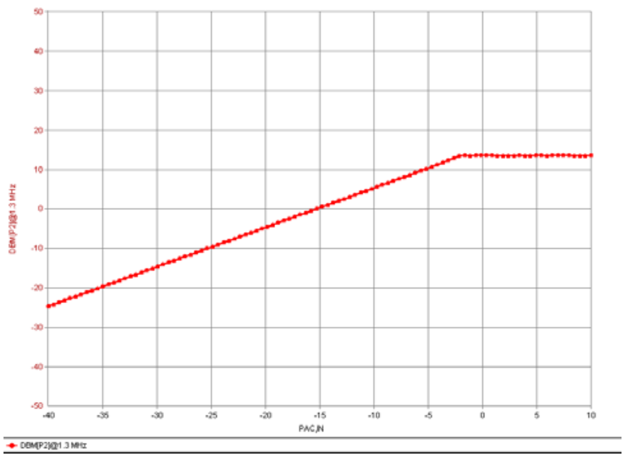

Figura 9 – Característica AM-AM.

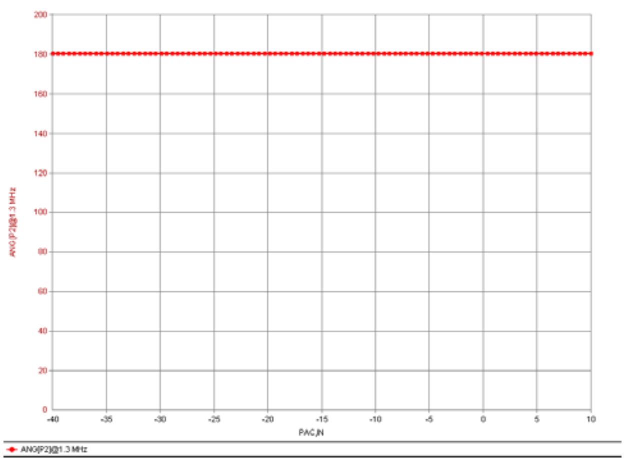

Figura 10 – Característica AM-PM.

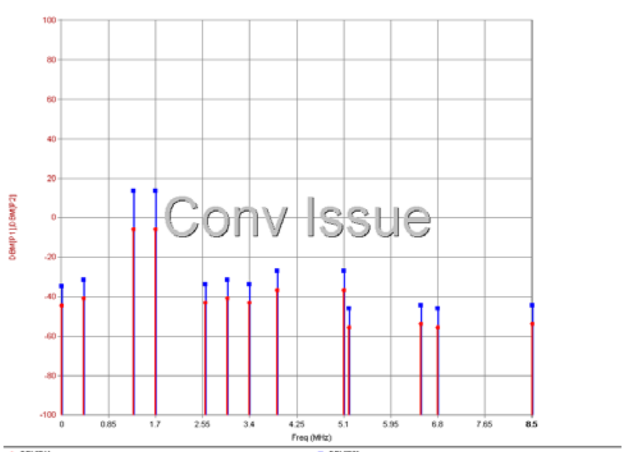

Figura 11 – Distorção de intermodulação.

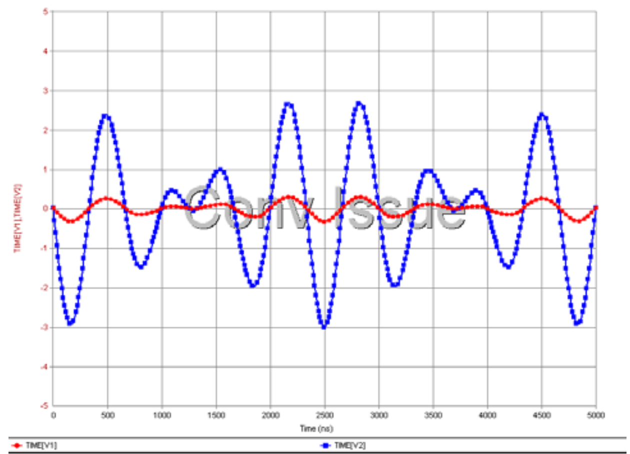

Figura 12 – Sinal de entrada e sinal de saída no domínio do tempo.

A Fig. 13 mostra o amplificador utilizando a técnica de pré distorção a diodo em série onde foram obtidos os seguintes resultados:

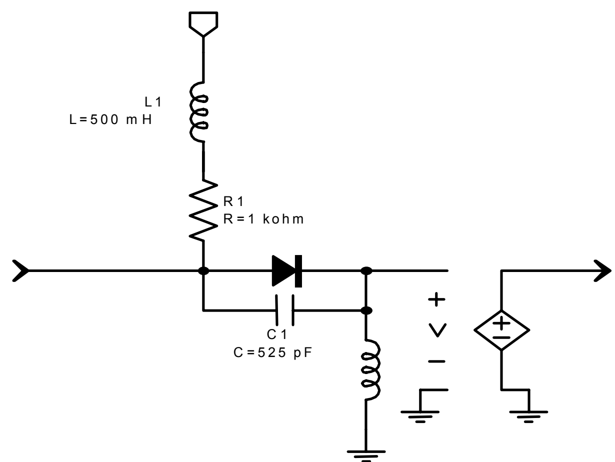

Figura 13 – Amplificador utilizando a técnica de linearização por pré-distorção.

Figura 14 – Característica AM-AM.

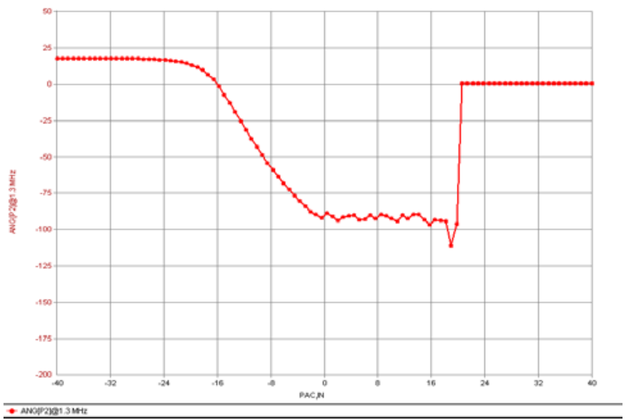

Figura 15 – Característica AM-PM.

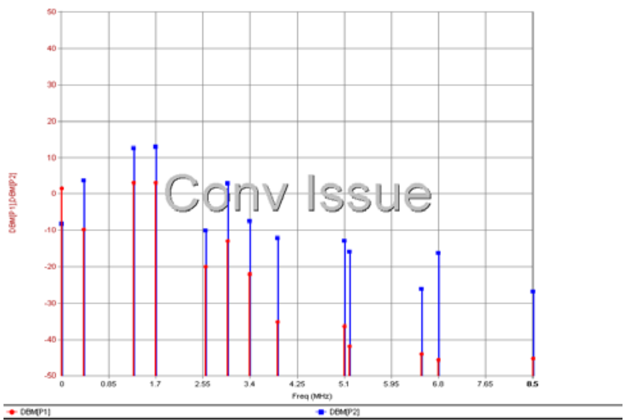

Figura 16 – Distorção de intermodulação.

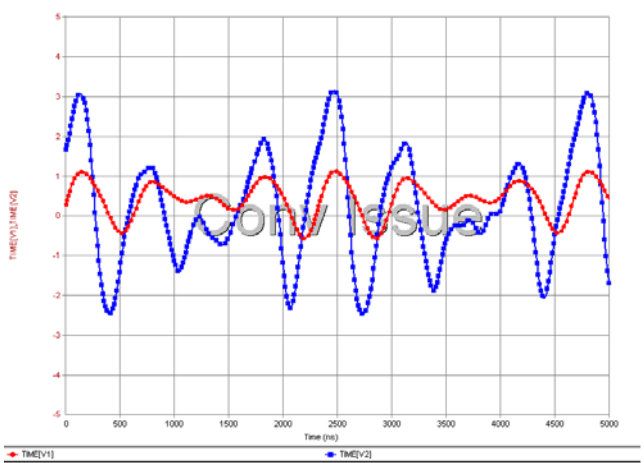

Figura 17 – Sinal de entrada e sinal de saída no domínio do tempo.

A Fig. 18 representa o amplificador utilizando a técnica de linearização por alimentação no sentido direto onde foram obtidos os seguintes resultados:

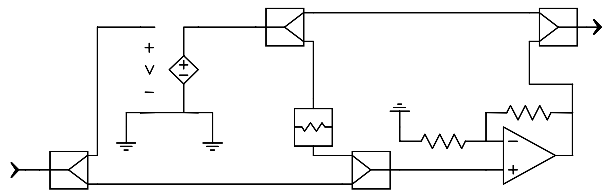

Figura 18 – Amplificador utilizando a técnica de linearização por alimentação no sentido direto.

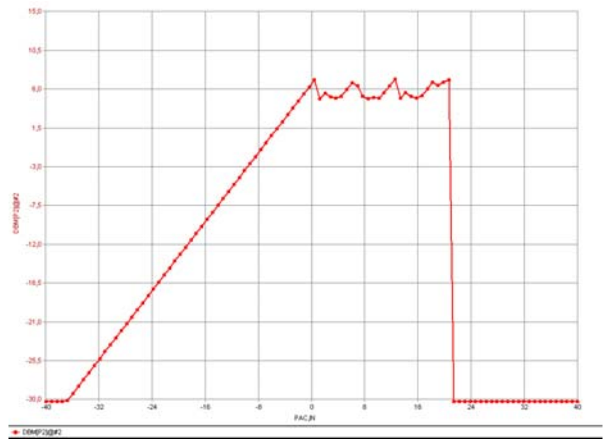

Figura 19 – Característica AM-AM.

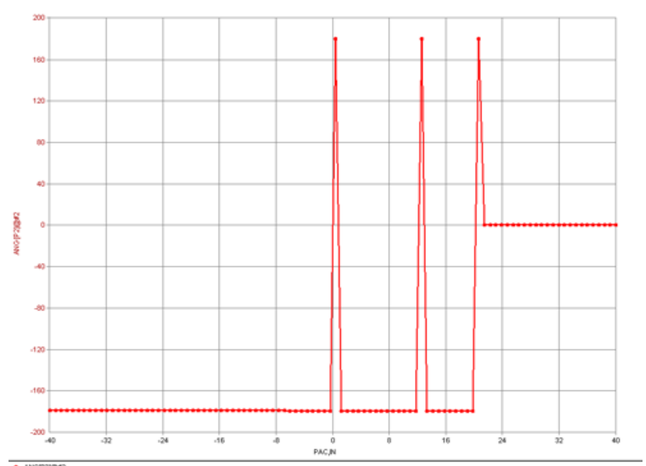

Figura 20 – Característica AM-PM.

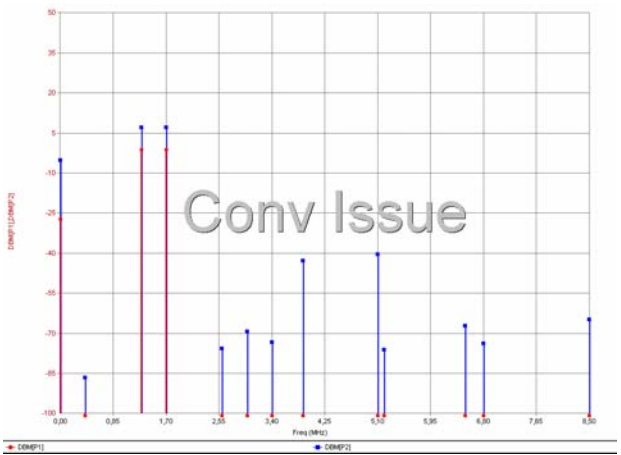

Figura 21 – Distorção de intermodulação.

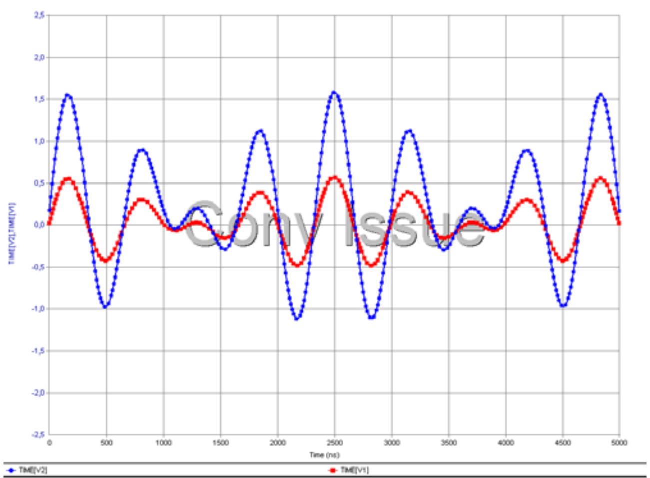

Figura 22 – Sinal de entrada e sinal de saída no domínio do tempo.

CONCLUSÃO

Devido a conceitos de dispositivos não-lineares, efeitos das não-linearidades e técnicas de linearização, foi possível observar que os resultados das simulações não foram totalmente satisfatórios.

Na simulação do amplificador sem a utilização de técnicas de linearização foram utilizados cem pontos para levantamento das características *AM-AM* e *AM-PM*. Foi possível observar deformidades na característica *AM-AM* e descontinuidades na característica *AM-PM*.

Na simulação do amplificador utilizando a técnica de linearização por realimentação as características *AM-AM* e *AM-PM* também foram simuladas com cem pontos. Nesta simulação não foi observada qualquer deformidade.

Na simulação do amplificador utilizando a técnica de linearização por pré-distorção a diodo em série as características *AM-AM* e *AM-PM* também foram simuladas com cem pontos. Nesta simulação foi observado deformidades na característica *AM-PM* e nos sinais de entrada e saída no domínio do tempo.

Na simulação do amplificador utilizando a técnica de linearização por alimentação no sentido direto foi observado deformidades na característica *AM-AM*, descontinuidade na característica *AM-PM.*

A versão do programa GENESYS/HARBEC utilizada nas simulações, não permitiu o total domínio dos resultados, provocando as situações mencionadas acima.

Agradecimentos

À ERICSSON TELECOMUNICAÇÕES S.A. pelo patrocínio ao curso de mestrado em telecomunicações do INATEL, à CAPES e ao FINATEL.

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Fluxo de Carga versus Fluxo de Carga Continuado Parte I: Métodos Analíticos

Dilson A. Alves[1] *e Rogério R. Matarucco* [1]

Resumo — *O método de fluxo de carga convencional é considerado inadequado para se obter o ponto de máximo carregamento* (*PMC*) *de sistemas de potência, devido à singularidade da matriz Jacobiana neste ponto. Os métodos da continuação são ferramentas eficientes para a solução deste tipo de problema, visto que técnicas de parametrização podem ser utilizadas para evitar a singularidade da matriz Jacobiana. Neste trabalho são desenvolvidas as expressões analíticas que serão usadas para convalidar os resultados obtidos pelos métodos modificados de Newton e desacoplado rápido, existentes e propostos, considerando as variações de cargas numa única barra.*

Palavras - Chave — *Fluxo de Carga, métodos da continuação, ponto de máximo carregamento.*

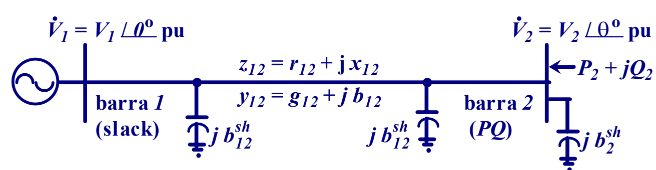
INTRODUÇÃO

A estabilidade de tensão tem se tornado uma questão crítica para a operação dos sistemas de potência. O crescimento contínuo da demanda associado às restrições econômicas e ambientais tem levado o sistema a operar próximo de seus limites. Portanto, o conhecimento preciso de quão distante o atual ponto de operação se encontra de seu limite de estabilidade é crucial para o operador. As análises estáticas de estabilidade de tensão de sistemas de potência podem ser realizadas através da obtenção do perfil de tensão das barras em função de seu carregamento (curvas PV, QV, e SV). Entre outras aplicações, estas curvas são utilizadas para se determinar os limites de transferência entre áreas de uma rede de transmissão, ajustes de margens, e comparação de planos de transmissão. Procedimentos automatizados de Fluxo de Carga (FC), utilizando o método convencional de Newton, foram adotados por muitas concessionárias para executar suas análises. Assim, estas curvas possibilitam a compreensão das condições de operação do sistemas para diferentes carregamentos. O uso dos métodos convencionais de FC para a obtenção das curvas está restrito à sua parte superior (correspondendo a operação estável). Para sistemas com cargas de potência constante, o aumento gradual de carga conduzirá ao PMC. Nestas condições, a matriz Jacobiana das equações do FC tornar-se-á singular. Consequentemente, o método convencional apresentará dificuldades numéricas. Estas ocorrerão mesmo quando do uso de cálculos com dupla-precisão e algoritmos anti-divergentes. Pontos de operação muito próximos ao PMC podem ser calculados utilizando métodos de FC convencional. Contudo, sempre será necessário ponderar se os problemas de não convergência são devidos aos problemas numéricos ou às limitações físicas do sistema. Em geral, as diferenças não são óbvias.

Os objetivos deste trabalho são os de introduzir os conceitos básicos dos métodos de Newton e desacoplado rápido propostos para a solução de fluxo de carga (FC) e demonstrar que, uma vez adequadamente equacionados, qualquer um deles pode ser usado para a obtenção do ponto de máximo carregamento (PMC) de um sistema de potência. Para alcançar tal objetivo, os métodos estão separados por grupos: analítico, de Newton, e desacoplado rápido, sendo os dois últimos apresentados respectivamente, nas partes II [1] e III [2] deste trabalho. Estes métodos, por sua vez, estão subdivididos de acordo com as curvas a serem traçadas: PV, QV, e SV. Ao final de cada grupo demonstra-se que os métodos utilizados no traçado das curvas PV e QV podem ser considerados como casos particulares do usado para o traçado da curva SV. Assim, primeiramente o traçado das curvas e os conceitos serão explicados a partir de equações analíticas obtidas para um sistema simples de duas barras. A seguir, as expressões analíticas são usadas para convalidar os resultados obtidos pelos métodos modificados de Newton e desacoplado rápido, existentes e propostos, considerando as variações de cargas numa única barra. Os métodos utilizados para o traçado das curvas PV, QV, e SV apresentados, podem, conforme será concluído na parte II [1], serem considerados como casos particulares do método da continuação usado para o traçado da curva SV, considerando variações de carga por todo o sistema.

Expressões Analíticas para um Sistema Simples

O objetivo da parte I é introduzir alguns conceitos básicos relacionados ao colapso de tensão utilizando, para isso, apenas expressões analíticas. Considere inicialmente um sistema simples de duas barras, interligadas por uma linha de



$$y_{12} = g_{12} + j\,b_{12} = \frac{r_{12}}{r_{12}^2 + x_{12}^2} + j\frac{-x_{12}}{r_{12}^2 + x_{12}^2} = y_{12}(cos\phi - jsen\phi)$$

onde $\phi = tg^{-1}\,(x_{12}/r_{12})$

FIGURA 1
SISTEMA DE DUAS BARRAS

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transmissão (LT), como mostrado na Figura 1. Posteriormente, quando da apresentação dos métodos de Newton e desacoplado rápido, propriamente ditos, as expressões aqui desenvolvidas poderão ser utilizadas para se convalidar os resultados obtidos para o mesmo sistema. Observa-se que vários trabalhos propostos na literatura foram desenvolvidos a partir de um sistema simples como este [3]-[5].

As injeções de potência ativa (P_2) e reativa (Q_2) na barra *2* do sistema da Figura 1 são dadas por:

$$P_2 = Pg_2 - Pc_2 = G_2V_2^2 - V_2V_1\left(g_{12}\cos\theta_{21} + b_{12}\,sen\theta_{21}\right) \quad (1)$$

$$Q_2 = Qg_2 - Qc_2 = -B_2V_2^2 - V_2V_1\left(g_{12}\,sen\theta_{21} - b_{12}\cos\theta_{21}\right) \quad (2)$$

onde $G_2 = g_{12}$, $B_2 = (b_{12} + b_{12}^{sh} + b_2^{sh})$, $\theta_{21} = \theta_2 - \theta_1$, Pg_2 e Pc_2, Qg_2 e Qc_2, são as potências ativa e reativa geradas e consumidas, respectivamente, especificadas para a barra *2*. Adotando-se a barra *1* como referência angular ($\theta_1 = 0$), (1) e (2) podem ser colocadas nas seguintes formas:

$$P_2 - G_2V_2^2 = -V_2V_1\left(g_{12}\cos\theta_2 + b_{12}\,sen\theta_2\right) = -y_{12}V_2V_1\cos(\theta_2 + \phi) \quad (3)$$

$$Q_2 + B_2V_2^2 = -V_2V_1\left(g_{12}\,sen\theta_2 - b_{12}\cos\theta_2\right) = -y_{12}V_2V_1\,sen(\theta_2 + \phi) \quad (4)$$

Dividindo-se (3) pela (4) obtém-se:

$$\theta_2 = -\phi + tg^{-1}\left[\left(Q_2 + B_2V_2^2\right)/\left(P_2 - G_2V_2^2\right)\right] \quad (5)$$

Elevando ambos os lados de (4) e (5) ao quadrado, e somando-as a seguir, obtém-se:

$$\left(P_2 - G_2V_2^2\right)^2 + \left(Q_2 + B_2V_2^2\right)^2 = V_2^2V_1^2y_{12}^2, \quad (6)$$

de onde se pode obter o módulo da tensão na barra *2* da seguinte equação biquadrática em V_2:

$$\left(G_2^2 + B_2^2\right)V_2^4 - \left(2\left(G_2P_2 - B_2Q_2\right) + y_{12}^2V_1^2\right)V_2^2 + \left(P_2^2 + Q_2^2\right) = 0, \quad (7)$$

a qual apresentará solução real sempre que:

$$\Delta = \left(2\left(G_2P_2 - B_2Q_2\right) + y_{12}^2V_1^2\right)^2 - 4\left(G_2^2 + B_2^2\right)\left(P_2^2 + Q_2^2\right) \geq 0\,. \quad (8)$$

Sempre que os valores especificados para P_2, Q_2 e V_1 forem tais que a condição acima seja obedecida, o módulo da tensão na barra *2* será calculado por:

$$V_2^2 = \left[\left(2\left(G_2P_2 - B_2Q_2\right) + y_{12}^2V_1^2\right) \pm \sqrt{\Delta}\right] \Big/ 2\left(G_2^2 + B_2^2\right), \quad (9)$$

de onde se verifica que podem existir dois valores positivos para V_2. O valor obtido utilizando o sinal positivo em (9) corresponde à solução de alta tensão ou solução estável (V_2^H). Já, o valor obtido utilizando o sinal negativo corresponde à solução de baixa tensão ou solução instável (V_2^L). Para o sistema sem carga ($P_2 = Q_2 = 0$), e $B_2 = b_{12}$ (elementos *shunt* de barra e de linha desprezados), as soluções serão V_1 e zero, respectivamente. À medida que a carga da barra *2* aumentar, o valor de V_2^H diminuirá, enquanto o de V_2^L aumentará. Quando as duas soluções se igualarem (condição em que $\Delta = 0$ em (8)) ter-se-á atingido o PMC, ou ponto de máxima transferência de potência, ou potência crítica (P_{cr}). A tensão correspondente a este ponto é conhecida como tensão crítica (V_{cr}). A Figura 2 ilustra as grandezas P_{cr} e V_{cr} de forma genérica. Em particular, a curva mostra a variação da magnitude de tensão na barra *2* da rede da Figura 1 em função da variação de potência P_2.

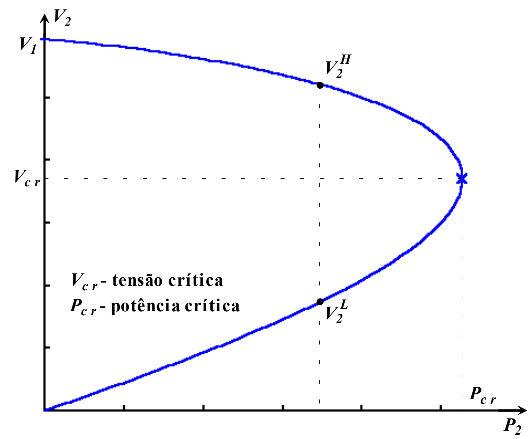

FIGURA 2
VARIAÇÃO DA MAGNITUDE DE TENSÃO V_2 EM FUNÇÃO DE P_2, COM $Q_2 = 0 =$ CONSTANTE, PARA A REDE DA FIGURA 1.

Equações Características da Curva PV

Considere um caso um pouco mais simples, para o qual os elementos *shunts* de linha e de barra são desprezados, ou seja, um caso em que $B_2 = b_{12}$. Obtêm-se os valores críticos para a potência ativa e a tensão (módulo e ângulo), colocando (8) e (9) nas seguintes formas:

$$\Delta = \left(V_1^2/2 + \left(r_{12}P_2 + x_{12}Q_2\right)\right)^2 - z_{12}^2\left(P_2^2 + Q_2^2\right) \geq 0\,, \quad (10)$$

$$V_2^2 = \left(V_1^2/2 + r_{12}P_2 + x_{12}Q_2\right) \pm \sqrt{\Delta}\,. \quad (11)$$

Considerando-se uma potência injetada ativa apenas ($P_2 = Pg_2 - Pc_2$ e $Q_2 = 0$), pode-se obter os valores máximos para as potências gerada (Pg_{2cr}) e consumida (Pc_{2cr}) fazendo o $\Delta = 0$ em (10), obtendo-se a seguinte equação:

$$P_{2cr}^2 - r_{12}/x_{12}^2\,V_1^2\,P_{2cr} - V_1^4/4x_{12}^2 = 0 \quad (12)$$

de onde tem-se:

$$Pg_{2cr} = V_1^2/2\left(z_{12} - r_{12}\right) \quad (13)$$

$$Pc_{2cr} = V_1^2/2\left(z_{12} + r_{12}\right) \quad (14)$$

A substituição de (13) e (14) em (11) fornece as seguintes tensões críticas:

$$Vg_{2cr} = \sqrt{z_{12}V_1^2/2\left(z_{12} - r_{12}\right)} = V_1/2\,sen(\phi/2) \quad (15)$$

$$Vc_{2cr} = \sqrt{z_{12}V_1^2/2\left(z_{12} + r_{12}\right)} = V_1/2\cos(\phi/2) \quad (16)$$

Nestas equações considerou-se apenas o sinal positivo da raiz por se tratar do módulo da tensão. O módulo da impedância da carga (z_c) no ponto crítico, é dada por V_{cr}^2 / P_{cr}. Com isso, fica fácil verificar, utilizando-se as quatro últimas equações, que a máxima transferência de potência ocorrerá quando o módulo da impedância da carga for igual ao módulo da impedância da linha. O ângulo crítico pode ser obtido de (5), colocando-a na seguinte forma:

$$tg(\theta_2 + \phi) = \left[\frac{-x_{12} / z_{12}^2}{P_2 / V_2^2 + r_{12} / z_{12}^2} \right] = \left[\frac{-x_{12}}{r_{12} \mu z_{12}} \right].$$

Como $P_2 = Pg_2 - Pc_2$, o sinal negativo para z_{12} no denominador corresponderá à carga, enquanto que o positivo à geração. O segundo termo da equação acima pode ser colocado ou na forma ($\sqrt{(1-\cos\phi)/(1+\cos\phi)} = tg(\phi/2)$), ou na forma ($-\sqrt{(1+\cos\phi)/(1-\cos\phi)} = cot\,g(-\phi/2)$), e assim os ângulos críticos são dados por:

$$\theta g_{2cr} = 90^{o} - \phi/2 \qquad (17)$$

$$\theta c_{2cr} = -\phi/2 \qquad (18)$$

As Equações (13) e (14) mostram que tanto a potência consumida quanto a gerada numa barra são limitadas, e em geral será possível gerar um pouco mais potência do que consumi-la. Por outro lado, como pode ser observado em (15) e (16), a tensão crítica para injeção de potência será maior do que a de consumo de potência. Uma característica desejada para um sistema é que a tensão crítica se mantenha a um nível, de preferência, o mais baixo quanto possível da tensão normal de operação, sem que isso, consequentemente, venha a prejudicar o perfil geral de tensão [6].

Uma forma de aumentar a máxima transferência de potência, é através da injeção de potência reativa. Para fornecer a compensação *shunt* necessária, pode-se utilizar de banco de capacitores ou compensadores estáticos. O uso de capacitores é atrativo do ponto de vista econômico, especialmente quando o suporte de reativos necessário é muito grande. A utilização de compensadores estáticos tem se tornado menos atrativa com o advento da tecnologia de chaveamento de alta velocidade (0,15 a 0,75 segundos) de bancos de capacitores controlados por tiristores, os quais podem ser operados por meio de relés de subtensão [6]-[7]. Entretanto, na Figura 3 pode-se observar uma característica indesejável do uso de compensação *shunt* por meio de capacitor. À medida que se aumenta a margem de estabilidade do sistema através do aumento da compensação, a tensão crítica se aproximará cada vez mais da faixa de operação normal do sistema (faixa sombreada: $0{,}9 \leq V \leq 1{,}1$p.u.), ou seja, o perfil de tensão tende a tornar-se cada vez mais plano. Consequentemente, o sistema fica mais propenso à ocorrência de colapso de tensão na faixa de operação normal. Dessa forma, em alguns casos, a despeito dos maiores custos iniciais e operacionais, o uso dos compensadores síncronos tem sido preferido ao invés de banco de capacitores *shunts* ou de compensadores estáticos, como por exemplo, no caso da Companhia Elétrica de Tóquio [6]. As razões desta escolha, conforme pode-se constatar na figura, são a de que estes além de não possuírem a característica de queda de potência reativa com o quadrado da tensão, possibilitam um aumento da margem de reativos com menores valores de tensão crítica.

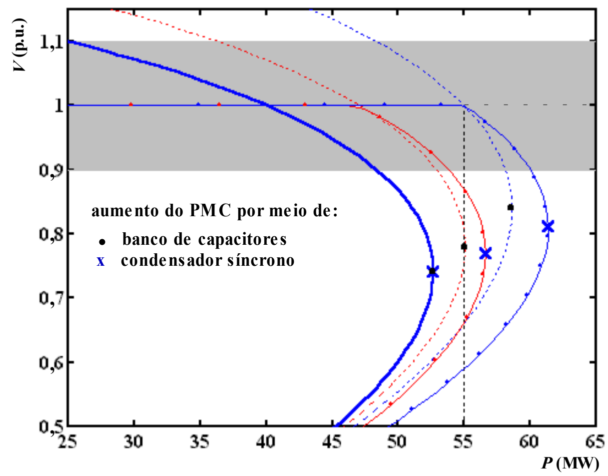

FIGURA 3
EFEITOS DA COMPENSAÇÃO DE REATIVOS SOBRE O PMC E A V_{CR}.

Uma outra observação refere-se ao valor da resistência (r_{12}) da LT. Como pode-se verificar das equações, à medida que r_{12} tender para zero, as máximas potências injetada e consumida tenderão para o mesmo valor $V_1^2/(2x_{12})$ (em módulo) e que é igual à metade da potência de curto-circuito da rede; os ângulos críticos tenderão para $\pm 45^o$, e as tensões tenderão para o mesmo valor $V_1/\sqrt{2}$.

Equações Características das Curvas QV e SV

Equações similares podem ser desenvolvidas para o caso em que $G_2 = g_{12} \neq 0$, $B_2 = b_{12}$ e $P_2 = 0$ (curva QV). Nestas condições as equações de (13) a (16) serão as mesmas bastando trocar r_{12} por x_{12}, observando somente que a última simplificação feita em (15) e (16) não é mais a mesma e sim:

$$Vg_{2cr} = \sqrt{z_{12} V_1^2 / 2(z_{12} - x_{12})} = V_1 / \sqrt{2(1 - sen\,\phi)}, \qquad (19)$$

$$Vc_{2cr} = \sqrt{z_{12} V_1^2 / 2(z_{12} + x_{12})} = V_1 / \sqrt{2(1 + sen\,\phi)}. \qquad (20)$$

Por outro lado, os ângulos críticos são dado por:

$$\theta g_{2cr} = -(90 + \phi)/2, \qquad (21)$$

$$\theta c_{2cr} = (90 - \phi)/2. \qquad (22)$$

Para o caso genérico de potência injetada na barra *2* (curva SV) considerando um ângulo de fator de potência qualquer (φ), a potência aparente crítica gerada (Sg_{2cr}) e consumida (Sc_{2cr}) são, respectivamente:

$$Sg_{2cr} = V_1^2 / 2\, z_{12} \left(1 - cos(\varphi - \phi)\right) \qquad (23)$$

$$Sc_{2cr} = V_1^2 / 2\, z_{12} \left(1 + cos(\varphi - \phi)\right) \qquad (24)$$

para o caso em que $G_2 = g_{12} \neq 0$, $B_2 = b_{12}$. As correspondentes tensões críticas serão dadas por:

$$Vg_{2cr} = \sqrt{V_1^2 / 2\left(1 - cos(\varphi - \phi)\right)} \qquad (25)$$

$$Vc_{2cr} = \sqrt{V_1^2 / 2\left(1 + cos(\varphi - \phi)\right)} \qquad (26)$$

Enquanto que os ângulos críticos são dados por:

$$\theta g_{2cr} = 90 + (\varphi - \phi)/2\,, \qquad (27)$$

$$\theta c_{2cr} = (\varphi - \phi)/2\,. \qquad (28)$$

Observe que estas equações estão na forma geral, e uma vez sendo válidas para qualquer fator de potência, as equações anteriores passam a ser uma particularidade destas.

Traçado das Curvas PV, QV e SV

O traçado da curva PV pode ser realizado através da seguinte equação:

$$P_2 = G_2 V_2^2 \pm \sqrt{V_2^2 V_1^2 y_{12}^2 - \left(Q_2 + B_2 V_2^2\right)^2} \qquad (29)$$

a qual foi obtida de (6). Dados os valores de Q_2 e V_1, para cada valor de V_2 obtém-se diretamente os valores de P_2. Da mesma forma que a equação para a tensão, esta equação mostra que há dois valores para P_2, e que ambos serão iguais quando $V_2^2 V_1^2 y_{12}^2 - \left(Q_2 + B_2 V_2^2\right)^2 = 0$.

Um outro aspecto importante sobre esta equação, quando comparada à (1), é que nesta P_2 é função apenas de V_2, enquanto que naquela é função também de θ_2, e que por sua vez, também variará com V_2. Portanto, dP_2/dV_2 obtida a partir de (29) será nula no ponto de máxima transferência de potência, enquanto que naquela, ou seja, na (1), ter-se-á apenas a derivada parcial de P_2 com relação a V_2, $\partial P_2/\partial V_2$, e que é obtida considerando-se θ_2 constante. Observa-se que $\partial P_2/\partial V_2$ será diferente de zero no ponto crítico, $\left(\partial P_2/\partial V_2\right)|_{V_{2cr},\theta_{2cr}} = V_1\, sen^2(\phi/2) / z_{12}\, cos(\phi/2) \neq 0$. Para o caso particular em que $B_2 = b_{12}$ e $Q_2 = 0$, ao se igualar dP_2/dV_2 a zero chega-se uma equação biquadrática em V_2, de onde se obtém (15) e (16).

O traçado da curva QV pode ser realizado através da seguinte equação:

$$Q_2 = -B_2 V_2^2 \pm \sqrt{V_2^2 V_1^2 y_{12}^2 - \left(P_2 - G_2 V_2^2\right)^2}\,, \qquad (30)$$

a qual também foi obtida de (6). Assim, uma vez conhecidos os valores de P_2 e V_1, pode-se obter diretamente o valor de Q_2 para cada valor atribuído a V_2. Comentários similares aos feitos para a (29) também podem ser feitos para esta equação.

Já a equação a seguir, também obtida a partir de (6), fornece a curva SV para o caso particular em que $G_2 = g_{12} \neq 0$, $B_2 = b_{12}$:

$$|S_2| = y_{12} V_2^2 \left(cos(\varphi - \phi) \pm \sqrt{(V_1/V_2)^2 - sen^2(\varphi - \phi)} \right), \quad (31)$$

para a qual, uma vez conhecidos os valores de V_1 e do ângulo do fator de potência φ, é possível traçar a curva SV variando-se o valor de V_2. Aqui também cabem comentários similares aos feitos com relação à (29). Outro fato importante agora, é que nesta equação se tem o módulo de S_2, devendo-se tomar o cuidado com relação ao sinal da função módulo:

$$|S_2| = S_2, \text{ se } S_2 = Sg_2 \qquad (32)$$

$$\text{e} \quad |S_2| = -S_2, \text{ se } S_2 = Sc_2. \qquad (33)$$

Estas equações possibilitam o traçado das curvas PV, QV e SV, de um sistema simples como o apresentado na Figura 1. Nas partes II [1] e III [2], as curvas PV, QV e SV completas serão primeiramente traçadas utilizando estas equações. A seguir, as curvas e as equações analíticas serão utilizadas para caracterizar as limitações dos métodos de cálculo de Fluxo de Carga existentes, métodos de Newton e desacoplado rápido, e as vantagens dos métodos propostos sobre estes.

Singularidade da Matriz Jacobiana

Conforme foi comentado na introdução, o uso dos métodos convencionais de FC para a obtenção das curvas PV,QV e SV, está restrito à sua parte superior (correspondendo a operação estável, ver Figura 2). Para sistemas com cargas de potência constante, o aumento gradual de carga conduzirá ao PMC. Afirma-se que nestas condições, a matriz Jacobiana das equações do FC tornar-se-á singular, isto é, o determinante da matriz será nulo. Uma conseqüência imediata desta singularidade é que o método de Newton convencional apresentará dificuldades numéricas mesmo quando do uso de cálculos com dupla-precisão e algoritmos anti-divergentes [8] e [9]. Por outro lado, nos métodos desacoplados, as matrizes utilizadas são calculadas, para a condição *flat-start* [2], a partir das respectivas submatrizes das matrizes Jacobianas dos métodos de Newton. Estas matrizes serão mal-condicionadas para o cálculo dos pontos das curvas (os quais, correspondem as soluções do FC) nas vizinhanças do PMC, bem como do próprio ponto. Este mal-condicionamento será responsável pela divergência do processo numérico de resolução do FC. Assim, as equações do FC não mais apresentam solução. Estas equações são essenciais para a análise estática da estabilidade de tensão, já que representam um limite para a região de operação estável. Quando as equações do FC não apresentam solução para uma dada condição de carregamento, conclui-se que a geração e a rede não são fisicamente capazes de suprir esta demanda, exigindo modificações ou no despacho da geração ou na topologia da rede de transmissão, ou em ambas, para que tal demanda possa ser atendida com segurança [10].

Cabe observar entretanto, que a singularidade da matriz J do método de Newton no PMC, é devida à redução do *rank* da matriz J, não significa que neste ponto (PMC) o sistema não tenha solução. Na realidade ela existe, é única, e bem definida. Portanto, para se obter a solução, é necessário acrescentar a informação perdida com a redução do *rank*, ou modificar a matriz de forma a eliminar a singularidade [11]. Para carregamentos maiores que o do PMC, no entanto, as equações de FC não têm solução. Pontos de operação muito próximos ao PMC podem ser calculados utilizando métodos de FC convencional [12]. Contudo, sempre será necessário ponderar se os problemas de não convergência são devidos aos problemas numéricos ou às limitações físicas do sistema. Em geral, as diferenças não são óbvias.

O objetivo agora é o de demonstrar que a matriz Jacobiana é singular (apresenta determinante nulo) no PMC. Para isso, considere as equações linearizadas do FC, que de acordo com o método de Newton-Raphson, são dadas por:

$$\left[\frac{\Delta P}{\Delta Q}\right] = \left[\begin{array}{c|c} H & N \\ \hline M & L \end{array}\right]\left[\frac{\Delta\theta}{\Delta V}\right] = J\left[\frac{\Delta\theta}{\Delta V}\right] \qquad (34)$$

onde J é a matriz Jacobina e H, N, M e L são submatrizes que correspondem às derivadas de potência com relação às tensões e aos seus ângulos. ΔP e ΔQ correspondem aos *mismatches* de potências ativas e reativas, respectivamente, enquanto ΔV e $\Delta\theta$ correspondem às correções das magnitudes e ângulos das tensões. Isto pode ser demonstrado para as condições estabelecidas pelas equações analíticas de (13) a (18). Para o caso do exemplo da Figura 1, J será dada por:

$$\left[\begin{array}{c|c} \partial P_2/\partial\theta_2 & \partial P_2/\partial V_2 \\ \hline \partial Q_2/\partial\theta_2 & \partial Q_2/\partial V_2 \end{array}\right], \qquad (35)$$

cujo determinante, após obter-se as derivadas parciais de (3) e (4), e substituí-las em (2), é dado por:

$$det|J| = [-y_{12}V_1V_2\,sen(\theta_2+\phi)][y_{12}V_1\,sen(\theta_2+\phi)+2b_{12}V_2] - [y_{12}V_1V_2\,cos(\theta_2+\phi)][y_{12}V_1\,cos(\theta_2+\phi)-2g_{12}V_2],$$

a qual pode ser simplificada para a forma:

$$det|J| = 2y_{12}^2V_1V_2(V_2\cos\theta_2 - V_1/2), \qquad (36)$$

Agora, utilizando-se as equações, (15) e (17) no caso de geração de potência, ou (16) e (18) no caso de consumo, comprova-se que o termo entre parênteses se anula, e, portanto, o $det\,|J|$ também será nulo no PMC. Na parte II [1] será demonstrado como se eliminar a singularidade da matriz J e possibilitar o cálculo do PMC sem qualquer problema numérico.

CONCLUSÕES

Neste trabalho foram desenvolvidas, para um sistema de 2 barras, as expressões analíticas que serão usadas para convalidar os resultados obtidos pelos métodos modificados de Newton e desacoplado rápido, existentes e propostos, considerando as variações de cargas numa única barra. Estas expressões possibilitam, para o sistema de duas barras em particular, o traçado completo das curvas PV, QV e SV, bem como a determinação de seus respectivos valores críticos (V_{cr}, θ_{cr} e P_{cr}, Q_{cr} ou S_{cr}). O traçado destas curvas pode ser realizado a partir do conhecimento do valor de V_1 e do valor de Q_2, P_2 ou do ângulo do fator de potência φ, respectivamente, por simples variação da tensão V_2 no terminal da carga.

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Fluxo de Carga versus Fluxo de Carga Continuado Parte II: Métodos de Newton

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Resumo — *O método de fluxo de carga convencional é considerado inadequado para se obter o ponto de máximo carregamento (PMC) de sistemas de potência, devido à singularidade da matriz Jacobiana neste ponto. Os métodos da continuação são ferramentas eficientes para a solução deste tipo de problema, visto que técnicas de parametrização podem ser utilizadas para evitar a singularidade da matriz Jacobiana. Neste trabalho são apresentados e avaliados os métodos de Newton convencional e propostos, considerando as variações de cargas numa única barra.*

Palavras - Chave — Fluxo de Carga, métodos da continuação, ponto de máximo carregamento.

INTRODUÇÃO

Os objetivos deste trabalho são os de introduzir os conceitos básicos dos métodos de Newton propostos para a solução de fluxo de carga (FC) e demonstrar que, uma vez adequadamente equacionados, a nova matriz Jacobiana não mais será singular no PMC. Assim, qualquer um dos métodos propostos poderá ser usado para a obtenção do PMC de um sistema de potência. Os métodos estão subdivididos de acordo com as curvas a serem traçadas: PV, QV, e SV. Ao final demonstra-se que os métodos utilizados no traçado das curvas PV e QV podem ser considerados como casos particulares do usado para o traçado da curva SV. As expressões analíticas apresentadas na parte I [1] são usadas para convalidar os resultados obtidos pelos métodos modificados de Newton, existente e propostos, considerando as variações de cargas numa única barra. Finalmente, conclui-se que todos os métodos aqui apresentados são casos particulares do método da continuação, e que utilizam, no passo preditor, a técnica de previsão trivial conhecida como polinomial modificada de ordem zero, a qual usa a solução atual e um incremento fixo no parâmetro escolhido, como uma estimativa para a próxima solução.

OBTENÇÃO DAS CURVAS QV, PV E SV PELO MÉTODO DE NEWTON [2]-[4]

A seguir apresentam-se os métodos de Newton-Raphson utilizados para o traçado das curvas QV, PV, e SV, para o caso de variação de potência em apenas uma única barra. O entendimento destes métodos aplicados a um sistema simples facilita a análise de casos mais gerais e mais próximos da realidade, nos quais a potência é variada ao longo de todo o sistema.

Curva QV

As curvas QV expressam a relação entre o suporte de reativos (Q_r) numa dada barra e a tensão naquela barra [4]. Trata-se de um método clássico de análise estática da estabilidade de tensão, no qual uma fonte fictícia de potência ativa nula e de potência reativa variável (por esta razão denominada como compensador síncrono, sem limite de reativos), é colocada numa barra especificada (para a qual se deseja obter a máxima potência reativa ou a margem de reativo) e a tensão é variada para obter a curva QV. Nos termos de FC, a barra é simplesmente redefinida como barra tipo *PV*, sendo uma de suas principais vantagens pois é de fácil implementação. Dessa forma, para cada tensão especificada executa-se um programa de FC e obtém-se a potência reativa necessária para se manter o nível preestabelecido de tensão. A redefinição da barra se faz necessária para a eliminação da singularidade da matriz *J*, que como foi visto se torna singular no PMC. Com a especificação da tensão V_k eliminam-se a linha e a coluna *k* da matriz *J* correspondente a $\partial Q_k/\partial V_k$; procedimento similar ao utilizado ao se adotar uma determinada barra como referência angular para eliminar a singularidade de *J*, no FC convencional. Por fazer uso do FC esse método permite levar em conta as não linearidades relacionadas aos limites de geradores e de *tap* de transformadores, bem como a dependência da carga com relação à tensão. Outra vantagem do uso da curva QV é que as características de compensadores *shunts* de potência reativa (capacitores, e compensadores estáticos ou síncronos) podem ser representadas no mesmo gráfico, sendo o ponto de operação a interseção das duas curvas. O procedimento utilizado para se obter a curva QV é o seguinte [5]:

- Execute um FC para a condição de operação desejada (geralmente a condição se refere a uma situação de pós – contingência). Observa-se que a não convergência do FC para o caso base pode ser devida ao déficit de potência reativa. Neste caso o procedimento mais apropriado seria ir para o passo seguinte. O montante de potência reativa fornecido pelo compensador após a convergência corresponderá ao déficit de reativos.
- Após a escolha da barra para a qual se deseja obter a curva, conecte um compensador síncrono com potência ativa nula.
- Varie a tensão especificada para o compensador (usualmente são utilizados passos de 0,01 p.u. ou menos) e resolva o FC. Registre os valores da tensão (*V*) e da potência reativa (*Q*) do compensador.

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- Repita os passos de 3 a 4 até obter um número suficiente de pontos, e, a seguir, plote a curva QV.

Uma outra forma de se obter as curvas QV, seria através da especificação do ângulo (θ_k) da barra k ao invés da tensão (V_k). Às vezes essa opção pode ser útil como se verá posteriormente. Com a especificação do ângulo θ_k eliminam-se a linha e a coluna k da matriz J correspondente à $\partial Q_k/\partial\theta_k$; a barra é redefinida como sendo do tipo $P\theta$ e não mais PV. Para que isso seja possível, o sistema matricial (35) da parte I [1] que corresponde ao sistema da Figura 1, deve ser colocado na seguinte forma:

$$\begin{bmatrix}\Delta Q_2\\ \Delta P_2\end{bmatrix}=\begin{bmatrix}\partial Q_2/\partial\theta_2 & \partial Q_2/\partial V_2\\ \partial P_2/\partial\theta_2 & \partial P_2/\partial V_2\end{bmatrix}\begin{bmatrix}\Delta\theta_2\\ \Delta V_2\end{bmatrix}, \qquad (1)$$

onde, após a eliminação da linha e da coluna correspondente à $\partial Q_2/\partial\theta_2$, para cada valor fixado de θ_2 obtém-se o respectivo valor de Q_2. Neste caso não mais ocorrerão problemas numéricos posto que a matriz Jacobiana de (1) não é singular no ponto crítico, uma vez que nesse ponto $\partial P_2/\partial V_2 \neq 0$, conforme os comentários referentes à (29) parte I [1]. Observa-se que embora o parâmetro seja a variável θ_2, pode-se traçar a curva QV com as tensões (V_2) e potências reativas (Q_2) obtidas para cada valor de θ_2 especificado. Esta curva será exatamente a mesma curva obtida pela especificação de V_2. É bom relembrar aqui que num FC convencional, para uma barra k qualquer, existem a princípio quatro variáveis: P_k, Q_k, V_k e θ_k. Quando a barra é uma barra de carga as potências P_k e Q_k são conhecidas *a priori* e, portanto, são especificadas e tratadas como variáveis independentes, deixando as outras duas como variáveis dependentes. Como no caso se procura a máxima potência reativa $Q_{máx}$ numa barra em que P_k é mantida constante, ou seja, se deseja obter a margem de potência reativa ainda disponível, P_k deverá ser especificada enquanto Q_k deverá ser tratada como variável dependente. Assim restam ainda as duas outras variáveis, V_k e θ_k, a serem definidas como variável dependente ou independente. Em função do número de equações possíveis para cada barra ser igual a *2*, deve-se especificar ainda mais uma variável. Assim, pode-se definir tanto V_k quanto θ_k como variável dependente.

Uma observação com relação às curvas é quanto à terminologia usada, por exemplo, no caso da curva QV que usa Q como variável dependente (eixo das ordenadas) e V como variável independente (eixo das abscissas), e que portanto deveria ser denominada por curva VQ ao invés de QV. Por outro lado, apesar de haver uma convergência na literatura para o uso da terminologia QV, neste trabalho é adotada uma ou outra terminologia conforme a conveniência. No caso do uso de θ como variável independente a curva deveria ser denominada por θQ, entretanto, como se verá mais a frente, o objetivo da mudança de variável (V para θ) é para possibilitar o traçado da curva QV e não θQ. Sendo assim, embora se use θ como variável independente, o que se obtém é a curva QV.

Curva PV

A curva PV é a curva de máxima transferência de potência como função da tensão para um dado fator de potência. A relação entre as curvas PV e QV indica que a curva PV é a linha sobre a qual não existe, por todo o sistema, desequilíbrios de potência reativa. As curvas QV devem ser obtidas para cada nível de carga de interesse para encontrar a margem de MW ou MVAr, ou seja, as curvas QV são calculadas ao longo da curva PV testando a robustez do sistema para vários níveis de carregamento. Além disso, as curvas PV são úteis para análises conceituais de estabilidade de tensão e para estudo de sistemas radiais, sendo usadas também, para sistemas malhados onde P representa a carga total do sistema ou a potência de intercâmbio. O benefício desta metodologia de análise é que esta provê uma indicação da proximidade do colapso ao longo de toda uma faixa de variação de carga, para a rede em análise.

Uma das formas de se obter a curva PV é através do uso de um FC convencional, o qual será executado para cada P especificado. Entretanto, como foi visto, este procedimento tem por inconveniência o fato de não eliminar a singularidade da matriz J. As curvas PV fornecem a variação (sensibilidade) da tensão da barra (ou de outras variáveis) com relação à carga, a margem de estabilidade de tensão, e a tensão para a qual a instabilidade ocorre. Ao invés de se usar um FC convencional pode-se conseguir uma boa estabilidade numérica com pequenas mudanças, similares às feitas para a obtenção da curva QV. Pode-se especificar tanto o ângulo θ_k quanto a tensão V_k. No primeiro caso elimina-se a linha e a coluna k correspondente à $\partial P_k/\partial\theta_k$ (o que é feito simplesmente colocando-se um número muito grande na diagonal); a barra é redefinida como sendo do tipo $Q\theta$. No segundo caso elimina-se a linha e a coluna k correspondente à $\partial P_k/\partial V_k$; a barra é redefinida como sendo do tipo QV. Para que isso seja possível, o sistema matricial (35) da parte I [1] e que corresponde ao sistema da Figura 1 p. ex., deve ser colocado na seguinte forma:

$$\begin{bmatrix}\Delta Q_2\\ \Delta P_2\end{bmatrix}=\begin{bmatrix}\partial Q_2/\partial\theta_2 & \partial Q_2/\partial V_2\\ \partial P_2/\partial\theta_2 & \partial P_2/\partial V_2\end{bmatrix}\begin{bmatrix}\Delta\theta_2\\ \Delta V_2\end{bmatrix}, \qquad (2)$$

onde, após a eliminação da linha e da coluna correspondente à $\partial P_2/\partial V_2$, para cada valor fixado de V_2 obtém-se o respectivo valor de P_2. Neste caso não mais ocorrerão problemas numéricos posto que a singularidade foi removida, uma vez que no ponto crítico $\partial Q_2/\partial\theta_2 \neq 0$ $\left((\partial Q_2/\partial\theta_2)|_{V_{2cr},\theta_{2cr}} = y_{12}V_1^2 \neq 0\right)$. No que se refere à terminologia adotada para a curva PV, valem os mesmos comentários feitos para as curvas QV.

Exemplos Ilustrativos

Para ilustrar os métodos de traçado das curvas QV e PV apresentados até aqui considere o sistema da Figura 1, apresentada em [1], para o qual foram adotados os seguintes valores $\dot{V}_1 = 1{,}19\underline{/0^o}$ p.u. (barra *slack*), z_{12} = 0,3 + j 1,0 p.u., e $b_{12}^{sh} = b_2^{sh} = 0$. Os objetivos das figuras apresentadas a seguir são o de convalidar os resultados obtidos com o traçado das curvas com as equações desenvolvidas na parte I [1], e o de comparar os desempenhos dos métodos modificados e o convencional.

Fluxo de Carga Convencional

A Figura 1 a seguir apresenta as curvas PV obtidas pelo método convencional considerando apenas variações de potência ativa na barra *2*. A curva foi obtida através de incrementos sucessivos de potência ativa na barra *2*. Os dois casos considerados, aumento de geração e de carga, foram plotados na mesma por conveniência, já que pela convenção utilizada as potências apresentam sinais opostos. Inicialmente os incrementos foram de 5 MW, para cada um dos quais foi resolvido um FC, sendo que o número de iterações gasta em cada um foi de 2 (o limite máximo de iterações adotado foi de 10). Para o primeiro ponto em que o FC divergiu foi feita uma redução de passo de 1/10, retornou-se ao passo anterior e aplicou-se o novo incremento, o qual passou a ser de 0,5 MW. O mesmo procedimento foi usado para o ponto de divergência subseqüente, enquanto que no seguinte o procedimento foi finalizado. Como pode-se ver nos detalhes da Figura 1, o PMC, ponto A ou B, não foi alcançado. Os valores exatos para a máxima potência (95,164 e 5,681 MW) e tensão crítica (0,997 e 0,742 p.u.) podem ser obtidos das respectivas equações da parte I [1], (13) e (14) para Pg_{cr} e Pc_{cr}, e (15) e (16) para Vg_{cr} e Vc_{cr}.

Singularidade da Matriz Jacobiana (*J*)

Conforme já mencionado, o método convencional começa a apresentar problemas numéricos na vizinhança de PMC, pois neste ponto a matriz *J* torna-se singular. As Figuras 2(a) e(b) apresentam os valores do determinante de *J* juntamente com os determinantes de outras matrizes que são apresentadas a seguir. Ambas as figuras foram obtidas especificando-se vários valores para a tensão da barra *2*, ou seja, redefinindo o tipo da barra como *QV* e *PV*, respectivamente. Foram realizadas 2 iterações por ponto da curva, considerando passo de 0,01 p.u. na tensão, observando-se ainda que o FC para a obtenção de um novo ponto da curva é iniciado a partir do FC convergido para o ponto anterior. Os objetivos destas figuras são ilustrar o método de identificação da barra crítica apresentado em [6], e confirmar a singularidade da matriz (*J*) no PMC (ponto A na Figura 2(a), e A' na Figura 2(b)). Nas figuras é mostrado também o determinante da matriz Jacobiana modificada (J_m), utilizando a tensão na barra *2* como parâmetro. Nota-se que J_m não é singular em A e A' quando do uso das modificações anteriormente sugeridas.

A metodologia proposta em [6] é baseada no uso da fórmula de *Schur* para determinantes. Assume-se uma variação incremental de geração ou de carga ΔP_i e ΔQ_i numa barra *i* de um sistema, enquanto que todas as demais injeções nodais de potência permanecem constantes. Nestas condições o sistema linearizado das equações do sistema será:

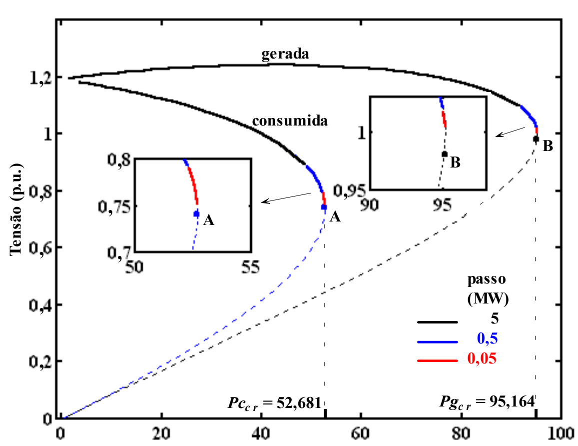

FIGURA 1
CURVAS PV UTILIZANDO FC CONVENCIONAL.

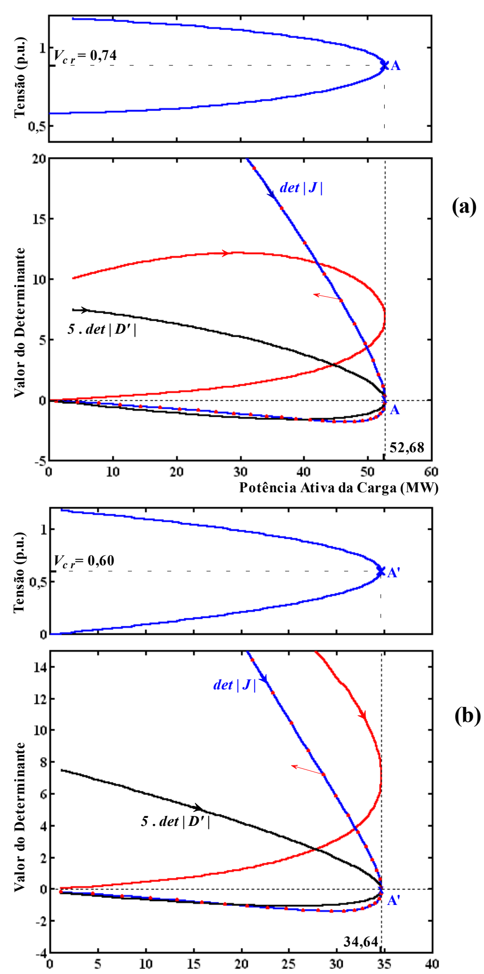

FIGURA 2
SINGULARIDADE DAS MATRIZES.

$$\left[0 \quad 0 \mid \Delta P_i \quad \Delta Q_i\right]^T = \left[\begin{array}{c|c} A & B \\ \hline C & D \end{array}\right]\left[\Delta\theta \quad \Delta V \mid \Delta\theta_i \quad \Delta V_i\right]^T , (3)$$

sendo que as submatrizes $A_{(2nb\text{-}2\text{-}npv)\ \times\ (2nb\text{-}2\text{-}npv)}$, $B_{(2nb\text{-}2\text{-}npv)\ \times\ 2}$, $C_{2\ \times\ (2nb\text{-}2\text{-}npv)}$, e $D_{2\ \times\ 2}$ são partições da matriz *J*, e *nb* e *npv* são respectivamente o número de barras do sistema e de barras *PV*. De acordo com a fórmula de *Schur*: $det| J | = det| A | \times det| D - C A^{-1} B | = det| A | \times det| D' |$. Uma vez que a matriz *A* é não singular, a singularidade da matriz *D'* implica na singularidade da matriz *J*. O sinal e a magnitude de *det*| *D'* | traduzem a sensibilidade do módulo e do ângulo da tensão em relação à variação de carga ativa e reativa na barra em análise. Se o *det*| *D'* | > 0, o sistema encontra-se na região normal de operação, região estável. Se o *det*| *D'* | < 0, o sistema encontra-se na região anormal de operação onde as ações de controle podem ter efeito oposto ao esperado, para o caso de cargas de potência constante. A barra associada ao menor *det*| *D'* | é considerada a barra crítica. Observa-se que a determinação da barra crítica por esta metodologia requer o cálculo de *D'* para todas as barras, o que implica num elevado consumo de tempo no caso de grandes sistemas. A vantagem de se usar o *det*| *D'* | ao invés do *det*| *J* | é que este último, em geral, apresenta valores muito elevados (da ordem de 5 vezes maior no caso de um sistema pequeno como este - comparar os valores de ambos nas figuras), enquanto que o primeiro não. Também, a mudança de sinal do *det*| *J* | ocorre de forma muito brusca, o que praticamente inviabiliza o seu uso nas análises de colapso de tensão. As Figuras 5(a) e 5(b) mostram também *det*| *D'* | e *det*| *A* | × *det*| *D'* |. Estes são nulos no PMC (pontos A e A').

Métodos Modificados

A Figura 3 apresenta o uso dos métodos modificados para a obtenção das mesmas curvas apresentadas na Figura 1, onde agora incluiu-se também, as correspondentes curvas de variação do ângulo da barra *2*. Os passos utilizados para a obtenção dos pontos da curva foram de 5,0 MW para o método convencional, 0,01 p.u. para os modificados parametrizados por tensão, e 2 graus para o parametrizado por ângulo. Os valores de potência máxima e tensão crítica podem ser comparados aos fornecidos quando dos comentários feitos para a Figura 1. Já os valores exatos dos respectivos ângulos críticos θg_{cr} = 53,35º e θc_{cr} = –36,65º, podem ser obtidos de (17) e (18) da parte I [1], respectivamente. Nestas curvas pode-se observar algumas características importantes dos diversos métodos. Como já comentado na Figura 1, o método convencional diverge no ponto C, sendo que para aproximar-se mais do ponto crítico A é necessário realizar uma redução de passo. Entretanto, não é possível, devido à singularidade de *J*, ultrapassar este ponto se a condição inicial anterior se encontrar antes do mesmo. Com uma condição inicial adequada, isto é, um ponto convergido ou um estado inicial escolhido que esteja muito próximo de uma solução de baixa tensão, portanto além do ponto A (PMC), pode-se traçar o restante da curva,

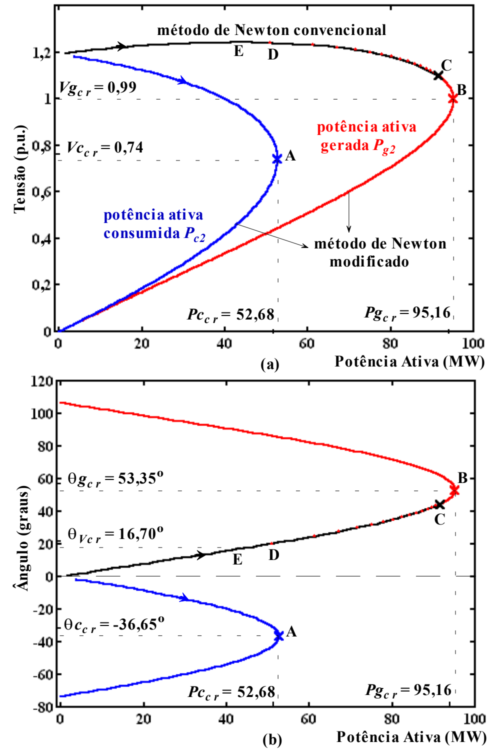

FIGURA 3
MÉTODO DE NEWTON MODIFICADO.

bastando para isso, usar passos negativos, ou seja, diminuir o valor da potência ativa. Caso similar acontece com o método parametrizado por tensão quando do traçado da curva de *Pg*, só que com relação ao seu respectivo ponto de singularidade, ponto E. Neste caso, o valor da tensão crítica, no caso tensão máxima, pode ser obtido de (32) fazendo-se $dP_2/dV_2 = \infty$, o que leva à condição $\sqrt{V_2^2 V_1^2 y_{12}^2 - b_{12}^2 V_2^4} = 0$, de onde se obtém o valor crítico para a tensão $Vg_{2Vcr} = z_{12}V_1/x_{12}$ = 1,243 p.u., o qual após a substituição na equação (26) fornece a respectiva potência crítica $Pg_{2Vcr} = r_{12}V_1 / x_{12}^2 = 42{,}483$ MW. Quanto ao ângulo crítico, pode-se obtê-lo, por exemplo, da condição de que o $det| J_m |$ = 0, ou seja, $\partial Q_2 / \partial\theta_2 = y_{12}V_1V_2 \cos(\theta_2 + \phi) = 0$, de onde se obtém θg_{2Vcr} = 90º – ϕ = 16,70º. Observa-se que partindo do *flat-start* (estimativa inicial onde todos os ângulos são assumidos iguais a zero e as tensões iguais a 1,0 p.u.) e incrementando a tensão de 0,01 em 0,01 p.u., é possível aproximar-se do ponto E, mas não ultrapassá-lo. Se após aproximar-se de E, com sucessivas reduções no valor do incremento do passo, tentar-se diminuir a tensão, retornar-se-á pelo mesmo caminho. A solução seria, por exemplo, ou partir de um ponto convergido que se encontra além deste ponto obtido por um FC convencional, como foi o caso (ponto D), ou ao aproximar-se do ponto, e em função do aumento do número de iterações, mudar de método. Esta última opção é apresentada posteriormente. Observa-se que estas mesmas curvas foram obtidas com (29) da parte I [1].

Quanto ao uso do ângulo como parâmetro, pode-se verificar da condição de que o *det* $|J_m|$ = 0, isto é, $\partial P_2/\partial\theta_2 = -y_{12}V_1V_2\,sen(\theta_2+\phi) = 0$ implica em $\theta g_{2Acr} = -\phi = -73{,}30^o$, e que portanto este não apresenta singularidade na região de interesse. Assim, pode-se traçar inteiramente ambas as curvas sem a necessidade de mudar de método. Isto já era esperado por se tratar de aumento de potência ativa, o qual é conseguido, principalmente, às custas do aumento da abertura angular e, consequentemente, do aumento de θ_2.

Curvas SV

Pode-se também traçar a curva SV, isto é, traçar a curva de crescimento da carga para um dado fator de potência ($fp = \cos\varphi$), o qual é mantido constante. Uma vez conhecido o ângulo do fator de potência, torna-se possível colocar tanto a potência ativa ($P_k = S_k\cos\varphi$) quanto a reativa ($Q_k = S_k\,sen\varphi$) em função da potência aparente S_k e do ângulo φ. Pode-se agora especificar tanto o ângulo θ_k quanto a tensão V_k. No entanto, nestes casos as respectivas linha e coluna *k* não mais seriam eliminadas, mas sim seriam trocadas as suas diferenciais em relação à variável anterior, V_k ou θ_k, e que agora é especificada, pelas diferenciais em relação à nova variável S_k. Outro modo mais interessante no entanto, seria o de considerar um fator de carregamento λ e dois outros fatores pré – especificados, K_p e K_q, os quais possibilitam a generalização do processo para o aumento de carga numa barra *k* especifica. As potências ativas e reativas escritas em função destes novos fatores seriam $P_k = \lambda\times K_p\times S_k\cos\varphi$ e $Q_k = \lambda\times K_q\times S_k\,sen\varphi$, respectivamente. Com isso, qualquer uma das curvas anteriores (PV: com K_q = 0; ou QV: com K_p = 0) inclusive agora a curva SV (incluindo também ângulos de fatores de potência diferentes de φ), pode ser obtida através da especificação ou da tensão (V_k) ou do ângulo (θ_k) da barra *k*. As curvas são obtidas considerando agora a nova variável λ e assim, na nova matriz *J*, denominada por J_m, não são eliminadas as respectivas linha e coluna *k*, mas sim conforme já comentado, substituem-se as respectivas diferenciais com relação a variável escolhida como parâmetro (a tensão V_k ou o ângulo θ_k, variável independente) pelas diferenciais com relação à nova variável λ. Assim sendo, para o sistema de duas barras p. ex., usando a tensão da barra *2* (V_2) ou o ângulo da tensão da barra *2* (θ_2) como parâmetro a equação resulta, respectivamente:

$$\begin{bmatrix}\Delta P_2\\ \Delta Q_2\end{bmatrix} = \begin{bmatrix}\partial P_2/\partial\theta_2 & \partial P_2/\partial\lambda\\ \partial Q_2/\partial\theta_2 & \partial Q_2/\partial\lambda\end{bmatrix}\begin{bmatrix}\Delta\theta_2\\ \Delta\lambda\end{bmatrix} = \begin{bmatrix}\partial P_2/\partial\theta_2 & -K_pS_2\cos\varphi\\ \partial Q_2/\partial\theta_2 & -K_qS_2\,sen\,\varphi\end{bmatrix}\begin{bmatrix}\Delta\theta_2\\ \Delta\lambda\end{bmatrix} \quad (38)$$

e

$$\begin{bmatrix}\Delta P_2\\ \Delta Q_2\end{bmatrix} = \begin{bmatrix}\partial P_2/\partial\lambda & \partial P_2/\partial V_2\\ \partial Q_2/\partial\lambda & \partial Q_2/\partial V_2\end{bmatrix}\begin{bmatrix}\Delta\lambda\\ \Delta V_2\end{bmatrix} = \begin{bmatrix}-K_pS_2\cos\varphi & \partial P_2/\partial V_2\\ -K_qS_2\,sen\,\varphi & \partial Q_2/\partial V_2\end{bmatrix}\begin{bmatrix}\Delta\lambda\\ \Delta V_2\end{bmatrix} \quad (39)$$

Observe que agora as curvas PV (fp=1, isto é, K_p=1 e K_q=0, Figuras 2(a)) e QV (fp=0, isto é, K_p=0 e K_q=1, Figuras 2(b)), as demais curvas passam a ser casos particulares da metodologia empregada para traçar a curva SV. Os valores críticos para potência, tensão e ângulo, podem ser obtidos de (23) a (28), respectivamente, enquanto que o traçado das curvas pode ser obtido de (31), apresentadas na parte I [1].

CONCLUSÕES

Neste trabalho são apresentados e avaliados os métodos de Newton convencional e propostos, considerando as variações de cargas numa única barra. Observa-se que os métodos propostos são casos especiais do método da continuação. A técnica usada para o traçado da curva QV, p. ex., faz uso da técnica de parametrização local com previsão trivial ou polinomial modificada de ordem zero [7]. No caso, $\lambda = Q_k$ (potência reativa da barra *k*), e a tensão do gerador fictício V_k é utilizada como parâmetro. Assim, a solução sucessiva das equações do FC pelo método de Newton com a prefixação de vários valores para o parâmetro em uso (λ, θ_k, ou V_k) são casos particulares dessa técnica de previsão. Dessa forma, todos os casos anteriores podem ser considerados como uma particularidade do método da continuação [4]. Ao incluir-se λ como variável, as equações do FC passam a ter (n+1) variáveis para *n* equações. Assim, pode-se definir qualquer uma das n+1 variáveis como parâmetro. O valor deste parâmetro (θ_k, V_k ou até mesmo λ) pode ser especificado e, portanto, removido do sistema. Assim, passa-se a ter novamente *n* equações a *n* incógnitas. A escolha adequada do parâmetro em função daquele que apresentar a maior taxa de variação durante o traçado da curva costuma ser o suficiente para eliminar a singularidade da matriz Jacobiana. Esta troca de variáveis corresponde à rotação de 90º do diagrama θ_k versus λ, ou V_k versus λ [7].

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ANALISANDO UM CIRCUITO ELETRÔNICO LINEAR EM TEMPO CONTÍNUO E EM TEMPO DISCRETO

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Resumo *— Este artigo consiste na análise do comportamento de um filtro digital FIR, implementado em hardware e simulado em software, associando-o aos conceitos de sinais e sistemas. A simulação foi feita utilizando o software Mathcad 2001 Professional e a implementação em hardware foi feita através do kit da família Motorola DSP56000.*

Abstract – *This paper treats the analysis of the behavior of a digital FIR filter, implemented in hardware and simulated in software, associating it to the signals and systems concepts. The simulation was implemented using Mathcad 2001 Professional software and the hardware was implemented using the Motorola DSP56000 family kit.*

Index terms — Kit DSP, Causalidade, Motorola DSP56000, Sinais e Sistemas.

INTRODUÇÃO

O circuito a ser implementado em hardware e simulado em software é um filtro digital passa-faixa tipo FIR (Finite Impulse Response), excitado por um sinal digital obtido através da amostragem, na frequência fs = 9600 (Hz), de um outro sinal composto por três senoides contínuas, cada uma com sua frequência particular, assim estipuladas: f1 = 223 (Hz), f2 = 1031 (Hz) e f3 = 3419 (Hz). As Figuras 1 e 2 a seguir ilustram o diagrama simplificado do projeto e a resposta desejada para o filtro passa-faixa, respectivamente.

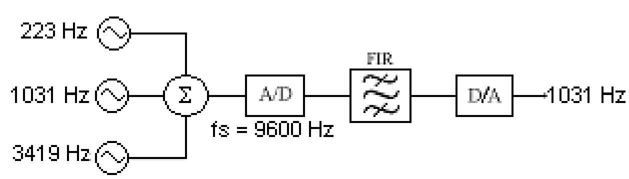

FIGURA. 1
DIAGRAMA EM BLOCOS DO PROJETO

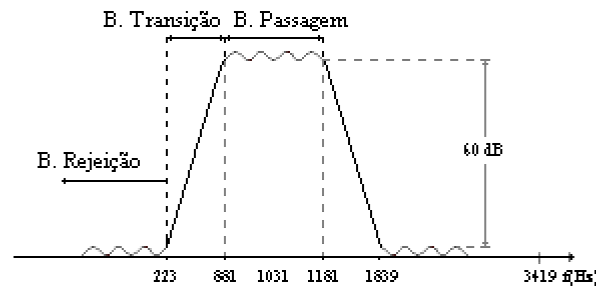

FIGURA. 2
ESPECIFICAÇÕES DO FILTRO PASSA-FAIXA DIGITAL FIR

Utilizando os conceitos de Sinais e Sistemas e contando com um software de apoio em cálculo numérico, podemos facilmente projetar e simular o circuito acima, facilitando a análise de seu comportamento. Para tal, utilizamos o software Mathcad 2001 Professional®. Nele geramos os sinais de entrada do filtro, definimos a sua função de transferência e obtivemos os resultados de saída. Todos os resultados puderam ser numérica e graficamente analisados, como veremos adiante.

No caso da implementação em hardware, geramos e somamos as três senoides através do software VisSim® e exportamos o sinal resultante para um arquivo tipo WAV, que pode ser executado e enviado para a saída da placa de som do computador. A digitalização do sinal, a filtragem e a conversão de digital para analógico novamente pôde ser obtida com um único circuito, conhecido como Kit DSP; no nosso caso, utilizamos um produzido pela Motorola.

CONCEITUAÇÃO BÁSICA

As razões básicas devido às quais não se pode implementar um filtro ideal, por exemplo passa-baixas, são os fatos de a resposta ao impulso desse filtro não atender ao princípio da causalidade e não ter comprimento finito ao longo do eixo do tempo. Para contornar o problema do comprimento infinito da resposta ao impulso somos compelidos a

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implementar um truncamento em determinado ponto dessa resposta, a prejuízo de uma oscilação, tanto na banda de rejeição, como na banda de passagem da resposta em frequência do filtro. No caso de contornar o problema com o princípio da causalidade, faz-se necessário implementar um atraso na resposta impulsiva temporal, deslocando-a de modo que a extremidade negativa coincida com o ponto de zero do eixo do tempo. Este atraso, causa, forçosamente, uma defasagem linear ao longo do eixo de frequência da resposta do filtro [1].

A Figura 3 ilustra a resposta impulsiva do filtro, truncada e atrasada, devido a necessidade de aproximação para a resposta ideal de um filtro passa-baixas digital.

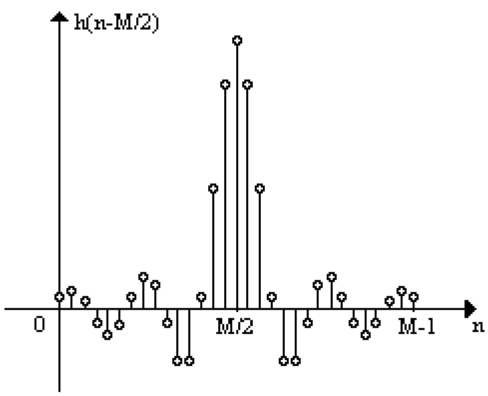

FIGURA. 3
RESPOSTA IMPULSIVA TRUNCADA E ATRASADA DE UM FILTRO DIGITAL PASSA-BAIXAS REAL

A Figura 4 ilustra o que acontece no módulo e na fase da resposta em frequência do filtro passa-baixas digital quando truncamos e deslocamos as amostras da resposta ao impulso no domínio do tempo. Note-se a ondulação nas bandas de passagem e rejeição, bem como a alteração na fase da resposta em frequência.

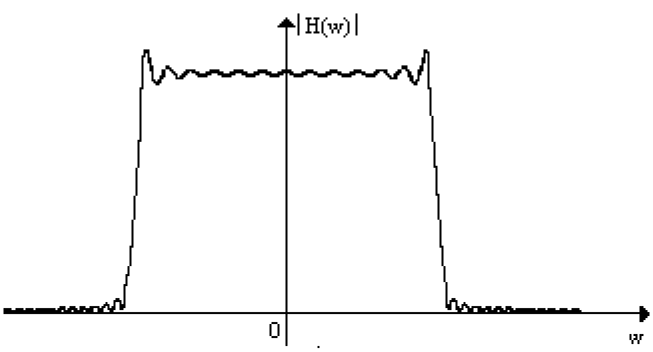

FIGURA. 4
MÓDULO DA RESPOSTA EM FREQUÊNCIA DO FILTRO PASSA-BAIXAS DIGITAL REAL AO TRUNCAR-SE A RESPOSTA TEMPORAL AO IMPULSO

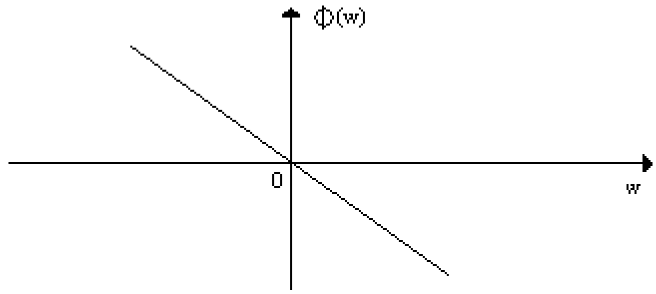

FIGURA. 5
FASE DA RESPOSTA EM FREQUÊNCIA DO FILTRO PASSA-BAIXAS DIGITAL REAL AO DESLOCAR-SE A RESPOSTA TEMPORAL AO IMPULSO

O objeto principal de nosso estudo é o filtro digital FIR e, por isso, não abordaremos as questões complementares desse projeto, como os conversores *A/D e D/A*, o somador, a geração das senoides etc., partindo agora para uma abordagem mais detalhada do filtro em si, começando pelo seu equacionamento, tanto no domínio do tempo quanto no da frequência.

No domínio do tempo, o sinal de saída do filtro linear e invariante no tempo é a convolução da sua resposta ao impulso com o sinal de entrada [2], sendo representada por:

$$y[n] = x[n] * h[n] \tag{1}$$

$$y[n] = \sum_{k=-\infty}^{\infty} h[k]x[n-k] \tag{2}$$

$$y[n] = \sum_{k=-\infty}^{\infty} h_k x[n-k] \tag{3}$$

onde $y[n]$ é o sinal de saída, $x[n]$ é o sinal de entrada e $h[n]$ é a resposta ao impulso do filtro.

No domínio da frequência, o sinal de saída do filtro linear e invariante no tempo é a multiplicação da função de transferência do filtro pelo seu sinal de entrada, na forma:

$$Y(z) = H(z)X(z) \tag{4}$$

$$H(z) = \sum_{k=-\infty}^{\infty} h[k]z^{-k} = \sum_{k=-\infty}^{\infty} h_k z^{-k} \tag{5}$$

$$Y(z) = \sum_{k=-\infty}^{\infty} h_k z^{-k} X(z) = \sum_{k=-\infty}^{\infty} h_k \left[z^{-k} X(z)\right], \tag{6}$$

onde $Y(z)$ é o sinal de saída, $X(z)$ é o sinal de entrada e $H(z)$ é a função de transferência do filtro.

Note-se que voltando (6) para o domínio do tempo, obtemos (3), que, neste caso é a própria equação de diferenças do filtro.

Expandindo tal equação de diferenças, temos:

$$y[n] = h_0 x[n] + h_1 x[n-1] + h_2 x[n-2] + \ldots, \quad (7)$$

Vimos, porém que a resposta impulsiva é truncada, então, a equação (7) pode ser rescrita por:

$$y[n] = h_0 x[n] + h_1 x[n-1] + \ldots + h_{M-1} x[n-M+1] \quad (8)$$

onde $(M-1)$ é a última amostra da resposta impulsiva $h[n]$, ou h_n. Vemos que essa equação sugere uma implementação direta, conforme ilustra o diagrama em blocos da Figura 6 [1]:

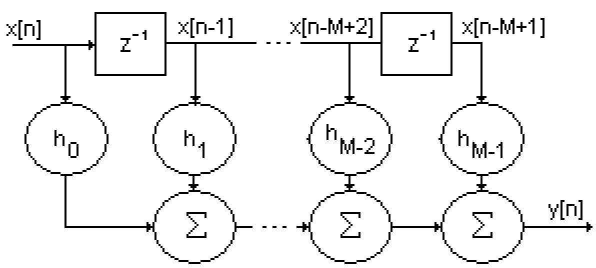

FIGURA. 6
IMPLEMENTAÇÃO DA EQUAÇÃO DE DIFERENÇAS NA FORMA DIRETA

PROJETO

O truncamento da resposta impulsiva temporal do filtro pode ser empregado através de técnicas muito mais elaboradas e vantajosas do que a simples consideração do sinal de resposta dentro de um intervalo de tempo. Tais técnicas são conhecidas como técnicas de janelamento, existindo diversas delas, cada qual, com características próprias, visando uma particularidade no funcionamento e na complexidade do circuito. No nosso caso, aplicaremos a janela de Kaiser, que apresenta a melhor relação entre a atenuação desejada para a banda de rejeição e a ordem do filtro (ou o número de amostras M consideradas na resposta impulsiva do filtro), que determina o tempo de processamento do circuito.

Seja $w[n]$ a função que define a janela de Kaiser [1]:

$$w[n] = \begin{cases} \dfrac{I_0\left[\beta\left(1-[(n-\alpha)/\alpha]^2\right)^{1/2}\right]}{I_0(\beta)} & 0 \le n \le M-1 \\ 0 & n<0,\ n>M-1 \end{cases} ,(9)$$

onde:

$$\beta = \begin{cases} 0{,}1102(A-8{,}7) & A>50 \\ 0{,}5842(A-21)^{0{,}4} + 0{,}07886(A-21) & 21 \le A \le 50 \\ 0 & A<21 \end{cases}, \quad (10)$$

$$\alpha = (M-1)/2, \quad (11)$$

$A =$ Atenuação entre a banda de passagem e a banda de rejeição,

$$M-1 = \frac{A-7{,}95}{2{,}285\Delta w}, \quad (12)$$

$\Delta w =$ largura da banda de transição, ou seja, a banda entre a frequência de rejeição e a frequência de passagem, em radianos.

Neste ponto já obtemos a função de janelamento $w[n]$ que vai ser multiplicada ponto a ponto pela reposta impulsiva de um filtro passa-faixa ideal, atrasada de $(M-1)/2$ amostras, gerando-se assim, a resposta impulsiva janelada e deslocada do filtro real. Com isto obtemos também a resposta em frequência do filtro real, que é uma aproximação da resposta ideal, pagando-se o preço imposto pelo janelamento e pelo truncamento. A seguir, veremos os resultados das simulações em software desse projeto.

SIMULAÇÃO EM SOFTWARE

Os resultados que obtivemos para $w[n]$ estão ilustrados a seguir:

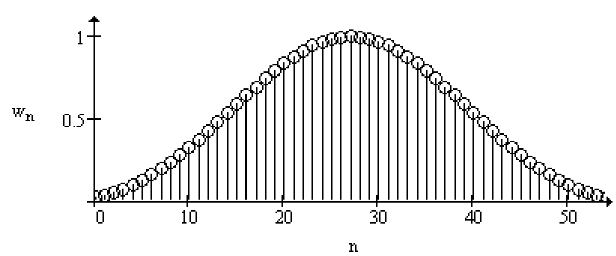

FIGURA. 7
REPRESENTAÇÃO GRÁFICA DA JANELA DE KAISER PARA A=60DB

Entenda-se por h_{d_n} a resposta impulsiva do filtro ideal atrasada, representada na figura 8 por uma linha e h_{pf_n} a resposta impulsiva h_{d_n} multiplicada pela janela de Kaiser $w[n]$, representada também na Figura 8 pelas amostras:

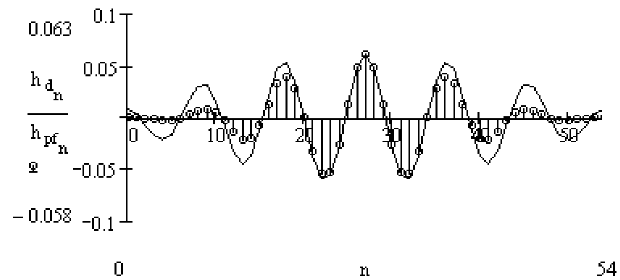

FIGURA. 8
RESPOSTAS IMPULSIVAS ATRASADAS, COM E SEM JANELAMENTO

As figuras 9 a 13 representam a resposta em frequência, o sinal de entrada, no domínio do tempo e da frequência e o sinal de saída, no domínio do tempo e da frequência, respectivamente.

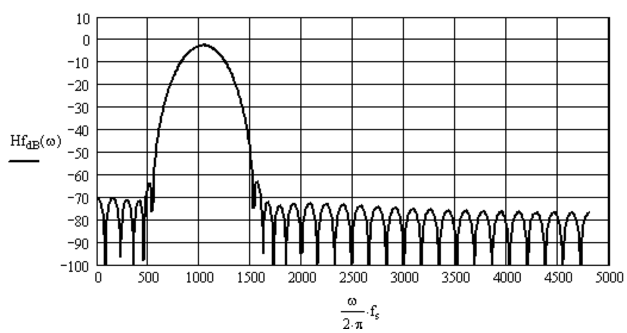

FIGURA. 9
RESPOSTA EM FREQUÊNCIA REAL OBTIDA NA SAÍDA DO FILTRO DIGITAL FIR

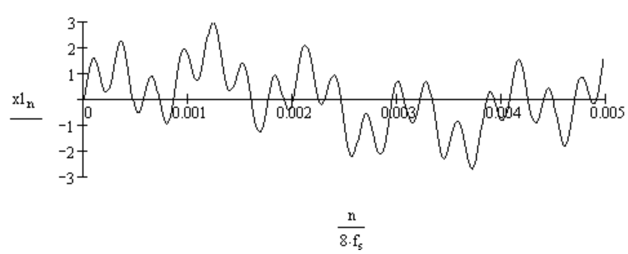

FIGURA. 10
SINAL DE ENTRADA NO DOMÍNIO DO TEMPO

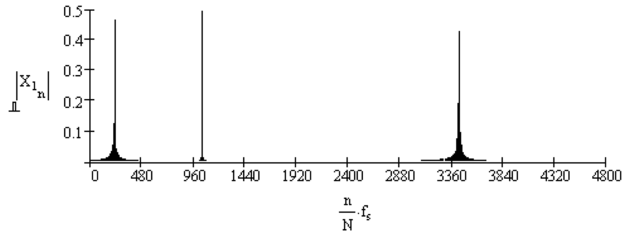

FIGURA. 11
SINAL DE ENTRADA NO DOMÍNIO DA FREQUÊNCIA

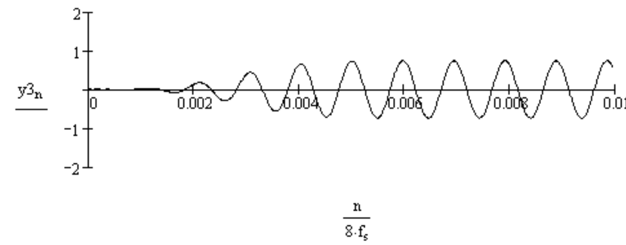

FIGURA. 12
SINAL DE SAÍDA NO DOMÍNIO DO TEMPO

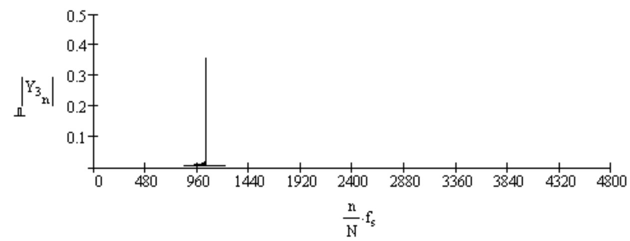

FIGURA. 13
SINAL DE SAÍDA NO DOMÍNIO DA FREQUÊNCIA

IMPLEMENTAÇÃO EM HARDWARE

O diagrama da Figura 6 foi implementado fazendo-se uso de um microprocessador especial para processamento digital de sinais, em forma, basicamente, de instruções *MAC* [3]. A instrução *MAC* (Signed Multiply-Acumulate) executa uma multiplicação entre seus dois primeiros operandos, que são data sources, no nosso caso de 24 bits e adiciona o resultado ao acumulador de destino, no nosso caso de 56 bits. Sendo assim, o processador armazena as *M* amostras mais recentes do sinal (onde *M* é a ordem do filtro) em algum lugar da memória *Y*, por exemplo; armazena todos os coeficientes h_n, em algum lugar da memória *X*, por exemplo e multiplica cada amostra de entrada pelo seu fator h_n correspondente, acumulando-se o resultado dessas multiplicações no acumulador *A*, por exemplo. Ao final, temos uma saída *y[n],* que é a soma acumulada de todas as multiplicações, termo a termo, de h_n pela sua amostra de entrada correspondente, resultando assim no sinal de saída *y[n]* que é o sinal de entrada *x[n]* filtrado.

Nos servimos de um kit completo de DSP, com o propósito de pudermos aproveitar ainda a facilidade de utilizar o conversor *A/D* e *D/A* do próprio kit, a fim de discretizarmos o sinal de entrada *x(t)* e obtermos *x[n]*.

As rotinas de inicialização do processador, de comunicação entre os conversores e o processador etc. são fornecidas juntamente com a documentação do Kit e carecem de pequenos ajustes, como por exemplo: sinal stereo ou mono, frequência de amostragem, etc. [3][4][5][7].

A Figura 14 ilustra o diagrama simplificado de um Kit DSP[4].

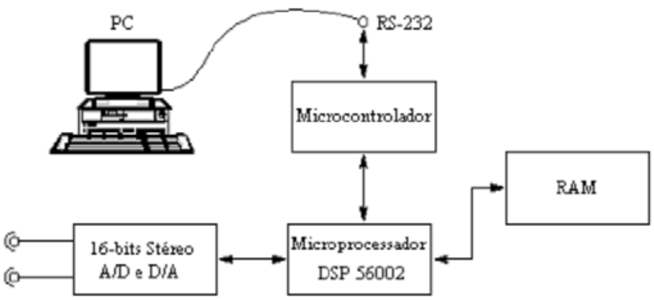

FIGURA. 14
DIAGRAMA SIMPLIFICADO DE UM KIT DSP

As vantagens que encontramos na utilização de um kit DSP, em relação a de um outro hardware convencional são, entre outras, tolerâncias menores (ausência de ajustes) e flexibilidade de implementação de mudanças eventuais no projeto. Uma outra grande vantagem foi a utilização de um conversor *A/D-D/A* já embutido no kit e apropriadamente ajustado ao DSP. Além disso, as rotinas em assembly para comunicação e controle entre o *A/D-D/A* e o DSP são facilmente obtidas na própria documentação do kit. Outra facilidade ainda é o fato de o kit trazer como suporte um programa depurador [5], que facilita o rastreio de problemas nas rotinas e promove a gravação delas do PC para o DSP, via interface RS-232.

Para fins didáticos seria ideal a implementação de uma via paralela analógica, capaz de realizar a mesma função do filtro FIR. Esta parte do projeto foi idealizada mas não pôde ser concluída e será alvo de um estudo futuro.

CONCLUSÕES

O objetivo fundamental deste artigo é apresentar um projeto de um filtro do ponto de vista educacional e poder complementar a necessidade do aluno com alguns fundamentos teóricos ligados à comunicação digital. Entre estes, podemos destacar a Transformada de Fourier de Tempo Discreto, Transformada Z, operações inversas, algumas propriedades tais como convolução, deslocamento no tempo e na frequência, linearidade etc. Houve também a necessidade de um estudo apurado de função de transferência, amostragem e equação de diferenças [6]. Nota-se, então, a grande relação entre estes conceitos abordados em um curso de Sinais e Sistemas e os projetos dos filtros digitais FIR.

A simulação em software facilitou sobremaneira a fixação dos conceitos obtidos pelo aluno em sala de aula, visto que é uma aplicação direta, na forma de cálculo numérico. Além disso, propicia ao aluno uma base sólida para implementação do projeto em hardware e comparação de resultados.

O trabalho com o hardware aproximou de maneira altamente positiva os conceitos da teoria à prática. Avaliamos ser esta uma necessidade preemente em todas as disciplinas de um programa de pós graduação, pois o aluno sempre encontra uma barreira considerável entre a simulação e a implementação.

AGRADECIMENTOS

Nossos agradecimentos sinceros aos professores Fabiano Valias Carvalho e José Panaro e também às instituições FINATEL e ERICSSON pelo apoio.

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ANÁLISE DE COMPONENTES NÃO LINEARES OPERANDO COM MÚLTIPLAS PORTADORAS

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I. Introdução

Os sistemas de comunicação estão sendo cada vez mais exigidos no mundo moderno. E as operações com altas taxas de transmissão devem ser aliadas ao máximo desempenho de energia com a menor deterioração do sinal, no intuito de oferecer confiabilidades cada vez mais elevadas.

Por este motivo, as modulações estão se tornando cada dia mais sofisticadas e o processamento de múltiplas portadoras de forma simultânea nos equipamentos de transmissão e recepção, estão se tornando práticas comuns em sistemas via satélite, sistemas de comunicação móvel, sistemas digitais de TV, entre outros.

Por este motivo, este trabalho abordará a não linearidade de elementos utilizados nas diferentes funções dentro da estrutura de rádio.

Com esta ferramenta pode-se simular o comportamento do elemento sob análise, com diferentes níveis de potência e com diferentes componentes de sinais em diferentes freqüências, ou seja, pode-se simular o dispositivo operando com múltiplas portadoras.

Para o ambiente acadêmico e profissional este trabalho resultará em um software que ajudará aos projetistas de amplificadores, misturadores (mixers) e outros circuitos, conhecerem o nível dos produtos de intermodulação com uma ou mais portadoras e consequentemente seus efeitos no domínio do tempo e da freqüência.

II. Sistemas Lineares

Um Sistema Linear é aquele que responde a um sinal de entrada sempre com a mesma proporção em amplitude e fase, independente mente do nível com que o mesmo é aplicado à sua entrada.

Um sinal composto por múltiplas portadoras, ocupa uma banda ao longo do espectro de freqüências, se este sinal for aplicado a um sistemas linear, o mesmo poderá sofrer distorções, pois sua resposta a cada uma das componentes não necessariamente deve ser igual em amplitude e ou fase.

Um filtro é um Sistema Linear que não responde da mesma forma à todas as componentes do espectro de freqüências, mas sempre responderá a um determinado sinal da mesma forma em amplitude e fase, independentemente do nível assumido pelo mesmo em sua entrada.

O Sistema Linear pode ainda ser definido como, sendo aquele que não introduz outras componentes harmônicas a partir dos sinais originais aplicados à sua entrada.

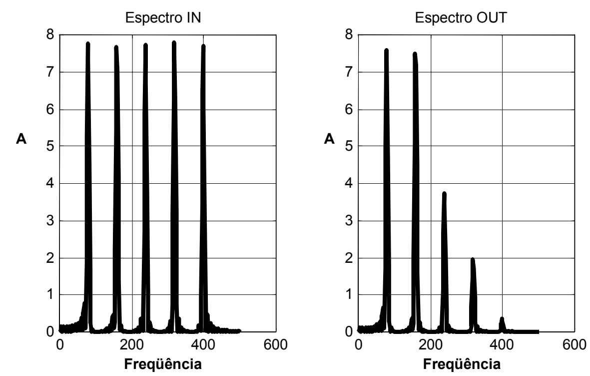

Figura 1 – *Resposta de um Sistema Linear (filtro) no domínio da freqüência.*

Na *Figura 1*, tem-se o comportamento de um filtro que altera as características das componentes de um sinal sem gerar espúrios ou harmônicas.

III. Função de Transferência de um Sistema Linear

Um Sistema Linear, quando excitado por um sinal senoidal de freqüência determinada, oferece na saída um sinal senoidal de mesma freqüência, mas que pode ter amplitude e fase diferentes das do sinal de excitação.

Um Sistema Linear ideal é aquele que permite transmitir qualquer sinal sem imprimir-lhe deformações.

Comparando-se a saída r(t) do sistema com a entrada f(t), podemos admitir uma variação de escala, em amplitude,

$$r(t) = K * f(t) \qquad (01)$$

onde k = constante

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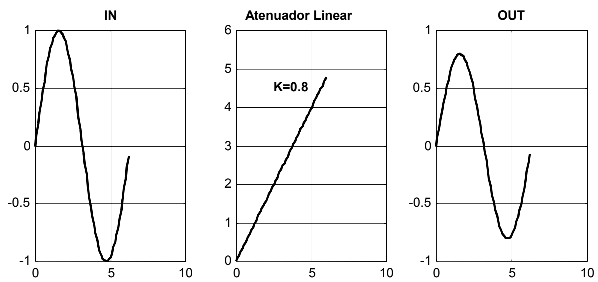


Figura 2 – *Sinais de entrada e saída de um Sistema Linear.*

Define-se a "*função de transferência*" do sistema como a relação entre as transformadas dos sinais de saída e de entrada.

$$G(j\omega) = \frac{R(j\omega)}{F(j\omega)} \qquad (02)$$

Demonstra-se que a função de transferência depende exclusivamente dos componentes de circuito que compõe o sistema, podendo ser calculada diretamente a partir dos mesmo.

A função de transferência fornece as informações de como o sistema atua sobre as componentes de freqüência do sinal de entrada.

A resposta do sistema ao sinal de entrada pode apresentar um retardo t_0, sem que nenhuma alteração ocorra na amplitude ou freqüência da forma de onda, descaracterizando o sinal original.

$$r(t) = K * f(t - t_0) \qquad (03)$$

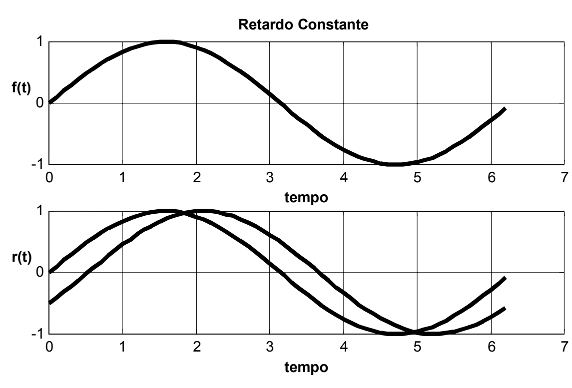


Figura 3 – *Medida do retardo em Sistemas Lineares*

Até este ponto considerou-se a variação da resposta de amplitude ao longo da faixa de resposta do sistema no domínio da freqüência, com retardo constante.

A defasagem introduzida seguia uma lei linear com a freqüência, mas mesmo sendo a resposta em amplitude constante, se a resposta em fase não for linear, isto é, se o retardo para todas as componentes não for constante, haverá igualmente distorção do sinal, caso este seja composto por múltiplas componentes.

A função de transferência G(ω) do sistema, será expressa na forma complexa:

$$G(\omega) = K * \varepsilon^{j\phi(\omega)} \qquad (04)$$

onde a defasagem introduzida pelo sistema sobre as componentes será supostamente linear, isto é:

$$\phi(\omega) = -\omega . t_0 \qquad (05)$$

em que t_0 é o tempo de retardo considerado igual para todas as componentes.

Para o sistema linear, em que $t_0 = 0$, não é introduzido nenhum tipo de retardo no sinal de saída.

A defasagem relativa $\phi(\omega_2)$ - $\phi(\omega_1)$ de uma componente em relação a outra, pode ser medida através da expressão (06). Esta medida é realizada comparando-se as fases na saída para as duas componentes, conhecendo as condições de fase na entrada do sistema.

$$\phi(\omega_2) - \phi(\omega_1) = (-\omega_2 t_0) - (-\omega_1 t_0) = -(\omega_2 - \omega_1) t_0 \qquad (06)$$

$$\frac{\Delta\phi(\omega)}{\Delta\omega} = \frac{\phi(\omega_2) - \phi(\omega_1)}{\omega_2 - \omega_1} = -t_0 \qquad (07)$$

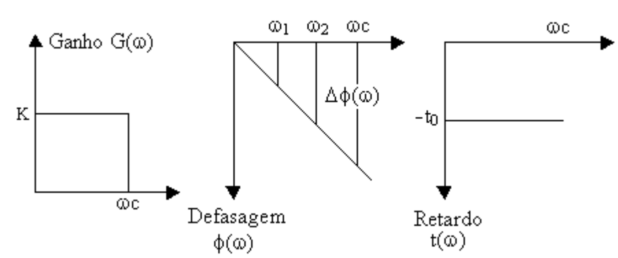


Figura 4 – *Análise de retardo e fase em Sistemas Lineares*

Quando o espectro útil do sinal estiver situado entre os limites da faixa de passagem do sistema, o efeito da atenuação na transmissão é pouco significativo, por isto, na engenharia de sistemas é comum se analisar primeiro a largura de faixa do sinal e então selecionar ou projetar o sistema que contemple no mínimo a faixa desejada.

Usamos a função de transferência *G(s)* do sistema para definir sua resposta ao sinal de entrada, como apresentado na *Figura 5* para os filtros e na *Figura 6* que representa a resposta de um par telefônico.

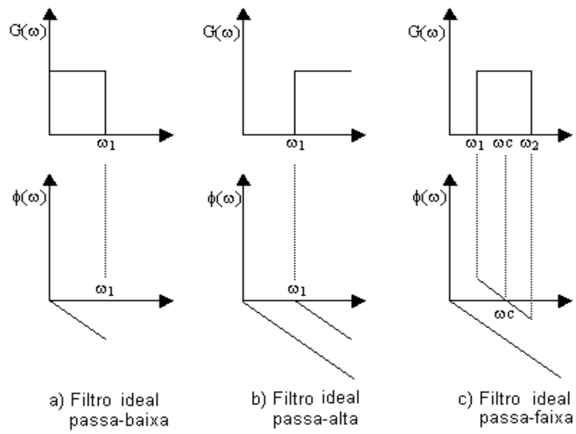


Figura 5 – *Resposta de filtros ideais*

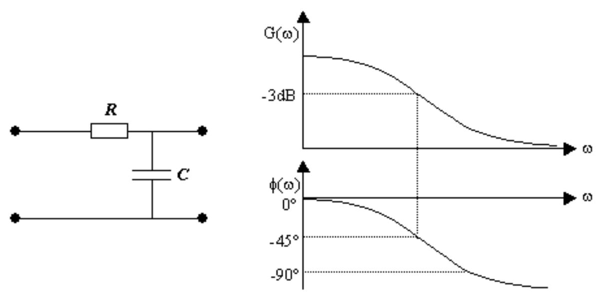


Figura 6 – *Circuito equivalente de um par telefônico*

IV. Sistemas Não Lineares

Existe para os sistemas uma relação entre amplitude do sinal de saída e a amplitude do sinal de entrada, que podemos analisar através do levantamento da chamada *característica de transferência*. É importante ressaltar que não deve-se confundir a expressão "*característica de transferência*" com a expressão *função de transferência*.

Quando o formato do sinal de saída independe da amplitude do sinal de entrada a resposta é dita linear, como pode ser visualizado na primeira parte deste trabalho.

O sistema é não linear quando a resposta é dependente da magnitude do sinal de entrada. Com isto, a *característica de transferência* se afasta do modelo linear.

A não linearidade verificada através da curva da característica de transferência, faz com que o sinal de saída apresente distorções em amplitude e novas componentes de freqüência, chamadas espúrios.

Portanto, uma característica importante do sistema não linear é a alteração do conteúdo harmônico do sinal de saída. Além destas componentes harmônicas, chamadas de espúrios ou produtos de intermodulação causarem distorções no sinal de saída, existe a possibilidade dos mesmos causarem a interferência em outros sistemas.

A *Figura 8* mostra como a distorção no domínio do tempo apresentada na *Figura 7*, pode ser analisada no domínio da freqüência.

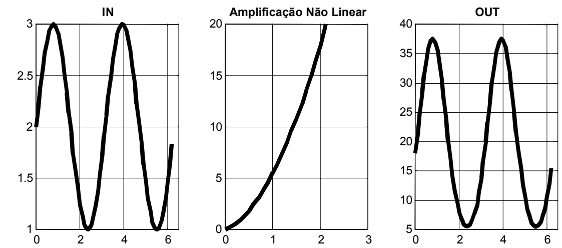


Figura 7 – *Sinais de entrada e saída de um Sistema Não Linear.*

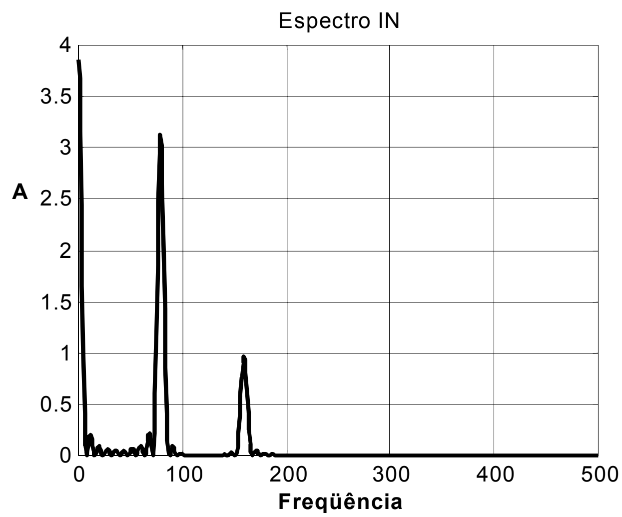


Figura 8 – *Espúrios e harmônicas geradas devido a não linearidade.*

A curva de característica de transferência pode ser desenvolvida a partir da série de Taylor em torno do ponto de operação escolhido.

$$e_0(t) = k_0 + k_1 * e_i(t) + k_2 * e_i^2(t) + k_3 * e_i^3(t) + ... \qquad (08)$$

O termo constante exprime uma componente CC e pouco pesa no resultado final, pois pode ser considerado igual a zero quando conveniente.

V. Efeitos da fase não linear

A distorção de fase ocorre quando $\phi(\omega)$ deixa de seguir uma lei linear com a freqüência. Através da equação (07) pode-se definir um retardo absoluto para cada freqüência individual ω, pela relação:

$$t(\omega) = \frac{\phi(\omega)}{\omega} \qquad (09)$$

E a distorção implica que $t(\omega)$ não seja mais uma constante e sim apenas uma função de ω.
Mesmo que a amplitude das componentes seja rigorosamente respeitada, o fato de haver retardos diferentes para diferentes componentes vai modificar a resposta, porque na soma as componentes não mais guardam a relação de fase original.

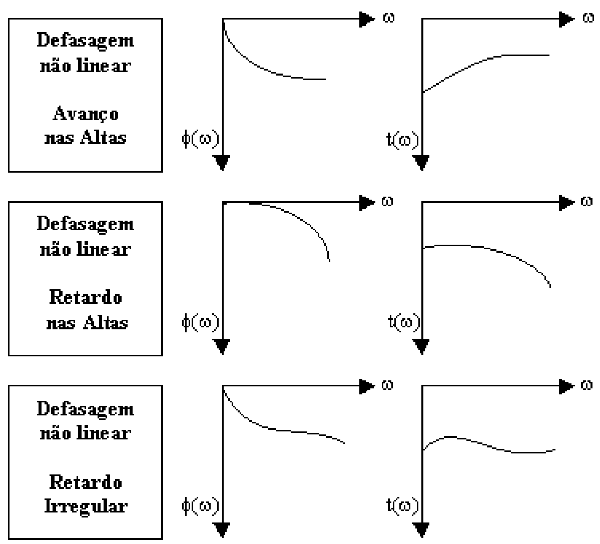


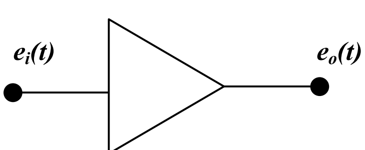
Figura 09 – *Respostas não lineares de fase*

VI. Não linearidade em amplificadores.

Para amplificadores tem-se um comportamento não linear, com o termo cúbico gerando os produtos de intermodulação dentro da banda de trabalho ou nos canais adjacentes em aplicações multi-portadoras.

Analisando um amplificador com duas portadoras, pode-se perceber estes efeitos.

Supondo o amplificador da *Figura 10*, tem-se:



$$e_0(t) = k_1 e_i - k_3 e_i^{\,3}(t) \qquad (10)$$

Figura 10 - *Amplificador com comportamento não linear*

Para o espectro em análise adotou-se para a entrada (IN) as freqüências de ω_1=502 rad/s e ω_2=942 rad/s, o que corresponde respectivamente a f_1=80Hz e f_2=150Hz.

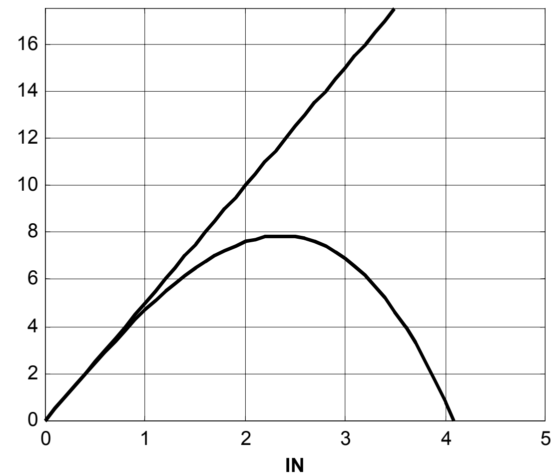


Figura 11 - *Função característica de transferência do amplificador*

$$e_i(t) = A\cos(\omega_1 t) + A\cos(\omega_2 t) \qquad (11)$$

$$e_0(t) = K_1 e_i(t) - K_3 e_i^{\,3}(t) \qquad (12)$$

$$K_1 e_i(t) = K_1(A\cos(\omega_1 t) + A\cos(\omega_2 t)) \qquad (13)$$

$$K_3 e_i^{\,3}(t) = K_3(A\cos(\omega_1 t) + A\cos(\omega_2 t))^3 \qquad (14)$$

$$\begin{aligned}
e_0(t) = &-\frac{3A^3}{4}k_3\cos((2\omega_1 - \omega_2)t) + \\
&(k_1 A - \frac{9A^3}{4}k3)\cos(\omega_1 t) + \\
&(k_1 A - \frac{9A^3}{4}k3)\cos(\omega_2 t) - \\
&(k_1 A - \frac{9A^3}{4}k3)\cos(\omega_2 t) - \\
&\frac{3A^3}{4}k_3\cos((2\omega_2 - \omega_1)t) - \qquad (15)\\
&\frac{A^3}{4}k_3\cos(3\omega_1 t) - \\
&\frac{3A^3}{4}k_3\cos((2\omega_1 + \omega_2)t) - \\
&\frac{3A^3}{4}k_3\cos((2\omega_2 + \omega_1)t) - \\
&\frac{A^3}{4}k_3\cos(3\omega_2 t)
\end{aligned}$$

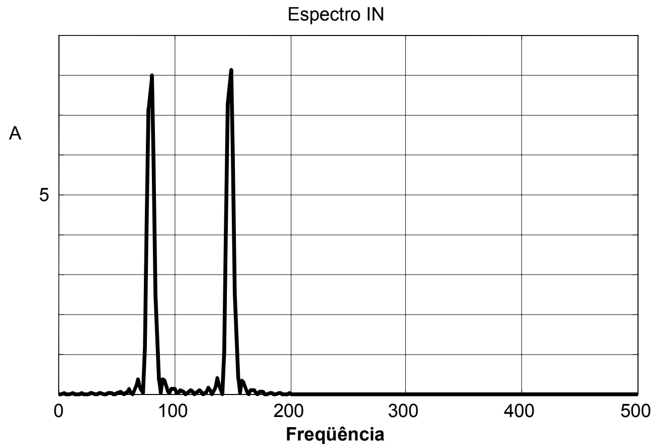


Figura 12 – *Espectro do sinal de dois tons na entrada de um amplificador não linear*

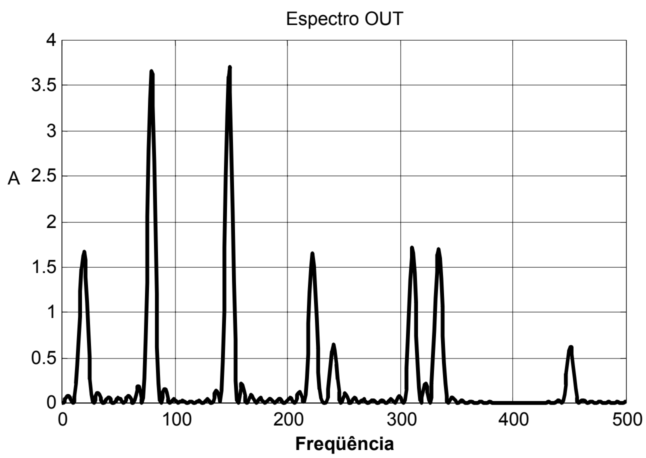


Figura 13 – *Espectro do sinal de dois tons na saída de um amplificador não linear*

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THEORETICAL BASIS FOR MATHEMATICAL MULTIMEDIA SOFTWARE

Leonardo Galdino de Morais [1] and Alex Sandro Gomes [2]

Abstract — *In this paper, we analyse the state-of-the-art of multimedia applications in the teaching of Mathematics. It will be studied in the light of the Theory of Conceptual Fields [1]Several works demonstrate that the educational softwares developed for the teaching of Mathematics tend to present a limited number of cases (Balacheff e Kaput, 1996; Schwartz, 1999; Hinostroza e Mellar, 2001). We believe that this is due to intrinsic limitations of the interfaces, which employ only graphical resources and direct manipulation. We shall discuss the main improvements in this area and present a model for the production of multimodal interfaces – those with multiple integrated forms of presentation, such as video and animation – oriented by a constructivistic proposal of cognitive development learning in this area.*

INTRODUCTION:

There is a plethora of educational software for the teaching of Mathematics available in the market, the majority strives to teach through successive repetitions of the solving of problems of the same type. At the end of this "marathon of exercices", the pupil feels that he has learned something. Such sensation can't stant modifications in the style of the questioning making it clear that, instead of learning the real contents, the student was simply trained to solve problem of a given pattern. According to Mayes [2], learning is the product of other activities. In this context, it is necessary to define and validate the models and methodologies that identify and evaluate the activities that cal help the student to learn, and translate these activities into educational software. We noticed the need of creating rich contexts, a wide repertory of situations, and the need of providing interfaces flexible enough to allow the emergence of multiple heuristics for the solving of problems in this conceptual field.

One of the characteristics of Mathematics is that its concepts are buildt on other concepts. The structure is not like a tree with many branches, but as a scaffold with many interconexions. Once the base of the scaffold is on a stable place it is not difficult to build it higher, but it is impossible to build one layer before the previous is finished. Due to this structure, it is almost always necessary that the teacher to impose some structure on the learning process. Our focus follows the Constructivistic Cognitive Theory.

THE LEARNING OF MATHEMATICS

The construtivism is rooted on the Piaget's works on the cognitive development of children and teenagers. His cognitive theory employs stages of development: starting with the senso-motor stage (which precedes speech) up to the stage where formal operations are performed. In this stage the child is capable of hypothetical-deductive reasoning [3]. Robert Shwarzenberger [4]observed that it is a reasonable hypothesis to suppose that the various cognitive mechanisms which control the childrens' individual learning are not different, qualitatively speaking, from the students'.

The Constructivistic Theory separaters training from teaching. In the first, the student is trained to produce an appropriate answer. The teacher imposes what is right or wrong, and the students absorb these facts, or not (which usually happens). The Construtivism asserts that teaching aims to produce autonomous understanding, and this shoud be the result of the student's mental process.

An important theoretical reference for the learning of Mathematic is Vergnaud's Theory of Conceptual Fields [1], according to which a concept is defined from three instances: its invariant properties, the systems of representation, and the instructions of use. Therefore, learning a mathematical concept implies to command a set of properties that emerge from different situations, and are mediated by different systems of representation. To command a conceptual field means to be capable of solving problems in different situations in which a concept is inserted.

The concept, the second element analysed in the represention process, and which assumes, in this work, an important position, is defined by Vergnaud [1]as a "tripod of sets"- the first set, named "S", containing the situations that convey meaning to the concept; the second, "I", containing the invariants on which the operationality of the schemes (meaning) is based; and "Y", the set containing the systems of representation, languages, which allow to represent symbolically the concept "Y" (significant). The situations ae aspects related to the deeper structure of the problems, and do not simply correspond to the contexts of the problems but to the relations between the quantities (numbers) which should occur to the subjects at the moment when they are organizing their actions for the tackling of the problems. The second element of the tripod is the set of the invariants

When interacting with real world, the individual will set in motion the knowlegde he has at that moment. The

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knowledge that emerges simultaneous to the actions are the invariant operatives, defined as the subject's knowledge that is subjacent to his behaviours, and that are, then, an integral part of his schemes of action. The articulated knowledge is, then, fragments of concepts which are employed in situations. The third component of the concept is that of symbolization, or significant. It is the way the individual is capable of expressing his thoughts. According to Vergnaud [1], there are at least six different types of situations involving these concepts; which must be completely mastered in order to be a real understanding of the conceptual field. They are:

TABLE 1
ADDITIVE SITUATIONS

I. Composition of measures - Ex: John has 12 shuttlecocks, and Peter 17. How many shuttlecocks they have together? There are two quantities given simultaneously, which the individual must start with to find a third quantity.	II. Transformation of measure - Ex.: Mary had 23 bombons. At the end of the day, she noticed that she had only 17 left. How many sweets bombons Mary ate on that day? The inicial and final qiuantities are known, but what is asked is the value of the variation between the first and the second moments.
III. Comparison of mesures - Ex.: I have 16 books, you have 43. How many books do you have more than I do? Once more, the quantities are known and simultaneous, aiming to compare the difference between the two (relation).	IV. Composition of transformations - Ex.: In the first match I scored 12 points, in a second match I scored 13 points. How many points did I score in all? The initial, intermediary, and final quantities are unknown. Only the transformations that take place during a span of time are known.
V. Composition of relations - Ex.: Mary is 3 years the senior of Antony. Marc is 4 years the senior of Mary. By how many years is Marc older than Antony? In this composition between two simultaneous relations, the elements are unknown but the relations are given.	VI. Transformation of relations - Ex.: *Mary had 3 toys more than John. She was given 4 more toys. Now, how many toys she has more than John?* None of the quantities are given, however, the existing relations and its alterations are known.

EDUCATIONAL SOFTWARE AND MULTIMEDIA IN THE TEACHING OF MATHEMATICS

The bibliography have been criticizing the quality of the educational software that seem not to correspond to the expectations of the teaching professionals [5]. The epistemological impact of the application of this new technology to the processes of learning and teaching is much smaller than the expected [6]. These results go against the evidence that the use of concrete materials – tangible interfaces – favours the learning of Mathematics [7]. Our hypothesis is that one of the reasons for this inefficiency is the fact that the process of designing considers certain aspects of the learning process in a superficial way, privileging aspects traditionally focused on the design of interfaces.

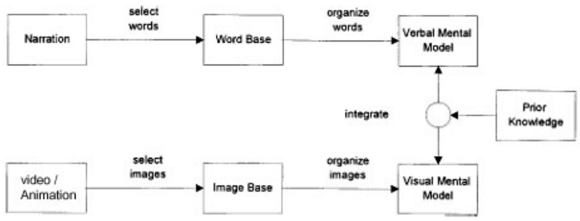
The process of educational software creation and evaluation demands the identification, or deduction of the knowledge that will probably emerge during the users' interactions with the interface, which take place in a non systematic way [8]. Having a systematic vision of the relation between the use of the interface and the actual learning implies in the use of a theoretical model of analysis that can do the modelling of the process of organization of the interaction with the interface in an understandable fashion. This modelling should happen in terms of theoretical elements that reveal the progressive adaptation of the users to the interface, and the knowledge that springs forth during its use.

The evidence gathered in our experience in the teaching of Methodology of the Teaching of Mathematics, point out that it is much simpler to negociate the meaning of mathematical relations through a dialogue than through the creation of an educational software interface. Anyway, educational interfaces are always limited when seen from the point of view of the functionalities related to the negotiation of meaning. The feedback provided are always restrictive, and in a few cases adapted to the situation experienced by the users.

Our aim is to promote a constructivistic learning, where the pupil is actively involved in the cognitive process, building significant representations and mental models.

In a constructivistic paradigm, the learning happens when the students' needs correspond to the visual and verbal representations of the memory of work at the same time. Researchers in the University of California [16] propose a multimedia learning model referenced by five principles, and by the multimedia learning cognitive theory: 1) Principle of multiple representation: it is better to present an explanation in words and graphics than only in words. This theory is corroborated by tests performed by Mayer and Anderson (1991) [17]; 2) Principle of contiguity: it is better to present words and corresponding images simultaneously than separately, offering thus a multimedia explanation; 3) Principle of coherence: multimedia explanations are better comprehended when they include only the needed information; 4) Principle of modality: it is better to present words in the form of a narration than as texts on the screen; 5) Principle of redundancy: it is better to present only animation with narration than animation, narration e and written text. The cognitive construction depends on the student's cognitive processing during the learning. The figure below shows the scheme for the Cognitive Theory of Multimedia Learning

FIGURE 1
SCHEME FOR THE COGNITIVE THEORY OF MULTIMEDIA.LEARNING



Words are represented as narrations, and images as animations or video. A cognitive apprentice will pay attention to relevant portions of the narrative (indicated by the arrow *selected words*) and will keep these words inside the verbal working memory (indicated by the box *word base*) analogously, he will pay attention to the relevant parts of the animation (indicated by the arrow *select images*) and will keep this images in the visual working memory (indicated by the box *image base*). Then , a active student will build conections mentally that organize words and images (indicated by the upper arrow that symbilizes the verbal channel, and the lower one that represents the visual channel) in a cause-effect chain (indicated by the boxes *Verbal Mental Model and Visual Mental Model*). Finally, he will build conections between the verbal and visual models, and his previous knowledge (indicated by the *integrate* structure). It is important to stress that these processes seem to take place interactively, instead of in predefined steps.

In order that a significant learning takes place, the student has to pass by each one of these cognitive processes. Selecting relevant words and images, organizing them in coherent verbal and visual representations, and integrating correspondin verbal and visual representations. All multimedia messages deliver information to the students, but not all are equally successful in promoting the understanding. The method we suggest was tested and approved by Richard E. Mayer *, Roxana Moreno [18]

ANIMATION

The theoretical foundation for the use of animation is the same for the use of static images [9]. Animations, just like static images, are considered as a subdivision of graphics in general. Pavio [10], in his dual theory of codification says that text and graphics are codified in two independent cognitive subsystems. Although keeping many similarities, animations have a series of properties, for instance, showing movement, which static images and graphics don't.

Animations have many functions. Among them we could cite: Attracting attention (when used to catch the attention); Motivating (when used as a feedback); Presenting contents (when originating from a concrete reference, and a visual context for ideas); Clarifying concepts (when propiciates a conceptual understanding even when not presenting new information). It is particularly important to catch the students' attention at the beginning of the lesson [19]. Animations can be used to attract the students' attention to key points. The clarifying function of the animation can offer an conceptual understanding even when it does not provide new information. Animations can help to exemplify abstract situations that, otherwise, would be hard to explain.

The concern in respecting preexistent patterns, in terms of the way the objetcs look in the animations, produces a positive effect in the understanding of the information presented. The coherence with other materials at the students' disposal is crucial since if the representation used in a textbook differs from the one used in the animation, this difference demands a greater cognitive effort from the student. Researches with concrete static images showed that abstract representations (schemes) are more easily remembered than concrete images [11]. On the other hand, if the goal of the instruction is a conceptual global recognition, the students will benefit from more realistic representations, such as videos.

According to Park [12], the greater the complexity of a concept, the greater the potential of understanding through the use of animation. He bases this argument on the fact that if the contents is very difficult of describing verbally, then animation can be employed effectively. [20] assert that animations help to create a mental picture of the system. When the differences between two very close concepts are not easily noticeable, then an animation can clarify the point.

VIDEO

The use of vídeo aiming at educational ends is not new. Beichner [13] reports some works on Physics performed in the 80s. Zollman [14] suggest the use of interactive vídeos as the base for laboratory tools for the modelling of complex events and qualitative analysis, among others. Other references are the work done by Marcuso and Webber [15], VideoPort (Pasço Scientific, 1999), and VideoGraph. The reasons for employing video in multimedia softwares, by its nature and the type of information it can convey, are the same for the use of animation. We can single out some advantages of the video. It allows the student to watch the real phenomenon instead of a simulation.

Research performed in laboratories for the teaching of Physics based in video show that both the students that worked with video, and the ones that worked with real experiments were able to obtain similar experimental data in the majority of experiments; in other situations, the students working with video could take advantage of the possibility of observing the phenomenon in slow motion or frame to frame. It is advisable that the pupil analyses and do the mathematical modelling starting with videos that show real situations (Rodrigues, 2001).

CONCLUSIONS

In this paper, we analysed the state-of-the-art of multimedia applications in the teaching of Mathematic. We noticed that the available bibliography in the field has a gap in dealing with the creation of interfaces that convey different contexts and situations. At the same time, it is important to offer interfaces flexible enough to allow the emergence of multiple heuristics in this conceptual field in order to produce an autonomous understanding stemming from the student's mental processes. The use of animation and videos associated to narrations propitiates greater assimilation of the contents presented, making them more efficient for the task of negociating themeaning of mathematical concepts. The animations can be used to build representations in order to facilitate the emergence of mental models. Presenting the problems with videos that picture the real world behind the mathematical concepts brings it closer to the students, and eliminates the possibility of double meanings in the interpretation of the real problem to be solved.

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EDUCAÇÃO À DISTÂNCIA POR TELECONFERÊNCIA INTERATIVA

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Resumo — *A partir de meados da década de 90, o ensino à distância teve considerável impulso no Brasil, mediante o uso de novas tecnologias de comunicação. Desde então, grande parte das iniciativas surgidas, mormente no campo acadêmico, têm-se utilizado principalmente da videoconferência e da Internet. Essas mídias, como as demais, têm suas vantagens e dificuldades, deixando uma lacuna que estamos pretendendo eliminar com o uso de uma terceira, a teleconferência interativa, por processo ainda inédito em nosso país, usando a via satelital. O objetivo do presente trabalho é apresentar e discutir uma experiência pedagógica coordenada pelo autor, realizada de outubro a dezembro de 2002, usando a teleconferência interativa. Nossa intenção é trazer ao debate público os resultados alcançados, visando colaborar para a solução de problemas de ensino e treinamento à distância em situações economicamente justificadas pela economia de escala.*

Palavras-chave — *Economia de escala, interatividade, mudança de paradigma, transmissão satelital.*

A EDUCAÇÃO À DISTÂNCIA NO BRASIL

A educação à distância (EAD) no Brasil tem um razoável histórico desde os primórdios do século XX, com base em ensino por correspondência e transmissões radiofônicas, conforme pode ser visto em [1], mas somente passou a se valer das modernas tecnologias da informação e telecomunicação a partir de meados dos anos noventa. A partir de então, registram-se diversas atividades baseadas no uso da Internet, da videoconferência, da teleconferência e de vídeos. Não nos deteremos aqui em tecnicalidades envolvendo esses veículos de comunicação, que os menos afeitos à questão poderão observar em [2].

Com respeito aos veículos citados, devemos considerar que a educação à distância, entendida como um processo de ensino ou treinamento voltado para a formação, tem sido praticada priorizando a Internet, como nos casos da Unirede (rede virtual de univesidades públicas), da UVB – Universidade Virtual Brasileira (rede virtual de universidades privadas), dentre diversas outras, enquanto que o exemplo pioneiro e mais notável de uso da videoconferência em cursos de pós-graduação é o da Univesidade Federal de Santa Catarina, através do seu LED-Laboratório de Ensino à Distância. Mais informações sobre iniciativas em educação à distância no Brasil podem ser encontradas em [3].

Os vídeos e a teleconferência, por sua vez, têm sido usados em caráter informativo. Merecem destaque, neste contexto, dentre outros, os ciclos de teleconferências coordenados e/ou dirigidos pelo autor, como os do projeto Engenheiro 2001, do Projeto E – Educação para o Emprego e o Empreendedorismo, e os Ciclos de Teleconferências sobre Segurança e Saúde no Trabalho executados para a Fundacentro. Mais informações são encontradas em [4] e [5].

AS PALAVRAS-CHAVE EM EAD

Consideramos serem três as principais palavras-chave em educação à distância: **mudança de paradigma, interatividade e economia de escala**. Comentemos cada uma.

A mudança do paradigma instrucional responde à pergunta, feita pelos céticos, de como pode a EAD funcionar tão bem, e amíude até melhor, que a educação tradicional, presencial. Isto se deve à mudança de paradigma, sem o que a EAD fracassaria.

O paradigma clássico da educação, vigente deste Platão e Aristóteles, é centrado na figura do professor e no verbo ensinar. O douto mestre, como um sol, irradia seus conhecimentos, repassando-os aos humildes alunos, que aprenderão ou não. Estudos recentes mostram que, em geral, os alunos absorvem cerca de 15% do que se lhes tentou transmitir.

No novo paradigma, a figura central passa a ser o aluno, evidentemente instalado em um adequado e meticulosamente planejado ambiente instrucional, e o verbo-chave é aprender, ou, melhor ainda, aprender a aprender. Não significa que os professores deixem de ter importância; pelo contrário, amplia-se o seu papel: além de transmitir conhecimento, devem fazê-lo da melhor forma compatível com o veículo de comunicação utilizado.

Do exposto, conclui-se que a primeira palavra-chave da EAD tem cunho claramente pedagógico.

A segunda palavra-chave é a interatividade, sem a qual a EAD também fracassará. A ausência física do professor deve ser compensada por um eficaz sistema de comunicação com a coordenação, sem o que o aluno sentir-se-á abandonado, frustrado, inseguro, e tenderá a desistir do curso. As suas dúvidas devem ser prontamente esclarecidas, o seu aprendizado permanentemente avaliado, a sua participação no processo educacional sistematicamente incentivada.

Note-se que a interatividade deve ocorrer nos dois sentidos, os alunos acessando a fonte do conhecimento e o professor acompanhando o desenvolvimento dos seus alunos. Para isso, mecanismos de *chat* e *forum*, monitores, uso de fax e telefone têm sido usados e, doravante no Brasil, o sistema que descrevemos adiante.

A interatividade é, portanto, uma palavra-chave de cunho comunicacional e, diríamos também, psicológico.

A economia de escala, por sua vez, é obviamente uma palavra-chave de natureza econômica. Está relacionada com a viabilidade econômica dos projetos de EAD.

De fato, as iniciativas recentes de EAD que conhecemos no Brasil são quase sempre, de uma forma ou outra, pagas com recursos governamentais ou institucionais, sem produzir lucro. Fazer EAD envolve custos, em geral elevados, o que exige que se tenha, para a viabilização econômica do empreendimento, que atingir uma escala de operação suficiente para ultrapassar o ponto de equilíbrio financeiro do processo. Isto vem de encontro à nossa percepção de que projetos abrangentes de EAD se fazem com parcerias e não praticando competição predatória entre as partes.

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A VIA SATELITAL

Esta via tem sido usada, até recentemente, para a realização de teleconferências. Uma resenha crítica a respeito, incluindo as vantagens e dificuldades do processo, é dada em [6]. Sendo as teleconferências eventos claramente informativos, não configuram, a rigor, educação à distância.

Entretanto, estão surgindo, recentemente, iniciativas pedagógicas por essa via, como a da Facinter – Faculdade Internacional de Curitiba, que está realizando cursos à distância por via satelital com interatividade por voz, e a da DTCom, instalada em Quatro Barras, PR, que oferece extensa programação de cursos em vídeos para os seus assinantes empresariais.

Na seqüência, relatamos a experiência objeto deste texto, que inova por introduzir a interatividade via *hardware* e *software*, em iniciativa pioneira no Brasil.

O PROJETO FUNDACENTRO

O autor participa, há quase dois anos, como coordenador de ensino à distância em projetos na Fundacentro - Fundação Jorge Duprat Figueiredo de Segurança e Medicina do Trabalho, que têm levado a 14 tele-salas espalhadas pelo Brasil a discussão da problemática da Segurança e Saúde no Trabalho através de 16 teleconferências e, de outubro a dezembro de 2002, seis cursos à distância de 12 horas cada, usando o processo que denominamos "teleconferência interativa", para cerca de 500 alunos por curso, que participam freqüentando as tele-salas da instituição.

As tele-salas estão localizadas em cidades espalhadas pelo país, de Belém a Porto Alegre. Por outro lado, uma comparação entre a teleconferência interativa e outros veículos pode ser vista em [7].

A programação sendo executada é dada no Quadro I. Mais informações podem ser vistas em [8].

DATAS	DISCIPLINAS
14/10 a 17/10	Atualização para Membros de CIPA
21/10 a 24/10	Estresse no Trabalho: Abordagem Individual e Organizacional
04/11 a 07/11	Prevenção da Silicose
11/11 a 14/11	PCMAT – Programa de Condições e Meio Ambiente de Trabalho na Indústria da Construção
25/11 a 28/11	Ergonomia e LER/DORT
02/12 a 05/12	Legislação em Segurança e Saúde no Trabalho

Quadro I – Programação dos cursos à distância

A geração das tele-aulas é feita em um pequeno estúdio instalado nas dependências da TV Cultura de São Paulo (ver Figura 1), que também faz o *up-link* para o satélite Brasilsat B1. Nesse estúdio, há um computador que abriga o *software* de comando do sistema.

Figura 1
Professor no estúdio

Em cada tele-sala há um computador dotado de um *software* de apoio incumbido de enviar ao estúdio, via Internet, as informações emanadas dos alunos no processo de interatividade. Essas informações são digitadas em um terminal interativo que cada aluno recebe e enviadas por rádio a uma base acoplada ao computador. O terminal interativo e a base são mostrados na Figura 2. Uma descrição pormenorizada pode ser vista em [9].

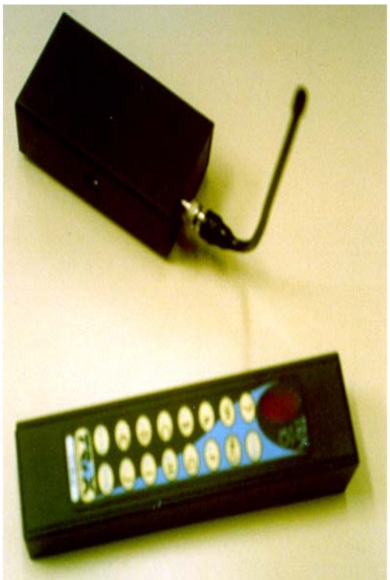

Figura 2
Base e terminal interativo

Há três tipos de interatividade nesse processo:

1) **Interatividade professor-alunos-professor**: o professor, em momentos planejados de sua planejada aula, insere perguntas de múltipla escolha (ou tipo sim ou não) que aparecem na tela e devem ser respondidas pelos alunos em dado tempo, acompanhado por uma barra móvel; as respostas dos alunos são informadas ao *software* de comando, que envia para a tela os percentuais das respostas. Este processo, portanto, permite a realização de três funções:

a) *Feedback* ao professor quanto ao aproveitamento dos alunos;
b) Avaliação do conhecimento adquirido pelos alunos para efeito de nota, quando aplicável;
c) Animação, estabelecendo uma sistemática de participação que elude possível tédio dos alunos.

2) **Interatividade aluno-professor-alunos**: o aluno pode apertar a tecla "?" do seu terminal, informando ao professor que deseja fazer uma pergunta verbal. Seu nome e localidade, junto com outros, aparece no monitor do professor que, em momentos planejados, concederá voz aos alunos que escolher. Estes dialogarão com o professor usando telefone sem fio, sendo os demais candidatos a pergunta instruídos a desistir de fazê-la se sua dúvida foi esclarecida, apertando a tecla "cancela".

3) **Interatividade aluno-monitor-aluno**: alunos que não tenham suas dúvidas esclarecidas durante a aula poderão fazê-lo em seguida, enviando *e-mail* a um dos monitores disponíveis, que procurarão responder em até 24 horas ou, caso se julguem incapazes, remeterão a dúvida ao professor.

No momento em que encerramos este artigo, haviam sido realizados os cinco primeiros cursos, com aceitação altamente favorável por parte dos alunos, mormente em regiões mais afastadas da Sudeste, onde as carências por informações e conhecimento são mais acentudas.

VANTAGENS E DIFICULDADES

Enumeramos as principais vantagens deste processo:

a) É absolutamente amigável aos alunos, por buscar reproduzir, com vantagens, as condições da sala de aula tradicional, num sistema que poderíamos chamar "presencial-virtual";

b) Em consequência, o ambiente de grupo tão caro a muitos alunos é preservado, permitindo a interação sinergética dos componentes da classe;

c) A preparação das aulas não exige nenhum esforço do professor além de uma organização prévia do material, do planejamento da sessão e da inserção das perguntas;

d) O custo dos equipamentos a serem instalados para a recepção do sinal nas tele-salas é pequeno.

Dentre as dificuldades, citamos:

e) O custo da transmissão por satélite, fazendo com que o processo somente seja economicamente viável acima de determinada escala de utilização;

f) A decorrente dificuldade de gestão de um sistema de grande porte;

g) O custo dos terminais interativos que, entretanto, se dilui se a utilização for continuada;

h) Problemas com a Internet, que podem acarretar perda de respostas dos alunos.

Evidentemente, nessa experiência piloto, foi necessário ultrapassar diversas dificuldades pontuais que não cabe relatar neste espaço, dentro de um processo sucessivo de aprendizagem, tanto no campo técnico como no pedagógico.

Entretanto, o projeto revestiu-se de pleno sucesso, demonstrando que a teleconferência interativa pode ser considerada uma alternativa válida e, conforme o caso, muito vantajosa para atender às necessidades de EAD no Brasil.

CONCLUSÃO

O objetivo deste trabalho foi apresentar o sistema que desenvolvemos para suprir uma lacuna que identificávamos no Brasil em EAD. Sua realização foi possível devido ao espírito pioneiro da Fundacentro que, preocupada em levar conhecimentos no campo de Segurança e Saúde no Trabalho aos diversos cantos do País, nos proporcionou a oportunidade de viabilizar essa experiência piloto.

É nossa intenção seguir aperfeiçoando o processo que, temos certeza, será de muita utilidade na educação à distância tanto aberta quanto corporativa, sempre que a escala de operação justifique a sua utilização.

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A PEDAGOGIA DAS COMPETÊNCIAS NOS CURSOS DE ENGENHARIA

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Resumo *— O processo de formação do Engenheiro pressupõe o desenvolvimento do indivíduo como particularidade e como generalidade. É necessário que as experiências individuais sejam estimuladas, pois cada estudante constrói o seu próprio conhecimento. As competências são adquiridas no decorrer da caminhada e precisam ser reconhecidas individualmente. Neste artigo, discute-se a pedagogia das competências no contexto dos Cursos de Engenharia, partindo-se de uma retrospectiva histórica da relação entre competência e ação. A teoria cognitiva é escolhida para alicerçar as considerações pedagógicas e as propostas apresentadas são sustentadas por quatro saberes: saber, saber fazer, saber ser e saber conviver. Discute-se a importância de romper com a dicotomia teoria-prática para efetivar a aquisição de competências, pois estas, estão sempre associadas à capacidade de o sujeito desempenhar-se satisfatoriamente em reais situações de trabalho, mobilizando os recursos sócio-afetivos e cognitivos além de conhecimentos de áreas específicas. Exemplifica-se o desenvolvimento de projetos nas disciplinas básicas de Matemática. Os resultados apresentados mostram a importância de mudanças no dia-a-dia nas salas de aula. É necessário inovar com situações problemas reais que podem ser resolvidos com os inúmeros recursos tecnológicos disponíveis na sociedade.*

Palavras Chaves — competências; disciplinas básicas de Matemática; ensino-aprendizagem; teoria e prática.

INTRODUÇÃO

O ensino superior é, em qualquer parte do mundo, um dos pilares do desenvolvimento econômico e contribui para a formação continuada dos indivíduos.

No relatório para a UNESCO da Comissão Internacional sobre Educação para o século XXI as tradicionais e as novas missões do ensino superior são discutidas, constatando-se que "o ensino superior está em crise há cerca de dez anos", numa grande parte do mundo em desenvolvimento [1]. Dentre as diferentes causas discutidas destaca-se a atração excessiva pelas ciências sociais, que conduz o desequilíbrio no mercado de trabalho.

Observa-se assim, a necessidade de uma abertura para o ensino de ciências exatas (caso das Engenharias) para que não se tenham "torres culturais", produzindo pesquisas acadêmicas que pouco contribuem para o desenvolvimento da sociedade.

Os cursos de engenharia são os responsáveis por espaços de formação científica e tecnológica gerando sistemas complexos que devem atender à sociedade.

Dentre as pistas e recomendações destaca-se o estudo de "novas formas de certificação que levem em conta o conjunto das competências adquiridas".

Para que se criem certificados pessoais de competências nos cursos de Engenharia é necessário que as competências adquiridas possam ser reconhecidas pelas empresas e pelo sistema educativo formal (universidades).

Evidentemente faz-se necessário discutir a pedagogia das competências. Neste trabalho, algumas reflexões são introduzidas, geradas no meio acadêmico, pela autora, enquanto professora de disciplinas de Matemática em cursos de Engenharia.

Discute-se um recorte, pois a dimensão do texto não permite aprofundar o tema, ainda tão pouco discutido no contexto das Engenharias.

PEDAGOGIA DAS COMPETÊNCIAS

O termo pedagogia, no contexto deste artigo é entendido como um conjunto de princípios que visam um programa de ação. Diante de uma concepção de vida, definem-se os princípios e idéias que devem ser adotados. Para tal, é necessário escolher os meios mais eficientes para realizar o programa de ação estabelecido.

Dois grandes grupos de teorias, que alicerçam as pedagogias, são estabelecidos em [2]: teorias críticas e teorias não críticas. Sua classificação está baseada na variável "marginalização". As teorias críticas baseiam-se na concepção de que a educação é um instrumento de superação da marginalidade, pois promovem a equalização social.

As teorias não críticas entendem que a educação é um instrumento de discriminação social, logo um fator de marginalização. O termo marginalização passa a ter diferentes significados, conforme os pressupostos de cada teoria.

Dentre as pedagogias não críticas pode-se citar: pedagogia tradicional, pedagogia nova e pedagogia tecnicista. A organização da pedagogia tradicional está baseada no princípio de que a educação é direita de todos e dever do Estado. O programa de ação dessa pedagogia reflete bem a sociedade da época (meados do século XIX), com a visão de que era necessário vencer a barreira da ignorância, ou seja, transformar súditos em cidadãos. A ignorância era entendida como marginalidade, assim, a escola deveria combater a ignorância, difundindo a instrução

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e transmitindo os conhecimentos acumulados pela humanidade e sistematizados logicamente. O professor torna-se figura central, pois domina os conhecimentos que devem ser transmitidos aos alunos.

A pedagogia nova apresenta um novo programa a partir da idéia de que os homens são essencialmente diferentes, portanto, advoga-se um tratamento diferencial a partir da descoberta das diferenças individuais. Assim, a marginalidade passa a ser vista como rejeição. As questões pedagógicas são centradas no aluno e os experimentos são baseados nas contribuições da biologia e da psicologia. A sociedade continua influenciando o contexto da pedagogia e a comparação entre o trabalho fabril e o trabalho pedagógico gera uma nova visão para a educação. visualiza-se a necessidade de operacionalizar os objetivos e mecanizar alguns processos. A marginalização é vista como incompetência, assim, o programa de ação deve ter como elemento principal à organização racional dos meios.

Ao comparar essas pedagogias observa-se que na pedagogia tradicional é necessário aprender, na pedagogia nova tem-se aprender a aprender e na tecnicista é importante aprender a fazer.

A origem da pedagogia das competências é analisada, em geral associada aos objetivos de ensino. Ao discutir sua origem pode-se associar à pedagogia baseada no desempenho ou pedagogia do domínio. A difusão dessa pedagogia aconteceu de forma diferenciada (ver [3]). Na França, por exemplo, difundiu-se como pedagogia por objetivos, e teve várias críticas, pois a referência teórica é o behaviorismo de Skinner.

No Brasil, as atuais políticas educacionais afastam-se do behaviorismo e incorporam a noção de competência com base no construtivismo.

A NOÇÃO DE COMPETÊNCIA

A noção de competência pode ser analisada nas relações de trabalho, no interior das empresas e nas relações educativas. Pretende-se neste artigo analisar a noção de competência nas relações educativas tendo como foco o interior das empresas, pois se considera a competência indissociável da ação, portanto, um caminho para romper com a dicotomia teoria-prática.

Perrenoud [4] esclarece que "competência é a faculdade de mobilizar um conjunto de recursos cognitivos (saberes, capacidades, informações etc) para solucionar com pertinência e eficácia uma série de situações". Por exemplo, um Engenheiro para projetar uma estrada precisar saber toda as etapas de desenvolvimento do projeto mobilizando as capacidades de ler levantamentos topográficos, aplicar conhecimentos matemáticos e físicos, etc. Isso implica diferentes saberes em diferentes áreas do conhecimento (matemática, física, desenho, etc.).

As diretrizes curriculares [5] para os cursos de Engenharia em seu Art 4º. estabelece uma extensa lista de competências e habilidades gerais a serem adquiridas no decorrer da formação do Engenheiro.

O desafio das universidades está na implementação de novos projetos pedagógicos estruturados para garantir o perfil requerido pelas diretrizes e pela sociedade. Pode-se questionar: Como garantir o perfil desejado e o desenvolvimento das competências e habilidades esperadas? Como reduzir o tempo em sala de aula, favorecendo o trabalho individual e em grupos (Art.5º.)?

Para garantir a aquisição das competências requeridas é preciso trabalhá-las e treiná-las. Isso exige tempo, seqüências e situações didáticas inovadoras e adequadas a cada área da Engenharia e a cada região. É usual os alunos acumularem saberes, serem aprovados nas disciplinas curriculares, mas não conseguem mobilizar o que aprenderam em situações reais do trabalho. É importante não marginalizar os problemas práticos, principalmente nas disciplinas básicas (matemática, física, etc.), assim como não perder tempo em treinamento dos saberes condizentes para situações complexas. Por exemplo, fazer deduções matemáticas de todos os teoremas que alicerçam o cálculo diferencial e integral.

Os projetos pedagógicos dos cursos de Engenharia devem reconstruir a transposição didática para que se possa otimizar o tempo e propiciar ao futuro Engenheiro as competências necessárias para mobilizar conhecimentos, transformando-os em ação.

A construção de competências para se efetivar, deve passar por um processo de reflexão sobre: os objetos de estudos, a escolha dos conteúdos, a organização das atividades didáticas, a criação de diferentes ambientes de trabalho e a avaliação. A proposta didática do curso deve estar focada em ações teóricas-práticas. Essas ações devem estar articuladas com "o fazer" e todo fazer deve estar articulado com a reflexão.

A ESCOLHA DE CAMINHOS

A realidade, no Brasil, aponta alguns caminhos para serem trilhados. Por exemplo, os atuais projetos pedagógicos que contemplam as diretrizes curriculares continuam com a estrutura disciplinar. Portanto, na realidade são currículos formatados na forma de disciplinas. Machado [6] discute a questão dos espaços e tempos escolares ocupados pelas disciplinas, e a idéia radical que "uma valorização do conhecimento científico disciplinar teria como contrapartida o menosprezo da noção de competência".

As experiências realizadas delineiam que a dicotomia disciplina-competência não existe. É possível fazer escolhas didáticas para cobrir os conhecimentos disciplinares importantes a partir de situações concretas. Evidentemente isto requer estratégias didáticas bem diferenciadas das tradicionais.

Partindo-se do princípio de que as disciplinas são importantes para o desenvolvimento das competências e habilidades dos alunos, sugere-se o seguinte roteiro didático:

- Buscar problemas práticos de interesse coletivo, da sociedade ou de interesse pessoal.
- Discutir os problemas apresentados sob o contexto dos conteúdos disciplinares, gerando projetos de estudo.
- Gerar prioridades a partir dos interesses do grupo e a partir da experiência do professor.
- Trabalhar a solução do problema resgatando todos os conhecimentos disciplinares através de recursos tecnológicos.
- Estabelecer um contrato didático envolvendo professor aluno e universidade (oferta dos recursos humanos e financeiros).

Para discutir as etapas listadas utilizam-se experimentos realizados em sala de aula, pela autora, em turmas de Engenharia Civil e Engenharia Elétrica - Telemática da UNISUL - Universidade do Sul de Santa Catarina.

Inicialmente tem-se a busca de problemas práticos. Essa busca pode ser feita de duas diferentes maneiras: trazidas pelos alunos ou apresentadas pelo professor. Quando os alunos são incentivados a busca de situações práticas de interesse de seu curso ou de seu interesse pessoal, surgem situações bastante variadas. Por exemplo, na turma de Engenharia Civil, na disciplina de Cálculo III, foi apresentado o projeto de estudo do túnel em construção na cidade de Florianópolis, do caminhão betoneira, da retirada de uma ponte na BR 101, da construção de um piso e do dimensionamento de janelas de uma sala.

Observar que são obtidos um conjunto diversificado de problemas. Essa diversificação não aconteceu quando o experimento foi realizado na Engenharia de Telemática na disciplina Matemática Aplicada à Engenharia, quando os problemas foram apresentados pelo professor utilizado somente situações de análise de circuitos.

É importante destacar que a multidisciplinaridade aconteceu e ambas as situações. No caso do problema do túnel, buscou-se a ajuda de outras disciplinas para o melhor entendimento de algumas partes do problema e no caso da Engenharia elétrica os problemas utilizados foram sugeridos pelo professor de análise de circuitos.

Na segunda etapa, os problemas foram apresentados e discutidos sob a ótica das respectivas disciplinas. A geração de projetos de estudos acontece naturalmente para que se tenha uma organização didática dos conteúdos envolvidos. Ao elaborar o projeto de estudo, contempla-se o dimensionamento de objetivos, etapas de desenvolvimento, recursos, estratégias adotadas e avaliação. É uma construção compartilhada entre professor e alunos, para que se tenha o envolvimento esperado e conseqüentemente a construção das competências e habilidades requeridas. Ao elaborar os projetos, verifica-se automaticamente, a necessidade de gerar prioridades e alguns problemas podem ser priorizados, podendo inclusive acontecer o descarte de problemas. Para exemplificar tem-se no caso da Engenharia Civil, com a priorização o problema do túnel e do problema do caminhão betoneira. Salienta-se que a mediação do professor é fundamental, pois este tem a visão macro da disciplina e argumentos para auxiliar as escolhas dos alunos. No exemplo citado os problemas priorizados propiciaram a discussão do cálculo de volume de sólidos através do uso das integrais duplas e triplas (conteúdos disciplinares). Esses problemas facilitaram também a construção, por exemplo, das competências: aplicar conhecimentos matemático, científicos e tecnológicos à Engenharia; resolver problemas de Engenharia; interpretar resultados e assumir a postura de permanente busca.

Para analisar, refletir, discutir, buscar soluções, fazer escolhas, resolver e validar soluções no caso dos problemas exemplificados foi necessário o desenvolvimento de todos os conteúdos disciplinares previstos acrescidos da busca e resgate de conteúdos de disciplinas já cursadas. Surgem, às vezes, a necessidade de conteúdos disciplinares mais abrangentes de outras disciplinas mais avançadas. O procedimento adotado nestes casos é a discussão informal, resgatando-se soluções mais intuitivas e menos científicas. Espera-se que em momentos posteriormente o aluno possa resgatar as soluções intuitivas de maneira mais formal.

CONCLUSÕES

Os experimentos desenvolvidos comprovam que a competência é indissociável da ação. À medida que o aluno vai refletindo e analisando a situação problema, com a mediação do professor, a necessidade de aprofundar conteúdos surge imediatamente. Assim, é possível nortear os estudos e discutir todos os conteúdos previstos na disciplina num processo contínuo de ação-reflexão-ação.

O mapeamento dos conteúdos curriculares norteou o desenvolvimento dos projetos de estudos, permitindo a construção das competências e das habilidades específicas em acordo com os interesses individuais e grupais. Observou-se o desenvolvimento da capacidade de argumentar, apesar da visão errônea de que as disciplinas de matemática devem preocupar-se mais com o raciocínio lógico.

É possível caminhar para um processo mais dinâmico a medida que se busca a interdisciplinaridade e a medida que se assume alguns pressupostos metodológicos inovadores. Por exemplo, a idéia de não linearidade do conhecimento pode ser abraçada, apesar da difícil implementação quando se têm grades curriculares fechadas através de muitos pré-requisitos disciplinares.

A mobilização de saberes, através da virtualização de ações e através da capacidade de buscar recursos para atingir os objetivos previstos nos projetos, facilitou o desenvolvimento das competências requeridas.

Os relatos aqui colocados são pontuais e recortados, podendo ter lacunas ou não propiciando a visão de pequenos detalhes que surgem no dia-a-dia de sala de aula. Espera-se que a visão macro dos procedimentos tragam a reflexão didática tão urgente no contexto das Engenharias.

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Uma Abordagem do Uso das Ferramentas ERP e ISA Visando o Apoio às Atividades de Ensino

Ricardo Villarroel Dávalos[1] and Oscar Ciro Vaca López[2]

Resumo *— A Com a finalidade de auxiliar os usuários, proporcionando recursos e procedimentos para um gerenciamento eficiente das informações, a Universidade do Sul de Santa Catarina – Unisul implantou um Sistema Integrado de Gestão (Enterprise Resources Planning - ERP), apoiado por uma Arquitetura de Sistemas de Informação (Information Systems Architecture - ISA). Este artigo apresenta algumas experiências da implantação do SAP/R3 e do uso do ARIS na reestruturação da Unisul, para promover uma melhor integração dos alunos, docentes e colaboradores aos processos de gestão universitária, sendo que o aperfeiçoamento e a manutenção destes sistemas é apoiada por um grupo de pesquisa, que também proporciona suporte e inovação aos processos de aprendizagem que se vem praticando. Além disso, descreve-se neste trabalho, uma abordagem do ensino de Reengenharia de Processos de Negócios (Business Process Re-engineering - BPR), considerando que mudanças tecnológicas têm tornado possível executar tarefas de maneira bem diferente daquela anteriormente utilizada. Tendo em vista que a reestruturação da universidade e a implantação do ERP são tarefas de longo prazo e que exigem melhorias contínuas, o principal objetivo deste artigo é contribuir com a aplicação de conceitos de integração, mudanças organizacionais e tecnológicas nos procedimentos de ensino.*

Palavras Chave — Arquitetura de Sistemas de Informação, Estratégias de Ensino/Aprendizagem, Reengenharia de Processos de Negócios, Sistemas Integrados de Gestão.

I. INTRODUÇÃO

O rápido crescimento da Universidade do Sul de Santa Catarina - Unisul, nestes últimos anos, levou à procura de alternativas para agilizar os processos de planejamento, controle e tomada de decisões, além do cuidado em estabelecer uma base para futuros projetos de melhoria. A iniciativa de implantação de um Sistema Integrado de Gestão (Enterprise Resources Planning - ERP) surgiu como ferramenta para proporcionar soluções e também como oportunidade para introduzir mudanças tecnológicas.

Pode-se definir um ERP de diversas maneiras, dependendo do ponto de vista do estudioso do assunto: como um sistema de informações para uma organização; como uma arquitetura de *software*, que facilita o fluxo de informações entre todas as áreas como, por exemplo, manufatura, logística, finanças, recursos humanos, etc.; como um banco de dados único, que interage com um conjunto integrado de aplicativos e que consolida todas as operações da organização em um único ambiente computacional.

Como forma de contribuir para o processo de desenvolvimento e implantação de ERP, neste cenário surge a abordagem da Arquitetura de Sistemas de Informação (Information Systems Architecture – ISA). Uma arquitetura não deve ser vista como uma solução formal para todo problema tecnológico e que a mesma pode dinamizar processos de negócios, reduzir a complexidade dos ERP, capacitar a integração nas organizações através do compartilhamento dos dados e habilitar a evolução mais rápida para novas tecnologias através do uso de ferramentas automatizadas que facilitam a elaboração de uma arquitetura [5].

Os ERP estão ocupando um espaço amplo no mercado de *software,* sendo uma das razões, o fato da reorganização das instituições em torno de processos, idéia básica da Reengenharia de Processos de Negócios (Business Process Re-engineering - BPR), que consiste em redesenhar processos de negócios e que a Tecnologia de Informação (TI) é o elemento capaz de materializar este novo conceito nas organizações, ou seja esta tecnologia é ao mesmo tempo um habilitador e implementador de processos, fornecendo a sustentação necessária à implementação e gerenciamento de novos processos.

As universidades, conscientizadas da importância do assunto, têm celebrado acordos com fornecedores de *hardware* e *software*, recebendo recursos geralmente a custos simbólicos. Professores são treinados, laboratórios equipados e a ISA, juntamente com o ERP, passam a ser temas de grande importância, a ponto de gerar alterações curriculares (Ex.: Louisiana State University, California State University, Massachusett Institute of Technology, Universidade de São Paulo, Universidade Newton Paiva, etc).

A Unisul celebrou uma parceria acadêmica com a fornecedora de equipamentos IBM (International Business Machines), com a fornecedora do Sistema Integrado de

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Gestão SAP (Systeme Anwendungen Produkte in der Datenverarbeitung ou Systems Aplication Products in Data Processing) e com a fornecedora da Arquitetura de Sistemas de Informação ARIS (Architeture of Integrated Information System) da IDS – Scheer (Integrierte Datenverarbeitunssysteme ou Integrated Information Systems), que objetiva equipar um laboratório onde serão desenvolvidas atividades acadêmicas que atendam as necessidades dos cursos de graduação e pós-graduação, bem como a área de pesquisa.

Além disso, a Unisul implantou o SAP/R3 com a expectativa de disponibilizar informações, fornecer meios para uma integração, diminuir o esforço gerencial e operacional, oferecer transparência e estruturação do planejamento operacional, e apoiar aos processos de gestão universitária. Pretende-se também analisar as mudanças organizacionais e redesenhar os principais processos que as suportam mediante o uso da ferramenta ARIS.

Dado que o compromisso de uma instituição com sua vocação universitária se revela através do dinamismo de suas atividades de pesquisa, a Unisul tem criado como fruto desta parceria, o Grupo de Pesquisa em Sistemas Integrados de Gestão – GPSIG, que procura gerar conhecimentos em BPR e tecnologia em ERP, para a melhoria das práticas acadêmicas e administrativas.

A integração do grupo com as atividades de ensino e pesquisa vem sendo trabalhada e o objetivo principal deste artigo é contribuir com a aplicação dos conceitos de integração, mudanças organizacionais e tecnológicas nos procedimentos de ensino, através das experiências aqui descritas.

II. SISTEMAS INTEGRADOS DE GESTÃO

Com o avanço da TI, as organizações passaram a utilizar Sistemas de Informação (SI) para apoiar suas atividades. Vários destes sistemas foram desenvolvidos para atender aos requisitos específicos das diversas unidades de negócio, plantas, departamentos e escritórios. Um SI poderia ser compreendido como um conjunto de componentes inter-relacionados, desenvolvidos para coletar, processar, armazenar e distribuir informações, facilitando a coordenação, o controle, a análise, a visualização e o processo decisório nas organizações.

Os ERP são SI que integram informações e processos entre as diversas áreas funcionais da organização, proporcionando recursos e procedimentos, para um gerenciamento eficiente destas informações.

Os ERP representam o estágio mais avançado dos sistemas tradicionalmente chamados MRP II (Manufacturing Resource Planning –MRP*).* É composto basicamente de módulos que atendem as necessidades de informação, ligados a todos os processos operacionais, produtivos, administrativos e comerciais. A Figura 1 ilustra a estrutura típica de funcionamento integrado de um ERP, a partir de uma base de dados única [6].

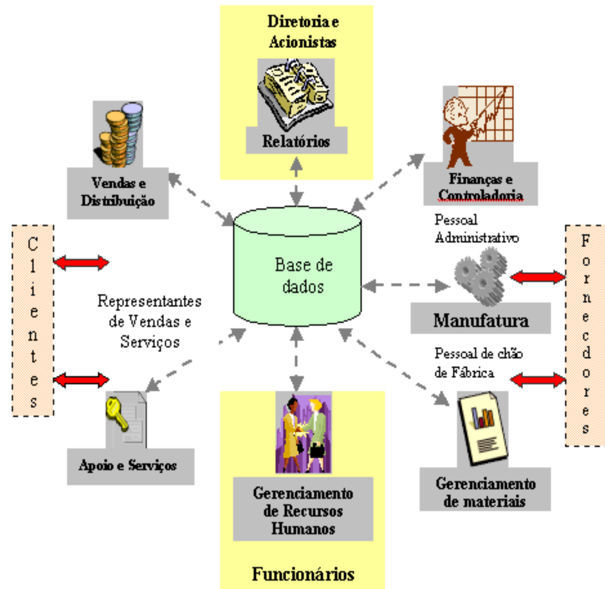

FIGURA. 1
ESTRUTURA TÍPICA DE FUNCIONAMENTO DE UM ERP

Os ERP abrangem uma gama de funcionalidades e processos empresariais. Logicamente, de acordo com o fornecedor do sistema, existe variação em amplitude (número de atividades e processos contemplados pelo sistema) e em profundidade (grau de especificidade e flexibilidade com que trata um processo determinado). De forma geral, estes sistemas fornecem suporte às atividades administrativas (finanças, recursos humanos, contabilidade e tributário), comerciais (pedidos, faturamento, logística e distribuição) e produtivas (projeto, manufatura, controle de estoques e custos).

Muitos ERP são comercializados em pacotes contendo módulos básicos para a gestão do negócio. Módulos adicionais podem ser adquiridos individualmente, em função do interesse e da estratégia da empresa. Todos esses aplicativos são completamente integrados, a fim de propiciar consistência e visibilidade a todas as atividades inerentes aos processos da organização. Nomes comerciais de ERP como SAP, BAAN, *Oracle Aplications*, BPCS, *Peoplesoft, JDEdwards*, MFG/Pro, Microsiga, Datasul, dentre outros, passaram a fazer parte das empresas de médio a grande porte no Brasil e no exterior.

Atualmente, os ERP se encontram cada vez mais ofuscados por: portais de negócios; cadeias de suprimento sincronizadas; sofisticados sistemas de logística; comercio eletrônico (*e-commerce*); provedores de ASP (Active Server Pages) e, principalmente, pelas ferramentas que irão possibilitar a integração de todos os processos de negócios.

Considerando as dificuldades que apresentam os ERP, os principais fornecedores já começaram a providenciar mudanças em seus produtos, tendo em vista a integração sintonizada de todos os processos internos e a conectividade da cadeia de suprimentos. Estes novos produtos estão sendo chamados de ERP II e sua evolução tecnológica vem sendo considerada como um fato natural, em decorrência das necessidades geradas pelos clientes. Assim, as principais características destes novos sistemas são a incorporação de módulos adicionais dentro dos módulos básicos ou também definidos como "*componentização*", a facilidade de troca de informações comerciais com outros sistemas concorrentes, a utilização de aplicações SCM (gestão da cadeia de suprimentos) e CRM (gestão de relacionamento com os clientes) de um outro fabricante e a orientação total para a *internet* [3].

III. Reengenharia de Processos de Negócios

Atualmente tem-se notado um grande interesse por parte dos empresários em assegurar que seus processos mais importantes sejam operados de maneira eficiente e eficaz, e este tem sido o objetivo da BPR. A idéia básica da reengenharia é estudar os processos fundamentais das organizações para efetuar inovações competitivas na qualidade, nas responsabilidades, nos custos, na flexibilidade e na satisfação.

Estas idéias estão em voga porque mudanças tecnológicas têm tornado possível imaginar maneiras de cumprir tarefas, radicalmente diferentes daquelas pelas quais eram executadas no passado. A modelagem de processos de negócios faz grande sentido para descobrir os componentes essenciais e sensíveis em que as melhorias farão diferença.

Nestes últimos anos a ênfase na definição de BPR vem sendo revista principalmente em suas definições de aspectos radicais e uso de TI. Assim, considerando estes aspectos, são indicadas algumas definições: o repensar fundamental e a reestruturação radical dos processos de negócios que visam alcançar drásticas melhorias em indicadores críticos e contemporâneos de desempenho, tais como custos, qualidade, atendimento e velocidade; uma abordagem utilizada no planejamento e controle da mudança; ferramenta gerencial que prega o questionamento e a inovação de processos produtivos; uma iniciativa organizacional para acompanhar uma estratégia orientada de (re)desenho de processos de negócios com a finalidade de atingir inovações competitivas na qualidade, responsabilidades, custos, flexibilidade e satisfação; etc [13].

Considerando a capacidade de captar informações de um processo de negócio e dar apoio às atividades de um projeto de BPR, os métodos de modelagem mais utilizados são: *Flowcharts; Workflow;* Metodologia de Definição Integrada; Modelagem de Negócios CIMOSA, Modelagem Orientada a Objeto; Linguagem de Modelagem Unificada - UML; Modelos de Simulação Dinâmica; Modelos de Relação entre Entidades; Diagramas de Causa e Efeito; Diagramas de Pareto; etc [10].

Os modelos de processos de negócios constituem uma referência para a implantação de SI, considerando-se que mediante os processos, estes sistemas estruturam suas funções. Um bom modelo poderá capturar informações em relação a processos utilizando quatro perspectivas: funcional, procedimental, organizacional e informativo. Além disso, revelou-se também que os modelos deveriam incorporar informações relacionadas com a importância da estratégia de um processo de negócio e seu valor para clientes.

As metodologias de BPR utilizam uma variedade de métodos de modelagem para dar suporte as suas atividades e em geral, consideram os aspectos: estratégia orientada e iniciativa de mudança organizacional; realização de objetivos organizacionais; consideração de limitações ou restrições; procura de mudanças radicais na performance de processos focalizando o cliente; avaliação da forma do trabalho, da estrutura organizacional e dos recursos humanos; uso da TI como facilitador de mudança e; manutenção e melhoria continua dos processos redesenhados [13].

O processo de desenvolvimento e implantação de SI é auxiliado pela ISA. O termo arquitetura foi inicialmente tratado como arquitetura de dados e como este termo tem acompanhado a evolução dos SI, apresenta uma visão mais abrangente, com a inclusão da perspectiva de negócios, da visão organizacional, dos próprios SI, da tecnologia disponível e o envolvimento dos usuários [17].

As perspectivas em ISA têm evoluído com a apresentação de modelos com enfoques diferenciados e envolvem de modo geral: a integração entre organização, negócios, sistemas, tecnologia e usuários; a apresentação de ferramenta de ISA; e a arquitetura tecnológica.

No final dos anos 80, o termo arquitetura, vinculado à área de *hardware,* passa a ser utilizado na área de *software* considerando toda a estrutura dos SI, desde o planejamento estratégico até o armazenamento de dados, inclusive a vinculação da ISA com a estratégia de SI.

Associadas à evolução do termo arquitetura, uma série de interpretações começa a surgir e passam a ser consideradas em quatro visões: arquitetura de dados; arquitetura tecnológica; arquitetura voltada para negócios; e arquitetura abrangente.

Contudo, o conceito que mais tem se destacado é o de arquitetura abrangente, que coloca a ISA como sendo o estabelecimento de um conjunto de elementos, cuja finalidade é proporcionar um mapeamento da organização, no tocante aos elementos envolvidos com o processo de desenvolvimento/implantação de SI.

Nesta linha de conceito abrangente, estão as pesquisas que trabalham com a integração dos SI e organização, denominados ERP. Os principais modelos de ISA encontrados na literatura são a estrutura proposta por Zachman, a arquitetura ARIS, a arquitetura CIM-OSA (Computer Integrated Manufacturing – Open System Architecture), a arquitetura SA2001 (System Architect 2001), dentre outros [5].

Enfim, a ISA abrangente, possibilita para os ERP, as contribuições básicas: aprimorar as atividades do planejamento estratégico, melhorar o desenvolvimento e a implantação, racionalizar a execução das atividades, economizar tempo, estabelecer ordem e controle no investimento de recursos, definir e inter-relacionar dados, fornecer comunicação clara entre os membros da organização, permitir melhorar e integrar ferramentas e metodologias de desenvolvimento de *software*, estabelecer credibilidade e confiança no investimento de recursos do sistema, e fornecer condições para aumentar a vantagem competitiva [17].

Assim, por exemplo, para poder entender um modelo ISA abrangente, a seguir será explicada, de forma geral, a arquitetura ARIS, que tem como característica principal refletir os componentes principais integrados de um SI e a perspectiva de negócios representada por uma seqüência de processos.

A arquitetura ARIS constitui uma estrutura na qual os SI integrados possam ser desenvolvidos, otimizados e convertidos em implementações técnicas EDP (Electronic Data Processing). Funções, organização, dados e controle compõem esta arquitetura, e usa como modelo para a modelagem dos dados, a abordagem ERM (entidade-relacionamento) estendida [16].

O modelo das cadeias de processos é tomado como ponto inicial para o desenvolvimento da arquitetura tornando-se difícil, entretanto, realizar uma análise sistemática destas cadeias, devido às suas complexas inter-relações e dependências, sendo que esta complexidade pode ser reduzida pela introdução de diferentes visões de processos de negócio que agrupam as informações.

Na visão funcional, um conjunto de processos de negócios é decomposto numa estrutura hierárquica de funções. Na visão baseada em dados, as classes de informação são definidas incluindo seus relacionamentos. Na visão organizacional, os relacionamentos entre as unidades da organização são descritos, unidades estas que são envolvidas em processos de negócios e que são responsáveis pelas informações e funções.

A complexidade é consideravelmente reduzida pela separação do problema original em visões diferentes mas, por outro lado, a descrição das relações entre estas se perde. Portanto, as diferentes visões são integradas em uma única, de controle, que liga as funções, os dados e a organização em um único processo e permite descrever a seqüência ou cadeia de processos.

A fim de enfatizar a diferença entre informação relacionada ao negócio e a informação relacionada ao suporte técnico, incorporou-se à arquitetura uma separação em três camadas diferentes: conceitual, técnica e de implementação.

A camada conceitual descreve um processo de negócio, independentemente das considerações técnicas. A linguagem usada para descrever o problema na camada conceitual é formalizada a ponto de poder ser usada como uma base para uma transformação consistente em uma linguagem de tecnologia de informação. As outras duas camadas, a técnica e a de implementação, são usadas para derivar a implementação técnica.

Considerando-se as diferentes visões de processos e a separação da arquitetura em camadas, foi desenvolvido o conceito ARIS, ilustrado na Figura 2. A visão de controle representa um componente essencial, resultando daí, a diferença entre esta e outras abordagens de arquitetura [16].

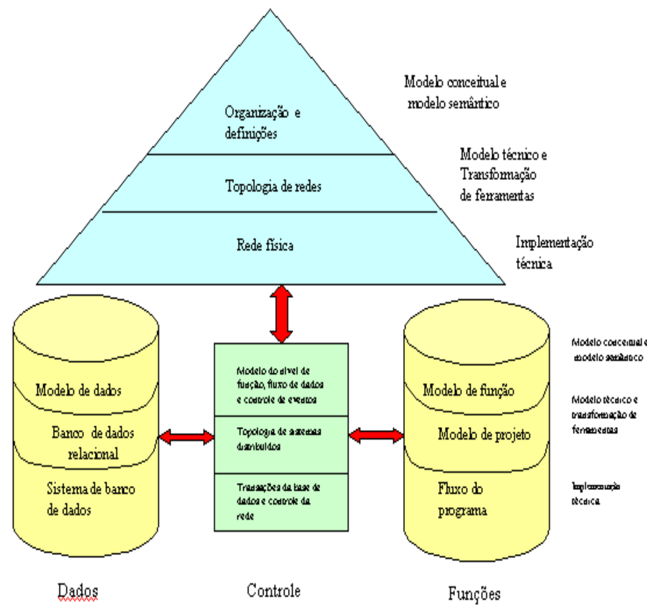

FIGURA. 2
O CONCEITO DA ARQUITETURA ARIS

A arquitetura ARIS, em conjunto com a metodologia BPI (Business Process Improvement), viabiliza a execução de projetos de BPR e oferece às organizações empresariais, a possibilidade de gerar uma base de dados de processos/procedimentos, que viabilizem implementar a melhoria contínua em ambiente corporativo, ou seja, a execução de uma ou várias atividades nos processos: análise de produtividade, redesenho, simulação dinâmica, otimização, especificação de sistemas, seleção de *software* de gestão, uso de modelos de referência, *benchmarking* de processos, implantação e gestão da qualidade, custos por atividade (Activity Based Costing - ABC), gestão do conhecimento e disponibilizar documentação via *internet/intranet*.

A abrangência das funcionalidades disponíveis pressupõe o uso da arquitetura por diversos departamentos/áreas da organização. Para que usuários de setores diferentes possam utilizar a mesma base de dados, compartilhando objetos e modelos, é necessário que todos os que geram documentação, tomem alguns cuidados, utilizando um "dicionário" de objetos válido em nível de corporação. O raciocínio se estende aos prestadores de serviço externo, que ao desenvolverem projetos, também geram documentação corporativa.

IV. IMPLANTAÇÃO DO SISTEMA INTEGRADO DE GESTÃO NA UNISUL

A seguir é descrito de forma geral, o processo de implantação do SAP/R3 mediante a descrição do "Projeto Visão" e a criação de um grupo de pesquisa para dar suporte a este sistema.

A. Projeto Visão

Na busca de um gerenciamento eficiente das informações, a Unisul implantou o SAP/R3 mediante o "Projeto Visão". O objetivo deste projeto foi reestruturar a universidade para promover uma melhor integração dos alunos, docentes e colaboradores nos processos de gestão universitária.

Inicialmente foram estudadas duas alternativas: comprar uma solução padrão e adequar a organização a este sistema ou reestruturar e normalizar processos antes de implantá-lo. Como a segunda alternativa demandaria grandes esforços (tempo, recursos humanos e financeiros, etc.), que culminariam, provavelmente, numa sistemática única de gerenciamento, levando à necessidade de uma grande parametrização do *software*, optou-se pela primeira alternativa, principalmente em função de que apenas alguns módulos relacionados com as atividades administrativas, financeiras e de controle de materiais seriam contemplados.

A primeira etapa do projeto contemplava a integração dos processos administrativos e financeiros, com a implantação dos módulos: financeiro (contabilidade geral, contas a pagar e receber, e tesouraria); administração (administração de ativo fixo); controladoria (contabilidade por centro de custo e por centro de lucro); suprimentos, logística e materiais (compras, controle de inventário, gerenciamento de estoques, verificação de faturas e planejamento de materiais baseado no consumo).

Esta primeira etapa foi definida por quatro fases: preparação do projeto; planejamento da implantação; implantação do sistema; início produtivo e suporte.

Nas primeiras duas fases foram realizadas cuidadosamente as análises de adequação para comprovar que, de fato, a solução atende minimamente às necessidades específicas da universidade. Nas últimas fases do procedimento de implantação, estão inseridas as atividades de: treinamento conceitual na lógica do SAP/R3, treinamento operacional, redesenho de processos, gestão da mudança organizacional, garantia das informações envolvidas, eventuais *customizações* e parametrização do sistema, entre outras.

A implantação do SAP/R3 contou com o comprometimento da direção e foi realizada por professores e funcionários da universidade, com a participação de consultores designados pelas empresas envolvidas na parceria. A importância desta implantação se justifica pela capacidade de apoio aos procedimentos de gestão e à tomada de decisões. Como a universidade apresenta uma grande quantidade de dados e processos, existe a necessidade de contar com procedimentos de tratamento da informação, mais precisos e rápidos.

A análise de adequação, da implantação, da manutenção e do uso do SAP/R3, demonstrou ser este, um procedimento de mudança organizacional, bastante abrangente e multifuncional, que está alterando toda a rotina com que a universidade desenvolve suas atividades.

As principais vantagens apresentadas pelo SAP/R3 são: a unificação da base de dados, eliminando-se o re-trabalho e a redundância de dados, trazendo maior confiabilidade às informações e o acesso em tempo real; melhor controle dos lançamentos do sistema; maior interação entre as áreas; diminuição da carga de atividades; redução do tempo total de andamento dos processos.

Em entrevistas realizadas com os usuários, além de constatadas as vantagens anteriormente descritas, os funcionários do setor administrativo, financeiro e de materiais demonstraram maior confiança e interesse em utilizar outros recursos que o SAP/R3 dispõe.

As principais dificuldades encontradas na implantação deste sistema foram: resistência à mudança por parte de alguns usuários quanto aos processos; morosidade na realização das atividades em função da insegurança dos usuários; ausência de informação normativa sobre os novos procedimentos de gestão; adequação ao novo ambiente de trabalho; administração das constantes exceções existentes nos processos.

Estas dificuldades foram contornadas mediante explanações e discussões sobre o andamento do procedimento de implantação, reconhecimento e remoção de resistências e mediante a participação dos integrantes do projeto.

A segunda etapa do projeto, a ser iniciada em breve, contempla a implantação dos módulos relacionados com: recursos humanos, projetos, gestão acadêmica e relacionamento com o acadêmico e parceiros.

B. Criação do Grupo de Pesquisa

Um grupo de pesquisa é composto por indivíduos organizados hierarquicamente, onde o fundamento organizador da hierarquia é a experiência, o destaque e a liderança no terreno científico e/ou tecnológico, apresentando envolvimento profissional e permanente com atividades de pesquisa, trabalho organizado em torno de umas poucas linhas comuns de investigação e compartilhando – de algum modo – instalações e equipamentos.

O GPSIG foi criado como um grupo estratégico de pesquisa para dar suporte às ações acadêmicas e administrativas na Unisul, integrado por professores e funcionários e liderados pelo Diretor de Pesquisa.

Os membros do Grupo possuem grande experiência, liderança e destaque no campo científico e apresentam envolvimento profissional e permanente com atividades de pesquisa. As suas histórias acadêmicas mostram que possuem formações diferentes e algumas convergências na especialização, nas pesquisas realizadas e nas disciplinas ministradas.

Considerando a abrangência e a complexidade dos assuntos abordados, o Grupo iniciou suas atividades com o nivelamento dos principais temas: planejamento estratégico e o programa de qualidade da Unisul; características das organizações universitárias; os processos nas organizações; sistemas de informação; implantação e usos do ERP na Unisul; prêmio Malcolm Balgrige de qualidade na educação; proposta de modelos de avaliação institucional para as universidades brasileiras; gestão da mudança através do *balanced scorecard.*

Os temas foram apresentados pelos integrantes do Grupo e por funcionários da Unisul, em forma de seminário. Adicionou-se a isto, os cursos e palestras dados pelos consultores da SAP e IDS-Scheer, assim como as discussões de artigos e as pesquisas realizadas na *internet*.

Uma vez estudados os assuntos, foram definidas duas áreas de atuação: Sistemas Integrados de Gestão por Processos e Gestão Universitária, sendo efetuado para cada uma, um planejamento estratégico, conduzido pelos objetivos e pelas necessidades do Grupo.

A seguir é apresentada a missão de cada área, respectivamente:

- gerar conhecimento e tecnologia em sistemas integrados de gestão por processos, para a melhoria da prática acadêmica e administrativa;
- gerar conhecimento em gestão universitária, para criar diferenciais competitivos para a Unisul.

Cada área tem por fim:

- ser referência como grupo de pesquisa aplicada em sistemas integrados de gestão por processos;
- ser um grupo de pesquisa de referência em gestão, gerando conhecimento para o alto desempenho de uma instituição de ensino superior.

Os participantes de cada área vêm realizando pesquisas e, nas freqüentes reuniões, os resultados são avaliados de acordo com os objetivos inicialmente propostos no planejamento estratégico e, além disso, dedicam-se à organização e a manutenção do laboratório.

V. Incorporação de Conceitos de BPR e ERP no Ensino

A BPR enfatiza a necessidade de se redesenhar os processos de negócios e que a TI disponível é o elemento capaz de materializar este novo conceito nas organizações, assim, estes processos são a referência para a implantação de um ERP. Considerando a abrangência dos assuntos relativos a BPR e ERP, são apresentadas a seguir algumas iniciativas a serem consideradas no ensino.

A. Iniciativas do ensino de BPR

Existem vários estágios na evolução de uma empresa em direção à organização por processos. Cada empresa atualmente se encontra em algum desses estágios e pode decidir passar para outro estágio que seja mais adequado às suas operações e perspectivas.

A idéia básica das iniciativas do ensino de BPR na universidade é de estudar os processos das organizações para efetuar inovações. É importante enfatizar que a automação dos processos de negócios já existentes, somente em raras ocasiões conduz a ganhos de produtividade superiores. A chave para o sucesso quase sempre jaz na modificação substancial e na melhoria dos processos de negócios, a qual é suportada por um sistema ERP muito bem afinado.

Quando se fala do ensino de BPR se tem dificuldade em responder as perguntas: o que, como e em que cursos ensinar?. Certamente os cursos voltados a SI são candidatos para ensinar este assunto. Em universidades onde este assunto tem-se desenvolvido, como por exemplo no Massachusett Institute of Technology - MIT, existem cursos novos em BPR, tais como, comportamento organizacional (com ênfase no desenho do trabalho), administração de operações (com ênfase nos procedimentos industriais), e contabilidade plena (com ênfase em sistemas financeiros), todos considerando a TI como base de estudos. Como outra alternativa, se poderia considerar que a BPR não deveria ocupar um curso inteiro, devendo ser combinado com outros tópicos para formar cursos como por exemplo: TI e Transformação Organizacional ou Mudanças nos Negócios e nos Sistemas [Davenport 2002].

O ensino de reengenharia em todos os cursos deveria transmitir: antecedentes históricos; tópicos de qualidade, melhoria contínua, TI, novas formas de análise de sistemas; as melhorias operacionais que tem a ver com o uso de TI, lidar com o fato de que se tornou um sinônimo de demissões, análise de empreendimentos realizados, a validade e outros assuntos relacionados com a BPR.

Uma prática que se vem aplicando na universidade para introduzir conceitos de BPR é a modelagem e simulação do funcionamento de novas formas operacionais de obtenção de resultados nas organizações, sejam eles produtos ou conquistas de qualquer outro tipo. Devido a sua interface gráfica, recursos de animação e a facilidade de modelagem de sistemas, o uso da simulação se traduz numa maior motivação dos alunos em aprender e aplicar os conceitos estudados [19].

Com a finalidade de estender estas práticas, o GPSIG se encontra preparando disciplinas voltadas à analise e redesenho de processos de negócios com o ARIS (ferramenta que surgiu através das experiências do sistema SAP/R3), para os cursos de graduação e de pós-graduação.

Espera-se mediante estas iniciativas mostrar as ligações entre a cadeia de suprimentos e o gerenciamento econômico/financeiro, entre os processos de fabricação e comercialização, etc. A experiência adquirida na implantação do ERP e as abordagens teóricas dos módulos Financeiro; Administrativo; Controladoria e Suprimentos, Logística e Materiais, também vêm contribuindo com este propósito.

Para contribuir ainda mais com o aprendizado experimental, pretende-se efetuar análises de estudos de caso, com modelos já existentes no ARIS. Este recurso pedagógico é usado satisfatoriamente em várias disciplinas, porém, as análises de equipes podem ser desvirtuadas pela falta de participação, pouca experiência em analisar coletivamente informações complexas e pela dominância exercida por alguns participantes.

Para contornar esta dificuldade é importante conhecer os alunos e, combinando as habilidades dos participantes, formar as equipes. Desta forma estaria sendo criado um ambiente de colaboração efetiva. As organizações em crescimento esperam que os profissionais trabalhem em várias equipes, realizando múltiplas funções. Esta experiência mostra que estudantes experimentam um ambiente de aprendizagem que melhor os prepara para ambientes de colaboração do mundo real [14].

B. Iniciativas de uso do ERP nos procedimentos de ensino

As alianças da SAP nasceram na Alemanha, na década do 80. Lá, mais do que aqui, o intercâmbio de conhecimento entre a iniciativa privada e o setor acadêmico é uma cultura fortemente arraigada. No Brasil, esta história começou há pouco tempo, nos primeiros meses de 1997, sendo que as primeiras instituições decidiram empregar este sistema no ensino de graduação, especialização e pós-graduação. As pesquisas que se vem desenvolvendo vão, desde a criação de *templetes* mais adequados à realidade de uma empresa brasileira do mercado agrícola nacional, até a produção integrada e gestão da cadeia de suprimentos.

A versão acadêmica do SAP/R3 está constituída por uma base de dados de uma companhia hipotética e seu uso está voltado para executar transações (centro de custo, ordens de compra, faturas, requisições, etc.), analisar desempenhos (rentabilidade, análise de vendas, planejamento da produção e compras, análise financeira, etc.) e avaliar a estrutura global da companhia. Os exemplos desta versão incluem Contabilidade Financeira (definição de dados para a estrutura organizacional da companhia), Tesouraria (disponibilidade de caixa e dados da administração), Controladoria (controle e definição áreas operacionais), Logística (estoques, linhas de produto, instalações, etc), Vendas e Distribuição (organização de vendas, registros de cliente, distribuição de produtos, etc.). Esta versão com a finalidade de dar suporte ao ensino na Universidade do Estado de Louisiana (Louisiana State University), vem sendo usada de forma satisfatória [20].

Mediante as atividades de ensino comentadas a seguir, o GPSIG pretende introduzir, através da versão acadêmica SAP/R3, o entendimento amplo da forma como a empresa opera, a integração de conceitos estudados nos diferentes cursos e sua relação com mudança organizacional e tecnológica; desafios envolvidos em sua implantação e desenvolvimento destes sistemas. Além disso, sabe-se que os processos de negócios nas organizações mudam, implicando também mudanças no sistema e modelo que os suporta. Pretende-se, para isto proporcionar uma cobertura significativa de ERP, através de um aprendizado experimental e estudos comparativos de impactos produzidos em diferentes organizações.

Considerando o recente início de atividades de pesquisa do GPSIG e a pouca literatura voltada para o ensino, as principais iniciativas de uso de ERP no ensino são: elaboração de uma apostila com descrição das principais pesquisas; organização de eventos; publicação de artigos; apoio às atividades administrativas; visitas a empresas e instituições que trabalhem com ERP; estudos de aplicação do sistema em sala de aula.

As iniciativas no ensino estão vinculadas a quais cursos serão envolvidos, quais disciplinas afetadas, eventuais inclusões de novas disciplinas, etc. Desta forma, nos cursos ligados às áreas de negócios (Administração, Contabilidade, Economia, Marketing), seriam utilizados estes sistemas para o entendimento amplo da forma como a empresa opera e a integração de conceitos dos diferentes cursos [11].

Também, nos cursos ligados às áreas de tecnologia (Computação, Sistemas de Informação e Engenharias), além da utilização anteriormente comentada, se mostraria aos alunos o papel dos SI na empresa e os desafios envolvidos em sua implantação e gerenciamento, podendo-se chegar até mesmo ao desenvolvimento de projetos integrados, envolvendo alunos de diversos cursos e de outros grupos de pesquisa. O Grupo de Sistemas Computacionais Inteligentes da Unisul, por exemplo, com o apoio do Governo do Estado de Santa Catarina e Ministério da Ciência e Tecnologia, vem implementando um SI para micro e pequenas empresas da região.

Além disso, professores em formação vêm desenvolvendo teses de doutorado relacionadas a metodologias de ensino baseados em conceitos de BPR e ERP. Contatos com professores e grupos de pesquisadores de outras instituições vêm sendo aprimorados, para intercâmbio de informações sobre trabalhos em andamento.

VI. CONCLUSÕES

Este trabalho apresentou um conjunto de experiências da implantação do SAP/R3 e o uso do ARIS como ferramenta de redesenho de processos de negócios. Além disso, foi descrita a formação de um grupo de pesquisa para dar suporte a estes sistemas e propor a incorporação de conceitos de BPR e ERP nos procedimentos de ensino, sendo que esta proposta pode ser aplicada em universidades que buscam soluções deste tipo.

O emprego dos sistemas abordados aqui proporcionam um grande apoio aos processos de aprendizagem, mediante a aplicação de estudos de caso e experiências de uso. Desta forma, a visão holística transmitida aos alunos contribui para a concepção de uma imagem única e sintética de todos os elementos da empresa, que normalmente estão relacionados com visões parciais, abrangendo suas estratégias, atividades, informações, recursos e organização. Esta prática está sendo melhorada, com o desenvolvimento de aplicações mais completas e detalhadas, nos cursos de pós-graduação.

A utilização de conceitos de integração, mudanças organizacionais e tecnológicas, propostas neste artigo, considerou características básicas em virtude da recente implantação do SAP/R3 e uso do ARIS. Estas iniciativas se tornam importantes pela disponibilidade de novas tecnologias em habilitar inovações educacionais e por esta razão, propõem-se discussões para definir procedimentos de aprendizagem mais adequados, com base nas experiências aqui relatadas .

Para introduzir conceitos de BPR e ERP nos currículos universitários é importante que a visão para sua utilização esteja focalizada nos processos de aprendizagem experimental e não como treinamento para profissionais. Algumas universidades vêm oferecendo cursos totalmente voltados para sistemas específicos. Evidentemente, esta proposta poderia funcionar como uma estrutura de treinamento para técnicos que iriam auxiliar na implantação e/ou utilização daquele sistema, mas foge dos objetivos da universidade. Por isso, recomenda-se cuidado especial ao introduzir estas iniciativas.

A experiência adquirida na implantação do SAP/R3 e uso do ARIS, vem sendo utilizada para modelar e simular processos de situações reais das organizações. A partir disto, pretende-se pesquisar metodologias que tragam inovações educacionais, baseados nos conceitos aqui abordados.

O GPSIG é consciente de que o trabalho não está concluído com a implantação do SAP/R3, apenas inicia, pois estes sempre terão novas versões e ajustes para que correspondam as mudanças organizacionais que vem sofrendo a Unisul. Além disso, a carência de pessoal treinado e os problemas decorrentes, fortalecem ainda mais as pesquisas que o grupo vem desenvolvendo.

Considerando a abrangência dos assuntos relativos a BPR e ERP, a reestruturação organizacional que ocorre na universidade e o início de atividades do GPSIG, espera-se contar, em curto prazo, com resultados mais consistentes e com a possibilidade de dar suporte mais eficiente às ações acadêmicas e administrativas.

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AULA EXPOSITIVA: UM ESTUDO EXPLORATÓRIO UTILIZANDO A TEORIA DAS INTELIGÊNCIAS MÚLTIPLAS PARA CURSOS DE GRADUAÇÃO DA ÁREA DE COMPUTAÇÃO E ENGENHARIA

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Abstract *— Durante muito tempo o cerne de muitos processos de ensino e aprendizagem têm sido o "aprender a aprender". As mudanças são características estáveis na dinâmica mercadológica atual e é necessário adequar o processo de ensino/aprendizagem para desenvolver profissionais capacitados a interagir nesse ambiente. O mercado atual provoca valorização de profissionais diferenciados (além da necessidade "tecnicista") como aplicação de certas técnicas de gestão moderna que exige competências específicas, desenvolvimento de novas tecnologias que requer, eventualmente, uma cooperação e uma colaboração por equipes virtuais, dentre outras. Estas e outra são características que devem ser estimuladas no ambiente formal de aprendizagem (sala de aula). Nesse trabalho a incorporação da Teoria das Inteligências Múltiplas à estratégia de ensino aula expositiva dentro do curso de graduação, tem como objetivo refletir sobre novas possibilidades que auxiliará o processo de aprendizagem e o desenvolvimento de habilidades pessoais e técnicas necessárias ao profissional em formação.*

Index Terms — Aula expositiva, estratégia de ensino, processo de ensino aprendizagem, inteligências múltiplas.

ESTRATÉGIAS DE ENSINO

O termo estratégia de ensino designa um conjunto de atividades didáticas, selecionadas e organizadas pelo docente, que servirão como meios de ajuda para que os objetivos sejam alcançados. A estratégia abrange métodos, técnicas e recursos institucionais a ser usado durante parte ou todo desenvolvimento de uma disciplina. [12] [17]

Em outras palavras, estratégia de ensino é o conjunto de métodos e técnicas que serão utilizados a fim de que o processo de ensino/aprendizagem se realize com êxito, levando em consideração o momento do ensino e a motivação necessária para o sucesso da metodologia escolhida. Focaliza a aprendizagem do educando respeitando sua liberdade e levando-o à assimilação de diretrizes, atitudes e valores que o tornarão melhor em seus múltiplos aspectos.

Dentre os métodos, que podem ser chamados de técnicas e estratégias, os mais utilizados no ensino de ciências exatas são: aula expositiva, projeto, seminário, trabalho em grupo, estágios, aulas em laboratórios e cada um deles apropriado para cada situação. [1]

Toda estratégia tem por objetivo o direcionamento da aprendizagem.

Várias das estratégias de ensino existentes e que podem ser utilizadas, de acordo com a necessidade, para alcançar aos objetivos planejados podem ser implementadas de duas formas: individualizada ou em grupo, de acordo com o tipo de habilidade e conteúdo que deverá ser trabalhado e a opção por cada uma delas está diretamente ligada aos objetivos a serem alcançados assim como à preferência do educador.

Na TABELAI encontra-se uma descrição dos tipos e categorias das estratégias existentes.

TABELA I
RESUMO DAS CATEGORIAS E ESTRATÉGIAS DE ENSINO
(ADAPTADO [16] E [14])

Categoria	Estratégias
Situações simuladas que reproduzem ou se assemelham à realidade pela equivalência	Dramatização, desempenho de papéis, jogos dramáticos, Estudo de caso.
Situações que colocam os estudantes em confronto com situações reais	Estágios, Visitas Técnicas, Projeto de final de curso
Estratégias que dividem a classe em pequenos grupos	Pequenos grupos com uma só tarefa, Pequenos grupos com tarefas diversas, Grupo de integração horizontal e vertical Grupo de verbalização e grupo de observação, Diálogos sucessivos, Pequenos grupos para formular questões, Grupos de oposição
Situações que exigem a presença de um especialista e/ou uma preparação prévia	Painel ,Simpósio,Seminário
Estratégias em que o educador centraliza a ação	Aula Expositiva,Debate com a classe toda
Pesquisas e Projetos	

Independentemente da estratégia a ser utilizada, a consciência de que existem diferentes estilos de ensino e aprendizagem e que há um número maior de habilidades pessoais e profissionais que podem e devem ser desenvolvidas de acordo com a abordagem da disciplina, deve estar presente durante toda o processo.

A flexibilidade de utilização de diferentes estratégias para um mesmo assunto ou dentro de uma determinada disciplina serve de uma importante ferramenta para a construção do conhecimento e desenvolvimento de

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determinadas habilidades, assim como um meio de avaliação de desempenho pessoal de todos envolvidos.

Essa situação propicia a um constante aprimoramento e um repensar de como um determinado conteúdo poderia ser trabalhado, num próximo momento.

Embora cada conteúdo tenha sua particularidade, todas as estratégias devem auxiliar a busca para ampliação dos conhecimentos, destrezas, aptidões técnicas, de comunicações e relações humanas pelos indivíduos; [2]

Como, além do repasse do conteúdo específico, deve haver também a finalidade a de se desenvolver habilidades e competências profissionais necessárias, Howard Gardner, professor doutor da Universidade de Harvard, a partir de um estudo científico, classificou quais habilidades poderiam ser desenvolvidas e consideradas fundamentais para a perfeita atuação do Homem na sociedade atual.

Nessa classificação das habilidades, definidas como inteligência, nota-se que muitas das classificadas por ele são as necessárias e fundamentais para a perfeita adaptação do profissional no mercado atual.

Ao utilizar determinadas estratégias, desenvolvendo inteligências específicas e objetivando a uma melhor preparação do indivíduo como um todo – pessoal e profissional – todos os envolvidos e instituições ligadas, direta ou indiretamente ao processo de ensino/aprendizagem , estariam alcançando uma de suas metas – ajudando na construção do conhecimento técnico assim como desenvolvendo habilidades e competências específicas para inserção do profissional no mercado de trabalho forma efetiva e competitiva.

TEORIA DAS INTELIGÊNCIAS MÚLTIPLAS SEGUNDO HOWARD GARDNER

O quociente de inteligência (QI) e o modo como era utilizado – meio para medição da inteligência – teve indiscutivelmente sua contribuição positiva nos meios científicos, acadêmicos e profissionais, mas agregado às suas vantagens veio à conseqüência de exercer um considerável efeito sobre a futura predisposição do um indivíduo à aprendizagem e ao seu desenvolvimento, dependendo do resultado alcançado. Determinado o valor do quociente de inteligência e comunicado à pessoa que havia se submetido ao teste, era como se a este valor fosse agregado um ‘ destino’.

A importância vinculada ao valor não é inteiramente inadequada. O escore em um teste de inteligência de fato prevê a habilidade da pessoa em relação à assimilação do conteúdo, mas não prevê sobre seu desempenho relacionado a habilidades e competências. [2]

Através da observação da existência de uma diferença entre o sucesso em assimilar matérias escolares (conteúdos) e sucesso na ‘vida pessoal e profissional’ do indivíduo, percebeu-se que inteligência era um conceito muito mais amplo do que o previsto nos testes de QI.

Com o desenvolvimento dos estudos sobre a pluralização da inteligência e fatos comprovantes de que nem sempre o melhor aluno da classe é o melhor profissional, houve a constatação de que desempenho pessoal escolar e profissional vai além da capacidade de assimilação de conteúdos proposta pelos meios acadêmicos.

Nesse contexto, houve o desenvolvimento de várias teorias e dentre elas a elaborada pelo Prof. Dr. Howard Gardner, que concebeu uma nova e diferente visão sobre as competências intelectuais humanas, baseando-se em muitos anos de pesquisa em psicologia cognitiva e neuropsicológica, levando em consideração a influência e a quantidade de informações existentes no contexto social, econômico e cultural em que a pessoa vive.

A Teoria das Inteligências Múltiplas é uma nova teoria de competências intelectuais humanas. Ela desafia a visão clássica da inteligência que muitos assimilaram explicitamente pela psicologia ou através dos testes de educação ou implicitamente - vivendo numa cultura com uma concepção forte, mas possivelmente circunscrita, de inteligência. [20]

Para chegarem a definição da pluralidade da inteligência, todas as definições de inteligência e meios de cognições humanas foram pesquisadas e estudadas [15].

Esta pesquisa envolveu tanto os relacionamentos a nível comportamental como os fisiológicos e está constantemente sendo reavaliada.

As inteligências presentes na Teoria das Inteligências Múltiplas, comprovadas pelos critérios relacionados são:

- **Inteligência Lingüística**: Capacidade de lidar bem com a linguagem, tanto na expressão verbal quanto escrita. A linguagem é considerada um exemplo preeminente da inteligência humana. Seja pra escrever ou para vencer um desafio verbal, a opção precisa das palavras prova o quão ela é importante. Na nossa sociedade ela chega a ser considerada como o melhor meio para executar negócios, tarefas, comunicar acontecimentos, etc. Características: gostar de ler; gostar de escrever; entender a ordem e o significado das palavras; fazer palavras cruzadas; convencer alguém sobre um fato; explicar, ensinar e aprender; contar estórias; senso de humor; etc.
- **Inteligência Musical**: Capacidade de interpretar, escrever, ler e expressar-se pela música. Características: reconhecimento de estrutura musical; esquemas para ouvir música; sensibilidade para sons; criação de melodias/ritmos; percepção das qualidades dos tons e sons; habilidade para tocar instrumentos, etc.
- **Inteligência Lógico-Matemática**: Competência em desenvolver e/ou acompanhar cadeias de raciocínios, resolver problemas lógicos e lidar bem com cálculos e números. É a mais conhecida faculdade cognitiva e normalmente associada à habilidade de desenvolver raciocínios dedutivos, construir ou acompanhar cadeias causais, m vislumbrar soluções para problemas, etc. Não requer articulação verbal, uma vez que pode resolver problemas ‘mentalmente’, sendo necessário somente à articulação verbal na comunicação dos resultados. Características: reconhecimento de padrões abstratos; raciocínio indutivo e dedutivo; discernimento de relações/conexões; preferências por jogos estratégicos e experimentos, etc.

- **Inteligência Espacial:** Competência relacionada à capacidade de extrapolar situações espaciais para o concreto e vice-versa Possui grande percepção e relacionamento com o espaço. Características: percepção acurada de diferentes ângulos; reconhecimento de relações entre objetos e espaços; representação gráfica; descoberta de caminhos no espaço tridimensional; imaginação ativa; gosto por jogos do tipo quebra-cabeça, etc.
- **Inteligência Corporal-Cinestésica**: Está relacionada à perfeita forma de expressão corporal, assim com a resolução de determinada dificuldade por meio de movimentos do corpo. Características: funções corporais desenvolvidas (danças, esportes, etc.); conexão corpo-mente; alerta através do corpo (sentidos); controle dos movimentos pré-programados; controles dos movimentos voluntários, etc.
- **Inteligências Pessoais** a) **Intrapessoal** → capacidade de se conhecer, de entrar em contato com seu próprio ' self', de se auto-avaliar. Reconhecendo seus pontos positivos e negativos, ficando desta forma mais fácil trabalhá-los. Está associado aos aspectos internos de uma pessoa, é o acesso à sua própria vida sentimental – a gama de afeto e emoções. Características: Concentração total da mente; Preocupação; Metacoginição; Percepção e expressão de diferentes sentimentos íntimos; Senso de autoconhecimento; Capacidade de abstração e raciocínio. b) **Interpessoal** → revela-se através de uma habilidade especial em relacionar-se bem com os outros, em perceber seus humores, suas motivações, em captar suas intenções, mesmo as menos evidentes e utilizar esta habilidade para agir com coerência e cooperativamente. Características: criação e manutenção de sinergia; superação e entendimento da perspectiva do outro; trabalho cooperativo; percepção e distinção dos diferentes estados 'emocionais'; comunicação verbal e não-verbal; capacidade de liderança e motivação, etc.
- **Inteligência Naturalista**: capacidade de observação, entendimento e organização de padrões no ambiente natural (reconhecer a flora e fauna). Características: gostar da natureza e sentir conforto ao ar livre; colecionar objetos do mundo natural; observar a natureza; notar as diferenças e mudanças na natureza; facilidade em guardar nomes de fenômenos naturais; etc.
- **Inteligência Existencial**: responsável pela necessidade do homem fazer perguntas sobre si mesmo, sua origem e seu fim.

A Utilização da Teoria das Inteligências Múltiplas Agregada a Estratégias de Ensino: Aula Expositiva

No momento da escolha de um dos métodos de ensino existentes, o educador deve ter em mente que o "ensinar" caracteriza-se pela combinação de atividades e deveres entre todos os envolvidos no processo de ensino e aprendizagem.

Nesse processo, sob a direção do educador, os estudantes vão atingindo gradativamente o desenvolvimento de suas capacidades mentais. O sucesso do desenvolvimento está diretamente ligado à capacidade do educador de sistematizar, tanto no planejamento quanto no desenvolvimento das aulas, os objetivos, conteúdos e as estratégias com a finalidade de facilitar o processo de ensino [13]

A estratégia utilizada dentro da sala de aula funciona como uma técnica insuperável para transmitir a informação necessária do assunto a ser trabalhado. Mas ajudar a transformá-lo em conhecimento e em mudanças de atitudes requer uma percepção maior por parte do responsável pelo processo de ensino e aprendizagem. Essa percepção pode ser desenvolvida num grau maior se houver a possibilidade de utilizar um referencial como forma de monitoramento de atividades didáticas .

A teoria das Inteligências Múltiplas e não um método estruturado, dessa forma, ajuda neste direcionamento, cujo objetivo é desenvolver um profissional o mais próximo possível do solicitado pelo mercado. Leva em consideração características pessoais individuais e aponta, sem classificar, para formas de desenvolver determinadas características pessoais. Por isso, tê-la como uma variável ativa durante a atividade da utilização das estratégias (seminário, aula expositiva, projeto) é uma forma de garantir o sucesso do desenvolvimento de características pessoais - capacidade de trabalhar em equipe, capacidade de escrever, ler e falar em público, capacidade de trabalhar de forma individual e a capacidade de utilizar as habilidades lógico-matemáticas desenvolvidas dentro dos cursos de exatas - de forma integrada às características técnicas.

Aula Expositiva

A aula expositiva consiste numa preleção verbal e escrita, utilizada pelos professores com o objetivo de transmitir informações sobre um determinado conteúdo específico. É uma estratégia antiga e, no Brasil, constitui seguramente a mais empregada no ensino de graduação. Em muitos cursos universitários é utilizado quase que de forma exclusiva e são em grande número as pessoas que identificam ensino com exposição de conteúdos. [9]

A aula expositiva, no sentido clássico, fundamenta-se na idéia de que é possível ensinar por meio da explicação oral, ou seja, condensar o conhecimento e expô-lo, verbalmente ou por meio da escrita, de forma lógica e clara. Assim, nesta técnica, a comunicação é importante para que ocorra a transmissão da informação e a recepção dela de forma correta.

Na aula expositiva, como o próprio nome diz, o foco está na exposição, feita por pessoas que tenham um conhecimento satisfatório sobre o assunto, e por isso, pode ocorrer o negligenciamento da importância do interesse e da atenção do aluno. Uma palavra desconhecida mencionada, um ritmo de fala maior do que o habitual, muitas idéias expostas ao mesmo tempo pode fazer com que a informação a ser transmitida não seja retida.

A aula expositiva e sua relação com a Teoria das Inteligências Múltiplas

Minimizar o descompasso existente no ensino superior, entre a preparação técnica e no desenvolvimento de suas habilidades e competências direciona a iniciativas pedagógicas inovadoras objetivando elevar a excelência do ensino.

A utilização da Teoria das Inteligências Múltiplas como direcionamento, dentro do contexto da estratégia aula expositiva, visa a diminuir esse descompasso, enquanto serve de ferramenta no desenvolvimento consciente de características e posturas exigidas atualmente.

Dentre as várias características necessárias para o bom desempenho profissional nos dias de hoje, pode-se destacar: Habilidade técnica específica da área de atuação da profissão escolhida; Capacidade de trabalhar em equipe (aprender a trabalhar em equipe); Facilidade e capacidade de "aprender a aprender", desenvolvendo a autonomia do aprendizado; Desenvolvimento de trabalhos individuais sem, contudo, perder a dimensão do todo; Capacidade de expressão oral e escrita.

Essas características poderão ser largamente estimuladas, durante as aulas expositivas, se forem direcionadas pela Teoria das Inteligências Múltiplas, mesmo sendo, essa estratégica, totalmente centralizada e direcionada pelo responsável pela transmissão do conteúdo técnico.

Ao fazer um paralelo entre a Teoria das Inteligências Múltiplas e as características pessoais/técnicas necessárias ao profissional de engenharia, pode-se observar que elas estão diretamente interligadas, por definição. Ou seja, ao estimular determinadas inteligências, o que se consegue é um desenvolvimento melhor da técnica e das características pessoais/profissionais da área. TABELA II.

A aula expositiva pode ser dividida em vários momentos interligados, que se repetem durante toda a atividade, dentre eles e o cuidado e coordenação desses momentos de forma consciente nos leva a uma melhor capacitação pessoal/profissional dos educandos.

Na Tabela II, encontra-se uma possibilidade de divisão das atividades relacionadas à aula expositiva e como e em qual momento as inteligências, objetivando o desenvolvimento das competências específicas são estimuladas.

Durante a atividade, o educador deverá fazer uma abordagem sobre o espírito de cooperação em equipe, de acordo com sua habilidade, de modo que os próprios participantes do processo tomem consciência de que já pertencem a um grupo e a conduta de uns influencia diretamente o desempenho de todos. Essa percepção induzida é o começo do desenvolvimento das inteligências pessoais.

A partir da percepção individual (inteligência intrapessoal – ao fazer com que as condutas alheias não tragam grandes transtornos ao seu processo de aprendizagem) e do grupo (inteligência interpessoal – ajudando o outro a tomar consciência da sua responsabilidade no desenvolvimento do grupo), é desenvolvido o espírito de cooperação e as conversas paralelas tendem a ser minimizadas devido ao fato de entenderem que há determinados "conhecimentos" que não serão adquiridos em livros ou em outros momentos.

A responsabilidade de integração do grupo e o desenvolvimento do senso de responsabilidade individual e grupal não é do educador. A ele cabe apenas expor que pessoas diferentes, trabalhando dentro do mesmo ambiente, com condutas e interesses individuais sempre existirá. Ou seja, estimula a consciência de que a sala de aula deve ser encarada com um laboratório para atividades e condutas futuras e que todos pertencem a um mesmo ambiente com alguns objetivos comuns.

Enquanto ocorre a explicação oral e escrita, a inteligência lógica é estimulada, pois, conforme o assunto vai sendo abordadas novas associações cognitivas vão sendo desenvolvidas e interiorizadas.

Muitas vezes, questões que trabalham essas associações podem ser formuladas e os estudantes terão que recorrer a conceitos pré-estabelecidos para respondê-las.

Durante todo processo da aula expositiva, a inteligência lingüística é estimulada. Por isso, é crucial que o educador tome todo cuidado com sua postura escrita e falada porque dela dependerá todo o desenvolvimento por parte dos estudantes. A utilização correta do vocabulário da área, assim como uma expressão clara e objetiva de todos os assuntos servirá de exemplo e de subsídios para uma posterior avaliação do desenvolvimento da postura profissional.

A expressão oral e escrito é fundamental para o bom desempenho profissional de qualquer área, e especificamente dentro do ensino de engenharia deverá ser estimulada de forma diferenciada uma vez que a maior ênfase está no desenvolvimento lógico e técnico do indivíduo, dando-se muita pouca ênfase à postura escrita e falada do estudante, como se não as fosse utilizar nunca na vida profissional. Nesse contexto, o exemplo torna-se fundamental, bem como o estímulo diferenciado em direção à inteligência lingüística. A discussão de textos relacionados à área e ao conteúdo a serem trabalhados pode servir como aliada nesse momento, fazendo que, além da capacidade de leitura e abstração de um texto escrito relacionado a um assunto técnico, seja desenvolvida a capacidade crítica individual de utilização prática e efetiva do conteúdo.

Devido à imaturidade, nas atividades iniciais, os estudantes devem ser constantemente monitorados para que ocorra o efetivo desenvolvimento.

Como pode ser observado, não se trata de acabar com a estrutura de sala de aula ou com a aula expositiva, mas simplesmente revitalizá-la, contando inclusive com o suporte dos recursos (giz, quadro negro, equipamentos tecnológicos, etc) e tendo como colaboradora para o sucesso pedagógico da disciplina a Teoria das Inteligências Múltiplas.

TABELA II

RELAÇÃO ENTRE COMPETÊNCIAS, INTELIGÊNCIAS ESTIMULADAS E MOMENTOS EXISTENTES NA AULA EXPOSITIVA

Competências	Inteligências	Momento
Habilidade técnica específica da área de atuação da profissão escolhida	Inteligência Lógica Inteligência pessoal (inter e intrapessoal) Inteligência Lingüística	Todos os momentos da utilização da estratégia
Capacidade de trabalhar em equipe. (aprender a trabalhar em equipe);	Inteligência pessoal (inter e intrapessoal) Inteligência lingüística	Expressão Oral (educador e educando) Expressão Escrita (educador) Pesquisas em assuntos relacionados (educando)
Facilidade e capacidade de "aprender a aprender";	Inteligência pessoal (inter e intrapessoal) Inteligência lingüística Inteligência lógica	Solicitação de feedback (educador) Expressão Oral (educador) Pesquisas bibliográficas (educando)
Desenvolvimento de trabalhos individuais sem, contudo, perder a dimensão do todo;	Inteligência Intrapessoal Inteligência lógica Inteligência Lingüística	Expressão Oral (educador, educando) Expressão Escrita Exercícios (educando) Solicitação de feedback (educador, educando)
Capacidade de expressão oral e escrita;	Inteligência pessoal (inter e intrapessoal) Inteligência lógica Inteligência lingüística	Exercícios (educando) Expressão Escrita (educador, educando) Solicitação de feedback (educador, educando) Pesquisas em assuntos relacionados (educando) Reprodução de textos escritos sobre o assunto (educando)

CONCLUSÃO

A estratégia utilizada dentro da sala de aula funciona como uma técnica insuperável para transmitir a informação necessária do assunto a ser trabalhado. Mas ajudar a transformá-lo em conhecimento e em mudanças de atitudes requer uma percepção maior por parte do responsável pelo processo de ensino e aprendizagem. Essa percepção pode ser desenvolvida num grau maior se houver a possibilidade de utilizar um referencial como forma de monitoramento de atividades didáticas.

A Teoria das Inteligências Múltiplas, por ser uma teoria e não um método estruturado, ajuda neste direcionamento, cujo objetivo é desenvolver um profissional o mais próximo possível do solicitado pelo mercado.

A teoria leva em consideração características pessoais individuais e aponta, sem classificar, para formas de desenvolver determinadas características pessoais. Por isso, tê-la como uma variável ativa durante a atividade da utilização das estratégias (seminário, aula expositiva, projeto) é uma forma de garantir o sucesso do desenvolvimento de características pessoais - capacidade de trabalhar em equipe, capacidade de escrever, ler e falar em público, capacidade de trabalhar de forma individual e a capacidade de utilizar as habilidades lógico-matemáticas desenvolvidas dentro dos cursos de exatas - de forma integrada às características técnicas.

Portanto, agregar a Teoria das Inteligências Múltiplas às estratégias de ensino, especificamente à aula expositiva, em cursos de 3º grau tem como objetivo revitalizar o ensino e facilitar a aprendizagem de forma a suprir as necessidades de mercado por um profissional que saiba inter-relacionar as habilidades técnicas e pessoais.

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Implementando um mecanismo de processamento de conhecimento em um ambiente de aprendizado baseado na Web

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Abstract *— The evolution of paradigm's related to epistemology, didactic and cognitive science has allowed the implementation of computational model's called cognitive architecture. This article describes an implementation of a cognitive architecture with the objective of increasing and sharing the constructed knowledge based on PBL (Problem-Based Learning). The architecture is used as a knowledge processing strategy in an learning environment that uses web technology, called INVENTE, which is integrated to a knowledge processing system called WITTY. While the WITTY system allows the making of applications of wide spectrum, particularly learning systems, the INVENTE is a WBLE (Web-Based Learning Environment) designed to support distance learning in technological teaching schools using Internet. Our cognitive architecture is implemented by incorporating the INVENTE functionalities, such as dynamic navigation, virtual environment metaphor, meaning and collaboration, and video conference together with WITTY knowledge acquisition capabilities. These functionalities can be used remotely via WEB SERVICES protocols (SOAP, WSDL, UDDI).*

Index Terms — Artificial Intelligence, Cognitive Architecture, Distance Learning, Web Based Learning Environment, Web Services.

I. Introdução

A pesquisa da utilização de ambientes de aprendizagem e ensino baseados na tecnologia Web têm sido objeto de estudo a partir dos serviços oferecidos pela Internet através do HTTP (Hiper Text Transfer Protocol)[1]. A maioria dos ambientes de WBLE (Web Based Learning Environment) têm como característica fundamental a oferta de conteúdos disponibilizados na forma de hipertextos[2].

Tal característica é insuficiente se considerarmos os conceitos e modelos que despontam a partir de uma análise dos processos envolvidos na aprendizagem e no ensino. Tais processos têm seus conceitos abordados na Epistemologia e nas Ciências Cognitivas (Psicologia Cognitiva, Didática e Ciências da Computação)[3].

O momento atual em que vivemos exige do profissional um novo perfil que exige uma série de competências, principalmente relacionadas a capacidade de desenvolver projetos, resolver problemas e a capacidade de aprender a aprender. Tais competências só são possíveis a partir da melhoria dos processos cognitivos envolvidos na aprendizagem. A incorporação de uma arquitetura cognitiva [4] a um ambiente de WBLE cria um diferencial na medida em que transforma a informação em conhecimento. A partir dessas considerações, este trabalho propõe que ambientes WBLE devam agregar funcionalidades a fim de prover suporte a uma abordagem educacional que utilize uma representação do conhecimento elaborado, de modo a incrementar o processo de aprendizagem. Essas funcionalidades propostas podem ser viabilizadas a partir da agregação de novas tecnologias para Web e de softwares para processamento do conhecimento. Em particular apresentamos uma proposta para ensino tecnológico a distância dentro do contexto do projeto INVENTE(INVestigação no Ensino TEcnológico à Distancia).

II. Ambiente de Ensino Tecnológico a Distância – O caso INVENTE

O Projeto INVENTE como uma solução para o ensino tecnológico a distância tem sido objeto de pesquisa no LAR (Laboratório de Redes) no Centro Federal de Educação Tecnológica do Ceará (CEFET-CE). Como produto do projeto, vários protótipos foram desenvolvidos, os quais têm evoluído através de várias versões descritas a seguir.

INVENTE 1.0

O Projeto INVENTE teve início com a investigação dos requisitos que diferenciam o ensino tecnológico do ensino convencional a distância[5]. Concluiu-se que a arquitetura inicial teria que considerar alguns pressupostos básicos que um ambiente para a educação tecnológica a distância deveria incorporar:

- Pressuposto 1: Os sistemas elaborados para a educação profissional a Distância podem e devem beneficiar-se do aporte da tecnologia de Realidade Virtual.

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[3] Roberto Wagner Silva Rodrigues, PhD Imperial College, Centro Federal de Educação Tecnológica do Estado do Ceará - CEFET-CE, Av. 13 de Maio, 2081, 60.040-531, Fortaleza, CE, Brasil, rwsr@cefetce.br.

- Pressuposto 2: É desejável que um sistema para a educação profissional a distância faça uso da capacidade de controle de QoS das redes, onde for possível.
- Pressuposto 3: É desejável que um sistema voltado para a educação profissional a distância utilize os recursos de vídeo e áudio sempre que necessário, garantindo uma qualidade mínima.
- Pressuposto 4: É desejável que um sistema para a educação profissional a distância permita a agregação de programas específicos das áreas de maneira amigável.
- Pressuposto 5: É desejável que um sistema para a educação profissional a distância possibilite a criação de novos ambientes não previstos na sua concepção original, de modo a se adequar à diversidade de instituições de ensino básico, técnico e tecnológico.

Esta versão 1.0 assume então como pressupostos básicos: o uso da realidade virtual, a exploração de recursos de áudio e vídeo, a utilização de infra-estrutura com provisão de qualidade de serviço (QoS) e a possibilidade de agregação de aplicações de domínio específico e de outras não previstas durante a concepção do ambiente virtual.

INVENTE 2.0

A introdução de programas de Educação a Distância despendem grandes quantidades de recursos (tempo e dinheiro) no treinamento de habilidades sobre novos aspectos técnicos e administrativos, o que não é suficiente. Há a necessidade ainda de desenvolver habilidades para gerenciar outras dimensões do novo ambiente à distancia, tais como a *navegação dinâmica*, a *metáfora*, o *significado*, a *cultura*, os *protagonistas e seus papéis*, o *tempo e o espaço*, a *consciência* e a *colaboração*.

Na proposta da versão 2.0 foi realizada uma reflexão sobre estes conceitos, chamados de dimensões críticas da Educação Tecnológica a Distância, dos quais ressaltamos como principais: a adaptação cultural, a exploração adequada dos sentidos e a flexibilização do ambiente virtual [6].

Como resultado dessa reflexão, a proposta da arquitetura da versão 2.0 foi concebida dentro de uma perspectiva mais conceitual e não de uma visão orientada somente à tecnologia. Isto levou a implementação de um Núcleo de Gestão que substitui o bloco "Framework WWW" da arquitetura anterior.

O Núcleo de Gestão é baseado em tecnologia Web e é responsável pela administração dos recursos do ambiente, pela gerência da base de dados, manutenção e administração das publicações e pelo controle de acesso aos recursos. A *Interface de Operação e Navegação*, contida no núcleo de gestão, fornece a interface necessária entre os usuários e os recursos do ambiente. As aplicações foram divididas em *aplicações genéricas* e *de domínio específico*, visando tornar mais clara a possibilidade da arquitetura agregar diferentes aplicações, sem induzir a predefinição de um tipo particular ou tecnologia a ser utilizada.

INVENTE 3.0

A versão 3.0 [7] foi implementada após investigarmos as principais características de uma aplicação de vídeo-conferência, onde chegou-se a conclusão de que outras funcionalidades precisavam ser agregadas a uma videoconferência padrão para que ela atendesse aos propósitos da educação tecnológica à distância. As principais funcionalidades agregadas foram:

- Capacidade de apresentação e manipulação de hipermídias: a transmissão em tempo real de documentos hipermídia entre os participantes de uma videoconferência enriquece a interação.
- Uso de laboratórios virtuais para realização de experiências e simulações: o uso da realidade virtual é um dos pressupostos do ensino tecnológico ressaltadas em [1]. Realizar experimentos em um ambiente de educação a distância não é uma tarefa simples. Uma das formas encontradas para realização de experiências de forma colaborativa à distância é através de simulações utilizando realidade virtual.
- Priorização no uso dos Recursos: é importante que as mídias transmitidas durante uma videoconferência possam ter níveis diferentes de prioridade. No ambiente de videoconferência proposto, o foco das atenções não é o áudio e o vídeo do transmissor, mas sim o funcionamento do ambiente como um todo na tentativa de promover o melhor aprendizado possível.

Com esta versão 3.0 e suas novas funcionalidades agregadas, e o fato da ferramenta ter sido construída numa abordagem conceitual, o INVENTE passou a incorporar recursos tecnológicos que permitem dar suporte a novas práticas pedagógicas o que nos levou a constatar que para viabilizar essa possibilidade é necessário uma reflexão dos processos envolvidos na cognição dentro de um contexto de ensino tecnológico.

III. A ANÁLISE COGNITIVA

Em geral, o cerne das atividades escolares encontra-se na produção de significações. Esse processo é alimentado de informações e dados provenientes de seu exterior, os quais foram acumulados historicamente e/ou gerados continuamente, em permanente transformação, procurando construir e/ou desenvolver o conhecimento e a inteligência das novas gerações[8].

As mudanças tecnológicas nos processos de trabalho industrial exigem uma reorganização da escola, no sentido da diminuição da importância das habilidades manuais em favor das habilidades cognitivas. Há portanto a necessidade de rever a concepção de conhecimento, o qual tem suas raízes na Epistemologia, onde é concebido como uma rede de significados em um espaço de representações; uma teia de relações cuja construção não se inicia na escola[8].

A idéia de rede de significados tem sido abordada pelas Ciências Cognitivas, que abrangem, dentre outras áreas de interesse, a Inteligência Artificial, a Psicologia Cognitiva e a Neurociência. Cada uma destas áreas tem contribuído com modelos computacionais construídos para aumentar a compreensão sobre a cognição humana[8], tais como Redes Semânticas, Sistemas de Produção e Redes Conexionistas[3].

Porém, antes de definir qualquer modelo computacional há a necessidade de se caracterizar níveis de cognição. A Pirâmide Informacional[9] (Figura 1) é um modelo que pode servir como instrumento para avaliar estes níveis de cognição num ambiente educacional. Isto nos permite evidenciar a necessidade de considerar conjuntamente componentes como dados, informação, conhecimento e inteligência, bem como o movimento de ir-e-vir, de sobe-desce , desce-sobe, que caracterizam as inter-relações entre tais componentes.

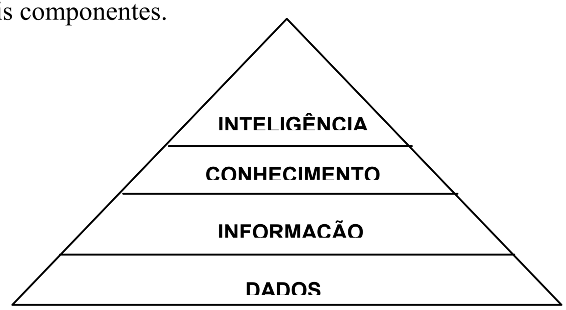

FIGURA 1
PIRÂMIDE INFORMACIONAL

Os níveis da pirâmide são caracterizados a seguir:

- Primeiro Nível - Dados : Os dados tanto qualitativos como quantitativos, às vezes acumulados sob a forma de supostas observações “desinteressadas”, embora potencialmente úteis, isolados são desprovidos de interesse.
- Segundo Nível – Informações : Informações são dados analisados, processados, inicialmente articulados. Apesar da informação ser uma matéria-prima fundamental na escola, o cerne das atividades desenvolvidas na escola não estão situadas nesse nível.
- Terceiro Nível – Conhecimento **:** O conhecimento é resultado da capacidade de estabelecer conexões entre elementos informacionais aparentemente desconexos, processar informações, analisá-las, relacioná-las, armazená-las, organizá-las em sistemas, avaliá-las segundo critérios de relevância.
- Quarto Nível – Inteligência : Este nível representa a competência de uma organização (um indivíduo, uma empresa, uma organização social, um governo) para administrar conhecimentos disponíveis, construir novos conhecimentos, administrar dados ou informações disponíveis, organizar-se para produzir novos dados e informações, sempre em razão de uma ação intencional tendo em vista atingir objetivos previamente traçados, ou seja, visando a realização de um projeto. A inteligência encontra-se diretamente associada à capacidade de ter projetos; a partir deles, dados, informações, conhecimentos são mobilizados ou produzidos.

A partir da análise da Pirâmide Informacional podemos concluir que :

- Os dois níveis iniciais da Pirâmide Informacional (Dados e Informação) caracterizam uma Didática e uma Epistemologia behaviorista enquanto que os demais Níveis (Conhecimento e Inteligência) caracterizam uma Didática e um Epistemologia sócio-construtivista;
- Para alcançar os níveis superiores da Pirâmide Informacional deverá ser adotado uma abordagem educacional que viabilize o seu alcance.

Sendo o INVENTE um ambiente para o ensino tecnológico que é caracterizado por atividades direcionadas a resolução de problemas e desenvolvimento de projetos[5][10], é desejável que incorpore funcionalidades que atendam a requisitos relacionados a estas características.

Dentre as várias abordagens educacionais que viabilizam o alcance de níveis cognitivos que caracterizam a produção de projetos destaca-se a Aprendizagem Baseada em Problemas[11].

IV. Aprendizagem Baseadas em Problemas

A Aprendizagem Baseada em Problemas (Problem-Based Learning/PBL) têm se firmado como uma das mais importantes inovações no campo da educação tornando-se em diversos países, um poderoso instrumento para a reflexão e o questionamento acerca da razão de ser, das finalidades da formação profissional e das mudanças que a ela devem ser imprimidas. PBL produz no processo de aprendizagem dos estudantes, os seguintes efeitos cognitivos:

- Ativação do conhecimento prévio – A análise inicial do problema estimula a recuperação de conhecimentos adquiridos previamente. O conhecimento prévio facilita a compreensão das novas informações.
- Reestruturação do Conhecimento – A maneira como o conhecimento é estruturado na memória torna-o mais ou menos acessível para utilização. A reestruturação do conhecimento se dá a partir da análise do problema. O conhecimento consiste de proposições que são estruturadas em redes semânticas. Uma proposição é uma afirmação que contém dois conceitos e sua inter-relação. Redes semânticas[12] consistem em um amplo número de proposições que se inter-relacionam umas com as outras. A Retenção das informações é melhor quando estão associadas a situações ou domínios de conhecimento que é familiar ao aprendiz. A lembrança é melhor daquilo que é pesquisado, ou da informação que resultou de um esforço ativo de interpretação[13].
- A elaboração sobre os conhecimentos prévios – Processamento ativo das novas informações e da discussão em pequenos grupos antes e depois da aquisição de novos conhecimentos. A elaboração

enriquece as redes semânticas desenvolvidas facilitando a recuperação do conhecimento.

- Aprendizagem em um contexto – O armazenamento de informações na memória e a sua recuperação podem ser significativamente aprimorados grandemente, quando ocorre uma elaboração do material durante o seu aprendizado. O problema serve como uma estrutura para armazenagem de pistas que podem auxiliar a recuperação de conhecimentos relevantes, quando necessários para problemas similares encontrados posteriormente.
- A motivação para aprender aumenta a quantidade de estudo – Como os estudantes são responsáveis pelo que deve ser aprendido, a motivação intrínseca para a aprendizagem cresce.

A criação de um nova versão do INVENTE propõe a agregação de mecanismos computacionais à atual arquitetura, justificados aqui a partir de uma análise epistemológica e cognitiva bem como na abordagem de aprendizagem baseada em problemas. O projeto da nova versão oferece um suporte a uma prática educacional que irá viabilizar um incremento do aporte cognitivo do aprendiz a partir de uma abordagem construtivista baseada em PBL.

V. INVENTE 4.0

A nova versão 4.0 (Figura 2) pressupõe a incorporação de uma interface para a diagramação de Redes Semânticas, produto da estruturação do conhecimento conduzido pelos aprendizes na metodologia do PBL, e do posterior armazenamento da rede semântica em uma base de conhecimento no servidor Witty usando WebServices.

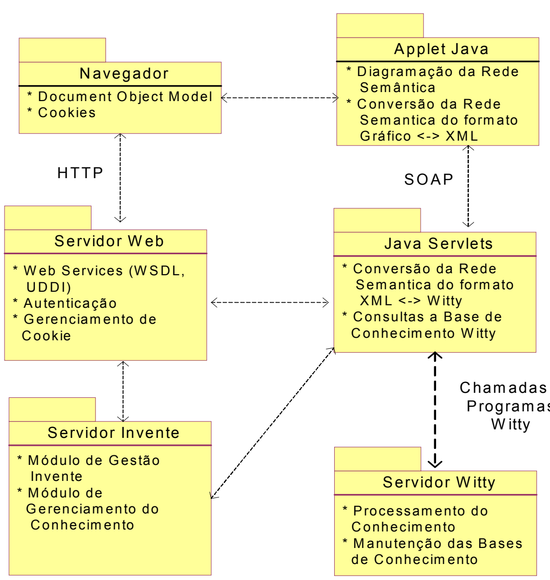

FIGURA 2
VISÃO LÓGICA DA ARQUITETURA DO INVENTE 4.0

A Rede Semântica que representa o conhecimento é traduzida em mensagem no formato XML[14] o qual é enviada ao servidor e em seguida é convertida para a representação em Lógica de Predicados[15].

Como uma Rede Semântica é uma classe de formalismo para representação do conhecimento em forma de grafo, na proposta da implementação do INVENTE 4.0, Redes Semânticas serão utilizadas para representar o modelo do conhecimento pelo aluno usando a interface Web. Os Nós do grafo representam entidades e links (predicados) que por sua vez representam relacionamentos entre essas entidades[16]. Observar que inicialmente usada para desenvolver um modelo psicológico da memória associativa humana[17][18], Redes Semânticas são úteis para codificar o conhecimento taxonômico de um domínio através de entidades, suas propriedades e relações[19]. O conhecimento incorporado em uma Rede Semântica pode ser convertido para Lógica de Primeira Ordem[19].

O emprego da Inteligência Artificial em aplicações de educação ocorre basicamente onde o computador funciona como máquina de ensinar (Tutores Inteligentes), ferramenta, simulador, assistente(Sistema Especialista)[20][21]. No INVENTE 4.0 será agregado a ferramenta Witty que é um software testado e estabilizado[22] desenvolvido para executar as tarefas de uma Máquina de Inferência que opera Bases de Conhecimento concebidas segundo a Lógica de Predicados.

A Ferramenta Witty é um ambiente de desenvolvimento de sistemas baseados em conhecimento, que permite a confecção de aplicações de amplo espectro, particularmente sistemas voltados ao aprendizado, organização de informações e aquisição de conhecimento. Para isso, dispõe de uma máquina de inferência que permite efetuar deduções sobre uma ou mais bases de conhecimento, de um conjunto de centenas de primitivas em uma linguagem ao estilo do Prolog, de um processo de casamento de padrões e de métodos comunicação com outros processos ou com a Internet [23].

Além da Ferramenta Witty será agregada a tecnologia WebServices[24], o qual tem sido apontada como solução para atender requisitos principalmente ligados a processamento distribuído, segurança e interoperabilidade. Web Services são componentes de software que são acessados de qualquer dispositivo conectado a Web usando um conjunto de protocolos de mensagens, padrões de programação, e facilidades de rede para registrar e descobrir recursos. Mais detalhadamente, um Web Service encapsula um processo discreto de uma organização que:

- (i) Se expõe e descreve-se – Um Web Service define suas funcionalidades a atributos assim outra aplicação pode entendê-lo, e tornar essas funcionalidades facilmente disponíveis para outras aplicações usando WSDL (Web Services Description Language)[25].
- (ii) Permite que outros serviços localizem-o na Web – um Web Service pode ser registrado em um serviço tipo "pagina amarela", assim uma aplicação pode localizá-lo

usando registros UDDI (Universal Description, Discovery, and Integration)[26].

- (iii) Pode ser chamado – uma vez que um Web Service é localizado e examinado, a aplicação remota pode chamar esse serviço usando um protocolo padrão da Internet como o SOAP (Simple Object Access Protocol)[27].
- (iv) Retornar uma resposta – Quando o serviço for fornecido os resultados são retornados para a aplicação que chamou usando o mesmo protocolo padrão da Internet [28].

A agregação que caracteriza a nova arquitetura do INVENTE 4.0 (Figura 2) possui os seguintes componentes:

- Navegador – Executa a função de Interface entre o aprendiz e o INVENTE.
- Apllet Java – Executa as funções de Diagramação de Redes Semânticas, conversão de documentos XML enviados pelo Java Servlet para o formato de diagrama, conversão do diagrama da Rede Semântica em documento XML, envia consultas para a Rede Semântica que serão executadas no servidor Witty.
- Servidor Web – Aceita as requisições feitas a partir do Navegador. Disponibiliza e registra os serviços executados pelos Servlets.
- Servidor Invente – Executa as funções de autenticação dos usuários, gerenciamento do INVENTE e do Controle ao acesso às bases de conhecimento.
- Java Servlets – Executa as funções de conversão das redes semânticas vindas do navegador no formato XML para o formato de lógica de predicados, e do formato de lógica de predicados para o formato XML. Faz chamada a programas armazenados no servidor Witty que executam funções de acesso à base de conhecimento. Interage com o Applet Java que roda no browser através do protocolo SOAP.
- Servidor Witty – Realiza a função de máquina de inferência, representa o conhecimento na forma de lógica de predicados permitindo a execução de consultas à base de conhecimento. Todas as funções de acesso e manutenção às bases de conhecimento são executadas através de programas escritos em uma linguagem similar ao Prolog e que são executadas pelo ambiente Witty. O acesso ao servidor Witty é feito através de TCP/IP.

Finalmente, é importante destacar que as novas funcionalidades agregadas ao INVENTE são caracterizadas como uma aplicação genérica segundo a especificação dada na versão 2.0[6].

VI. Trabalhos Relacionados

A conjunção de abordagens educacionais, Psicologia Cognitiva, Inteligência Artificial e Aplicações de Redes de Computadores tem sido objeto de investigação e desenvolvimento em todos os grandes centros de pesquisa no mundo[29][30][31].

Os trabalhos relacionados ao tema reforçam a tese do valor e da importância do desenvolvimento do conhecimento e da sua aplicação como um diferencial nas instituições de ensino, nas organizações empresariais e nas nações.

A proposta da nova arquitetura do INVENTE está relacionada a várias pesquisas que vêm sendo realizadas. A incorporação de mecanismos de inteligência artificial em ambientes de Ensino baseados na Web são propostos em [32]. A Representação do Conhecimento através de Ontologias e sua representação usando bases de conhecimento é tratado em [33], e a integração de Ontologias em ambientes de Educação com Inteligência Artificial em[34]. A utilização de Redes Semânticas em um software educacional baseado na Web é abordada em [35]. Atualmente, o projeto Web Semântica conduzido pelo W3C[36] tem como proposta a padronização de Ontologias nos mais diversos domínios do conhecimento para viabilizar o intercambio de documentos XML usando a especificação RDF[37].

A arquitetura do INVENTE 4.0 se diferencia pela agregação de WebServices ao suporte a uma ferramenta que reforça uma prática educacional peculiar ao ensino tecnológico.

VII. Conclusões

Ao mesmo tempo em que as abordagens de educação devem buscar um aumento do nível de cognição dos aprendizes, os Ambientes de Educação a Distancia baseados na WEB deverão fazê-lo incorporando ferramentas que auxiliem essas novas abordagens no alcance desses objetivos. O atual estágio de implementação do INVENTE reproduz as abordagens tradicionais de educação. A proposta do INVENTE 4.0 mostrada neste trabalho inicia um processo de melhoria na medida em que dá suporte a práticas educacionais que incorporam processos de construção do conhecimento em níveis cognitivos relacionados a capacidade de resolver problemas e desenvolver projetos. Isto permitirá que atividades relacionadas a resolução de problemas levem ao desenvolvimento de importantes habilidades próprias do ensino tecnológico a distância. Sómente assim os aprendizes terão a oportunidade de pensar e criar oportunidades para experimentar a procura de conhecimento, seleção, aplicação usando uma ferramenta de ETD.

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A COMPUTAÇÃO GRÁFICA E O DESENVOLVIMENTO DE PRODUTOS

Eduardo Félix Ribeiro Romaneli, Dr. Eng. [1]

Abstract *— This paper tries to show to undergraduate students of Engineering, how Graphics Computing can help in the design of a product regarding quality and security issues. The research was limited the mechanical, electrical and thermal analysis of an ordinary electrical coffeemaker in order to evaluate its thermal safety from the user point of view. As a practical approach it was selected the softwares OrCad 9.2 and RadTherm to perform the required simulations. These programs were chosen due to their friendly operation, reliability and availability. It was observed the behavior of the virtual model under normal operation conditions through a quantitative analysis regarding parametric surface temperature. Finally, based on the experimental results, the safety requirements of the coffeemaker was analyzed..*

Index Terms — Graphics Computing, Product Development, Simulation, Teaching-Learning.

INTRODUÇÃO

No gerenciamento e controle do processo de desenvolvimento de um produto, a questão da inovação é cercada de incertezas exigindo decisões baseadas em variáveis de previsão difícil [1]. Por outro lado as novas tecnologias imprimem um ritmo mais rápido de inovações necessitando que as empresas dominem o processo de inovação para manter-se no mercado.

A atividade de desenvolvimento de novos produtos ou de redesign não é tarefa simples nem direta, mas antes envolve diversos interesses e habilidades necessitando uma excelente sinergia entre as áreas de tecnologia, ciências sociais e design. Enquanto a tecnologia visa simplicidade na fabricação, facilidade de montagem e eficiência do produto, a área das ciências sociais ou de *marketing* deseja novidade, pouco investimento e vantagem competitiva. Por sua vez, a área de design almeja um produto que cumpra seu papel, porém dotado de estética e estilo [1].

O DESIGN DAS CAFETEIRAS MODERNAS

A forma de se fazer café tem modernizado-se muito nas últimas décadas e, particularmente depois da II Guerra Mundial, tem alterado significativamente os hábitos alimentares de milhões de pessoas. A evolução deste aparelho está intimamente ligada às mudanças sociais e comportamentais da sociedade do século passado. A evolução da cafeteira seguiu duas linhas mestras, o estilo e técnica.

Segundo a definição de BAXTER (1998) o estilo original das cafeteiras foi fortemente influenciado por fatores intrínsecos, adquirindo um simbolismo especial, uma identificação com um estilo de vida, o *american way of life.* Do ponto de vista da técnica os esforços foram centrados na melhoria da qualidade do produto. O produto final, em um conceito mais elaborado, é o café pronto para se servido. Os projetistas incorporam as inovações técnicas a medida que se tornavam economicamente viáveis. Dois pontos marcaram esta evolução: a eletrificação urbana e as mudanças do paladar da população. O resultado deste esforço é a moderna cafeteira elétrica, totalmente automática e de acordo com a técnica atual de ser preparar o melhor café.

A medida que o café popularizou-se, a cafeteira elétrica tornou-se um fenômeno cultural. A moderna cafeteira é um equipamento surpreendentemente simples, considerando-se o esforço despendido durante décadas para seu desenvolvimento e as leis da física envolvidas no seu funcionamento. Apesar da simplicidade, todo eletrodoméstico está submetido a normas rígidas quanto a segurança do usuário, principalmente no quesito segurança contra incêndio. A cafeteira elétrica, adicionalmente, por processar água em elevada temperatura representa um risco para o usuário caso seja mal projetada, daí a importância da simulação na fase de projeto.

A revisão cronológica do desenvolvimento das cafeteiras [3] mostra uma profunda ligação com o desenvolvimento econômico das regiões, especificamente com o processo de eletrificação. As mudanças sociais, assim como as mudanças comportamentais exerceram uma influência determinante na evolução das cafeteiras. O design não poderia deixar de acompanhar estas mudanças e ao mesmo tempo que tentou suprir as necessidades subconscientes de uma classe média que experimentava uma grande prosperidade econômica não deixou de incorporar os avanços tecnológicos disponíveis.

O crescimento da concorrência, porém, tornou o ciclo de vida dos produtos muito curto e a necessidade de lançar produtos com diferenciais funcionais em relação aos competidores gerou a demanda por técnicas que encurtassem o processo de concepção de um produto. Entre estas técnicas

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a prototipagem virtual é uma ferramenta essencial para a redução dos esforços de projeto.

Observando-se o interior de uma cafeteira é fácil compreender que a física por trás do funcionamento do equipamento não é muito complicada. Observando-se a parte superior (Fig. 1) notam-se: um pequeno reservatório que armazena a água para iniciar o ciclo de preparo do café; um tubo (preto no exemplo) que conduz a água do reservatório até a área de gotejamento; e a área de gotejamento onde a água passa por pequenos orifícios e simplesmente cai sobre o pó de café.

FIGURA 1
VISTA SUPERIOR DA CAFETEIRA [2]

A força por trás deste sistema é a gravidade. A gravidade empurra a água para baixo através do filtro e dos grãos de café moído para dentro do bule. Esta é a engenhosidade do gotejador, a cafeteira produz café sem contato manual utilizando-se da gravidade. Este foi o marco principal da evolução do design das cafeteiras.

FIGURA 2
O ELEMENTO DE AQUECIMENTO E BASE [2]

O aspecto físico envolvido no processo de gotejamento da cafeteira é o aquecedor. Trata-se de um fio com característica de dissipar uma quantidade determinada de calor quando suas extremidades são submetidas a uma diferença de potencial elétrico conhecida. Este elemento tem duas funções, primeira é ferver a água e a segunda é manter o café aquecido depois de pronto. Tecnicamente o aquecedor transfere energia térmica para a água fria. O calor naturalmente vai do objeto mais aquecido para o mais frio. Na Fig. 2 é apresentada a conexão entre o elemento de aquecimento e o prato que mantém o café quente. O elemento é pressionado diretamente contra a parte inferior do prato com a ajuda de um pasta condutora de calor que ajuda a melhorar a transferência do calor.

Outro elemento essencial para o funcionamento é o interruptor. O interruptor está conectado a sensores de temperatura que desliga o aparelho quando a temperatura da base torna-se muito elevada. Através da alternância ora ligado, ora desligado, o aquecedor mantém-se em temperatura constante (Fig. 3.)

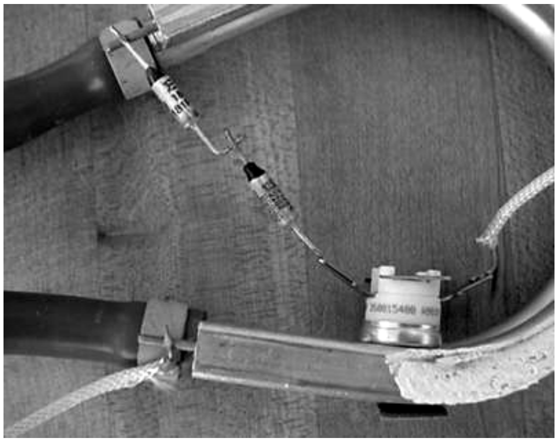

FIGURA 3
SENSOR DE TEMPERATURA [2]

A parte mais importante para o correto funcionamento da cafeteira, porém, é invisível. Trata-se de uma válvula unidirecional de controle de fluxo que tem como função evitar que a água quente retorne para o recipiente de armazenagem e forçar as bolhas, que se formam a partir da água fervente, a seguirem para o gotejador na parte superior.

Aplicação de Recursos Computacionais no Projeto de uma Cafeteira Moderna

Os programas de CAD/CAE têm a função de auxiliar no projeto das cafeteiras durante o estágio de desenvolvimento para investigação de fenômenos térmicos, mecânicos, fadiga, assim como características relacionadas com o fluxo de água, transferência de calor entre outros.

Existem diversos programas para o desenvolvimento de produtos disponíveis no mercado. Provavelmente, o método de análise mais utilizado na engenharia seja a Análise por Elementos Finitos. Esta análise é um conjunto de algoritmos complexos que utilizam métodos matemáticos para dividir um objeto heterogêneo em partes menores, porém, homogêneas e de modelagem mais simples. Ele é utilizado nas áreas de simulação estrutural, design automotivo e aeroespacial, design eletroeletrônico, design de máquinas e equipamentos mecânicos, etc. Geralmente o método é utilizado para resolver problemas de esforço, deformação, transferência de calor, distribuição de campos magnéticos e outros problemas que envolvam elementos contínuos que seriam insolúveis de outra forma. A correta aplicação de recursos da computação gráfica tem como objetivo otimizar a visualização científica destes dados.

APLICAÇÃO DOS RECURSOS DE DESIGN COMPUTADORIZADO

A primeira etapa para o desenvolvimento de um protótipo virtual é a preparação de modelos matemáticos que representem fielmente o comportamento físico do equipamento. Este modelo global geralmente incorpora diversos modelos mais simples que podem representar as características elétricas, mecânicas, termodinâmicas ou químicas do protótipo. Durante o desenvolvimento a escolha de um ou mais modelos podem representar o equipamento em determinada análise. O principal modelo para a manipulação "física" em ambiente virtual é o arquivo com a representação espacial tridimensional do objeto em estudo.
A aplicação do modelo em CAD permite que os materiais aplicados na construção do protótipo sejam avaliados em relação a aspectos fisico-químicos nos quesitos de segurança, usabilidade, manufaturabilidade, manutenção, etc. A disposição mecânica de interruptores, fios, aquecedores, termostatos, canos, reservatórios, entre outros, é feita com a ajuda do CAD.

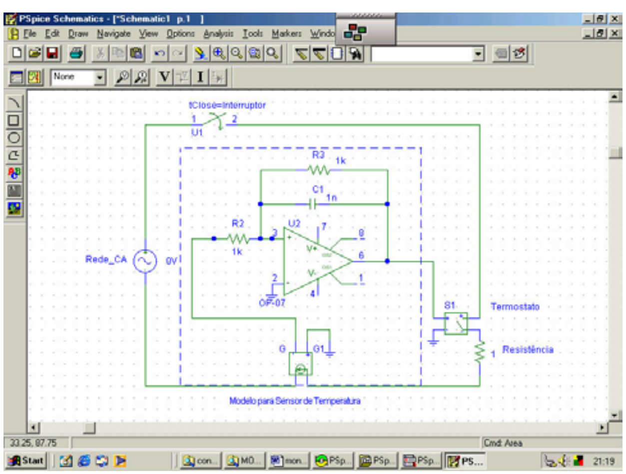

FIGURA 4
SIMULADOR PARA CIRCUITO ELETRÔNICO DE CAFETEIRA.

A utilização de programas de simulação digital pode, a partir do modelo tridimensional gerado pelo CAD, mostrar o funcionamento da cafeteira em situações críticas como a operação em um ambiente com alta temperatura e/ou com oscilações de tensão de rede. Para atingir-se este objetivo, pode-se optar pela utilização de dois programas do tipo Computer Aided Engineering (CAE). O primeiro seria um simulador de circuitos eletrônicos que tem como tarefa determinar a dissipação de energia na resistência da cafeteira sob diversas situações podendo simular alterações paramétricas na tensão de entrada e o efeito dos desvios na curva normal de produção da resistência de aquecimento, assim como do ponto de operação do elemento sensor de temperatura. A Fig. 4 apresenta o circuito elétrico equivalente da cafeteira simulado no programa OrCad 9.2.

O resultado é visualizado através de gráficos bidimensionais onde as variáveis podem ser tensões ou correntes que podem ser parametrizadas em função da temperatura ambiente. A Fig. 5 mostra um exemplo de cafeteira com um elemento de aquecimento de 280 W operando em uma rede CA (CORRENTE ALTERNADA) de 220 V.

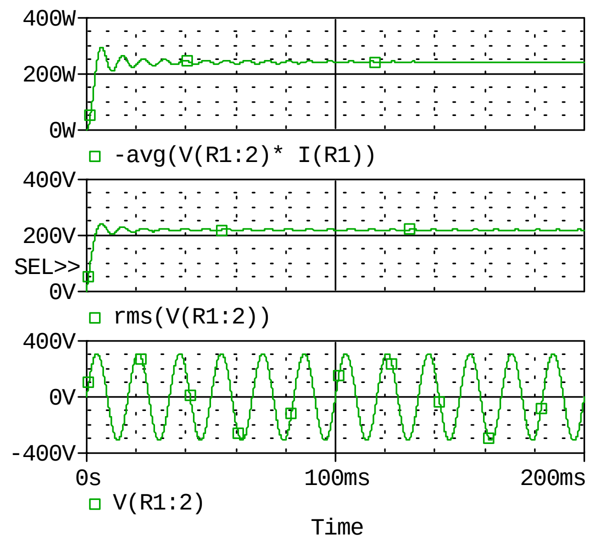

FIGURA 5
TENSÃO DE REDE E POTÊNCIA MÉDIA DISSIPADA

Esta etapa permite que se estude o comportamento da cafeteira quando submetida a fatores externos agressivos, como tensão de rede acima ou abaixo do valor nominal, surtos de tensão devido a fenômenos metereológicos ou por manutenção da rede de distribuição por parte da concessionária de energia elétrica. Para a etapa seguinte, é necessário identificar qual a situação mais desfavorável de funcionamento.

Uma vez determinados os pontos de geração de calor e escolhidos os tipos de materiais que seriam empregados na estrutura física da cafeteira, o próximo passo é a simulação da distribuição de calor por toda a estrutura. Esta etapa é de fundamental importância para interação entre o equipamento e o usuário, pois determina se em algum ponto da cafeteira haverá risco potencial do usuário se ferir devido a alta temperatura.

Um dos programas dedicados à esta tarefa é o RadTherm que tem como objetivo executar uma análise por elementos finitos (dividindo o objeto em pequenas partes com propriedades homogêneas, conforme a Figura 6) para a determinação do gradiente de distribuição das temperaturas na cafeteira. O programa tem como modelo de entrada, a maquete gerada através do CAD. O resultado é a uma animação tridimensional do comportamento da temperatura da cafeteira no tempo (entre sua efetiva ativação e a operação em regime permanente) e em todas as partes. Este filme tridimensional pode ser dividido em cenas principais de forma que possa ser impresso e analisado detalhadamente. Assim, é possível se identificar os pontos críticos de controle da estrutura e corrigir estes problemas a um custo bastante reduzido.

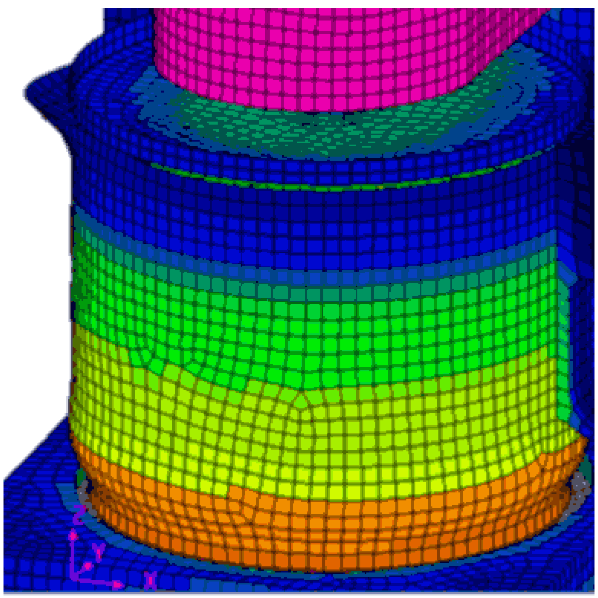

FIGURA 6
DIVISÃO DA CAFETEIRA EM ELEMENTOS FINITOS.

O resultado final da simulação para este caso é muito satisfatório pois em nenhum momento os elementos que compõem a cafeteira apresentaram temperatura superior a 165 ^{o}F ou 73.8 ^{o}C conforme escala que correlaciona as cores com as temperaturas apresentada na Fig. 7. A estrutura de plástico de engenharia da qual o corpo da cafeteira é composto apresenta uma temperatura máxima de 115 ^{o}F o que equivale a 46^{o}C. Deve observar que a temperatura ambiente é de 65^{o}F o que equivale a 18^{o}C. Para regiões tropicais onde a temperatura ambiente chega a 40^{o}C, estes números devem ser revistos. Todas as temperaturas devem ser deslocadas linearmente pois na realidade estas grandezas são variações em relação à temperatura inicial.

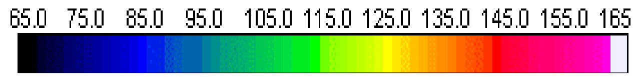

FIGURA 7
ESCALA DE TEMPERATURA EM GRAUS FAREINHEIT

CONCLUSÕES

A evolução das cafeteiras acompanhou o processo de eletrificação das diversas regiões, de forma natural, as cafeteiras à fogareiro foram substituídas por suas concorrentes elétricas. À esta evolução funcional associou-se uma evolução no design exterior do aparelho que passou a fazer parte do conjunto de eletrodomésticos essenciais para o perfeito funcionamento de uma casa segundo apregoavam as campanhas de marketing da época.

À evolução técnica seguiu-se uma mudança da técnica de elaboração do café, primeiro ferviam-se o pó e a água, em seguida os métodos de recirculação tornaram-se dominantes e finalmente a técnica de gotejamento, presente até os dias atuais, veio para tornar-se padrão.

A popularização do plástico derivado de petróleo na manufatura de artefatos domésticos foi a barreira final para que a cafeteira tomasse o formato atual. A popularização dos recursos de computação gráfica ajudou a baixar os custos e deu aos fabricantes uma versatilidade enorme para alterar formas, cores e materiais dos quais estes eletrodomésticos são fabricados. O consumidor foi sem dúvida o maior beneficiário desta revolução do design, sendo que atualmente, ele tem equipamentos melhores, mais bonitos, mais funcionais e principalmente mais seguros do que a algumas décadas. Tudo isto, em grande parte, graças aos novos recursos de design de produto disponíveis à grande maioria dos engenheiros e designers envolvidos no processo produtivo industrial.

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INOVAÇÃO TECNOLÓGICA VERSUS PROCESSO PEDAGÓGICO

José Heleno Ferreira [1],Leandra Ulbricht[2] e Vania Ribas Ulbricht [3]

Abstract *— This paper tries to make a reflection about changing and innovations that the 20th Century brought to humankind, especially in the knowledge area. In face of these transformations, the Virtual World, accessed by the new technologies, has been used in different ways and served different interests. It can rebuild social relations or boost an educational revolution, helping the creation of new teaching processes.*
Index Terms — Virtual Evironments, Teaching-Learning, New Technologies

INTRODUÇÃO

O século XX foi sem dúvida o século das grandes transformações na história da humanidade. Embora toda a história seja um contínuo de transformações e inovações, há diferenciais importantes entre o século XX e os anteriores. Além de ser esse, seguramente, um tempo de transformações mais rápidas, num ritmo, às vezes, alucinante, é também o período em que as inovações técnicas, culturais e sociais atingiram, em menor espaço de tempo, grande parcela da humanidade.

O volume e a intensidade das transformações técnicas, nem sempre, porém, são devidamente proporcionais às necessárias mudanças sociais para que todos tenham acesso às primeiras. Essa situação provoca, de acordo com Feliz Guattari [1], uma dicotomia entre o avanço técnico e o avanço social, o que resultará em contradições sociais, conflitos e marginalização de um crescente número de pessoas. A respeito do momento histórico atual, o autor afirma que enquanto as transformações técnico-científicas contêm possibilidades de criação e concretização de novas e diferentes formas de pensar e agir, as condições sociais e subjetivas para a implantação das mesmas encontram-se ainda em estado de devir.

Da técnica, esperava-se, no "Século das Luzes", o advento de um mundo novo, onde os seres humanos estariam livres das dores e do sofrimento, da miséria e da fome, da violência, das tarefas braçais e do trabalho pesado, podendo então se dedicar ao ócio e aos prazeres sensíveis e intelectuais. Essa foi a tônica dominante durante os séculos XVIII e XIX, no período histórico conhecido como Iluminismo, quando pensadores de diversos países e correntes filosóficas afirmavam estarem os seres humanos diante de uma nova forma de organizar o mundo, apregoando a capacidade de a ciência resolver todos os males até então vividos pela humanidade [2].

Os protagonistas do "Século das Luzes", porém, não viveriam o bastante para presenciar os desastres ecológicos, as bombas atômicas, as guerras e tantos outros "benefícios" trazidos pelo progresso científico. Não veriam ou não teriam tempo suficiente para analisar as conseqüências do avanço industrial para os trabalhadores e não tiveram ainda o distanciamento necessário para perceber que as inovações técnicas, embora tenham trazido benefícios para uma parcela da humanidade, também aumentaram as desigualdades sociais, aumentaram a fome e a miséria e que, muito embora permitissem ao mundo contemporâneo produzir alimento além do necessário para atender as necessidades básicas da população mundial, mais de um terço do planeta vive em condições miseráveis, subalimentado e faminto.

O abalo da razão instrumental trouxe consigo uma crise epistemológica, ou crise dos paradigmas que não se restringe à esfera da produção científica, atingindo também a produção do conhecimento, as relações pedagógicas, o processo de ensino-aprendizagem, o espaço escolar. Assim, entre todas as grandes mudanças que marcam o século que há pouco findou-se, seguramente, a relação com o conhecimento é a maior delas. Num mundo repleto de objetos descartáveis, em que a ordem imperativa é consumir, experimentar, substituir, descartar... as informações e o conhecimento são também interpelados a partir de seu valor utilitário, a partir da possibilidade de uso e desuso.

A relação da humanidade com o saber: quatro estágios históricos

A relação dos homens e mulheres com o saber passa por quatro longos estágios durante a história da humanidade. Antes da escrita, nas sociedades de cultura oral, o saber era ritual, místico e encarnado por uma sociedade viva. As informações e o conhecimento eram repassados oralmente e a tradição assegurava a cultura e dava sentido à organização social de uma comunidade. O provérbio africano – "Quando um velho morre, incendeia-se uma biblioteca" – explicita essa situação em que o saber é resguardado por aqueles que viveram muitas experiências sociais, que ouviram as histórias dos seus antepassados e que, por isso, encontram-se

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em condições de propagar o conhecimento. Esse seria o primeiro e mais longo estágio da história da relação da humanidade com o saber. Com o advento da escrita ter-se-ia então um segundo estágio. A figura emblemática do conhecimento não é mais o velho, mas o livro. Um único livro que narraria a história de um povo, as experiências de um grupo social e asseguraria o sentido para a vida e a organização social. A bíblia, o alcorão seriam exemplos desse estágio da relação da humanidade com o saber. A figura do velho, que contava a história dos grupos sociais, é substituída pela figura do intérprete, que comenta o saber expresso no livro sagrado [3].

O terceiro estágio teria início com o advento da imprensa. A possibilidade e necessidade de imprimir um número maior de livros faz surgir as enciclopédias e as bibliotecas. O intérprete do livro do saber será então substituído pelo sábio, pelo erudito.

Num mundo em que o processo de transformação se dá sempre com maior rapidez, o terceiro estágio será infinitamente mais curto que os anteriores e dará lugar ao quarto e atual estágio: a desterritorialização da biblioteca, possibilitada pelos avanços da informática, a dinâmica de rede mundial de computadores, a possível conexão simultânea entre milhões de pessoas dos mais diferentes lugares e a criação dos hipertextos e hiperdocumentos. Tem-se então a divulgação simultânea de uma infinidade de textos e informações sobre os quais ninguém tem absoluto controle, que podem ser acessados, lidos, recortados, enviados para outrem, que podem ter trechos suprimidos ou acrescentados, que podem, enfim, ser modificados e apropriados por milhões de pessoas ao mesmo tempo. A informação torna-se fluxo contínuo.

CULTURA, TÉCNICA E SOCIEDADE: A NECESSIDADE DE SUPERAR O MANIQUEÍSMO

Atualmente vive-se uma crise de sentido, como resultado da passagem de uma cultura identidária para uma cultura planetária. Se na cultura identidária clássica, o ser humano identificava-se como membro de uma comunidade que dava sentido ao ser fazer histórico-cultural, na cultura planetária essa condição encontra-se ameaçada, não sendo possível ao indivíduo identificar-se como membro de uma comunidade, uma vez que a produção de sentido não lhe é assegurada comunitariamente, mas planetariamente [3].

Todo sentido se produz dentro de uma determinada cultura e é, portanto, convencional, histórico, em contínua transformação. Em toda e qualquer sociedade são estabelecidas redes semânticas que estruturam o espírito das pessoas em comunicação e é isso que permite aos membros de uma determinada cultura se reconhecerem entre si.

O avanço tecnológico, a possibilidade de indivíduos de diferentes lugares e culturas se comunicarem simultaneamente geram uma crise na produção de sentido cultural das sociedades identitárias. Se, virtualmente, todos e tudo podem estar em contato, a base do universo se fragmenta e se recompõe continuamente. O fundo simbólico que sustenta as várias tradições culturais se parte, vislumbrando o vazio. As pessoas tornam-se, cada vez mais, estrangeiras em sua própria cultura e a crise de sentido torna-se crônica, podendo ser denominada de 'pós-cultura' [4]. Não há como escamotear as transformações que o contexto pós-cultural traz para as relações humanas, o que afetará, logicamente, o sistema educacional. Os conhecimentos tornam-se obsoletos cada vez mais rapidamente, a noção de uma carreira, escolha de uma profissão encontram-se abaladas diante de uma mercado sempre mais movediço, a noção de saber estoque é substituída pela noção de saber fluxo e o processo de transmissão do mesmo precisa ser definitivamente repensado:

O estado de pós-cultura, apesar de representar o caos (no sentido de que todas as estruturas e redes semânticas encontram-se abaladas ou em constante modificação), representa também progresso, no sentido de que encontram-se abertas novas e crescentes possibilidades de exploração sistemática de diversos espaços culturais possíveis. É com esse otimismo que o autor cunha a expressão "cultura desperta", afirmando a necessidade de se colocar com prudência diante do mundo, mas também de se estar abertos às novas possibilidades, sem preconceitos ou recusas e cegueiras diante do movimento e das mutações contemporâneas, sob o risco, para aqueles que não conseguirem navegar nesse novo mundo de informações, de ficarem cada vez mais à margem dos acontecimentos e das possibilidades infinitas de exploração cultural abertas pelo processo de transformação tecnológica que vivenciam todos os seres humanos, isolados e alheios a essa cultura da impermanência, da qual todos são convidados a participar [3].

O IMPACTO DAS NOVAS TECNOLOGIAS

É comum encontrarmos a expressão "impacto das novas tecnologias", largamente utilizado na literatura específica sobre o tema, em textos e obras que analisam o mundo contemporâneo e as novas relações entre os seres humanos, o saber e a informação. Essa sensação de impacto se justificaria pelo aceleramento das transformações técnicas, pelo volume de informações a que somos submetidos a todo instante e pelo estado de desapossamento em que nos encontramos diante dessa realidade. Na verdade, nem mesmo aqueles que se esforçam quotidianamente para estarem ligados (plugados) à realidade, conseguem acompanhar o ritmo das transformações e nem estar completamente informados acerca de tudo o que se cria e se escreve e se diz sobre o mundo como um todo.

Pierre Lévy [3] critica a expressão "impacto das novas tecnologias" fundamentando-se na impossibilidade de se separar técnica, cultura e sociedade. A cultura (a dinâmica das representações que dá sentido à vida de uma comunidade), a sociedade (os seres humanos, as relações que estabelecem entre si) e a técnica (artefatos produzidos pelos seres humanos) estariam de tal forma imbricados que, afirmar o impacto de um sobre o outro seria compreendê-los separadamente, o que o autor afirma ser impossível.

Esse ponto de vista busca negar uma relação de causa e efeito entre a tecnologia (que seria entendida como causa) e a cultura (que sofreria os efeitos das inovações tecnológicas). Ao contrário, exige um análise global, dialética: os seres humanos (a sociedade), a partir das relações que estabelecem entre si, a partir de suas necessidades e da interpretação que têm do mundo (a cultura), inventam, produzem, utilizam e interpretam de diferentes formas as técnicas. Nesse sentido, a tecnologia é entendida como condicionante e não determinante da vida social. Esta é uma questão fundamental para a análise do mundo atual: a sociedade encontra-se condicionada por suas técnicas, mas não determinada.

Desta maneira, o ciberespaço não determina o desenvolvimento da inteligência coletiva, mas cria condições para isso, assim como cria condições para o desenvolvimento do seu oposto, ao qual o autor se refere como "bobagens coletivas" [3]. A possibilidade de comunicação simultânea com pessoas de vários lugares do planeta, os serviços que podem ser prestados através desse canal de informação e comunicação e os desserviços que o mesmo pode prestar. Nesse sentido, vale lembrar, de um lado, as denúncias de pedofilia e racismo praticados e divulgados via Internet e, de outro, projetos sociais desenvolvidos com o objetivo de socializar e diminuir a exclusão social, elaborados a partir da utilização da informática e dos mais altos recursos tecnológicos, como o Projeto Capilaridade (apresentado neste texto).

A ENGENHARIA DO CONHECIMENTO RECONSTRUINDO LAÇOS SOCIAIS: O PROJETO CAPILARIDADE

Deisimer Gorczevski e Nize Pellanda [4] apresentam a experiência do Projeto Capilaridade, desenvolvido em Porto Alegre em 1999, onde o público alvo do projeto foi composto por 75 jovens do Morro da Cruz e da Vila Grande Cruzeiro (Porto Alegre) em situação de completa exclusão social e fundamentou-se no objetivo de utilizar a tecnologia como ferramenta ou alavanca para desenvolvimento do potencial criativo.

O projeto fundamentou-se teoricamente nos filósofos Félix Guattari e Pierre Lévy, e nos biólogos Francisco Varela e Humberto Naturana, além de Jean Piaget.

Os jovens, público alvo do projeto, tinham em comum uma realidade de exclusão, advinda de suas condições sociais, raciais, culturais e sexuais. Essas condições fizeram com que a grande maioria deles fosse rotulada, quotidianamente, como "marginal", "louco", "moleque de rua", "viciado", "aidético", "prostituta" entre outros. A marginalidade se concretizava também pelo não acesso aos bens culturais e necessidades básicas: moradia, educação, saúde, emprego, etc. Como resultado da exclusão, a violência nas relações cotidianas e o autodesprezo marcavam esses jovens, além de uma postura de resistência a qualquer proposta que lhes fosse apresentada como possível ajuda.

Assim, a maneira encontrada para sensibilizar e recuperar a auto-estima dos jovens envolvidos no projeto passou necessariamente pelo autoconhecimento e pelo conhecimento da realidade que os cercava, não se admitindo a separação entre conhecer e ser, ou seja: a compreensão de que os jovens eram o que conheciam e como conheciam. Nesse sentido, o espaço cibernético ofereceu a possibilidade de cada sujeito se inventar e inventar a realidade que quisesse, sempre em contato com outros sujeitos sociais. O uso do computador possibilitou a esses jovens pensar sobre o pensar.

Estabelecendo uma rede com o Movimento de Crianças e Adolescentes e a ONG Novo Mundo do Trabalho, o projeto foi se desenvolvendo, sempre buscando possibilitar aos jovens que se expressassem e que mostrassem a forma como enxergavam a realidade social que viviam. Além da produção de textos que eram escritos e enviados a diversas ONG's, órgãos públicos e imprensa, utilizou-se largamente o computador para expressar sentimentos, para contatar namorados(as) e outras questões ligadas aos interesses e anseios próprios da faixa etária dos envolvidos no projeto. A utilização da fotografia, que depois era escaneada e trabalhada pelos jovens foi outro instrumento detonador do processo de restabelecimento de laços sociais. Se no início, os jovens se recusavam a fotografar o local em que viviam, alegando não haver nada ali que merecesse o feito, algum tempo depois, aceitavam, ainda relutantes, a proposta, mas fotografavam apenas as mazelas dos seus locais de moradia. Ao final, já fotografam, por exemplo, o pôr do Sol visto do morro, o rio Guaíba, que corta a cidade de Porto Alegre e cuja sinuosidade pode ser avistada do alto do Morro da Cruz.

Todo o projeto se baseou na certeza de que é impossível transmitir conhecimento e que o saber não surge do campo da transmissão, mas do da invenção, certeza essa que questiona radicalmente o processo de ensino-aprendizagem que tradicionalmente se efetua nas escolas. Assim, avaliando o projeto, suas autoras afirmam que a utilização do computador foi determinante no sentido de instigar a inteligência, de possibilitar que o sujeito agisse sobre sua própria realidade e, ao mesmo tempo em que acompanhava o produto de seu fazer e apropriava-se do seu trabalho, podendo tornar-se sujeito de sua própria aprendizagem.

MAS SERIA PAPEL DA EDUCAÇÃO FORMAR PROFISSIONAIS?

Ao descrever a história da educação escolar a partir do princípio do trabalho, (SAVIANI, *apud* [5]) não afirma ser esse o papel da educação. Ao mesmo tempo, ao analisar os desafios que as novas tecnologias impõem à educação e o perfil do trabalhador que interessa às empresas no mundo contemporâneo, não se discute o papel da educação e, sim, as exigências que fazem à mesma um grupo social: os grandes empresários. É preciso pensar a educação de forma mais ampla, buscando pensar o ser humano como um todo e o processo social no qual ele se insere, bem como a construção de uma sociedade em que homens e mulheres possam realizar todo o seu potencial criativo.

Atualmente há um consenso de que as finalidades básicas da educação (não da escola) são formar o indivíduo, formar o cidadão e formar o profissional. Afirma ainda que historicamente, pelo menos até o advento da Revolução Industrial, a escola tem se dedicado à formação do indivíduo, capacitando-o a compreender a si mesmo e ao mundo que o cerca, a definir objetivos e metas e os meios de alcançá-los, a produzir e/ou apreciar objetos de artes, a usufruir do lazer. Percebe-se uma perfeita sintonia entre a afirmação de Chaves e a análise histórica da educação escolar como espaço para as classes ociosas, de Dermeval Saviani [6].

Após a Revolução Industrial e, no Brasil, após a lei 5692/71, a escola assume também a tarefa de preparação do profissional. Essa tarefa é entendida, por vezes, dentro de uma lógica estreita, compreendendo formação do profissional como preparação para o exercício de uma profissão específica. Essa forma de compreender a função da escola se evidencia, no caso brasileiro, nos cursos médios com habilitações técnicas e nos cursos universitários profissionalizantes desde o seu ingresso. Uma outra lógica, mais ampla, entende a formação profissional como formação para o mundo do trabalho, buscando uma superação da visão negativa das atividades manuais e do esforço físico, presente, por exemplo, na bíblia e em toda a tradição judaico-cristã.

Quanto ao terceiro item, a formação do cidadão, CHAVES afirma ter a escola falhado sistematicamente, mais por omissão que por comissão. Para assumir essa função, a escola teria que se deparar com valores morais, políticos e econômicos, e a fuga desse debate tem sido a tônica da formação oferecida pelas escolas ao longo da história da educação. As conseqüências dessa falha se fazem notar na presença de profissionais tecnicamente bem formados, porém sem habilidades para pensar a sociedade globalmente e contribuir para um melhor convívio social entre os seres humanos [6]. O autor mostra ainda a necessidade de a escola assumir a formação para a cidadania e acredita estar presente essa preocupação nos temas transversais definidos pelo Ministério da Educação do Brasil, uma vez que todos eles têm cunho ético-moral-valorativo: globalização, pluralidade cultural e diversidade; saúde e meio ambiente, drogas; sexualidade e as questões ligadas à gravidez na adolescência, homossexualidade, prostituição, pornografia, exploração do sexo nos meios de comunicação de massa e outros; trabalho, desemprego, consumo, lazer; violência urbana e entre grupos étnicos; desigualdades socioeconômicas e miséria.

Diante dos graves problemas que a sociedade brasileira enfrenta, tais como a miséria e a violência urbana, a crise da família, desestruturada em função de pressões econômicas (necessidade de pais e filhos trabalharem para o sustento da família) e novos valores sociais (aceitação de filhos antes e fora do casamento, ênfase na liberdade e autonomia do indivíduo etc), ausência de uma postura ética de vários governantes e uma sucessão de escândalos políticos e financeiros que abalam o país nos últimos anos, a desprivatização da vida, através da televisão que mostra as tragédias sociais e familiares de personagens anônimos em programas cada vez mais popularescos e expõe a vida dos famosos (atores e atrizes, por exemplo) como se fossem íntimos de todos os telespectadores, o fato de a religião estar se tornando, a cada dia mais, um espetáculo e tantos outros, CHAVES [6] preconiza a educação humanística e a formação para o convívio social como principal contribuição que a escola pode dar aos alunos para que estejam aptos para o enfrentamento das mazelas sociais que nos afligem. Logicamente, isso não significa que a escola deva abrir mão da formação científica, mas, sim, não se eximir de responsabilidade diante do debate ético, político e econômico que envolve a vida social.

Para isso, afirma ainda o autor, ser necessário não apenas a instrução acadêmica, mas, sim, a formação prática. Praticar a cidadania e a democracia na escola seria então fundamental para esse processo de formação do cidadão. Aqueles alunos que participam da vida escolar, que têm possibilidade e responsabilidade de decidir os rumos da vida escolar, que são chamados ao debate diante dos problemas que surgem no dia a dia, estariam se preparando para serem futuros cidadãos. Uma escola em que as questões raciais e de gênero são tratadas de forma aberta e sem preconceitos, em que a diversidade cultural e sexual sejam respeitadas na prática, estará preparando futuros cidadãos capazes de respeitar a diversidade presente no mundo contemporâneo.

E que contribuição a tecnologia teria nesse contexto? Cabe-nos questionar a forma como os computadores estão sendo absorvidos pelas escolas públicas e privadas. A ausência de uma reflexão aprofundada e de pesquisas sistemáticas acerca das condições em que a utilização da informática no processo de ensino-aprendizagem se tornariam mais ou menos eficazes traz o perigo da mistificação das reais possibilidades da informática no processo de aprendizagem, bem como questionamentos infundados.

Apesar de todos os questionamentos possíveis e necessários, não se pode negar o fato de que a humanidade vive hoje a era da informática ou do conhecimento, o que traz uma responsabilidade ainda maior à instituição escolar. Negar aos educandos, principalmente àqueles oriundos das classes populares, o manuseio e uma relação reflexivo-crítica com as novas tecnologias poderá, no futuro, significar uma ainda maior exclusão social.

Vários autores, entre eles PAPERT [7] e SCHAFF [8], afirmam que a escola "parou no tempo" e que as grandes transformações sociais não a atingiram em sua estrutura. PAPERT [7], para afirmar o caráter anacrônico das escolas em geral diante das inovações tecnológicas, conta uma história em que um grupo de viajantes do tempo, vindos do século XIX, chegou ao final do século XX para analisar as transformações ocorridas em suas profissões. Entre esses viajantes, estariam cirurgiões e professores. Enquanto os primeiros se espantam diante de tantas inovações, chegando a não reconhecer o trabalho dos cirurgiões contemporâneos como a profissão exercida por eles em meados do século XIX, os professores, mesmo admirados com a modernização do espaço, com uma ou outra inovação tecnológica, reconhecem o processo de ensino-aprendizagem, que se desenvolve, em sua essência, da mesma forma que há 150 anos.

Essa história, que possui muitas variantes, ilustra perfeitamente as condições estruturais de nossas escolas. Para fugir a esse estereótipo, não bastaria modernizá-las, nem dotá-las dos mais avançados instrumentos tecnológicos. Seria preciso, antes de tudo, uma profunda transformação nos processos psicológicos e pedagógicos postulados pela escola tradicional. De nada adiantará a escola possuir recursos tecnológicos avançados se os mesmos forem utilizados, pedagogicamente, como antes, assim como o professor que distribui a seus alunos um texto mimeografado e aquele que prepara seu texto didático num computador estão, em termos didáticos, exercendo o mesmo trabalho. O computador pode também ser usado de forma a que o aluno seja um mero receptor de informações, tal qual o é na tradicional aula em que se copia as informações do quadro negro.

CONCLUSÃO

É necessário investir na formação dos professores e em pesquisas e estudos acerca das possibilidades de utilização das inovações tecnológicas num trabalho pedagógico e na elaboração de softwares educativos. Só assim será possível enfrentar a anacronia estrutural da escola brasileira e, ao mesmo tempo, enfrentar academicamente posturas infundadas acerca das novas tecnologias no processo de ensino-aprendizagem, tais como as que afirmam ser o computador uma máquina fria, tirânica, que conduz o aluno à passividade, ou aquelas que vêem no computador uma solução milagrosa, uma máquina perfeita e inquestionável.

Não sendo possível ignorar o fato de que se vive atualmente a Revolução da Informação e que a informática, o computador, principalmente, está sendo um elemento importante nesse processo, é preciso que os educadores em geral se instrumentalizem para a discussão em torno de sua utilização em sala de aula. Se é verdade, que a informática aplicada à educação tende a ser um mecanismo para a rearticulação do poder e do controle da burguesia sobre as massas, é também verdade que ela pode ser utilizada e apropriada pelas classes populares no sentido de dilapidar a hegemonia da classe dominante. Afinal, a escola, como nenhum outro espaço social, não é um feudo em que esteja presente os interesses de apenas de um grupo social. Em todos os espaços sociais estão se enfrentando diuturnamente, interesses sociais, políticos, econômicos e culturais contraditórios, não sendo possível, nem moralmente aceitável, não se posicionar diante dos mesmos!

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O APRENDIZADO INFORMATIZADO

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Abstract — *It's hard to realize that when the student is performing a task, he is doing a mental work. This paper makes considerations about computer aided learning, setting up its main characteristics, steps and environmental conditions.*

Index Terms — mental work, teaching-learning, computerization.

INTRODUÇÃO

A partir das crescentes transferências de tecnologia, os sistemas produtivos modificaram-se substancialmente, assim como os postos de trabalho. A educação continuada passou a ser uma necessidade premente. Por outro lado, no decorrer do dia-a-dia, o indivíduo também necessita mudar a forma de realizar seu trabalho, tendo em vista que as diiversas tarefas a serem executadas exigem modos operativos, às vezes, bastante diferentes.

Muito se fala dos novos papéis de indivíduos e organizadores em decorrência dos chamados "tempos modernos". O "fio condutor" para atendimento a essa modernidade que se traduz pela incorporação de novas tecnologias, no cotidiano das pessoas e em diferentes cenários, deve impulsionar ações que permitam aos indivíduos participar com propriedade e conhecimento desta modernização.

É necessário que a escola e principalmente as universidades priorizem a formação de competências específicas relativas às necessidades que se vislimbra no mercado de trabalho.

Todo trabalho realizado pelo homem possui componentes físicos e mentais. Richard [1] considera que a tarefa é resultado da construção das interpretações, que leva necessariamente a diferentes atividades de compreensão, pois o ser humano compreende para aprender (modifica a rede de conhecimentos existentes) e ainda compreende para agir (elabora um plano de ação para obter um resultado).

Em sistemas informatizados é necessário que sejam considerados as habilidades e capacidades perceptivas e cognitivas humanas assim como os aspectos ligados a tarefa a ser desenvolvida.

CONDIÇÕES DE EXECUÇÃO E ANÁLISE DO TRABALHO MENTAL

As condições de execução do trabalho mental realizado por um aluno no ato da aprendizagem, diz respeito essencialmente ao próprio educando: repousado ou fatigado, iniciante ou experiente, motivado ou desinteressado, atento ou distraído, etc. Porém, outras condições são identificáveis como: as condições em que as informações são percebidas como: freqüência, intensidade, lisibilidade, etc.; o desenvolvimento cronológico do trabalho, isto é, se o rítmo é livre ou imposto; prazo de respostas; atenção obrigatória ou não entre as diversas operações; a coerência do exercício solicitado - trabalho global ou parcial; possibilidade de controlar ou não o resultado.

Com relação à análise do trabalho, realizado pelo estudante, esta deve seguir a dois métodos clássicos que são: a observação do aluno ao realizar a tarefa e a análise dos protocolos verbais.

Como o trabalho mental não possui gestos próprios para observação, deve-se observar o movimento das mãos e dos olhos que procuram e fixam a informação na tela do computador.

Na análise dos protocolos solicitar-se-á para que o aluno verbalize todas as operações que desenvolve explicitando o porque de determinada ação, dando importância a cada troca de estratégia e separando cada operação feita identificando suas exigências. Enfim deve-se procurar estabelecer uma síntese de comunicação entre o aluno e seu posto de trabalho, que é o computador.

É importante ainda levar em consideração a carga mental a qual o aluno é submetido. O trabalho mental não é visto a não ser os resultados que dele advém, porém, estes não refletem exatamente o esforço feito, que é somente percebido pelo aluno ao desenvolver a atividade.

O trabalho mental pode ser analisado como um fluxo contínuo das operações que contribuem para sua realização. Considerando o trabalho desenvolvido pelo aluno ao realizar uma aprendizagem, pode-se tentar organizá-lo e ordená-la como a que segue:

- percepção da informação - principalmente através da visão e audição;
- integrar a nova informação com outras já conhecidas;

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- tratamento da informação - confrontar, comparar e se necessário procurar informações complementares;
- construir ou complementar as representações mentais;
- decidir e agir - escolher uma estratégia para por em prática ou ainda, mais raramente, escolher uma dentre as múltiplas soluções;
- verificar o resultado - se positivo, integrá-lo as demais soluções, caso contrário testar uma segunda solução [2].

É importante salientar que estas operações são, na maioria das vezes, realizadas simultaneamente uma vez que o trabalho mental possui continuadamente fechamentos e interações. Da mesma forma um estudante, colocado para resolver um problema já resolvido anteriormente, dificilmente vai realizá-lo como o fez da primeira vez, pois as operações realizadas contribuirão para resolver melhor e mais eficientemente a operação seguinte. Maiores diferenças serão percebidas entre uma mesma operação realizada por diversos alunos.

Segundo Guittet [3], o indivíduo quando é colocado frente a uma mensagem, primeiramente percebe sua forma, o todo, antes de observar detalhes. Desta maneira, a informação necessita de uma apresentação global (esqueleto, a intenção principal, pontos chaves) antes de se deter em uma análise detalhada do assunto. Como a memória retém, sobretudo, as formas globais, os detalhes devem estar impregnados de significação e utilizados dentro de um contexto.

O trabalho mental não pode ser estritamente modelizado ou estabelecido. Impor ou mesmo definir métodos para o trabalho mental, como foi feito, e ainda hoje o é pelo ensino tradicional, tem pouco sentido; seria o mesmo que reduzi-lo a um trabalho manual, onde dificilmente se adquire qualquer estrutura nova, numa época em que a tecnologia propicia amplos canais de se obter a informação para o aprendizado.

A FADIGA MENTAL

A fadiga mental não cessa pela interrupção da atividade, como acontece no esforço físico, pois ela continua até o próximo sono.

As principais fontes de sobrecarga mental estão ligadas:

- ao próprio trabalho desenvolvido (deve-se fornecer ao aluno tarefas de acordo com suas capacidades, elas não devem ser muito inferiores a sua capacidade, pois provocaria fadiga por monotonia e desinteresse, nem muito superiores pois ocorreria processo idêntico);
- as limitações provocadas pelo tempo dado para realizar a tarefa (pois pode exceder ao rítmo de trabalho do aluno, em cada tarefa deve ser respeitada as suas diferenças individuais);
- as necessidades frequentes de troca de atividade (responder a perguntas, abrir porta, pegar bloco de papel, etc.);
- as condições do ambiente (climatização, ruído, espaço disponível, iluminação, decoração);
- a quantidade de informações a memorizar para a realização da tarefa (quantidade de teclas a serem digitadas, sinais a serem fornecidos, etc.).

ASPECTOS RELACIONADOS AO *SOFTWARE*

O programa informático vai realizar a comunicação do estudante com o computador. Logo é importante escolher corretamente o *software* a ser utilizado para a aprendizagem.

O *software* que será utilizado para a aprendizagem deve respeitar algumas regras como:

- sua concepção deve ser feita a partir das capacidades, competências, lógica e vocabulário conhecidos pelos estudantes;
- deve ser fácil de ser assimilado pelos estudantes iniciantes em informática, porém deve ter facilidades de utilização para os alunos que estão habituados a usar computador. Desta forma o programa utilizado estará apto para contribuir na progressão dos alunos e acompanhar seu desenvolvimento.

No aspecto de interação com o estudante, os projetos de ensino assistido devem incluir uma variedade de critérios como os propostos por COAD [4]:

- usar termos, passos e ações consistentes;
- minimizar o número de digitações ou cliques de *mouse* necessários para a obtenção da execução de uma tarefa;
- minimizar o tempo necessário para obter resultados significativos nos diferentes níveis de conhecimento;
- as respostas devem ser rápidas e prontas (uma pessoa não deve ser deixada sem resposta sobre o progresso que está esta fazendo e esperar até que um sistema complete uma de suas ações);
- utilização de passos curtos, levando a uma ação bem definida;
- revisão e aperfeiçoamento da interação (as pessoas cometem erros que outras devem corrigir e o mesmo acontece com as ações executadas na interação homem-máquina. Se a taxa de correções é alta, então a interação deve ser revista e aperfeiçoada);
- os usuários não tem a obrigação de lembrar ou escrever informações de uma janela, para então aplicá-las em outra janela. Programa-se o computador, não a pessoa**.** Da mesma forma, tudo que o usuário necessita lembrar da disposição das sequências e teclas especiais deve ser organizado para facilitar sua resposta;
- manter reduzido o tempo e esforço para aprender. Não se deve esperar que o usuário leia a documentação impressa, deixando-o estudar sozinho suas sutilezas e nuances.

Deve ser fornecida referência *on-line* para os recursos mais avançados;

- lembrar sempre que as pessoas só usam o *software* que lhes é agradável. Em caso contrário só o tolerarão enquanto forem obrigadas [5].

CONSIDERAÇÕES FINAIS

No desenvolvimento da aprendizagem, como em qualquer outra tarefa, não é suficiente que o professor forneça cada vez mais informação ao estudante, para desenvolver no aluno a competência requerida. A aquisição do saber e do saber-fazer pode facilitar as relações entre professor e aluno mas não modificará a motivação e os valores do estudante. É necessário que seja criado um ambiente propício ao desenvolvimento da motivação do aluno. Este ambiente deve dar um sentido a aprendizagem, fazer o aluno dialogar, participar efetivamente, desenvolvendo desta forma a confiança em si mesmo.

É ainda necessário, ter em mente, que todo indivíduo diante de novos conhecimentos, possui uma memória de imagens e experiências que vão guiar sua ação e permitir a compreensão do que lhe é apresentado como novo, pois todo conhecimento para ser assimilado deve se reequilibrar com os conhecimentos existentes.

Em uma sala de aula recebemos estudantes com personalidades diferentes, que no momento destinado à aprendizagem ainda podem estar repousados ou não, motivados ou desinteressados, fatores que irão influenciar diretamente em seu processo de adquirir um novo conhecimento. Em se tratando de aprendizagem com o auxílio do computador ainda teremos como variante os que são iniciantes no uso da máquina e aqueles experientes, dos quais se destacam os especialistas em informática.

Neste sentido os programas computacionais que serão utilizados para aprendizagem devem buscar mais eficiência do ponto de vista da didática, da motivação, e principalmente dos objetivos que devem ser alcançados, que é a aprendizagem do aluno.

Para nos auxiliar nesta tarefa contamos com o auxílio das diversas ergonomias que nos auxiliam desde a hora da concepção do *softwares* até a fase de testagem e que resultam produtos mais atrativos e amigáveis para o usuário.

No ensino auxiliado pela informática existem pelos menos dois objetivos: um é a aprendizagem de um determinado conteúdo de forma muito mais autônoma que na aprendizagem tradicional e o um segundo objetivo é o uso da ferramenta computacional e ambos são deveras importante, para que aconteça a aprendizagem.

Neste sentido cabe aos professores um outro papel que é o de examinar os programas computacionais que farão uso para verificar se eles auxiliarão realmente seus alunos em suas atividades de aprendizagem.

Este trabalho teve o objetivo de chamar a atenção dos professores para alguns aspectos que nos passam despercebidos em nossas atividades diárias e lembrar-lhes que a informática alterou também seu campo de trabalho, dando-lhes mais uma incumbência que é fazer uma análise prévia dos *softwres* que irão utilizar em suas aulas.

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O ENSINO DA MATEMÁTICA NAS FASES INICIAIS DOS CURSOS DE ENGENHARIA

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Resumo — *As novas tecnologias da informação e comunicação têm gerado mudanças nos processos vivenciados pela sociedade do novo século. No contexto educacional, as Instituições de Ensino Superior assumem o compromisso de formar profissionais criativos, pró-ativos, com sólidos conhecimentos em sua área de atuação e com visão interdisciplinar. Este é um grande desafio, principalmente quando se constata o perfil dos alunos ingressantes nas universidades do Brasil. Por um lado, interessados na tecnologia e no uso de computadores, por outro, com sérias lacunas em conceitos básicos. Na UNISUL o NEEM trabalha no levantamento do perfil do aluno ingressante no contexto da matemática. Várias ações foram implantadas no sentido de superar os problemas detectados, como por exemplo, plantão pedagógico, monitorias, cursos extraclasse, cursos a distância. Neste artigo as estratégias adotadas são discutidas e os respectivos referenciais teóricos são apresentados. Os dados apresentados apontam caminhos que minimizam as lacunas e norteiam reflexões no contexto didático-pedagógico.*

Palavras-chaves — *Educação matemática, dificuldades de aprendizagem, ações didáticas, recursos tecnológicos.*

INTRODUÇÃO

Em decorrência da inserção das novas tecnologias da informação e comunicação em setores da sociedade, passa-se por um momento de questionamentos sobre a formação do profissional do futuro. Em todos os níveis de ensino as reflexões já se fazem presentes, no entanto, ainda não está claro qual o melhor caminho a ser seguido.

Especificamente em cursos de engenharia, que propõem historicamente um ensino caracterizado por um grande enfoque às questões técnicas, as reflexões propostas acerca do problema levantado refletiram mudanças em estruturas curriculares bem como levantaram a necessidade da criação de uma política consistente de educação tecnológica (ver [1]).

Essa política constitui-se na formação de profissionais capazes de acompanhar e gerar mudanças tecnológicas. Entre pontos que precisam ser levados em consideração para a formação desse profissional, destaca-se a necessidade de uma maior interação entre os sistemas de ensino superior, médio e fundamental buscando preencher lacunas existentes com relação aos conhecimentos básicos necessários a um aluno ingressante de um curso de engenharia.

Na UNISUL – Universidade do Sul de Santa Catarina os pesquisadores do NEEM – Núcleo de Estudos em Educação Matemática realizam sondagens que, aplicadas no primeiro dia de aula, constatam a diversidade da formação do aluno no ensino médio (ver [2]). Aproximadamente metade dos alunos ingressantes concluiu o ensino médio há pouco mais de dois anos, possui computador, acesso à Internet e conhecimento regular de computação. A maioria possui pouca disponibilidade de horas para estudo extraclasse e classificam seus conhecimentos básicos de matemática como regulares.

Percebe-se que a tecnologia é uma realidade presente na vida dos alunos ingressantes. Esta constatação vai de encontro às competências, sugeridas por [3], a serem desenvolvidas no ensino médio para a garantia da qualidade do ingressante no ensino superior: competência na tecnologia da informação, competência na comunicação internacional e intercultural, competência na capacidade de aprendizado.

Surge a triste realidade: o aluno tem sérias dificuldades em matemática básica. Referência [4] destaca que muitos problemas relacionados com o ensino da matemática no ensino superior podem estar ligados às crenças transmitidas ao aluno desde o ensino fundamental.

Diante das constatações, o NEEM implantou ações extraclasse, detalhadas na próxima seção, que visam superar os problemas detectados. Destaca-se que o sucesso da implantação de ações extraclasse só existe se houver uma conexão com ações em sala de aula.

O PROJETO DO NEEM

O NEEM foi criado em dezembro de 1996 com os objetivos: formar grupos de pesquisas técnicas, aperfeiçoamento e/ou científicas dentro do contexto da Matemática e da educação Matemática; viabilizar a iniciação científica; promover seminários sobre conteúdos específicos da Matemática, ensino da Matemática e da educação Matemática; promover cursos de extensão em nível de ensino fundamental, médio e superior; criar fóruns de discussão e reflexão sobre o ensino da Matemática em todos os níveis; facilitar e promover a interdisciplinaridade no contexto da UNISUL.

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Desde sua criação, a equipe de professores atuantes no NEEM constata as lacunas de conteúdos no processo de ensino-aprendizagem da matemática dos alunos ingressantes. Assim, surge o projeto "Ensino extraclasse: uma proposta emergencial para as disciplinas de matemática" com várias propostas de ações que, em conjunto, formariam um amplo programa de apoio a alunos que necessitassem de um reforço pedagógico ou de uma recuperação paralela.

Para constatar a problemática levantada, que diz respeito à falta de conhecimentos básicos dos alunos ingressantes em um curso superior, o NEEM, em 1998, iniciou a aplicação de sondagens no primeiro dia de aula com os alunos de primeira fase em cursos que possuem disciplinas de matemática em seu currículo. Desta forma, são levantados dados, como: ano de conclusão do ensino médio; nível de conhecimento que o aluno acredita possuir a respeito de alguns tópicos de matemática; o interesse em realizar um curso extraclasse, que envolva conteúdos de matemática básica, com o objetivo de reforçar e rever esses conhecimentos; o nível de conhecimento básico de computação e se utiliza a Internet e disponibilidade de horas de estudo extraclasse.

Juntamente com o questionário, os alunos respondem a um teste de conhecimentos básicos em matemática. O teste (sondagem) é composto de seis questões, divididas em: duas questões que tratam de operações básicas com números reais, duas questões que tratam de funções do segundo grau e duas questões que tratam de funções do primeiro grau.

Os resultados obtidos contém informações valiosas para o desenvolvimento do projeto. É possível acompanhar e dimensionar as ações semestralmente através dos relatórios gerados.

Para alicerçar as ações definiu-se como referencial teórico a concepção construtivista da aprendizagem e métodos de ensino validados empiricamente, pois estes são determinantes para estabelecer referencias e critérios para a análise da prática e da intervenção pedagógica (ver [5]).

Na visão construtivista pressupõe-se que a estrutura cognitiva dos indivíduos está configurada por uma rede de esquemas de conhecimentos. No decorrer da vida, estes esquemas são revisados, modificados, tornam-se mais complexos e mais ricos em relações.

O aluno, no processo de ensino-aprendizagem revisa seus esquemas mentais, considerando os novos conteúdos abordados e a partir daí ocorre a construção do conhecimento.

Nessas situações é importante um papel ativo por parte do aluno e também do professor como mediador do processo. É o professor que encaminha as ações e atividades educativas.

A complexidade dos processos educativos impede uma previsão do que vai acontecer em sala de aula. Assim, as atividades extraclasse apresentam-se como estratégias que podem atender dificuldades não resolvidas ou não detectadas em sala de aula.

Uma das ações implantadas de imediato chama-se *plantão pedagógico*, consistindo em atendimento individual e extraclasse, prestado por um conjunto de professores a alunos que necessitam de apoio em seus estudos. Vale destacar que não se trata apenas de um atendimento individualizado, mas sim uma atividade que é norteada por pressupostos pedagógicos refletindo as necessidades dos alunos e promovendo interações do tipo professor-aluno e professor-professor. Isso tem se mostrado altamente positivo para o contexto ensino-aprendizagem, pois a elaboração do conhecimento exige do aluno um envolvimento pessoal, tempo e esforço, assim como ajuda especializada, estímulo e novas motivações.

Outra ação, já implantada, é a *monitoria*, na qual alunos de fases mais adiantadas auxiliam os alunos que cursam as disciplinas de matemática. A atuação dos monitores não se restringe apenas ao atendimento de alunos, mas busca uma integração destes com a filosofia pedagógica seguida pelo NEEM, com a participação em atividades de estudos e pesquisas voltadas ao ensino-aprendizagem da matemática.

Essas duas ações são desenvolvidas numa sala ambiente, dispondo de material pedagógico desenvolvido em outros projetos e também de equipamentos computacionais. Esses recursos são usados com base em projetos de informatização de disciplinas, também desenvolvidos por pesquisadores do NEEM.

Para atender os alunos que têm a visão de que não estão preparados para as disciplinas de matemática, ou ainda necessitam melhorar o seu nível de maturidade, os *cursos extraclasse* de matemática básica são oferecidos. Esses cursos não têm o objetivo de revisar conteúdos ministrados em disciplinas da graduação, mas tratar de conteúdos defasados desde o ensino fundamental até o ensino médio.

Uma outra ação, que já está parcialmente implantada na forma de projeto piloto, é o oferecimento de *cursos a distância*. Por acreditar que a educação a distância pode atender uma boa parte dos alunos que possuem problemas de horários, os cursos a distância surgem como uma alternativa ao aluno que estuda em horários diversos, dependendo de sua disponibilidade. Estes cursos são oferecidos via *Internet* e o aluno tem o acompanhamento da equipe do projeto.

Observa-se que as universidades particulares têm um grande desafio, principalmente quando estão fisicamente próximas das universidades federais. Os altos custos da educação superior provocam inadimplências e evasão. Assim, é necessário desenvolver projetos criativos que produzam diferenciais. O atual projeto do NEEM já é reconhecido pelos alunos como uma atividade diferencial no contexto das disciplinas de Matemática.

As concepções e idéias adotadas pela equipe, permitem trabalhar de forma interdisciplinar, em que a matemática é vista não simplesmente como uma ferramenta, mas como um objeto de estudo.

Após alguns semestres de execução do projeto, pode-se enumerar vários resultados interessantes obtidos a partir de dados qualitativos e de concepções por parte dos alunos e dos professores envolvidos no processo.

Já se observa uma metodologia diferenciada de estudo - um processo mais humanizado. Isso porque os alunos sentem-se integrados numa equipe em que alunos e professores caminham juntos na concretização de objetivos bem delineados.

Alguns conteúdos de matemática podem ser apresentados de diversas formas aos alunos. Quando um aluno procura o professor de plantão, ou até mesmo o monitor para lhe auxiliar em algum conteúdo, muitas vezes ele se depara com outra maneira de resolver problemas, diferente da que lhe foi apresentada em sala de aula. Esse processo tem-se mostrado bastante rico sob dois aspectos. O aluno tem a oportunidade de entrar em contato com maneiras diferentes de resolver problemas e de escolher a que lhe for mais conveniente. Os professores, por sua vez, têm trocado idéias sobre as diferentes abordagens que podem ser discutidas em sala de aula, repensando a sua prática pedagógica, com o objetivo de atingir os anseios dos alunos.

É importante ter claro que as ações extraclasse devem estar conectadas com as ações em sala de aula para que se possam ter resultados positivos. Essa relação é uma busca incessante, pois envolve professores de diferentes disciplinas e sem compromissos diretos com os projetos do NEEM.

Para se atingir essa relação destacam-se três caminhos: resolução de problemas; a interação entre as diferentes linguagens usadas pelos professores e os recursos computacionais.

No contexto das engenharias é fundamental trabalhar com a metodologia de resolução de problemas. Vários experimentos dos pesquisadores (ver exemplos em [6] e [7]) mostram que a partir de problemas específicos de engenharia é possível trabalhar os conceitos de matemática definidos nas ementas curriculares. Não é uma tarefa simples, pois exige do professor pesquisas e ações de interação com profissionais de outras áreas do conhecimento. Quando os alunos são envolvidos na busca de problemas, novos desafios são destacados, pois é possível surgirem problemas cuja resolução exige interpretações físicas e técnicas que não são de domínio do professor de matemática. Entretanto, essa situação, de certa forma desafiadora, é produtiva pois, entende-se que o processo é de ensino-aprendizagem, e portanto, professor e aluno devem conjuntamente buscar a solução.

Sabe-se que cada área do conhecimento tem suas linguagens próprias e que na maioria das vezes são parcialmente diferentes das linguagens utilizadas pelo professor das disciplinas básicas de matemática. Por exemplo, o professor de matemática usa o termo "argumento de um número complexo" enquanto que o professor de análise de circuitos usa o termo "fasor". A unidade imaginária do campo dos complexos é representada pela letra "i" praticamente em todos os livros de Matemática, ao passo que nos livros de Engenharia Elétrica vamos encontrar a letra "j".

Essas diferenças de notações ou linguagens causam grandes conflitos para os alunos que podem deixar de existir a partir do momento que haja uma aproximação entre as disciplinas de Matemática e as demais disciplinas do curso. Considera-se esse um grande desafio, pois é necessário colocar efetivamente em prática um processo interdisciplinar.

A prática interdisciplinar, largamente falada e pouco praticada, exige uma forte interação entre professores de diferentes disciplinas e alunos, pois não basta utilizar a mesma linguagem, é necessário "trocar métodos".

O uso dos recursos computacionais tem se tornado um elo de interação entre as disciplinas de matemática e as demais disciplinas do curso. Por exemplo, o aluno ao necessitar desenvolver um método, analisado na matemática, inserido no contexto de uma disciplina específica da Engenharia pode usar os recursos computacionais para buscar encaminhamentos de resolução. É evidente que isto funciona desde que as disciplinas de Matemática tenham trabalhado de forma adequada os recursos computacionais. É necessário visualizar o computador como uma ferramenta de trabalho e como um objeto de estudo. Por exemplo, ao usar um software para resolver uma integral, não basta saber o resultado, é necessário construir computacionalmente o resultado.

CONCLUSÕES

É possível visualizar, no decorrer da experiência, em constante processo de construção, que as ações desenvolvidas dentro do projeto, podem ser discutidas sob dois pontos de vistas. Primeiramente têm-se resultados explícitos, quando o aluno procura a equipe de professores e monitores do NEEM, para discutir suas dúvidas e suas atividades de sala de aula. Essas atividades já estão consolidadas e incorporadas às atividades extraclasse do aluno, conforme comprova os dados avaliativos coletados (índices de atendimento, satisfação e outros).

Por outro lado, têm-se resultados não explícitos, visualizados e constatados através de diferentes ações. Por exemplo, a variedade de metodologias que circula no ambiente do NEEM, geram reflexões sobre métodos de ensino em sala de aula. Essas reflexões não resolvem tudo mas produzem um repensar constante da prática e, as estratégias geradas, os novos procedimentos e os novos modos de fazer, além de uma sólida cultura para atingir a qualidade, ajudam na superação das dificuldades de aprendizagens que surgem.

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On the use of a constructivist framework to support Collaborative Learning in Teacher Life-Long training in Technical Areas[1]

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Abstract *— Brazilian math assessments are an important social problem nationwide. The teachers´ skills are one of the most important variables to consider in this situation and the use of educational technology contributes significantly to improve the students´ achievement. Moreover, if we can provide distant courses, we can reach a broader range of teachers. AMADeUs, our project, is based on the principle that a multi-dimensional learner evaluation is very important to build a better picture of students' development and participation. Design decisions are taken based on experiences with matematica.net; pilot studies are been conducted to orient the design processes and a methodology for this type of courses.*

Index Terms — Teaching, Learning and Assessment Strategy in Virtual Classroom, Intelligent Training Technology.

INTRODUCTION

Nowadays, computational environments for Distance Education (e.g. BlackBoard, WebCT) are mostly generic tools that allow for course creation without any link to the domain in question. Furthermore, they do not offer any specific support for neither the student nor the teacher.

A common way of designing and implementing environments is based on instructionism, which considers that good presentations of knowledge are enough to guarantee learning. This suffers from a serious limitation: little or no consideration for the learner's needs. Works in AIED (Artificial Intelligence in Education) have been striving to solve this problem for a long time.

As far as distance learning goes, there is a gap to be filled with the application of higher-level educational environments, which, not only provide better tools for the teacher, but also that provide adequate support for the learning process. As far as teaching is concerned, we should aim at providing support not only for the teacher to follow the learning of specific concepts, but also for him/her to follow the evolution of competencies such as organisation, group interest, and communication. Thus, methodologies for multi-level evaluations are of great interest.

The computational system we are proposing not only incorporates evaluation techniques, but also caters for the processes of negotiation (amongst learners, and learners and teacher) and mediation. This is achieved by the use of intelligent support agents that will help users. In its first application, our platform will be used for teacher formation.

The AMADeUs solution stems from the necessity of implementing an architecture that took the domain specific needs into consideration. The first domain was elementary math teacher continuous formation and computer science undergraduate students.

This paper is organised as follows. The first section describes our motivation. Then we present some environments used in teacher formation. The third section introduces a model for a collaborative learning support system including both traditional collaborative tools and content guided tools. The fourth section describes the intelligent support in development. We then describe a proposal for a multi-level assessment technology and present a user centered design approach. Finally, we present our conclusions and references to future work.

MOTIVATION

There are important assessment problems associated with maths learning in elementary levels [48]. In general, students finish secondary courses with minimal knowledge, (i.e. with competencies to solve primary maths problems). In the last three years of school, no more knowledge is acquired. The same report indicates that assessments improve significantly when educational technology is used in learning.

In this light, we can see that there is a clear need to better form maths teachers. Actually, formation courses occur in various ways, the main distinction being the number of teachers and distance from formation centers. In the first case, if the number of teachers is too large, administration prefers to organize single, short-duration events. In the second case, teachers are trained by private consultants. The interventions are usually brief and non-systematic. Graduate professionals, with short pos-graduate formation, conduct those courses. In both cases, teacher participate in short time courses without continued evaluation.

Many authors indicate that teacher's formation should be organized as a continuous process. Information technology can be an alternative solution to make it feasible. In our project, teachers are engaged in communities of practice and were accompanied with mixed methodology. Virtual and classroom activities are combined and distributed in a long-term formation program. Post-graduate tutors assisted the teachers. Also, teachers were able to work

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and challenge peers from the same school and far from those work place.

SOME POSSIBLE SOLUTIONS

The socio-constructivist approach to learning [18] suggests that the learner is part of a social group, and, as such, should be able to question, discover and understand the world in which he/she is inserted. The boom of communication technologies has made it possible for us to implement computer environments that take advantage (and encourage) group interaction. Such environments are known as Computer Supported Collaborative Learning Environments (CSCLE). Amongst the various possibilities for CSCLE, we want to focus on the tecnology based on projects. The idea is to teach based on discovering solutions for real life problems. According to [39], knowledge and ideas emerge from situations where we need to learn from meaningful experiences. Boud, Keogh e Walker [25] define reflection as being the act of mulling things over, and trying to understand our own experiences. This is a fundamental skill in learning, and is also the one we lack most. When talking about reflection, we cannot leave out the process of articulation. Self, Karakirik, Kor, Tedesco and Dimitrova [33] define articulation as being the act of verbalising our thought processes. Amongst the main benefits of this are the fact that verbalising might help us develop our thought processes; articulating something brings its weaknesses to light, and may generate interesting discussions on the topic.

As a general rule, collaborative learning is more productive when participants are engaged into open-ended problem solving. A possible way of constructing these learning situations is to propose projects involving learner groups and to provide intelligent support that reinforces the ideas of reflection and articulation.

A project can be defined as a process that is divided into stages, related to one another, forming a flow. Each stage can be evaluated through the execution some tasks. The environment we are building is based on the idea of workflows – which allow us to visualise and evaluate the work being done in the different stages of the project. The idea is to provide tools for evaluating tasks, monitoring group interaction and evaluating the learning process.

THE AMADEUS USER CENTERED DESIGN

The AMADeUs´ initial architecture was based on a literature review together with the participants´ experiences in various areas. The AMADeUs team is multi-disciplinary, consisting of teachers, Educational specialists, Psychologists, and Computer Scientists.

The interface design is centered on users´ actual practices in a user centeder design routine [35] [36]. As the design progressed, we incorporated tools for intelligent support and group monitoring and formation. Part of our new insights came from the case studies we have carried out – as described below.

Case studies

We have carried out a first course to observe the parameters that could orient the interface and architecture design processes. The syllabus focused on maths´ teaching and learning with educational software. Ten (10) teachers from a public school in Recife participated in the study.

The course was focused on the use of educational technology in maths education. We organized interleaved sequences of theoretical meetings and experimental classes with educational software sessions. Both were conducted at the school. The course had six modules: introduction to educational technology in mathematical education, additive structures teaching and learning, multiplicative structures teaching and learning, fraction teaching and learning, function structures teaching and learning

We adopted a mixed methodology encompassing local and distant seminars. The course was programmed to last one year. The local meetings were conducted twice a month, lasting three (03) hours at a time. Those meetings were interleaved with virtual discussions through both synchronous and asynchronous communication tools. By observing the activity in the discussion list environment, we have concluded:

- This first experience was very hard. Teachers were really skeptic about distance learning.
- Participants´ engagement during chat was modest. Discussions were difficult to mediate and anonymous contributions confused participants.

User Needs and User Centered Design of Teaching Support Environments for E-learning

In order to investigate solutions that aid educators in their educational practice in e-learning environments, this paper presents the analysis of some of the Educators' activities to understand their tasks in executing their jobs. Thus, the complexity of the tool's appropriation tends to be reduced, centering the development of the whole design in the users, their needs and their tasks. We have chosen three teaching activities to start with: course planning, teaching materials creation and delivery and evaluation/tutoring. This choice is based on the fact that there is a shortage of tools to support these fundamental (and yet non trivial) tasks.

This work argues that Educators need to modify their activities in order to fit with some existing tools in e-learning environments. This sometimes promotes a restriction of what could be accomplished and limits the Educator´s creativity, thus entailing possible failures during the course development.

Questions such as: how these environments support real teachers' activities, which activities are exercised in these environments and whether the support available is carried out efficiently and in agreement with the educators' practice, are more and more necessary to aid educators to teach in a reflexive way, making their tasks more flexible and dynamic.

Based on a questionnaire that investigated teachers' procedures in planning, delivering and tutoring, we interviewed twenty Brazilian Educators experienced with e-learning environments and performed a qualitative data analysis with a software named NUD_IST (Non-numeric Unstructured Data Index Searching and Theorising). The reason for choosing NUD_IST was the difficulty classification and analysis of not structured data used in this research. This resulted in a classification of teachers' tasks which was used to build prototypes of tools to aid teachers in planning their courses, delivering their materials and tutoring the students. As argued in [35] [36], we believe that understanding users´ needs is a success factor in product development. This motivates us to use User-Centred Design (UCD) to guide our task on developing the tools´ prototypes.

At the time of writing we are specifying our systems use cases based on [35] [36], considering the user needs and requirements. The use cases elaborated in the specification will be validated in an e-learning environment named AMADeUs (Microworld Agents and analysis of the development in the use of instruments). The objective of AMADeUs is the construction of an e-learning environment based on the microworld concept [2], methodologies and tools that allow a significant progress of the reflections on teaching technologies [44] and an improvement in the use of those technologies in the teaching-learning process.

The planning and creation course use case resulted in set of procedures that would be performed by teachers, which include the elaboration of a course program, with its objectives, activities, bibliography, calendar, evaluations and communication tools. The teacher materials creation and delivery use case resulted in elaborating teaching materials guide and also in a set of procedures to complete the delivery according to their needs; and the results from the tutoring use case based on the task that students activities may be traced, driving the best way in their learning, aiding tasks execution and obtaining subsidies for its evaluation to define systems' tools.

User-Centered Design of Workflows in E-Learning

The socio-construtivist learning approach [18] suggests that the learner must have the initiative to question, discover, and understand the world through his interaction with the other elements of the historical context of which he is part. In this philosophy, we singled out the use of technology in cooperative learning based in projects [50], whose objective is not only to incorporate up-to-date access to information, but mainly to promote a new learning culture through the creation of environments that foster the making and exchange of knowledge. The method based in project was devised to teach through the discovery of solutions for real.

The development of a project can be defined as a process, divided in stages related one to another, forming a Workflow. Each stage is evaluated through the execution of one or more tasks that must fulfil certain objectives, and generate some products.

Some of the features of cooperative learning based on projects are [14] [15]: consider the expectations, potentialities, and needs of the students; build the necessary space where teachers and pupils have autonomy to develop the cooperative learning process with reciprocity, responsibility, and honesty; develop the ability to work as a team, make decisions, facilitate the communication, and formulate and solve problems, develop the ability to learn how to learn in such a way that each one may rebuild the knowledge through the integration of abilities according to his universe of concepts, beliefs, and values.

We believe the most natural way to promote the teaching based in projects in a web-based learning environment – using workflow technology as its base [Georgakopolous1995]. However, the existing Workflow (e.g., StaffWare [www.handysoft.com], LotusNotes [www.lotus.com], BizFlow [www.handysoft.com]) Management Systems were not conceived with educational environments in mind, which is why they do not satisfactorily tackle actions such as teaching, evaluating, and orientating. On the other hand, the majority of Virtual Learning Environments (VLE) (e.g., Blackboard [www.blackboard.com], LotusLearningSpace [www.lotus.com], WEBCT [www.webct.com]), don't offer management and automation tools for educational workflows. Generally, it's up to the teachers and students to externally plan a cooperative project, and to propose support mechanisms to make it feasible. Special instances are VLE with Workflow Flex-eL ([www.flex-el.com]) [44], and VLE based on Zebu Projects [14].

Our proposal aims at creating a virtual project-based learning environment whose cooperation process is promoted by the integration of comunication functionalities with an educational workflow. This environment, named AMADeUs [46], is a generic framework offering adaptative teaching tools centered in group work. Tools to allow the implementation of a constructivist evaluation proposal taking into account all the stages of the workflow are in the process of being developed. The basic idea is to create a structure to stimulate the emergence of the right distance-teaching actions through the most representative users, which are, teachers, pupils, parents, content-makers, coordinators, and managers.

The development process for this system takes into account methods and tools for the ethnographic analysis of formation activities [38] [40]. We used a Software Engineering undergraduate course as a use case. The first part presents a social analysis starting from data collected from transcriptions of interviews and dialogs between teachers and pupils in the presence of observers, and an e-mail list used to facilitate the communication between members of the group [45]. The first requirements are then produced from the classification of the information collected using Nud-Ist. In the second part, the system modelling using scenarios [37] and UML diagrams that embed qualitative information in each task to perform [35] begins.

Initially, we adopted a component-oriented development technique using JAVA and XML (eXtensible Markup Language) in a three-layered framework (adaptative interface components, workflow components, and communicaton middleware) [1] [42]. New ethnographic analysis is performed for the study of the structure of the activity using the new tool. The development cycle ends when the study of the social activities points to a satisfactorily employment of the tool by the user.

THE AMADEUS ARCHITECTURE

One of the main novelties about our project resides on our use of constructivism to allow the implementation of an assessment system that permits a continuous evaluation and diagnosis of the learning process, differently from most on-the-market learning environments. Furthermore, we also intend to promote effective collaboration by organising participants´groups in project teams, and guiding their interaction [31] in accordance with the guidelines for effective collaboration defined in [34]. We have also taken special care while designing the interface – we have used user centered design techniques [referência aqui] and taken users´ awareness into consideration.

Our initial model consists of several agents, three of them directly concerned with intelligent support. The idea is to evaluate the entities´ performance during construction of the first prototype. The results obtained then will show us whether we need to modify agents' funcionalities. The system's architecture is shown in Figure 1.

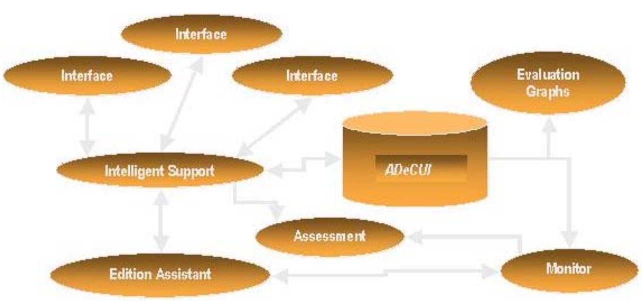

FIGURE 1
THE AMADEUS ARCHITECTURE.

Since we want AMADeUs to be as generic as possible, we have been also thinking about a way of using its core with computer science applications. To us, one of the best ways to do it is to build a tool for collaboratively carring out projects. According to [14] such environments must provide tools for: defining processes to account for collaborative process; selecting and implementing tools for performing project-related tasks; storing and retrieving information about past projects; using the internet as its basic platform. Thus, we will be incorporating tools for guiding the collaborative process in the AMADEUS framework [56]. One of the most effective ways of doing so is to incorporate intelligent support agents that help participants interact, reflect, and thus reach more refined solutions.

Cooperation Components

In AMADeUs, there are several environments students (and teachers) can interact in. We have provided environments for individual learning (interfaces, email box, pigeonhole), for group interaction (lists, chats, foruns, evaluation central, common workspaces) and so forth. We have paid special attention to group formation and negotiation issues and evaluation.

We have also provided space teachers to interact with one another and to find better ways to perform their activities (planning of courses, tutoring, evaluation). In fact, we are working on finding out a methodology to design tools for the teacher to use.

Awareness Interfaces

The first results obtained during a pilot study have indicated that asynchronous user component web interfaces are too complicate for use. Maths' teachers, as a significant number of teachers in elementary education, are not familiar with information technology. Our main intention concerning the interface is to create extremely simple web interfaces that approximate, as much as possible, users' models concerning cooperative learning to teach. Another principle adopted in web design was that signaling co-presence could improve cooperative initiatives and facilitate the users´ conceptualizing process [23].

Our aim is to create, through the interface, awareness of social participation, with specific roles and objectives, but interdependent with each other through social contracts.

The group's coordination, as promoted by expert tutors, intends to facilitate group conscience emergence. As we have already mentioned, the intelligent support provided will aim at reinforcing good collaboration – and that certainly involves group participation from all members. The main semiotic principle is the limited number of elements and signs in the web interface. The interface is also used to communicate co-presence in the web site. Participants can follows peers and tutors navigation through little signs on the pages.

User Software Component

The most important collaborative component is a middleware component, a shared workspace. Its architecture is open, what allows the use of different contents-oriented educational software in training situations.

Considering that one of the most important features of any educational groupware is the set of resources that deal with the interaction between the participants, and that the mere transmission of contents through the Web is not enough to the teaching of Mathematics; we propose to expand the notion of interaction to one that includes actions.

Since AMADeUs is an environment designed to educate teachers to teach Mathematics using computational tools, it is necessary to take into account a different interaction paradigm (frequent in games played on-line): interaction through action, which is based on the concept of micro-worlds. This interaction occurs through the use of virtual shared environments also called User Software Component, USC. These components allow the creation of more than one level of interaction, promoting situations fundamental to the teaching proposed by the environment. This component complements the proposal for communicative interaction through texts in communication tools.

There are two ways to instruct in VLE: directly and indirectly. In the first case, lessons are presented by the instructors who also pose questions and wait for the answers, give feedback, and evaluate the results. This makes a VLE independent of the type of contents in an generic environment. The second type adopted is synchronous and visual. Our proposal aims at increasing the possibilities of interaction through shared action. In this case, instead of following rules, the students explore the relations actively and cooperatively. Our idea is to overcome the limitations of the existing educational environments, combining the properties of intelligent tutors and micro-worlds through cooperative systems or tutored discovery. Besides, it was observed that the tools and environments should amplify the teachers´ abilities to produce situations and proper follow up to the pupils´ learning.

In the AMADeUs environment, the tools associated to the development of indirect instructions are non-web applications of the shared environment type, named user´ software components. These components are launched during the surfing of the environment, and support the shared use of up to four people, teachers or pupils. The advantage in using this type of collaboration tool is that the pupils use different strategies leading to the emergence of different kinds of knowledge [47] [49]. In previous studies, we have shown how the use of different interfaces determines the emergence of different properties of concepts. Users profited by participating of direct and indirect instructions [VBK1999].

The micro-world environments are conceived to favor the students´ activities. These systems seem to be the best adapted to the learning in situations of classroom mediation or in educational IT lab conditions, where pupils work in pairs, and are oriented by the teacher.

The notion of interaction through the Internet is related, in many cases, to processes mediated by text and image communication. The interaction can take place through other forms of action. From the point of view of cognitive development it is interesting to combine textual with imagistic and manipulative forms. In this case, we propose that the interaction between the actors of a learning group takes place through actions performed in the same shared workspace. An image tells more than a thousand words. Words are frequently ambiguous. However, sometimes, the meaning of a discourse is enhanced by some actions and vice versa.

The USC interface displays three parts: a map at the upper right corner, an educational software environment at the center, and a chat at the lower right corner. The game machine is shared among several educational applications. The machine has communication resources between applications, access resources to the server to send and receive information about the pupil´s development or about the interface quality, communication resources through chat, and the interface local control (statecharts). There are three layers of software: interface, mathematical modelling, and interface control.

The USC have two main parts. The first one is a client into each are that incorporated a communication component (chat), a coordination one that permits participants to program the time sharing strategy. The third part is educational software (micro-worlds) that are plugged and shared with the other students. There are three user software components under development: two in the domain of the teaching of Mathematics and another for Physics teaching.

Multi-Level Evaluation

Evaluation in e-learning is organized according to different strategies. Systems' design is typically guided by a priori effectiveness comparisons of different evaluation strategies. In this platform, our aim is to coordinate the positive contributions of specific evaluation strategies, taking advantage of the best features of each of them.

Our design principle is that comparing and combining different actors' points of view can substantiate evaluation results better that using single strategies. The idea is to take different strategies that focus on single actor's (students, tutors or graders) points of view and combine their results in order to produce a better picture of our users. In this light, we have proposed a combination of four strategies, namely: open-end evaluation (the traditional evaluation of production, exams or papers), continuous participation evaluation (grades, tutors and staff continually evaluating contributions on chats rooms, forums and e-mail list services; interface agents following and grading students activities, and intervening in the interaction), self-evaluation and peer-evaluation.

For each strategy, we have designed specific environments and support agents. All those points of view are integrated, processed and represented in simple reports and graphs. Results from different sources are compared and combined to produce a coherent and usable student evaluation. In this way, we are able to produce more consistent results. Active and passive units and environments compose this specific architecture.

Student's participations are monitored in chat rooms, discussion forums, e-mail lists, individual e-mail to tutors and teachers. Intelligent interfaces in user software components are responsible for modeling and evaluating students learning in action. Peer points of view are captured in specific environments where peers are invited to evaluate colleagues and judge their production.

We use the evaluation task as opportunities to promote learning. All material delivered is then adapted from the aspects students had learned and those they are still having problems with. All adaptative content is constructed dinamically and presented in the right time to studentes.

COLLABORATIVE LEARNING SUPPORT

Aiming at supporting more effective colaboration, AIED research has been trying to better understand the collaboration process and to build systems that support it. Learning collaboratively implies achieving solutions that would not be found otherwise and negotiating shared knowledge [26]. Dillenbourg [28] [29] argues that we can support collaboration by (1) fixing initial conditions; (2) constructing scenarios; (3) supporting productive interactions, by structuring the dialogue and (4) monitoring and regulating the learning process. In our platform, we intend to support collaboration in these four levels. The idea is to follow Dillenbourg's guidelines and structure the interaction (via tools that facilitate communication and agents tha monitor the dialogue) and through the presence of mediators (either the teacher or artificial ones).

Intelligent Support

As far as intelligent support goes, we have several agents working on different levels. In the following, we present each of them. In fact, in order to account for a multi-level evaluation and (subsequent) support, the student modelling component our system consists of a multi-agent society, whose members are described below.

A1 – Action Modelling Agent

This agent is initialised every time a new student logs onto the system, and follows him/her until the end of the interaction. A1 is basically responsible for collecting (and analysing) students´actions. When the agent finds out that the learner is having some difficulties with the syllabus, it sends the teacher a notification. A1 reasons about the actions following 3 criteria: (1) possible misconceptions; (2) correct actions and (3) strategies used for solving the current problem

A1 can also learn tutor´s actions, and can take the initiative with the tutor´s permission. That includes suggesting new learning situations and interacting with learners.

A2 - Student´s Production Agent

This agent analyses students´records (their production and teacher/instructor´s evaluations) in order to suggest the strengths and weaknesses of each student. It also uses information from A1. As we determine students´competencies, A2 accumulates a learner model. Besides performance and quality of production, the following parameters are also included: (1) can help in topic; (2) needs help in topic.

When it deems necessary, A2 asks A3 to form groups based on the contents needed by learner *x*.

A4 - Rithm Monitoring Agent

Sometimes, students in distance learner courses indicate their lack of motivation/ understanding by not doing their activities, and not logging on the system. Thus, A4 uses this information to try to assess whether there are problems and where they are, and thus inform the learner models. It can try to solve it by forming groups, sending communications to the leaners and informing the tutor that there are problems.

A5 – Interface Agents

This agent analyses users activities in the microworlds interfaces, and will try to help its charge by taking local decisions (which situation to present now? Does the interface need to be adapted?) It will base its decisions on a library of past situations faced by previous students of the system. A5 also provides feedback for the learning monitoring system A.De.C.U.I.. It also has functionalities to interpret situations and feedbacks.

The agent that monitors the microworld interfaces is responsible for monitoring whether the student has already seen all the available situations. It also helps the tutor to identify and propose new problem situatiosn for the students and to reinforce learning by assessing what has been done in each microworld. The first part of this agent design was recentelly obtained thur the identification of adequate learning algorithms best adapted to those specifique data strucuture **[ref reic ana emilia isbn**].

A6 – Editoring helper

This is responsible by helping the teacher to create new learning situations for the students. The teacher consults the production knowledge base and conceptual maps graph in order to assess what would be most beneficial for the student. The teacher can also see other teacher´s work for similar situations.

A7 – ADeCUI´s data Analyser

This agent will analyse the data present in A.De.C.U.I. in order to give feedback to the interface agents about what the learners know and what are their weaknesses. Data mining techniques are being applied here in order to guarantee that the relevant information will be available to the agent or to the teacher in due time.

Group Agents

A3 - Group Monitoring Agent

This agent works with information from A1 and A2 in order to form groups to learn given topics. When A3 needs to form a group, it asks the agents A2 to inform which learners could fit the profile, and sends them messages inviting them to join a group. Agents A1 and A3 then negotiate in order to find activities that are beneficial for all the group members.

Agent A3 also monitors the group interactiong, trying to keep the group motivated and collaborating effectively. In order to do so, A3 keeps track of the social roles played by group members, identifying the following: collaborator, tutor, competitor, leader, reflective, shy and idea generator.

A3 also has the following responsibilities: a) motivate members that are not participating as much, and trying to reinforce the guidelines for consensual decision making [34]; b) mediating possible conflicts; c) reminding participant of options not explored yet. A3 also keeps a group model, which includes a detailed log of the interaction, not only for users to see and reflect upon but also for the teacher to consult.

CONCLUSION AND FURTHER WORK

In this paper, we have briefly presented AMADeUs, our project of a computational distance learning platform that tries to address the deficiencies found in most on-the-market distance learning products: we provide mechanisms for multi-level evaluation; intelligent support that addresses not only the needs of the learner but also the needs of the teacher (in dire neglection these days); we take issues like motivation and effective collaboration into consideration.

We also have members working on methodologies to design environments that are adequate for the teachers´ pedagogical activities; we are also working on group formation and negotiation. Even though our project was conceived with maths in mind, we have already seen that it can be used in other domains. Our next idea is to adapt it to be used in Computer Science Education. The idea of collaborative projects can be widely used in computer science (for designing software, for example).

In the very near future we intend to carry out a couple more case studies to validate our design methodology. We also intend, as soon as we can, to put the system to good use, in order to evaluate it, and modify it accordingly.

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O DISCURSO DA QUALIDADE TOTAL EM EDUCAÇÃO
Um estudo no âmbito da Educação em Engenharia

Liane Ludwig Loder[1]

Resumo — *Esse trabalho pretende discutir a eficácia da implantação de Programas de Qualidade Total (PQT) em Educação em geral, e em Educação em Engenharia em particular, a partir da análise de experiência de implantação de um programa congênere no âmbito da Escola de Engenharia da Universidade Federal do Rio Grande do Sul-UFRGS, particularmente, no Curso de Engenharia Elétrica desta Instituição. Esse estudo aborda esse tema partindo da descrição dessa experiência. Na seqüência, é exposto o referencial teórico da análise pretendida, destacando-se, dentro de uma perspectiva histórica, a gênese da concepção dos Programas de Qualidade Total e os fundamentos que norteiam a aplicação desses princípios em processos educativos. Após, é feita uma análise crítica dessa experiência, a partir de conceitos da Análise do Discurso (AD). Ao final, são apresentados argumentos que justificam a inadequação e o previsível insucesso, em termos de melhoria da aprendizagem dos alunos em sala de aula, da aplicação desses Programas em Educação .*

Palavras chave —Qualidade Total em Educação, Educação em Engenharia.

DESCRIÇÃO DO CASO

O Programa da Qualidade Total (PQT) na Escola de Engenharia da Un. Fed. do Rio Grande do Sul (UFRGS)

O PQT implantado na Escola de Engenharia da UFRGS em 1998/2, em seu objetivo mais amplo, pretendia nortear e amparar as iniciativas administrativas e pedagógicas da Instituição tendo em vista a melhoria da qualidade de seus diferentes Cursos, tanto em nível de graduação como de pós-graduação.

A estimativa era de que essa melhoria teria reflexo na diminuição dos índices de evasão nos Cursos, bem como na readequação dos Currículos em função das demandas impostas pelo mercado de trabalho, e também no aumento do nível de satisfação dos professores, funcionários e dos próprios alunos com as suas condições de trabalho (infraestrutura física, recursos humanos e materiais disponíveis).

A complexidade da Instituição que abriga nove cursos de graduação (Eng^a Civil, Elétrica, de Materiais, Mecânica, Metalúrgica, de Minas, de Produção e Química), seis cursos de pós-graduação em nível de Mestrado e Doutorado, além de cursos de especialização, tendo cerca de 3000 alunos para um corpo docente de 167 professores e 112 funcionários, dificultou sobremaneira o trabalho de implantação do Programa de Qualidade, não permitindo atingir, na avaliação dos responsáveis por esse Programa, todas as metas inicialmente estabelecidas, dentro do prazo previsto. A partir dessa constatação, o campo de aplicação do Programa de Qualidade foi restrito a um dos Departamentos da Escola e o Departamento escolhido foi o de Engenharia Elétrica.

O Programa de Qualidade Total (PQT) no Departamento de Engenharia Elétrica (Delet)

O PQT na Engenharia Elétrica foi implementado com o objetivo geral de melhoria da qualidade do Curso. Para tanto, o Programa previa a implantação de uma metodologia de trabalho que otimizasse o uso de recursos disponíveis, obtendo uma maior eficiência nas ações administrativas do Departamento e uma maior eficiência pedagógica no cotidiano do Curso.

Foram feitas várias reuniões, assistidas e coordenadas pelos consultores, em que professores e funcionários se manifestaram, a partir do que foram levantados e descritos os problemas existentes no dia-a-dia do Departamento.

Em uma fase inicial, foram classificadas as atividades do Departamento nas seguintes categorias: Recursos, Processos, Produtos, Clientes. Os resultados obtidos estão resumidos na Tabela 1, a seguir:

TABELA I
ATIVIDADES DO DEPARTAMENTO POR CATEGORIA

Recursos	Professores, Alunos, Funcionários, Instalações prediais e Equipamentos.
Processos	Curso de graduação, Cursos de Extensão, Cursos de Pós-graduação, Pesquisas, Consultorias, Publicações, Capacitação de professores , Capacitação de funcionários, Comunicação interna.
Produtos	Formação de RH, Geração de conhecimento e Prestação de serviços.
Clientes	Alunos, Professores e Funcionários.

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Feito esse levantamento, foram estabelecidas ações e formados grupos de trabalho para executá-las. Esses grupos foram categorizados, segundo as necessidades identificadas, em onze categorias e tinham por responsabilidade:

- Extensão - fomentar a criação de cursos de curta duração destinados a Empresas e Profissionais de Engenharia Elétrica;
- Graduação - compatibilizar os horários das diferentes disciplinas e definir as salas de aula a serem utilizadas;
- Reforma curricular;
- Pesquisa - divulgar para a comunidade interna dos calendários das agências de fomento, relatórios das atividades desenvolvidas pelos diferentes grupos do Departamento;
- Pós-graduação - acompanhar o processo de implantação do Doutorado em Eng^{a} Elétrica e estudo sobre a possibilidade de oferta de Mestrado profissional;
- Qualificação do espaço físico;
- Laboratórios - melhoria do espaço e dos equipamentos destinados às aulas de laboratório;
- Informatização - melhoria dos serviços prestados à rede interna de computadores do Departamento, criação de "home-pages", disponibilização de documentos e formulários eletrônicos via rede interna;
- Melhoria do ensino - estudo e implementação de novas metodologias de ensino;
- Avaliação - melhoria do sistema de avaliação interna da ação docente;
- Colóquio Delet - promoção de seminários internos visando uma integração das ações executadas pelos demais grupos.

Algumas das ações implementadas, total ou parcialmente, foram:

- Criação de "home-pages" dos diferentes laboratórios destinadas a registrar e disponibilizar informações a respeito das atividades de cada laboratório e, dessa forma, melhorar a troca de informações interna e possibilitar que a ação de cada grupo de professores seja acompanhada pelos demais e possa dar origem à ações conjuntas, intensificando a interação entre os diferentes grupos e, conseqüentemente, o desempenho geral do Departamento nas suas diferentes atividades;
- Diminuição do ruído sonoro ambiente (o prédio sede do Departamento de Engenharia, onde funciona o Curso homônimo, é margeado por avenidas de intenso tráfego de veículos). Melhoria da ventilação de um dos laboratório de ensino de graduação;
- Contratação de um assessor administrativo experiente objetivando desonerar a Chefia do Departamento de questões administrativas rotineiras. Dessa forma, possibilitando uma ação mais efetiva do Professor-Chefe não só como coordenador das várias ações em curso, mas também como agente principal da obtenção de recursos financeiros necessários para realizar essas ações;
- Acompanhamento de algumas aulas - essa ação, proposta e realizada pelo consultor do Programa de Qualidade, consistia na distribuição de questionários aos alunos, ao final das aulas, objetivando, conforme as palavras do consultor: "*avaliar o desempenho do Professor em sala de aula, identificando a velocidade em que os assuntos são expostos (ritmo), a capacidade do Professor manter o aluno motivado (auto-avaliação), se o objetivo principal foi alcançado (entendimento da matéria apresentada), a habilidade do professor associar os conhecimentos apresentados e a utilização desse para o aluno (utilidade).*"

Esse projeto teve seu fim decretado por falta de recursos financeiros em meados de 2000, após aproximadamente um ano de atividades.

FUNDAMENTAÇÃO TEÓRICA

Qualidade Total em Educação

Por Qualidade se entende uma característica, propriedade ou estado que torna um produto ou um serviço plenamente aceitável. Por sua vez, um produto ou serviço é considerado de boa qualidade se apresenta alto grau de conformidade a um custo compatível. Nesses termos, a Qualidade é pensada em função do cliente, a partir de suas necessidades. Segundo os teóricos da Qualidade esta definição de qualidade, com algumas adaptações, pode ser aplicada à educação.

William Glasser, médico e psiquiatra americano, autor de *Escola sem fracasso,* estabelece sete diretrizes para uma Escola de qualidade- *os sete pontos centrais de Glasser: 1. Gestão democrática ou por liderança da escola e das salas de aula; 2. O Diretor como líder da comunidade escolar; 3. O professor como líder dos alunos; 4. A escola como ambiente de satisfação das necessidades de seus membros; 5. O ensino baseado na aprendizagem cooperativa; 6. A participação do aluno na avaliação de seu próprio trabalho; 7. O trabalho escolar de alta qualidade como produto de uma escola de qualidade.*

Segundo Glasser, a Qualidade Total somente é alcançada quando toda a Escola, na integridade de seu corpo social: professores, alunos, administradores, orientadores, supervisores, equipe técnica e de apoio, pais e sociedade, tornaram-se partícipes reais num processo incessante de aperfeiçoamento dos serviços educativos prestados pela Instituição.

O professor, nesse contexto, é o administrador mais crucial para o sucesso da Escola. O professor visto como líder dos alunos cria esquemas para evitar que a tarefa escolar seja aborrecida, enfadonha ou sem sentido para o aluno, se interessa pelos estudantes, sabe que o sucesso de seu trabalho depende da cooperação dos que são dirigidos por ele e compreendendo que os estudantes só se dedicam se verificarem algum benefício no que irão fazer, se esforça para estruturar a atividade escolar de modo que os alunos percebam claramente este benefício.

Elementos da Análise do Discurso (AD)

Através de excertos de obra Helena Nagamine Brandão[1], abaixo transcritos, condensamos o estudo que fundamenta a análise a ser desenvolvida nesse artigo:

> *" a linguagem enquanto discurso é interação e um modo de produção social; ela não é neutra, inocente (na medida em que está engajada numa intencionalidade) e nem natural, por isso um lugar privilegiado de manifestação da ideologia ... a linguagem é o lugar de conflito, de confronto ideológico ... seu estudo não pode estar desvinculado das condições de produção."*

Segundo o mesmo texto de Helena Brandão, as dimensões a serem consideradas na AD são:

- quadro das instituições em que o discurso é produzido, as quais delimitam a enunciação;
- os embates históricos, sociais, etc. que se cristalizam no discurso;
- espaço próprio que cada discurso configura para si mesmo no interior de um interdiscurso.

A autora ainda destaca que para Michel Foucault, um dos expoentes da AD:

> *" o discurso é um jogo estratégico e polêmico, o discurso é o espaço em que saber e poder se articulam, pois quem fala fala de algum lugar."(p.30)*
>
> *"Se processo discursivo é produção de sentido, discurso passa a ser o espaço em que emergem as significações."(p. 35)*
>
> *" analisar o discurso é fazer desaparecer e reaparecer as contradições: é mostrar o jogo que* (elas) *jogam entre si." (p.40)*

Nas conclusões do texto de Brandão, encontramos::

> *"o discurso materializa o contato entre o ideológico e o lingüistico no sentido de que ele representa no interior da língua os efeitos das contradições ideológicas, o desafio a que a Análise do Discurso se propõe é o de realizar leituras críticas e reflexivas que não reduzam o discurso a análises de aspectos puramente lingüísticos nem o dissolvam num trabalho histórico sobre a ideologia." (p. 83)*

ANÁLISE DO CASO DE ACORDO COM OS PRECEITOS DA AD

O discurso da Qualidade Total (QT) em Educação

Analisando o discurso da Qualidade Total na Educação usando como fio condutor os preceitos da Análise do Discurso (AD), como apresentados anteriormente, podemos destacar os seguintes elementos:

Condições de produção desse discurso*:* analisando o contexto histórico-social, os interlocutores, o lugar de onde falam, a imagem que fazem de si e do outro e do referente, identificamos o surgimento do discurso da Qualidade Total na Educação como tendo origem no movimento mais amplo de reordenação do sistema produtivo em termos mundiais.

O impacto que a produção asiática teve sobre o mercado internacional, fez com que se começasse a estudar o modelo subjacente àquele sistema produtivo, os ocidentais começaram a constatar que havia algo de diferente na produção industrial asiática, ao se debruçarem sobre o processo adotado pelas organizações asiáticas e sua capacidade de oferecer mercadorias de interesse da clientela, o interesse pela GQT (Gerência da Qualidade Total) foi aumentando. Em pouco tempo, as preocupações quanto a qualidade começaram a surgir nas indústria e nas organizações ocidentais.

O princípio orientador da concepção da Qualidade Total está calcado no pressuposto de que quanto maior seja o entendimento que as pessoas tenham da organização que integram e maior for o poder decisório e o compromisso das mesmas com suas finalidades, maior a produção e melhor o produto. Assim, a participação, o compromisso e o poder decisório são elementos-chave neste modelo gerencial.

Paralelamente ao debate sobre as novas demandas de qualificação, surge o debate sobre as formas de gestão da educação. Sendo o modelo da Qualidade Total bem sucedido nas empresas, vingou a idéia de aplicá-lo na escola. Os defensores dessa idéia alegam que o discurso da Qualidade Total aplicado à Educação baseia-se no pressuposto de que, sendo a Qualidade Total um sistema gerencial que se apóia em conceitos e princípios aplicáveis a qualquer instituição e organização humana, independente de sua dimensão, especialidade ou característica, ela pode ser aplicada a: empresas, escolas, hospitais, etc.

Segundo esse discurso, a Gestão da Qualidade Total (GQT) aplicada à Educação contribui de forma efetiva para a qualidade de ensino na medida que introduz mecanismos e instrumentos que permitam reduzir desperdícios resultantes de um gerenciamento inadequado: desperdício de tempo, de idéias, de experiências, etc.

Formação discursiva*:* se refere ao conjunto de enunciados marcados pelas mesmas regularidades. Nesse aspecto, se inserem as idéias de que podemos conceber a Gestão da

Qualidade Total (GQT) como um conjunto estrategicamente organizado de princípios e métodos que visa à mobilização e à cooperação de todos os membros de uma unidade de produção, com intuito de melhorar a qualidade de seus produtos e serviços, de suas atividades e objetivos, para obter a satisfação do cliente e um acréscimo de bem estar para os seus membros, de acordo com as exigências da sociedade.

Há cinco imperativos fundamentais da qualidade que devem ser perseguidos num programa de GQT: conformidade, prevenção, excelência, responsabilidade e medição.

Todo o produto ou serviço deve atender uma necessidade, satisfazendo o cliente. Assim é necessário que haja uma adequada conformidade a especificações definidas com base em estudos sobre a satisfação dos alunos, pais e professores.

Por prevenção deve-se entender medidas para que erros, falhas ou defeitos sejam evitados. Por exemplo, devem ser considerados os dispositivos para auxiliar os alunos em dificuldade, ao longo do curso.

Fazer correto deste o princípio é o que constitui a base da excelência. O respeito às especificações, às exigências, aos engajamentos feitos devem conduzir ao êrro zero.

A medição tem a ver com desenvolver procedimentos de avaliação dos alunos, das políticas educacionais e da gestão escolar com o objetivo de identificar problemas e a não qualidade. Sem medida adequadamente feita, é impossível identificar corretamente os problemas.

Por responsabilidade deve ser entendido o respeito aos quatro imperativos citados acima: a conformidade, a prevenção, a excelência e a medição. Essa responsabilidade é individual e coletiva e perpassa todas as pessoas e todos os níveis da escola e também o ambiente externo à ela.

Para que um programa de GQT possa ser implementado, respeitando os cinco imperativos da qualidade, alguns pontos são chave, segundo seus defensores: convencer os dirigentes; implantar uma estrutura de qualidade, obter a adesão do pessoal no nível de gerência intermediária, elaborar e implementar programa de formação em todos os níveis.

Os obstáculos que devem ser evitados são: passividade das chefias, falta de constância de propósitos, resultados imediatos e mobilidades de administração.

Se os princípios aqui alinhavados forem seguidos pelas escolas, é razoável esperar que os resultados obtidos sejam melhores, afinal, indepenedente da aplicação ou não dos princípios da QT, uma gestão democrática da educação passa por uma maior participação dos atores na gestão da escola.

Diálogo*:* Do ponto de vista discursivo não há enunciado desprovido da dimensão dialógica, todo o discurso é fundamentalmente diálogo. O discurso é o efeito de sentido construído no processo de interlocução. Nesse aspecto, o discurso da Qualidade Total em Educação perde sua pretensa substância e talvez nem possa ser caracterizado como um discurso, efetivamente, pois diálogo é o que mais lhe falta.

Na verdade, a QT em Educação, como em qualquer outra área em que se a aplique, se impõe como uma solução para as mazelas da escola na forma de um bloco hegemônico de procedimentos cuja aplicação, total e extensiva, garante resultados positivos, segundo seus defensores. Não há espaço para dúvidas, para alternativas de percurso e isso justamente o desqualifica para aplicação a que se propõe: a educação, área de conhecimento necessariamente dinâmica e criativa, em constante reflexão e mudanças de rota, num movimento que é próprio da atividade humana, sua essência.

Sentido*:* para a Análise do Discurso, não existe um sentido *a priori*, mas um sentido que é construído, produzido pelo processo de interlocução. No caso da Qualidade Total em Educação, essa busca de sentido que pretende se dar através do processo de interlocução não ocorre, uma vez que essa interlocução simplesmente não existe. O PQT não vai sendo construído, à medida que é implantado, ele é imposto e sua aplicação na íntegra é a garantia para seu sucesso, segundo seus defensores. Por esse aspecto, novamente, temos dificuldade em caracterizá-lo *strictu sensu* como discurso.

No entanto, mesmo com a ausência tanto de diálogo como de sentido, se considerarmos a definição alargada de discurso de Laclau segundo o qual "*cada ato social tem um significado, e é constituído na forma de seqüências discursivas que articulam elementos lingüísticos e extralinguísticos"(Laclau, 1991, p137)*[2], ainda podemos falar em discurso da Qualidade Total.

Sujeito: para a AD a noção de sujeito deixa de ser uma noção idealista, imanente: o sujeito da linguagem não é o sujeito em si, mas tal como existe socialmente interpelado pela ideologia. Nesse aspecto, os sujeitos são os enunciadores desse discurso e os objetos desse discurso-comunidade, alunos, professores, apresentam-se como assujeitados nesse processo.

CONCLUSÕES E PROPOSTAS

Sob nosso ponto de vista, todas as iniciativas para tornar mais abrangente a formação dos alunos universitários, bem como propiciar que um número cada vez maior de indivíduos em nossa sociedade tenha acesso a esta modalidade de formação, com melhor qualidade, são válidos. No caso das Instituições brasileiras, têm sido comum, hoje em dia, as seguintes iniciativas: implantação de Programas de Qualidade Total, Ensino à Distância via Internet ou através de Videoconferências, uso de recursos de Informática no Ensino e assim por diante.

Entretanto, estas iniciativas têm se revelado insuficientes para dar conta das questões de ordem epistemológica envolvidas nos processos educativos em curso, justamente por não priorizá-las.

No caso específico dos PQT, algumas das objeções que podemos fazer em relação ao seu uso em Educação referem-se, em primeiro lugar, à aplicabilidade restrita desse modelo à área administrativa das escolas, contribuindo tão somente para a melhoria da administração da atividade escolar, sem possibilidade de qualquer repercussão no seu projeto pedagógico.

Uma segunda categoria de objeções reside na ingerência descabida pro(im)posta por esses PQT´s no fazer pedagógico da escola, através da substituição do trabalho de especialistas em educação por especialistas de áreas essencialmente tecnológicas, trazendo com isso a substituição da discussão necessária no âmbito pedagógico por métodos e técnicas essencialmente utilitárias.

Consonante com esse pensamento, Vieira[4] afirma que:

> *" um modelo adotado no intuito de obter maior retorno de capital não necessariamente se aplica à esfera do trabalho não material, como é o caso da educação. Assim, uma fábrica de componentes eletrônicos não é a mesma coisa que uma escola ou uma sala de aula. O trabalho que se desenvolve numa instituição educacional, qualquer que seja a sua complexidade, envolve um processo cujos resultados são apenas parcialmente mensuráveis. Isto porque a aprendizagem é um processo que envolve conhecimento, sentimento e ação, componentes nem sempre passíveis de medida.*
>
> *O produto da aprendizagem pode não apresentar resultados a curto prazo. do mesmo modo, um processo que produz resultados em determinada realidade, pode não surtir efeitos em outra, pela influência de fatores como a história da vida dos agentes envolvidos no processo educativo, determinações culturais, etc. Há que se considerar também que a educação não se restringe a uma questão de insumos... entende-se que a lógica da produção material não necessariamente se aplica à realidade educacional. Pensar em qualidade na educação, mesmo do ponto de vista de sua gestão é algo que ultrapassa uma perspectiva de qualidade total, muito embora existam aspectos que possam ser incorporados à gerencia de seus serviços.."*

Por que o discurso da Qualidade Total encontrou terreno fértil na Educação ? Segundo Paulo Volker[5]:

"A escola moderna assimila, em vários pontos, a tradição de ensino dos seus antepassados (a meritocracia, a erudição, a formação abstrata e desvinculada do real, etc.), tanto quanto assimila aspectos essenciais do mundo da produção (a compartimentação, a especialização, o tecnicismo, o positivismo, o pragmatismo, etc.). De uma forma ou de outra, como toda a instituição, padece também da falta de entusiasmo e adesão de seus membros. ... as estatísticas de fracasso escolar, da repetência, da evasão, da falta de produção de pesquisas e até de ensino se avolumam. Essa realidade justificou a adoção de um método que tentasse garantir a qualidade deste trabalho".

No caso específico da Engenharia Elétrica, os resultados obtidos pelo PQT estiveram muito aquém do esperado pelos incentivadores do mesmo, tanto em nível de qualificação das ações administrativas de rotina, quanto, e principalmente, das ações pedagógicas. Apesar das reuniões feitas terem servido como um momento de reflexão de todos os envolvidos sobre suas atividades, o que talvez tenha sido o resultado mais importante e significativo desse processo, a superficialidade de análise imposta pelas diretrizes da Qualidade Total, no nosso entendimento não permitiram e nem permitiriam, caso houvesse continuidade desse processo, um aprofundamento necessário principalmente sobre o aspecto do ensino, consistindo em um mais uma prova inequívoca da ineficiência e inadequação do uso dessa metodologia para essa finalidade.

Conforme Silva Jr[3]:

> *"o uso dos programas de Qualidade em Educação é uma ideologia administrativa que se constitui em impossibilidade teórica, pois ao transpor para propostas pedagógicas as teorias administrativas empresariais, temos, na realidade, uma psicologização dos problemas educacionais e um total desconhecimento das contradições sociais e ideológicas presentes na Universidade, enquanto unicidade institucional, na qual as identidades e individualidades se formam para o mundo do trabalho".*

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EXPERIÊNCIAS EM EDUCAÇÃO A DISTÂNCIA EM DISCIPLINAS DE INFORMÁTICA E COMPUTAÇÃO PARA PÓS-GRADUAÇÃO

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Abstract *— Discussions and more discussions about computer use in educational activities are taking the academia, schools and media. As a result of a new educational approach, which establishes the computer as a versatile information-communicator channel, systems that support course delivery and monitoring emerge, such as WebCT. This paper presents experiences using WebCT to offer classes to graduation courses related to computing and information systems. Each occasion taken into account in this report covers a full semester, when 75% of the activities are developed through computer mediation, at distance, and 25% are present activities, scattered through the semester. In this paper are presented the WebCT facilities that were employed, the pedagogical strategies, and an analysis of the obtained results.*

Index Terms — Distance education, computer aided learning, report on educational graduate experiences, WebCT.

INTRODUÇÃO

O aprendizado a distância suportado por computador tem um pouco de estudo por correspondência, ensino telemático, estudo a distância e aprendizado aberto e a distância. É uma forma para desenvolvimento de recursos humanos que prescinde de uma completa interação presencial entre estudante e instrutor, que remonta a experiências de aprendizado do início do século XVIII e ao espetacular *boom* do início do século XX, com as escolas e universidades por correspondência nos EUA. Forma esta que reaparece no fim do século XX como uma promessa de ser uma revolução na forma e substância do ensino superior.

Aprendizado mediado por computador cobre conceitos apresentados sob diferentes siglas abrangendo e mesmo combinando diferentes abordagens, tais como CAL (Computer Aided Learning) [1], ALN (Asynchronous Learning Networks) [2], ODL (Online Distance Learning) [3] e IBT (Internet-Based Training) [4].

Frente a esse novo paradigma educacional, que estabelece o computador como um canal para comunicação de informação, com variados graus de inteligência e participação, grande parte dos modelos educacionais em uso tem se mostrado inadequada e necessita ser melhorada.

A tecnologia que permite o oferecimento de aprendizado mediado por computador está centrada na comunicação e processamento da informação usando diferentes mídias (áudio, vídeo, hipertexto, voz, etc.), na existência de redes de comunicação e em metáforas educacionais construídas a partir de teoria educacional e psicologia cognitiva. A tecnologia é dada ao aprendiz para que a use na representação e expressão daquilo que sabe [5].

A WWW (World Wide Web) propicia o acesso e a transmissão de qualquer tipo de informação digitalizada, quase que instantaneamente, além de diferentes tipos de comunicação pessoa a pessoa. Assim, acabou, também, alavancando o aprendizado mediado por computador, tornando-se a espinha dorsal de ferramentas de comunicação efetivas, entre as quais destacam-se o correio eletrônico, as listas de discussão, as salas de conversação (*chat*) e a teleconferência, que integradas compõem sistemas de apoio para o oferecimento e acompanhamento de cursos.

Querer oferecer cursos a distância significa exigir que os atores participantes do processo de aprendizado, professor e aprendizes, necessitem interagir. Interação corresponde à comunicação, participação e retro-alimentação de resultados [6]. É a interação que permite o cultivo de habilidades instrucionais e um diálogo enriquecedor com seus pares.

Independente dos prós e contras, a educação a distância é uma realidade regulamentada na Lei de Diretrizes e Bases da Educação (LDB) e decretos federais, oferecida como opção para a obtenção de créditos em programas de Mestrado da PUC-Campinas, e que tem chamado a atenção de alunos e professores em toda a Universidade e em várias regiões do Brasil, apesar de objeto de controvérsias.

Este trabalho trata de relatar a experiência de uso da educação a distância para oferecimento de disciplinas de mestrado ligadas à área de informática e computação, durante seis ocasiões, cada qual com duração de um semestre, em que 75% da carga horária foi desenvolvida a distância, através de suporte computacional, e 25% consistiu de encontros presenciais dentro da PUC-Campinas. Os encontros presenciais foram espaçados durante o semestre. Inicialmente é apresentada a estratégia pedagógica usada. A seguir são apresentados comentários sobre as facilidades usadas no WebCT. Segue o critério de avaliação usado e a apresentação de técnicas para um desenrolar satisfatório das atividades, principalmente no que se relaciona à motivação e participação dos alunos. Para finalizar, são apontados

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recursos que o WebCT não oferece e que seriam importantes, bem como observações finais e conclusões.

ESTRATÉGIA PEDAGÓGICA

A tecnologia que permite o oferecimento de educação a distância na PUC-Campinas está centrada no uso do WebCT[4], um dos sistemas de apoio para o oferecimento e acompanhamento de cursos existentes no mercado. O WebCT destaca-se pela sua propagada utilização em mais de 2500 instituições, em 81 países do mundo.

Segundo Schär e Krueger [1], o aprendizado não é um fenômeno unitário. Existem diferentes mecanismos de aprendizado, cada qual suportado de maneira diferente. Além disso, falta uma teoria comum para o aprendizado. Para o ensino com suporte computacional, filosofias contrastantes que vão do objetivismo ao construtivismo estabelecem extremos de um contínuo. O objetivismo está baseado na idéia de que estudantes aprendem por que se lhes falam, e que o conhecimento é objetivo e existe independentemente dos estudantes. O construtivismo presume que pessoas aprendem fazendo, ou seja, constróem conhecimento situando experiências cognitivas em atividades autênticas. Como resultado, o conhecimento emergente pode ser um tanto intuitivo, mas consolidado.

Nota-se na estratégia pedagógica escolhida um pouco da doutrina objetivista, principalmente na produção de material, e muito da construtivista, na dinâmica de preparação e discussão dos materiais produzidos. Considera-se que o conhecimento é uma produção social, cujo acesso por um sujeito implica a mediação de, pelo menos, outro sujeito.

Tal qual Ramal [7] preconiza, nas seis oportunidades relatadas, o professor procurou ser o dinamizador da inteligência coletiva do grupo, através da verificação tanto das respostas a que o aluno chegou, como dos caminhos utilizados para isso. Os percursos dizem muito mais sobre o desenvolvimento de habilidades e competências do que as respostas, vinculado a uma nova relação com o erro. Aprende-se no ensaio e no erro.

Em vez de acumular dados no arquivo mental, aprender é desenvolver competências, habilidades, procedimentos, visões de mundo, posturas de vida e de trabalho. A idéia básica é permitir que o conhecimento seja buscado e construído pelos alunos, a partir de pesquisas e experiências pessoais e coletivas. O acesso à informação dentro e fora da escola, torna ingênua a tentativa de estabelecer planejamentos rígidos e esquemas antecipados de aprendizagem. Todas as trajetórias são individuais e a educação necessita ser personalizada.

A estratégia usada consistiu das seguintes etapas:

- A definição, pelo professor, de temas que devem ser tratados, juntamente com uma bibliografia básica. Esses temas em conjunto compõem o programa para uma disciplina, tal como Tecnologia de Banco de Dados na Web ou Engenharia de Software. Em geral, são escolhidos de 8 a 10 temas, cada qual a ser tratado durante toda uma semana de atividades. Um grupo de dois a três alunos fica responsável por um dos temas e este grupo é formado em função de parcerias e projetos comuns, a partir da complementação de competências [7].
- Os alunos pesquisam, escolhem e propõem uma referência que aborde o tema definido para o grupo. O tempo limite para que haja uma referência aprovada pelo professor pode variar de uma a duas semanas, a partir do primeiro encontro presencial[5].
- Cada grupo fica responsável pelo desenvolvimento de um trabalho escrito sintetizando a referência escolhida. Não se trata de tradução. O trabalho deve seguir orientações de conteúdo e estrutura [6].
- Cada grupo prepara o material para uma "apresentação", baseada na referência escolhida, em uma semana previamente definida [7].
- Cada grupo conduz a discussão sobre a sua apresentação, bem como sobre assuntos correlatos, durante toda a semana agendada[8]. O aprendizado através de discussão e debate, segundo Bourne *et al.* [2], uma entre várias abordagens aplicáveis à educação a distância, pode ser muito demorado quando envolve muitos aprendizes, mas é potencialmente mais rico do que discussões em classe.
- Cada grupo de alunos revisa um dos trabalhos escritos por um outro grupo[9]. A revisão deve ser iniciada a partir da data de entrega do trabalho escrito e ser entregue e discutida na terceira aula presencial. Deve haver a preocupação de recomendar alterações ou correções relacionadas à estrutura, redação e conteúdo.

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[4] WebCT pertence à WebCT Inc. provedor de soluções para *e-learning* - www.webct.com

[5] A origem da referência é aprovada pelo professor e, para isso, esta deve ser submetida a julgamento. A referência deve somar algo em torno de 10 páginas de texto, de maneira a evitar sobrecarga cognitiva nos demais alunos, que posteriormente têm como atividade obrigatória a sua leitura. Cada grupo fica responsável por colocar à disposição cópia digital (no WebCT) da referência aprovada.

[6] É marcada uma data para uma primeira versão do trabalho. Em geral, essa data é a mesma da segunda aula presencial para todos os grupos e deve ser disponibilizada cópia digital desse trabalho escrito.

[7] Deve-se gerar a apresentação usando PowerPoint (marca registrada da Microsoft Corp.), com mais ou menos 20 *slides*, cada qual contendo anotações do que seria dito durante uma apresentação presencial dos slides, se esta se realizasse. As anotações devem complementar o conteúdo dos *slides*. Na data estipulada, o material da apresentação deve ser colocado à disposição dos demais alunos no WebCT, em formato digital.

[8] Como resultado das discussões, o grupo responsável deve providenciar mudanças no material de apresentação para deixá-lo disponível, até uma semana depois de encerrada a discussão. Há também um acompanhamento mais cuidadoso por parte do professor, de maneira que haja uma revisão completa do material da apresentação, tanto em conteúdo como em forma. Uma cópia de cada apresentação, em formato HTML, é gerada pelo professor e é disponibilizada no WebCT.

[9] O trabalho de revisão deve ser realizado usando-se o recurso de controle de alterações disponível no editor Word (marca registrada da Microsoft Corp.). A revisão deve ser entregue impressa em papel na aula presencial e publicada em formato digital no WebCT.

- Individualmente, os alunos realizam a leitura de cada referência escolhida e se preparam para o respectivo período de discussão. Como resultado, devem confeccionar uma ficha bibliográfica[10].
- Cada aluno participa da discussão ocorrida em cada uma das apresentações. Todo tipo de contribuição é esperado nessas discussões e, para isso, deve-se utilizar a leitura realizada sobre a referência. Também são esperadas dúvidas e comentários sobre assuntos correlatos aos que estão em discussão, além da indicação de outras referências e fontes de informação interessantes.
- Cada aluno participa das atividades em grupo que ocorrem nas aulas presenciais.

USANDO O WEBCT

A ferramenta WebCT apresenta facilidades que dão suporte a diferentes formas de comunicação, colaboração e administração, acessíveis apenas a quem está cadastrado em um determinado curso, oferecidas de acordo com o tipo de usuário: administrador, estudante ou instrutor.

Um dos pontos importantes quando se prepara um curso a ser oferecido via WebCT é a escolha dos recursos que serão usados durante o curso. Quando se tem que decidir sobre esses recursos, depara-se com o conhecidíssimo dilema comunicação síncrona (aquela que ocorre em tempo real) vs. comunicação assíncrona.

Lembra Goldberg [8], um dos idealizadores do WebCT, que, em vários de seus contatos com educadores pelo mundo, há a preferência pela comunicação assíncrona. Isto porque, a comunicação síncrona acaba por não se tornar realidade, devido às limitações atuais da Internet, que não oferece a necessária qualidade de serviço, como largura de banda. Além disso, facilidades de comunicação e colaboração assíncronas, além de eliminar barreiras de distância, também permitem eliminar barreiras de tempo, o que no caso dos estudantes típicos de um mestrado profissional é quase um requisito. Isso porque a grande maioria trabalha e espaços em suas agendas são só encontrados nos fins de semana e em altos horários noturnos. Outra vantagem é o tempo ganho para se argumentar melhor quando requerido. Não há necessidade de respostas imediatas. Há chance para pesquisa e revisão, antes da resposta. Os estudantes têm a oportunidade de estabelecer diálogos provocativos. Isto ocasiona um certo grau de confiança que não existiria em uma sala de aula convencional. Essa possibilidade de reflexão constitui uma oportunidade de metacognição, atividade esta necessária para a realização de um pleno processo de aprendizado.

Foram colocadas à disposição listas de discussão como facilidades principais para comunicação e colaboração, separadas de acordo com o tema a ser tratado durante uma semana. Também foram usados o correio eletrônico e as salas de bate-papo. Solicitou-se aos estudantes a criação de páginas com os seus dados pessoais a fim de facilitar a comunicação entre pares e entre professor e aluno.

Opcionalmente, a facilidade síncrona de *chat* foi utilizada pelos estudantes em uma dezena de ocasiões, mas, em várias dessas ocasiões, os alunos desistiram devido à sua lentidão e a problemas com a execução do software.

Quanto ao material de curso, o WebCT oferece facilidades para autoria de páginas, mas preferencialmente deve-se optar por editores de documentos externos e depois importar o material.

CRITÉRIO DE AVALIAÇÃO

Além de materiais educacionais e estratégias diferentes, o aprendizado mediado por computador requer avaliações que devem ser vistas sob quatro prismas: o conteúdo ou conhecimento do domínio; habilidades heurísticas; habilidades metacognitivas; e estratégias de aprendizado [9].

Para cada uma das atividades desenvolvidas em grupo, a entrega dos respectivos produtos (trabalho escrito, revisão, preparação da apresentação e controle da discussão) teve que ser feita acompanhada de uma distribuição de trabalho, definida pelo próprio grupo, que representa uma oportunidade para reflexão sobre a atividade realizada.

O critério de avaliação considera que o rendimento final tem que ser igual ou superior a 70% e leva em conta os seguintes pontos: a pontualidade no cumprimento de tarefas; a adequação do conteúdo do trabalho desenvolvido ao tema definido; o desenvolvimento e correção da apresentação; encaminhamento das discussões da própria apresentação; o desenvolvimento e discussão da revisão; a participação nas aulas presenciais; e a constância, qualidade e prontidão nas participações.

MOTIVAÇÃO PARA PARTICIPAÇÃO E COLABORAÇÃO

Um ambiente como o WebCT permite que ocorra um aprendizado construtivista, o que, segundo Wilson [10], realiza-se através de um local onde aprendizes podem trabalhar juntos e dar suporte um ao outro, guiados por objetivos de aprendizado e atividades para solução de problemas, o que tenta-se concretizar através da estratégia pedagógica, apresentada anteriormente.

A concepção de espaços de aprendizagem suportados por computador, dentro de uma orientação colaborativa decorrente da natureza social do aprendizado, constitui uma proposta alternativa e contemporânea da prática pedagógica articulada à construção de pedagogias transformativas [11].

Várias técnicas podem ser usadas para encorajar a ocorrência de participação e colaboração, desde a coerção através do critério de avaliação até o modelo instrucional de Collins *et al*. [9], *Cognitive Apprenticeship*, no qual várias estratégias levam o estudante a receber exemplos prontos, a refletir sobre os mesmos e a praticar. Mesmo assim, vários

[10] Essa ficha deve ser encaminhada via WebCT para o professor, até o dia de início da apresentação.

são os alunos que não participam ou participam minimamente devido a diferentes razões. Segundo Hannafin *et al*. [12], a maioria dos aprendizes não apresenta as habilidades substanciais de auto-monitoração que a educação a distância exige. Por isso, recomenda-se que estes recebam mais suporte acadêmico dos pares e do professor. Aprendizes devem, através de uma interação que ofereça a oportunidade para reflexão, adquirir essas habilidades.

Entre as técnicas usadas durante o oferecimento das disciplinas de mestrado citam-se:

- A preparação das apresentações por parte do professor, com o cuidado de seguir as mesmas regras impostas aos estudantes, criadas e articuladas antes das primeiras apresentações dos alunos para servir de exemplo.
- A preparação dos trabalhos escritos seguindo uma metodologia para produção científica e a realização da revisão de trabalhos de pares, além de sua comparação com uma revisão produzida pelo professor.
- A semeadura de questões durante cada apresentação, algumas das quais são encaminhadas com a observação que devem ser respondidas por todos os alunos. Perguntas abertas, segundo Nunn [13], permitem aos alunos compartilharem suas perspectivas quanto à qualidade de suas experiências educacionais. A provocação de dissonância cognitiva (através da provocação de curiosidade, de desconforto, da negação de conceitos já estabelecidos e da colocação de problemas) segundo Peirce [14], ajuda no desenvolvimento de habilidades para raciocínio crítico.
- O acompanhamento das respostas dadas e não dadas, com a cobrança de melhoria e clareza, e o aprofundamento da discussão com novas questões, principalmente para elucidar o raciocínio do aluno, como ocorre em um bom diálogo socrático.
- O oferecimento de ajuda, através do canal de comunicação privado, para tirar dúvidas ou para o encaminhamento de questões colocadas por colegas.
- A cobrança periódica daqueles alunos que não cumpriram deveres, através de canal de comunicação privado, com o aviso sobre a sua situação em relação à avaliação, de maneira a sempre permitir que o aluno tenha condição de reverter uma situação ruim. A interação realizada deve promover uma retroalimentação efetiva que ajude ao aluno a refletir sobre a qualidade de seu trabalho [15].
- A consideração de uma auto avaliação dos elementos de um grupo, através da distribuição percentual do trabalho individual desenvolvido em uma atividade.

O QUE FALTA NO WEBCT

Um sistema para o apoio ao aprendizado deve poder suportar a personalização, ou seja, adaptar a apresentação do conteúdo e a operação da ferramenta, permitindo considerar os objetivos, conhecimento e outras informações, conforme o perfil do aprendiz (modelo do aprendiz).

Com relação ao WebCT, não há facilidades que se preocupem em estabelecer um perfil para os alunos. Como isso não ocorre, pode-se dizer que não há suporte à personalização. Nem mesmo para adaptação de suporte à navegação.

Informação que não pode ser encontrada ou usada de nada vale. Prover informação não significa educação [16]; faz-se necessária uma tecnologia educacional que exista para associar recursos de informação com ferramentas interativas e dinâmicas que guiem o aprendiz à criação de um conhecimento pessoal. O objetivo de um tutor oferecedor de seqüência de material é prover ao aprendiz a seqüência planejada individual mais adequada de unidades de conhecimento para aprendizado e realização de tarefas de aprendizado. Este tipo de facilidade pode se basear, entre outras coisas, no conhecimento do estudante e nas suas preferências (no tipo de mídia e de material); e procura solucionar o problema da perda no hiperespaço. Mais do que personalização, a tutoria significa a automatização dos aspectos pedagógicos envolvidos no aprendizado.

Dois tipos de seqüenciamento podem ser considerados. O seqüenciamento ativo que implica em ter um objetivo de aprendizado, um subconjunto de conceitos ou tópicos que se deve dominar. E o seqüenciamento passivo (remediação), que é uma tecnologia reativa que não requer um objetivo de aprendizado, mas sim oferece um subconjunto do material de aprendizado, que pode resolver um entendimento errado ou a falta de conhecimento.

Outro aspecto importante em um sistema tipo WebCT é o do suporte à solução de problemas, que infelizmente não existe. Esse suporte pode se realizar através da análise inteligente de soluções do aprendiz, que lida com as respostas do aprendiz, sem se preocupar em como estas foram obtidas. O sistema na figura de um tutor necessita saber se a solução está correta ou não, o que está falho ou faltando e, possivelmente, identificar qual conhecimento errôneo ou faltante é responsável pelo erro. Outro tipo de suporte se concretiza através da interação para solução de problemas, com passos da solução de problemas. O nível de ajuda pode variar desde a indicação de um passo errado, uma dica, até a execução do próximo passo para o aprendiz. Solução de problemas baseada em exemplos sugere ao aprendiz casos solucionados com sucesso a partir de sua experiência anterior.

É essencial a existência de facilidades que permitam reflexão pós-atuação, ou seja, o ambiente deve prover um registro da atividade desenvolvida, para aprendizado e solução de problemas. Até certo ponto, o WebCT oferece esse tipo de facilidade, ao registrar todas as discussões e trocas de informações havidas, indicações de tipos de atividades realizadas no tempo, tais como leituras e submissão de mensagens. Segundo Wilson [10], outros objetivos pedagógicos atingíveis através de metacognição compreendem, entre aqueles não suportados pelo WebCT: a provisão aos estudantes de experiência com o processo de construção de conhecimento; a provisão de experiência em, além de apreciação de, múltiplas perspectivas; e a permissão de um processo de aprendizado centrado no estudante, onde seja possível atuar em um papel importante de estabelecimento de objetivos para aprendizado.

CONCLUSÕES

Discussões e mais discussões sobre o uso do computador em atividades educacionais tomam conta da academia, das escolas e da mídia. De certo, apenas, é que o uso do computador e da WWW como ferramentas educacionais está ocorrendo em todas as escolas, colégios e universidades, algumas vezes até estabelecendo um ambiente educacional virtual, embora, pareça estar se perdendo uma ótima oportunidade para uma apreciação completa do relacionamento entre tecnologia e educação [17].

Este trabalho constitui uma síntese do uso de uma ferramenta de apoio para o oferecimento e acompanhamento de cursos, usada em disciplinas de programas de mestrado. Nesta síntese procura-se apresentar a estratégia usada em conjunto com a ferramenta e parte dos resultados obtidos, que se apresentam na forma de uma análise da ferramenta.

Nas seis oportunidades relatadas houve uma participação média por disciplina de 950 intervenções, chegando em uma das situações a haver mais de 1.300 intervenções. Com cada disciplina tendo sido oferecida durante 15 semanas, isto significa, que com média de dez estudantes, cada um contribuiu com 95 intervenções, o que dá uma média de seis intervenções semanais. Muito acima do que seria conseguido em classe.

O tempo de dedicação médio, por aluno, foi de duas horas e 35 minutos semanais, em contato com o WebCT. Nesse montante não estão incluídas as pesquisas e leituras feitas através da WWW ou em bibliotecas. Alguns alunos chegaram a reportar uma dedicação de mais de dez horas em algumas semanas. É interessante notar que, nas semanas de discussão, alguns dos apresentadores ficam empolgados e realizam excelente trabalho de pesquisa para poder responder a questões de seus pares. Experiências como essas permitem ao aluno ter o controle para influenciar o próprio processo de aprendizado.

A oportunidade para reflexão sobre o papel do professor, sobre a preparação de material e sobre a avaliação é um dos principais resultados, senão o principal resultado, de toda a experiência relatada. Essa oportunidade ocorre em quase todas as situações envolvidas. Educação a distância, e aprendizado suportado por computador em geral, baseia-se em um modelo aberto de aprendizado que traz momentos de ansiedade aos melhores professores, mesmo àqueles experientes com a tecnologia, como lembra Muirhead [6].

Finalizando, é importante lembrar o alerta do historiador David C. Noble [18] para o perigo da massificação desse tipo de processo educacional, pois, ao mesmo tempo em que o aprendizado suportado por computador é a última moda para várias instituições pelo mundo, a educação não prescinde de um relacionamento interpessoal entre professor e aluno, e aluno e aluno, que objetiva o auto-conhecimento individual e coletivo. Além disso, argumenta Noble, no bojo do que se oferece hoje como aprendizado suportado por computador encontram-se interesses econômicos e não educacionais, que acabarão por provocar o fim da instituição universitária.

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FRAMEWORK DE BASE CONSTRUTIVISTA PARA UM AMBIENTE DE AVALIAÇÃO EM EDUCAÇÃO A DISTÂNCIA

David Nadler Prata[1] , Alex Sandro Gomes[1], Patricia Tedesco[1]

Resumo *— A EAD encontra-se, atualmente, em um processo avançado. Várias são as instituições de ensino que disponibilizam cursos a distancia. No caso da avaliação, normalmente, as instituições de ensino exigem que o professor forneça notas dos alunos, mas não definem "como" essas notas serão mensuradas. Fica a cargo do professor definir as formas de avaliação para atingir os objetivos institucionais. Por outro lado, no caso dos ambientes EAD do mercado, em geral, as formas de avaliação já são pré-determinadas e não levam em consideração as teorias e práticas pedagógicas que existem no mundo acadêmico. No nosso modelo, o professor é determinante central do processo de avaliação – centrado no professor. Para isso, temos uma abordagem de design centrado no usuário. Através de entrevistas, interações e prototipação, procuramos moldar um ambiente de avaliação construtivista. O modelo apresentado visa um ambiente mais flexível para avaliação.*

Palavras-chave: Avaliação, Educação a Distancia, centrado no usuário.

Abstract *— Nowadays, Distance Learning is going through an advanced process where many schools are offering this kind of learning. When the matter is assessment, generally the schools demand that teachers give a score to students, but usually they don't explain how to do this systematically and mainly they don't show a specific strategic measure that have to be used. Otherwise, the most of DLE is been created with a specific assessments' process disrespecting pedagogical theory and teachers' practices that are butress to academic world. On our model, the teacher is a central objective of assessments' process, so is a teacher-centered model that considers design approaches focus on user. Interviews, interactions and prototypation are used to develop an environment of contrutivism assessments which intend to be more flexible and to give improvement to DLE.*

Index terms: assessment, distance learning, user-centered-design.

INTRODUÇÃO

Não é difícil perceber que os princípios da escola construtivistas vêm ao encontro do modelo de EAD. Na teoria construtivista [4] a ênfase é estabelecida no aprendiz de preferência ao professor. É o aprendiz que interage com objetos e eventos e assim ganha um entendimento das características inclusas nesses objetos ou eventos. O aprendiz, assim, constrói suas próprias conceituações e soluções aos problemas. A autonomia e iniciativa do aprendiz são aceitas e encorajadas.

Há muita sobreposição entre construtivismo e a teoria construtivista social de Vygotsky. Porém, a teoria construtivista de Vygotsky, apresenta melhores condições para um professor mais ativo e envolvido com a aprendizagem. Alguns princípios Vygotskyanos podem ser aplicados em qualquer sala de aula, como [6]: (a) a aprendizagem é uma atividade social, colaborativa; (b) a zona de desenvolvimento proximal – diferença entre o nível de desenvolvimento atual (capacidade de solucionar problemas sozinho) e o nível de desenvolvimento potencial (capacidade de solucionar problemas com auxílio de um adulto ou pessoa mais qualificada) – pode servir como um guia para aulas e para o planejamento curricular.

A avaliação, até o início dos anos 80, tinha como objetivo medir os resultados do ensino como meio de responsabilidade em garantir a qualidade da aprendizagem produzida. Desde então, esta forma de avaliar recebeu novos papéis visando melhorar os atributos de ensino. A avaliação no processo ensino-aprendizagem caracteriza por ser utilizada, também, para aprimorar a qualidade e produtividade da aprendizagem. Esta nova forma de abordar a avaliação revolucionou-a em sua complexidade, sofrendo transformações e sendo incorporada como metodologia, de caráter intrínseco, acoplada a aprendizagem. Este processo de avaliação se desdobra aparecendo não somente como fim, mas também como meio, interagindo com técnicas e metodologias de aprendizagem.

Este artigo descreve um modelo construtivista para avaliação em EAD que se baseia em três estratégias; avaliação tradicional, ponto de vista dos estudantes e acompanhamento da aprendizagem.

AMBIENTES DE AVALIAÇÃO EM CURSOS A DISTÂNCIA

Existem vários ambientes em EAD. Esses ambientes provêm mecanismos para acompanhamento do aprendizado e elaboração de testes com estatísticas. Observando os

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trabalhos de Morgan [10], Tarouco [14], Bergamo [1], Plugge et al. [11] e Silva [13], verificamos a relação de 18 ambientes para EAD com suas ferramentas de avaliação e acompanhamento do aprendizado.

Podemos observar a identificação de 4 mecanismos para suporte ao acompanhamento do aprendizado: rastreamento das ações do aluno, redirecionamento por teste, registros de chats e registros de listas de discussão. Para a avaliação tradicional contamos com: análise de texto, auto-avaliação, reuso de questões, testes temporizados, testes personalizados, testes pela Web, testes adaptáveis e trabalhos via Web. Os ambientes de EAD analisados foram: AulaNet, Blackboard, Carnegie, ClassNet, CyberQ, Docent, E-college, EduSystem, Embanet, FirstClass, IntraLearn, LearnLine, Learn Space, Serf, TopClass, Virtual-U, WebCourseInABox e WebCT.

O DESIGN DO AMBIENTE

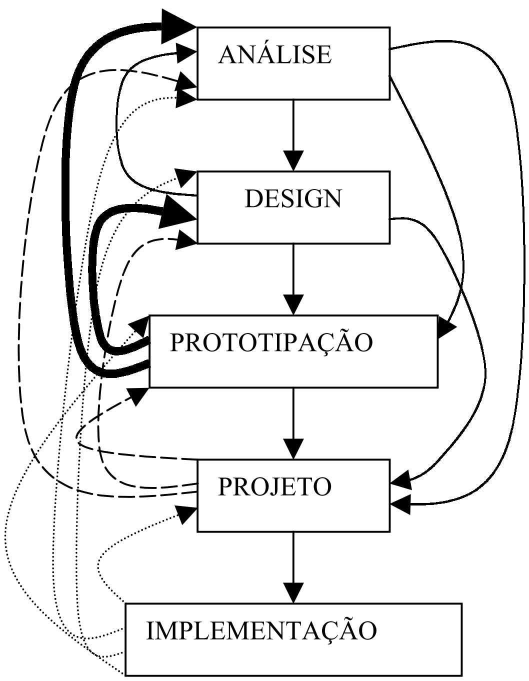

Figura 1-Ciclo deVida do desenvolvimento do Ambiente de Avaliação do AMADeUs

O modelo clássico do ciclo de vida da Engenharia de Software não prevê explicitamente o design de interface homem/computador. O design tende a ser tratado como um tópico de nível avançado, separado do modelo clássico de Engenharia de Software. Desta forma, o engenheiro de software tende a ver o design de interface como uma parte adicional a Engenharia de Software. Acontece que no ponto de vista do usuário, com as aplicações modernas que utilizam interface gráfica (GUI), a interface é o sistema. A interface é o que o usuário vê e trabalha interagindo. Qualquer coisa que não possa ser identificada como parte da interface tem menor significância para o usuário. As

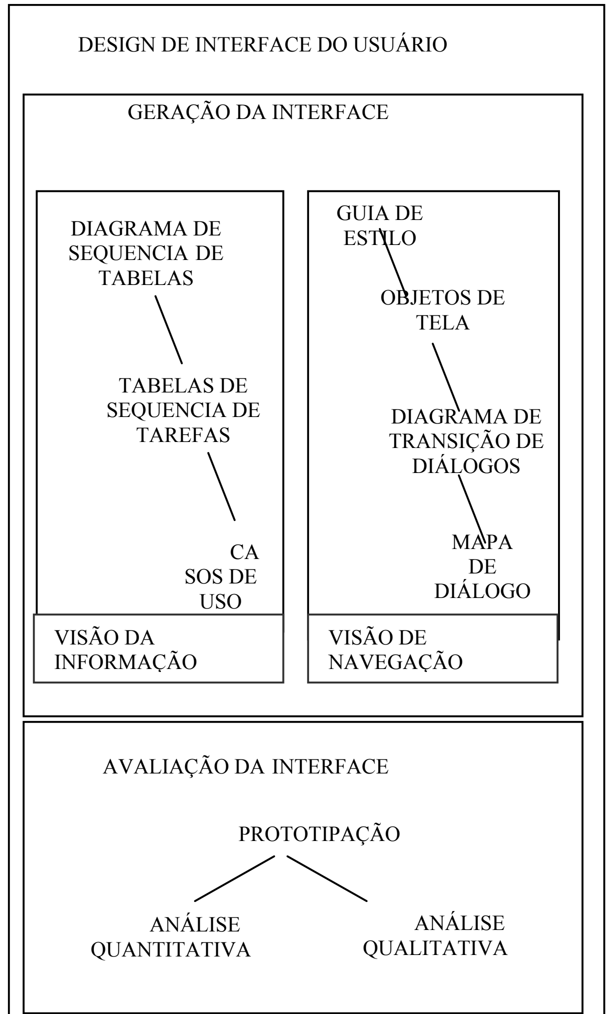

Figura 2-Design do Ambiente de Avaliação do AMADeUs

interfaces gráficas (GUI) juntamente com as ferramentas de prototipação levaram a um modo de fazer design mais experimental, que vem ao encontro dos modelos de design centrado no usuário. Essa maneira de se fazer engenharia de software requer uma nova visão em seu ciclo de vida. Na nossa visão, o desenvolvimento de software exige uma série de iterações em suas atividades (Figura 1). O design assume um papel bem definido no ciclo de vida da Engenharia de Software. Neste seu papel, o design não se preocupa somente com as telas do sistema, mas também com a seqüência de tarefas que o usuário terá que desempenhar para atingir seus objetivos.

Dentro do ciclo de vida de design da interface do usuário temos duas fases principais: a geração e a avaliação [8].

A geração da interface do usuário possui duas fases: a visão da informação e a visão de navegação.

A visão da informação se inicia com a construção de diagramas das seqüências de tarefas do usuário. Os diagramas das seqüências de tarefas produzirão as tabelas de seqüência de tarefas. As tabelas de seqüência de tarefas produzirão os casos de uso, que também serão usados, posteriormente, na fase de projeto da Engenharia de software.
A visão de navegação inicia-se com a definição de um Style Guide (Guia de estilo), guidelines (linhas de ação), padrões e convenções, a serem utilizadas no design. De posse do Style Guide pode-se construir a hierarquização dos objetos de tela, posteriormente, o diagrama de transição de diálogos, depois, o mapa de diálogo.
A fase de avaliação se inicia com a prototipação do design de interface do usuário. A análise quantitativa (tempo de aprendizado, número de erros, número de passos requeridos) pode ser feita utilizando técnicas como o modelo GOMS (Goal Operator Method Selection) [2]. A análise qualitativa (questionários, protocolo verbal, vídeo) pode ser feita utilizando o NUDIST, criando categorias hierarquizadas ou não, anexando materiais (documentos, imagens) a essas categorias (nodos), criando idéias, construindo e testando teorias sobre os dados.

PROPOSTA CONSTRUTIVISTA DE AVALIAÇÃO

Para se entender o processo de avaliação na modalidade de ensino a distância, torna-se necessário compreender como a Educação utiliza-se dessa prática. Dentro do campo educacional, a avaliação assume diferentes papéis. A classificação a seguir é definida por Bloom e seus colaboradores, onde a avaliação pode ser formativa, somativa ou diagnóstica. A avaliação formativa ocorre durante o processo de instrução; inclui todos os conteúdos importantes de uma etapa da instrução; fornece feedback ao aluno do que aprendeu e do que precisa aprender; fornece feedback ao professor, identificando as falhas dos alunos e quais os aspectos da instrução que devem ser modificados; busca o atendimento às diferenças individuais dos alunos e a prescrição de medidas alternativas de recuperação das falhas de aprendizagem. A avaliação somativa ocorre ao final da instrução com a finalidade de verificar o que o aluno efetivamente aprendeu; inclui conteúdos mais relevantes e os objetivos mais amplos do período de instrução; visa à atribuição de notas; fornece feedback ao aluno (informa-o quanto ao nível de aprendizagem alcançado), se este for o objetivo central da avaliação formativa; presta-se à comparação de resultados obtidos com diferentes alunos, métodos e materiais de ensino.

Na educação à distância, a avaliação deve ser contínua, realizada no processo enquanto o professor acompanha a construção do conhecimento e voltada a promover o progresso individual dos participantes. A avaliação deveria ser um ato dinâmico, implicando na tomada de decisão, servindo para identificar habilidades dos envolvidos no processo de aprendizagem, visando proporcionar um feedback útil aos mesmos e informações proveitosas para a comunidade escolar.

Grande parte dos ambientes de Educação a Distância reproduz formas somativas de avaliação, e logo reconhecem as limitações dessa transposição direta. Entendemos que realizar avaliações do desenvolvimento de alunos de um ambiente virtual implica em criar um novo paradigma de avaliação e o mesmo adaptado as características dos recursos disponíveis num ambiente virtual. Partimos da hipótese de que a avaliação em EaD não pode ocorrer mediante a produção de materiais isoladamente e posterior envio para avaliação. Além disso, considerar apenas a análise de um avaliador pode ser limitado, dados que há outros aspectos da aprendizagem que estão implicados na atividade em comunidades de aprendizagem.

A proposta de avaliação do A.M.A.De.Us é construtivista em sues princípios e na relação que é criada pela mesma entre alunos e professores. Ela é ao mesmo tempo proativa e continuada, realizada sobre toda a produção dos alunos, sob as diversas formas de participação dos alunos e sob múltiplos pontos de vista. A proposta construtivista é conseguida pois os resultados da avaliação servem de base à estruturação da intervenção dos professores e tutores do ambiente. A proposta pedagógica do ambiente AMADeUS para avaliação leva em consideração a observância de múltiplos parâmetros da atividade no ambiente destro de uma metodologia diagnóstica e suas avaliações a partir de pontos de vistas de usuários diferentes.

Com relação à avaliação por múltiplos parâmetros, entendemos uma avaliação que integra avaliações de diferentes atividades e produções engajadas e produzidas pelos participantes de um curso a distância. Um dos parâmetros analisados advém da análise das ações dos alunos nos componentes de interface (User software components). Esses componentes são monitorados por agentes de interface que enviam logs da atividade de resolução dos problemas para o servidor. A avaliação da aprendizagem de conceitos ocorre durante o uso dos micromundos e a resolução de instrumentos de avaliação. Essa avaliação particular apresenta para o professor uma representação gráfica do que um aluno sabe corretamente ou erroneamente.

Com relação à realização da avaliação por diferentes pontos de vista, entendemos como sendo a integração de pontos de vistas de diferentes usuários sobre o desenvolvimento de um único aluno. Analisamos três pontos de vista para produzir julgamento sobre um aluno: o ponto de vista de seu professor, o ponto de vista de seus pares e o seu ponto de vista pessoal.

No primeiro caso, o professor dispõe de vários mecanismos e ferramentas de avaliação que produzem uma nota correspondendo à integração dos vários parâmetros. A participação dos alunos é avaliada mediante monitoramento de suas atividades em diversos ambientes dos ambientes, como chat, fórum, listas e mediante o controle de entrega de materiais. Os critérios de avaliação, sendo negociados entre instrutores e alunos, podem ou não considerar essa dimensão da atividade. Uma estratégia de avaliar a participação dos alunos no curso pode ser mediante a medida proporcional de freqüência com relação ao total de participações ou a média de participações dos alunos.

Nessa direção o sistema AMADeUS permite o acompanhamento de diversas atividades, individuais e coletivas, como a participação na lista de discussão do ambiente e nas atividades realizadas de forma síncrona (eventos e encontros). O professor dispõe de ferramentas que permitem sistematizar os dados relativos à participação dos alunos nessas diferentes atividades.

No caso da avaliação por pares, os participantes de uma turma, ou comunidade de aprendizagem emitem pareceres e julgamentos sobre os colegas. Nos ambiente os pares podem avaliar a participação dos alunos. São avaliadas as participações em fóruns, e-mails, assim como trabalhos submetidos. Essa avaliação pode não ser obrigatória adotada pelo grupo mais pode ser uma alternativa de dinâmica de avaliação por parte de pares. O resultado dessa avaliação pode ou não ser incorporada pelo instrutor/tutor o resultado enquanto parte da avaliação final ou apenas para servir de parâmetro para avaliar a consistência da produção dos educandos. O tutor pode apenas utilizar-se dessa dinâmica para aumentar a participação dos alunos, ao mesmo tempo em que terá uma fonte alternativa de informações sobre a produção dos alunos.

No caso da auto-avaliação, os próprios alunos são solicitados a avaliarem-se autonomamente. A integração desses três conjuntos de avaliações, tratadas por agentes inteligentes autônomos, gera uma representação do processo de desenvolvimento vivido por cada participante de um curso.

MODELO CONCEITUAL DO AMBIENTE

Por questões minuciosas de entendimento do modelo, definiremos com antecedência o que consideramos ser o significado de alguns termos que usaremos nessa seção.
Existem diferentes definições para testar, medir e avaliar [3]. Testar significa submeter alguém a um teste verificando seu desempenho. Medir significa determinar para alguém uma quantidade, extensão ou grau, tendo por base um sistema de unidades convencionais. Avaliar significa julgar alguém, tendo por base uma escala de valores. Partindo dessa perspectiva, nosso modelo apresenta uma divisão conceitual da seguinte natureza:
Testes - elaboração de exames, definição de mecanismos de acompanhamento do aprendizado e pontos de vista.
Critérios - Definição de critérios, qual o grau de valor que terão os testes: provas, mecanismos de acompanhamento e pontos de vista.
Avaliação – julgamento dos resultados baseados nas definições dos critérios aplicados aos testes.
De acordo com Herman, Aschbacher e Winters [5], desenvolver avaliação qualitativa em um ambiente construtivista consiste em três passos:
Passo 1: Listar o conhecimento e habilidades que você deseja que os estudantes aprendam como resultado do fim de uma tarefa.
Passo 2. Projetar tarefas que requerem que os estudantes demonstrem essas habilidades e conhecimento.
Passo 3. Desenvolver critérios explícitos de performance que meçam a extensão a qual os estudantes devam dominar em relação às habilidades e conhecimento.
O modelo proposto proporciona ao professor um meio de sistematização desses passos permitindo-o adaptar o ambiente de acordo com seus objetivos.

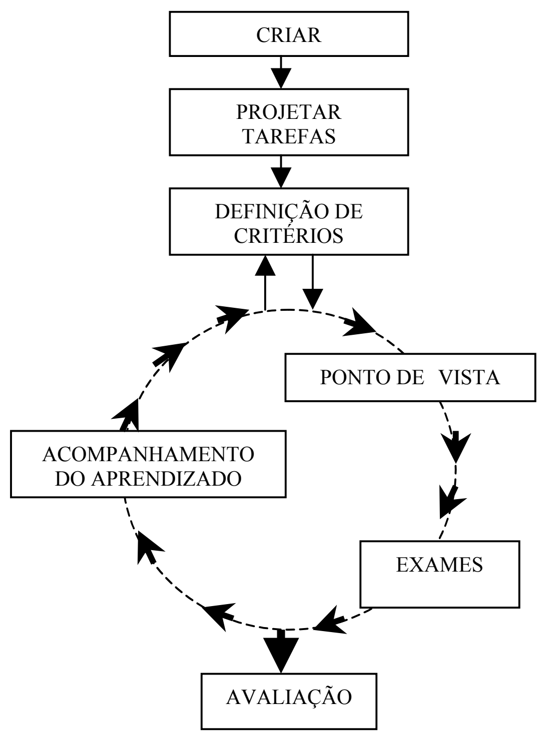

Figura 3-Modelo Conceitual do Ambiente de Avaliação do AMADeUs

Para isso, o ambiente disponibiliza diferentes estratégias de avaliação. O professor é capaz de coordenar especificamente quais contribuições serão avaliadas e definir o grau de cada medida. Nosso objetivo é que o professor possa comparar diferentes pontos de vistas do aluno, ou dos alunos (grupos), podendo avaliar os resultados substancialmente melhor do que em uma única estratégia.

Seguindo esse raciocínio, definimos a combinação separada de critérios para os seguintes testes:

Ponto de vista – auto-avaliação do estudante, avaliação intrapessoal dos estudantes, avaliação do professor por parte do estudante, avaliação do curso por parte do estudante.

Acompanhamento do aprendizado – avaliação continuada das contribuições em salas de bate-papo, fórum, mensagens, servidores de lista, portfólio; agentes de interface rastreiam e seguem as atividades dos estudantes.

Exames – a avaliação tradicional de provas, projetos ou artigos por parte dos instrutores.

Em nosso modelo sócio-construtivista, o uso estratégico do ponto de vista, faz com que o avaliador seja o próprio estudante. Nesse caso, chamaremos o indivíduo que avalia, em nosso ambiente, de "avaluador". Cada avaluador avalia individualmente, mas o sistema permite realizar médias de grupos de avaluadores projetando um consenso coletivo.

Para cada estratégia, ambientes e agentes são projetados. Todos os pontos de vista são integrados, processados e representados em relatórios simples e gráficos. Os resultados de origens diferentes são comparados e combinados para produzir uma avaliação coerente e útil do estudante. Essa estratégia parece expressar resultados mais consistentes e de consenso coletivo. Essa arquitetura é composta de unidades ativas e passivas do ambiente. A participação dos estudantes é rastreada em chat room, fórum, listas de e-mail, e-mails individuais para os professores. Interfaces inteligentes nos componentes de software do usuário são responsáveis pela modelagem e avaliação do aprendizado do estudante em ação. O ponto de vista do professor é construído por ele mesmo através da análise da produção dos estudantes da maneira tradicional. Esse ponto de vista é complementado pela avaliação participativa. O ponto de vista dos estudantes é capturado em ambientes específicos onde os estudantes são convidados a avaliar seus colegas e julgar suas produções.

CONCLUSÃO

A falta de contato visual entre alunos-alunos e professor-aluno no ambiente construtivista EAD faz com que a avaliação seja deficitária. O professor carece de mais informações para um melhor julgamento sobre o comportamento do aluno. Através do modelo apresentado, proporcionamos formas alternativas à avaliação formal para julgar o aprendizado do aluno. Essa abordagem flexibiliza a avaliação, adaptando ao estilo (modelo de avaliação) do professor, proporcionando estratégias diferentes de julgamento do estudante através da definição de critérios, como: ponto de vista, acompanhamento do aprendizado e teste.

Este trabalho faz parte do projeto AMADeUs, uma plataforma educacional para aprendizagem a distância que está sendo implementado no Cin da UFPe.

AGRADECIMENTOS

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SISTEMA PROGRAMÁVEL PARA AULAS DE FÍSICA - SPAF

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Resumo. *Este trabalho apresenta uma proposta de desenvolvimento de uma plataforma hardware/software (hw/sw) reconfigurável, para aquisição e processamento de dados em aulas práticas de Física. Pesquisas têm demonstrado que simulações por computador facilitam enormemente o aprendizado de Física, no entanto, tais sistemas, na sua maioria, representam um alto de custo de investimento. Este projeto propõe portanto, uma plataforma reconfigurável de baixo custo, que sirva de interface para diversos experimentos da Física. A arquitetura da plataforma proposta baseia-se em um sistema microprogramado, composto por um microcontrolador, um dispositivo reconfigurável FPGA (Field Programmable Gate Array), memória, interfaces, assim como, bibliotecas de componentes de software e hardware (cores) customizados de acordo com os diferentes experimentos do usuário.*

Palavras Chaves: Ambientes Interativos de Aprendizagem, Ensino de Ciências, hardware/software codesign, FPGA.

INTRODUÇÃO

A melhoria da qualidade da maioria dos produtos e serviços oferecidos pelos diversos setores da sociedade moderna tem sido atribuída à entrada em cena de um ator coadjuvante: o computador. Da medicina à educação ele tem mostrado ser uma ferramenta extremamente útil. Na educação, por exemplo, o computador tem sido de grande valia no processo ensino-aprendizagem, não somente na construção, como também na disseminação do conhecimento. Por outro lado, há muito tempo, pesquisadores investigam o mecanismo de compreensão dos conceitos como os da Física pelos estudantes e como estes conceitos podem se repassados através de equipamentos como este. Temas como a eletricidade, ótica, termodinâmica e cinemática, por exemplo, têm apresentado grandes dificuldades de compreensão por parte destes alunos. Observa-se também que em áreas de ensino como a Física, muitas vezes, o custo dos equipamentos e acessórios para cada nova experiência é elevado, e que nem sempre apresentam a funcionalidade e flexibilidade desejadas. Novas tecnologias no entanto, podem permitir a um custo mais baixo, a fácil adaptação de novos acessórios e geração de interfaces mais rapidamente, sem a necessidade de aquisição ou modificação substancial da plataforma existente.

Paradigmas de projeto, como o hardware/software codesign, com dispositivos de hardware reconfiguráveis, podem ser extremamente úteis para este tipo de problema devido à facilidade de adaptação, não só no que diz respeito às rotinas de software, como também na adaptação de componentes de hardware para interfaceamento de acessórios, displays, sensores, etc.

Este trabalho propõe portanto, um modelo de uma plataforma para prototipação rápida para experimentos de física fundamentada no paradigma hardware/software codesign.

A seção 2 discute as dificuldades dos estudantes na compreensão de conteúdos da Física. Na seção 3 são analisadas estratégias didáticas para superar essas dificuldades através do uso de recursos computacionais. A seção 4 descreve alguns sistemas comerciais usados no ensino de Física. A seção 5 expõe o modelo proposto neste trabalho e a sexta seção apresenta algumas conclusões acerca do desenvolvimento que foi realizado.

AS DIFICULDADES DOS ESTUDANTES

Observa-se de um modo geral que os estudantes têm dificuldade em explicar principalmente os fenômenos que estão à sua volta como a queda dos corpos, o movimento de objetos, a luz, a eletricidade, os estados da matéria, etc. Muitos estudantes tendem a associar uma força com a velocidade de um objeto e não a sua aceleração. Não faltam aqueles que pensam que a gravidade terrestre só atua em objetos em queda. De onde viria tal dificuldade? Poderíamos imaginar que para um observador a 'olhos nus' é muito mais fácil supor que o sol gira em torno da terra do que o contrário. Trowbridge e McDermot[1] pesquisaram a compreensão de conceitos elementares como a velocidade de um objeto em uma dimensão e perceberam que muitos estudantes confundem velocidade com a posição do objeto.

Atualmente no ensino da Física, surge uma preocupação muito grande com relação às concepções pré-existentes dos alunos sobre determinados conceitos, concepções estas que atrapalham ou impedem a compreensão dos conceitos verdadeiros. Zylbersztajn[2] em seu trabalho mostra que durante muitos anos as idéias incorretas dos alunos ficaram conhecidas como 'misconceptions' ou 'misunderstandings', ou seja, concepções errôneas ou desconhecimento do assunto. Hoje, nota-se uma tendência entre os pesquisadores em usar expressões com uma conotação negativa menos acentuada: 'alternative frameworks', 'alternative conceptions', 'children's science' e 'concepções espontâneas'. Estas noções originam-se tanto através da experiência direta com o mundo físico, como também através de experiências indiretas com o mesmo, isto é, mediada pela interação social e lingüística com o círculo familiar, comunidade e meios de comunicação. Pesquisas têm demonstrado que estas concepções, na forma de expectativas, crenças, princípios intuitivos e significados atribuídos a palavras cobrem uma

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vasta gama dos conceitos que fazem parte dos currículos de disciplinas científicas. É igualmente verdadeiro que, para muitos, algumas destas noções são fortemente incorporadas à sua estrutura cognitiva, tornando-se resistente à instrução. Tradicionalmente, professores e pesquisadores devotaram pouca atenção à existência de tais noções, considerando-as simplesmente como erros que seriam facilmente corrigidos. Por isso, problemas relativos ao ensino de Física tem sido mais comumente ligados ao uso de técnicas matemáticas e menos às dificuldades de nível conceitual. Apenas mais recentemente pesquisadores em Ensino de Ciências parecem ter se dado conta das implicações educacionais decorrentes do fato de que alunos constroem concepções a respeito da realidade que os cercam. Concepções estas que lhes proporcionam uma compreensão pessoal desta realidade, influindo na maneira pela qual estes alunos aprendem (ou deixam de aprender) os conceitos que lhes são ensinados. A crescente quantidade de estudos demonstrando a ocorrência de concepções espontâneas relativas a vários tópicos permitem aos pesquisadores na área afirmar que:

'*Na realidade há um confronto entre a física ensinada (oficial) e a espontânea e sem dúvida o objetivo do ensino é a aprendizagem da oficial; este confronto muitas vezes se realiza de forma pouco harmoniosa e seu resultado não é uma visão conceitual coerente e rica, mas a superposição e justaposição de conceitos de diferentes origens e alcance, que prejudicam qualquer pretensão de aprofundamento teórico do aluno*' [3].

Aceitando-se este ponto de vista, coloca-se então a questão prática sobre que implicações para o ensino poderiam daí se derivar. Uma conclusão a que poderíamos chegar é que:

'*... não é produtivo ignorar a bagagem cultural do aluno e todo o conjunto de noções espontâneas que ele carrega ao se deparar com o ensino formal na escola. Se não se cuidar adequadamente da física espontânea dos alunos sobrarão duas estruturas superpostas, entre as quais os alunos escolherão uma dependendo do contexto; em geral quando o problema envolver muitos elementos formais usarão a aprendizagem formal; quando o problema envolver elementos do dia-a-dia e com características bem figurativas ou capazes de estimular a percepção, usarão o esquema espontâneo*' [3].

As pesquisas sugerem também que a instrução convencional é ineficaz para tratar com certas concepções errôneas. As concepções alternativas dos estudantes de velocidade e de aceleração, por exemplo, são considerados não serem facilmente afetadas pelos tradicionais métodos instrutivos. Transformar idéias e/ou corrigir defeitos do conhecimento dos estudantes na física é além do alcance dos métodos tradicionais de ensino porque tendem a ignorar a possibilidade de que a percepção dos estudantes é possivelmente diferente daquela do professor.

COMO SUPERAR AS DIFICULDADES

O alvo principal de uma metodologia construtivista alternativa de ensino deve então ser o desenvolvimento de circunstâncias tais que facilitam o engajamento ativo dos estudantes na compreensão do aprendizado funcional da Física. Além disso, tal metodologia deve permitir aos estudantes aplicar eficazmente conceitos e princípios físicos em novas situações. É aí que as simulações de computador se encaixam como uma luva. Thornton e Sokoloff mostram em seus estudos [4] que ferramentas de *laboratório baseados em microcomputadores* (MBL) em tempo real são fundamentais para a solidificação dos conceitos básicos da cinemática. Uma das ferramentas discutidas é chamada de *MOTION DETECTOR* (Detector de Movimento), ela é composta por um conjunto de hardware e software específicos e é usada para a medição, exibição e gravação da posição, velocidade e aceleração de um objeto. Através das ferramentas de laboratório, os estudantes são ativamente envolvidos na sua aprendizagem. Eles são estimulados a fazer prognósticos (esboços) do movimento dos objetos, discutir com os demais alunos em grupo e a estabelecer suas próprias conclusões. Durante três anos, Thornton e Sokoloff, pesquisaram e estudaram se as ferramentas de computador efetivamente auxiliam no ensino da cinemática. A avaliação dos alunos consistiu na aplicação de um teste antes da aplicação das ferramentas no ensino e num teste posterior às mesmas. Estes testes eram compostos por questões de múltipla escolha e outros onde os alunos deveriam escrever as suas respostas e desenharem gráficos. Após o trabalho, concluíram que existem fortes evidências que o aprendizado assistido pelas ferramentas de computador tanto facilitam a compressão bem como a retenção dos conceitos da cinemática. Dentre os pontos positivos encontrados destacam-se: *Foco nos fenômenos reais* – Os estudantes aprendem os conceitos pela investigação dos fenômenos reais em comparação à simbologia e abstrações do ensino tradicional; *Feedback imediatamente disponível* – Os experimentos são fundamentais para entendimento dos conceitos básicos e ajudam na compreensão de conceitos mais abstratos. É uma característica importante das simulações em computador; *Engajamento dos estudantes* – Eles são estimulados a se engajar efetivamente nas experiências, a expressar suas opiniões e discutir suas expectativas de resultados. Este processo é considerado como um poderoso auxílio na aprendizagem dos estudantes; *Ferramentas poderosas reduzem trabalhos desnecessários* – Experiências que consomem muito tempo ou que acontecem muito rápido, experiências caras ou de difícil execução podem ser reproduzidas em computador. Os estudantes concentram-se apenas nos detalhes essenciais das experiências; *Compreensão de assuntos específicos e familiares antes de passar ao geral e abstrato* – O ambiente educacional guia os estudantes a entender do mais simples ao mais complexo. O nível de dificuldade pode ser controlado facilitando a abstração das leis físicas, de fenômenos complexos e processos reais.

Outra pesquisa feita na Grécia por Jimoyiannis e Komis investiga os efeitos de simulações de computador na compreensão dos estudantes dos conceitos cinemáticos [5]. As questões da pesquisa são: Quais as principais dificuldades enfrentadas por estudantes ao aplicar os conceitos de velocidade e de aceleração em movimentos simples no campo gravitacional? Quais são os efeitos do uso das simulações nas concepções alternativos dos estudantes? O uso das simulações ajuda desenvolver modelos científicos?

Participaram da pesquisa 90 estudantes do 1º ano do curso secundário do colégio Lyceum, na Grécia, com idade entre 15-16 anos. A maioria deles tinha experiência em computador. Os estudantes foram divididos em dois grupos, controle e experimental, o primeiro com 60 estudantes e o segundo com 30. A pesquisa ocorreu cinco meses depois que os estudantes tinham recebido o ensino dos conceitos básicos de cinemática (velocidade e aceleração, movimento linear, movimentos simples da trajetória como queda livre e o lançamento vertical e horizontal no campo gravitacional da terra). Aos estudantes do grupo experimental foram oferecidas duas lições em computador de 1h no laboratório. Ao grupo de controle foi ministrado apenas o ensino tradicional. Pediu-se a todos os estudantes para responder algumas tarefas (T1a, T1b, T2a, T2b, T3a e T3b) envolvendo velocidade e aceleração de objetos em queda livre. A Figura 1 mostra a comparação apenas das respostas corretas dos estudantes em ambos os grupos.

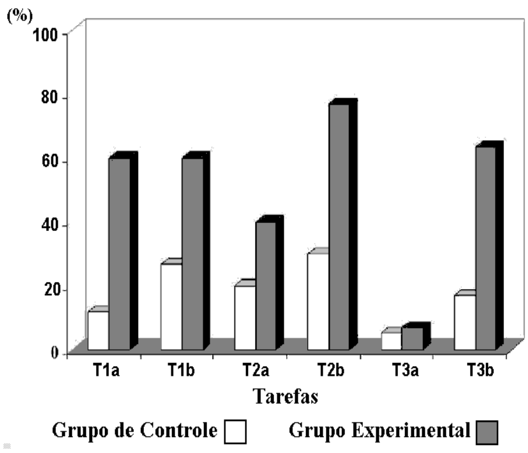

FIGURA 1.
RESPOSTA DOS ALUNOS

A análise estatística indica que há diferenças significativas de aprendizagem entre os dois grupos. De imediato ela sugere que os ambientes educacionais baseados em simulações ajudam a estudantes e superar seus constrangimentos cognitivos e as concepções errôneas sobre a trajetória. Observamos que em todas as perguntas a maior quantidade de acertos pertence ao grupo experimental. Somente em uma questão houve um certo equilíbrio. Uma análise mais profunda envolvendo todas as respostas dos alunos indica que há diferenças significativas na concepção dos estudantes a respeito dos conceitos de velocidade e de aceleração, dependendo se estiveram engajados nas tarefas que exigem o uso de representações estroboscópicas ('câmara lenta') da física interativa ou não. De um ponto de vista qualitativo, a escala dos tipos de respostas dos estudantes é similar para ambos os grupos indica concepções alternativas do mesmo tipo, mas é diferente quanto as suas freqüências. Entre as concepções alternativas mais freqüentes está a confusão entre velocidade e aceleração. Os estudantes no grupo experimental exibiram taxas significativamente melhoradas dos acertos. A hipótese sobre o papel de simulações de computador no ensino da física é confirmada fortemente com a análise da correlação múltipla entre os grupos. Isto indica que os ambientes educacionais baseados em simulações ajudam a estudantes a superar seus confinamentos cognitivos e refinar suas concepções alternativos sobre os conceitos básicos da cinemática.

SISTEMAS PARA AULAS DE FÍSICA

Existe uma grande variedade de sistemas comerciais que podem ser usados para aulas práticas de Física. A revista Pierron Science publicada na França, exibe Kits para aulas, como por exemplo, o Kit Expert mostrado na figura 2.

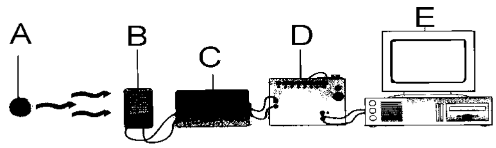

FIGURA 2.
COMPONENTES DO KIT EXPERT

Kits como este podem ser usados em diversas experiências, com recursos para conexão de instrumentos para captação de dados (B), condicionadores de sinais (C), conversores analógico/digital (D), todos, em geral, conectados a um microcomputador (E). Este computador por sua vez, através de softwares específicos processa os dados e os exibe na forma de gráficos, tabelas ou relatórios. Os acessórios para um conjunto de experimentos em termodinâmica, acústica, ótica e mecânica, inclusive com os componentes de softwares, sem considerar o custo do microcomputador, ficam um pouco acima de US$ 3,200.00 (três mil e duzentos dólares).

Empresas como a National Instruments também produzem kits (incluindo componentes e softwares) que podem ser úteis em aulas de Física, ou em sistemas reais, em automação industrial, porém seus preços estão acima de US$ 3.000.00 (três mil dólares).

Existem outros kits com aplicação especifica, cujo objetivo é desenvolver o raciocínio e a criatividade através de experiências na área de mecânica, através da construção de máquinas simples. Em geral estes sistemas apresentam um custo menor quando comparado com os anteriores, cerca de US$ 160.00 (cento e sessenta dólares), entretanto suas aplicações são bastante restritas.

O SISTEMA SPAF

A figura 3 mostra o esboço do Sistema Programável para aulas práticas de Física (SPAF) proposto neste trabalho. O KIT (C) é baseado em uma plataforma reconfigurável, ou seja, poderá ser programado e reprogramado via microcomputador (A) para executar uma série de experimentos com diferentes interfaces (D), dentre os quais destacamos: mecânica, termodinâmica, acústica, etc., permitindo a demonstração e análise dos resultados.

Um banco de dados (B) com *cores (módulos de software/ desenvolvidos para cada tipo de experiência)* e funções especiais juntamente com uma interface gráfica permitirão um gerenciamento amigável das experiências a serem realizadas em laboratório. Os pontos mais importantes deste sistema são a versatilidade e o baixo custo deste equipamento quando comparado àqueles apresentados no item 4. A previsão do preço kit envolvendo apenas a plataforma básica reconfigurável é em torno de US$200.00 (duzentos dólares).

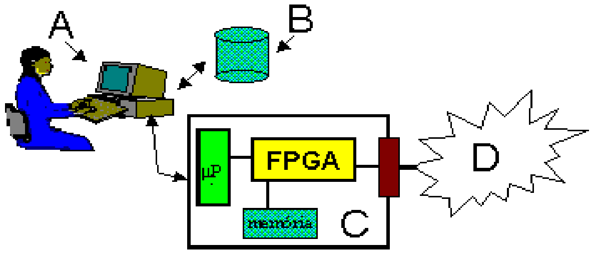

FIGURA 3.
ESBOÇO DO SISTEMA SPAF

O sistema SPAF utiliza como plataforma de desenvolvimento de sistemas a plataforma *Chameleon* [6]-[9], desenvolvida no Centro de Informática da Universidade Federal de Pernambuco (UFPE). Esta plataforma é direcionada para projetos baseados na metodologia Hw/Sw co-design. Seus componentes básicos são um microcontrolador (processador), um FPGA e dois bancos de memória (RAM e EPROM). A comunicação com o microcomputador (Host) é feita através de uma porta serial, como mostra a figura 4.

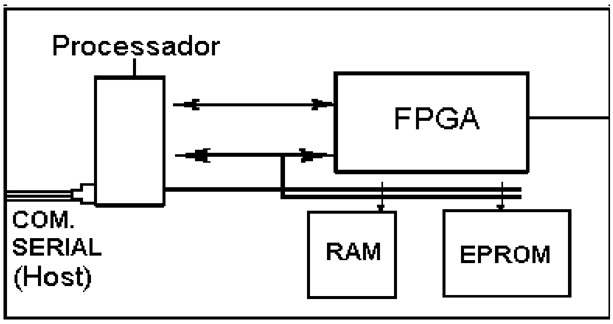

FIGURA 4.
COMPONENTES BÁSICOS DA PLATAFORMA SPAF

A arquitetura do Chameleon compreende uma placa de prototipação e ferramentas de CAD que ajudam no desenvolvimento e testes de sistemas digitais. A placa básica de prototipação é composta por componentes de software e de hardware que compartilham de uma memória comum e de canais de comunicação. Os processos do software são executados em um microprocessador da família compatível 8051, que pode, inclusive, executar processos em tempo real através do sistema operacional do tempo real de Keil Inc. [10]. Os processos de hardware serão implementados em um único componente FPGA, o XC4000 da empresa Xilinx [11]. Um barramento de dados 8-bits e um barramento de endereço 16-bits favorecem a troca de dados entre o processador, o FPGA e os bancos de memória. Uma interface de comunicação paralela assíncrona e bidirecional está também disponível para gerenciar os sinais de controle e dados comuns entre os componentes de hardware/software.

Um dos elementos chaves desta plataforma é a utilização de componentes de hardware reconfiguráveis, como o FPGA XC4000, o qual permite fácil geração de novas interfaces através de programação em software, para acoplamento de novos periféricos sem mudança ou adição de novo hardware.

SISTEMAS RECONFIGURÁVEIS

Em sistemas de computação tradicional existem dois métodos clássicos para a execução de algoritmos. O primeiro é a utilização de circuitos integrados de aplicação especifica (ASIC), que em geral, são específicos para uma única tarefa, são mais rápidos, mais exigem um alto custo de produção e não permitem mudança de sua funcionalidade. Um novo projeto, de um novo ASIC teria que ser feito para uma nova aplicação.

Solução baseada em software, por sua vez, apresenta vantagens, tais como flexibilidade, e baixo custo na implementação de funções complexas. No entanto, esta solução é limitada na exploração de paralelismo e aplicação de alta velocidade. Processos em software são implementados em dispositivos como microprocessadores e microcontroladores.

Computação Reconfigurável (CR) pretende preencher este espaço existente entre hardware e software, permitindo alcançar potencialmente muito mais performance que os componentes de software, mantendo um alto nível de flexibilidade em relação aos dispositivos de hardware (ASICs).

Arquiteturas reconfiguráveis têm sido desenvolvidas e aplicadas em uma série de áreas de ensino e pesquisa, além de produtos em processamento de imagens, biotecnologia, telecomunicações, controle, etc. Podemos entender um sistema reconfigurável [12]-[13] com aquele que atende às seguintes especificações: capacidade de implementar novas funções de hardware; executar novas operações de forma mais eficiente que os processadores de uso geral (computadores comuns); alterar sua arquitetura de acordo com novas necessidades, inclusive em tempo de execução, o que depende do tipo de dispositivo utilizado.

Dentre as vantagens presentes nos sistemas reconfiguráveis estão a geração rápida de protótipos de sistemas digitais, fácil adaptação de novas interfaces sem mudanças de componentes, desenvolvimento de projetos em alto-nível abstração.

Este tipo de arquitetura permite uma abstração maior da tecnologia na qual será implementada o sistema do usuário, desde que tudo pode ser desenvolvido em software através de ferramentas de CAD (Computer Aided Design). Estes sistemas permitem ainda que sistemas completos possam ser desenvolvidos e emulados remotamente via internet. Dentre dispositivos desta classe podemos citar os FPGAs, um dos dispositivos utilizadas na plataforma de desenvolvimento apresentada neste trabalho.

Dispositivos Lógicos Reconfiguráveis

O FPGA[13], como o próprio nome sugere, *conjunto de portas lógicas programáveis em campo*, é um componente que visa agilizar o desenvolvimento de sistemas digitais pela facilidade de confecção dos mesmos. Introduzidos pela Xilinx em 1985, atualmente possui uma vasta variedade de modelos e fabricantes. De uma maneira geral, a estrutura básica de um FPGA é composta por uma matriz bidimensional de blocos Lógicos, os quais podem implementar funções combinacionais e seqüenciais. Estes blocos lógicos, comumente chamados de CLBs (Configurable Logic Blocs) são interconectados através de canais de roteamento. Estes dispositivos possuem alta densidade de integração, VLSI (*Very Large Scale Integration*), podendo implementar funções lógicas com mais de 6 milhões de gates, integrando em único chip, núcleos (*cores*) de cpus, memória, barramentos, interfaces especiais, etc.. Estes circuitos podem ainda ser mapeados de maneira estática, na qual, a toda nova aplicação necessita-se de uma re-inicialização do chip através de um *reset*, ou de maneira dinâmica , através dos Gate Arrays Dinamicamente Reconfiguráveis (DPGAs), no qual os processos podem ser mapeados dinamicamente no chip sem a necessidade de *reset (reconfiguração on-the-fly)*. Estas características, fazem com que FPGAs se apresente como uma solução interessante para prototipação rápida de sistemas digitais, os quais podem ser modificados constantemente de acordo com a complexidade do problema a ser resolvido, tipo de interface, velocidade de processamento, etc., com a e flexibilidade de sistemas de software.

Metodologia do Projeto de Execução de Experiências

O sistema SPAF permite que diferentes experiências possam ser desenvolvidas e armazenadas em um banco de dados pelo usuário e facilmente plugadas ao sistema quando requeridas, em função de sua aplicação. Uma das principais características do sistema é a fácil reprogramabilidade do FPGA, ou seja, a mudança de sua funcionalidade (permuta de experiências). Isto é garantido através de arquivos de configuração gravados em sua memória. Os componentes de software bem como os arquivos de configuração podem ser armazenados no host ou na própria na plataforma, dependendo do tipo de aplicação requerida. Como pode ser observado na figura 5, um conjunto de *cores* (componentes A, B e C) de experiências estariam disponíveis em uma base de dados acessíveis através de um sistema que gerencia a configuração e reconfiguração do FPGA e dos componentes de software do microcontrolador.

O microcontrolador da placa é o responsável pela programação e reprogramação do sistema e pela comunicação com o host. O ambiente para desenvolvimento de componentes de software é o Keil e os módulos desenvolvidos em C. O sistema para o desenvolvimento do módulos de hardware é o sistema Xilinx Foundation[14] e os módulos descritos em VHDL[15]. Após a geração dos respectivos cores ou códigos executável do microcontrolador e de configuração do FPGA, com suas respectivas interfaces, de acordo com cada aplicação, estes arquivos são armazenados no banco de dados das experiências. Cores ou núcleos de interfaces podem ser re-usados por outras experiências ou aplicações.

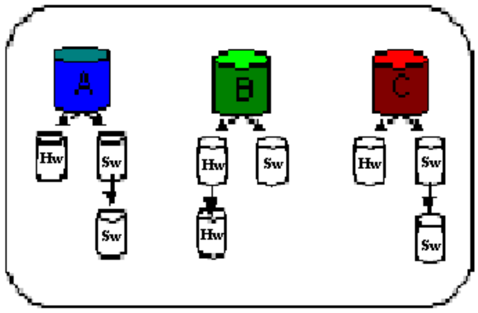

Figura 5.
Cores em banco de dados

Quando requisitados, de acordo com a experiência a ser implementada, estes arquivos são devidamente carregados pelo host à placa de prototipação através de um link serial.

A figura 6 mostra o fluxo de compilação e síntese destes componentes.

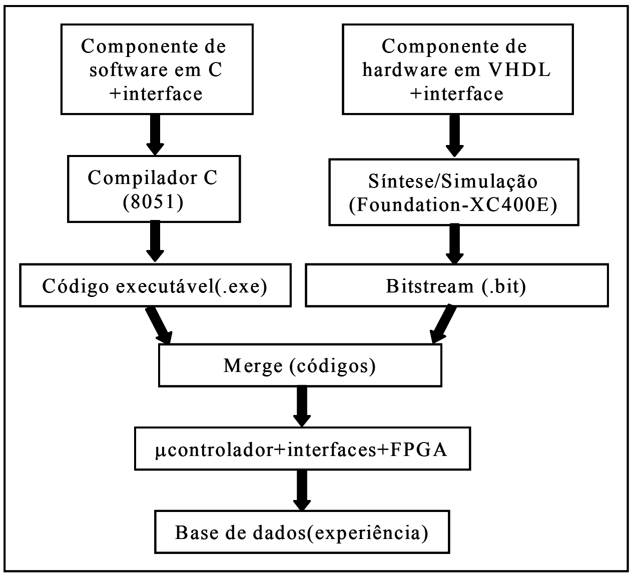

Figura 6.
Fluxograma da geração de código

Um programa monitor residente na placa prototipação é responsável pelo recebimento e armazenamento deste código na memória RAM presente na placa. Como mencionado anteriormente, um banco EPROM armazena um programa monitor responsável pela inicialização do sistema e controle dos programas de aplicação do usuário. Após a carga completa dos componentes de hardware e software, o monitor configura adequadamente o FPGA e executa a partição de software em RAM.

A figura 7 mostra o esboço do sistema para tipos diferentes de experiências. Observe que todo o sistema deve ser previamente especificado e verificado antes da implementação na plataforma.

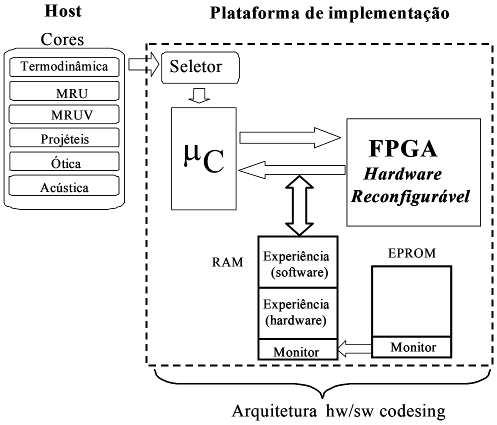

FIGURA 7.
INSERÇÃO DE EXPERIÊNCIAS

Dependendo do tipo experimento, diferentes cores de hardware podem ser substituídos ao longo de sua execução controlados por rotinas em software que podem reconfigurar no tempo diferentes interfaces ou módulos em hardware.

GERAÇÃO DE INTERFACES

A plataforma SPAF permite a conexão de diferentes módulos de hardware para a implementação de diferentes experiências de Física. Através de uma interface gráfica, o usuário pode, a nível de especificação do sistema, definir qual e onde determinada interface deve ser colocada e qual o seu driver apropriado. *Cores* de drivers de hardware, para conversores A/D e display LCD foram desenvolvidos. O driver A/D permite que um conversor compatível AD628, possa ser facilmente conectado ao sistema via FPGA, permitindo que sinais analógicos possam ser convertidos e tratados adequadamente de acordo com a experiência do usuário. Um *core* de LCD, modelo L2000, foi também desenvolvido e permite que leituras das experiências possam ser localmente visualizadas na placa de prototipação. Além dos *cores* que são implementados como componentes virtuais em hardware específicos, o modelo permite também que outros componentes de processamento rápido como FFTs, convolução, etc, possam também ser implementadas como *cores* de hardware. Os componentes de software podem ser usados como elementos que controlam parte do experimento, ou rotinas que implementem equações, funções especiais, etc., e que não requeiram alta performance.

Além das interfaces em componentes hw/sw na plataforma e demais interfaces especiais, uma interface gráfica permite fácil aquisição de dados, geração de gráficos, impressão, estatística, etc.

CONCLUSÕES

Este artigo descreve o desenvolvimento de um sistema reconfigurável de coleta, análise e apresentação de dados para o ensino de Física. Embora o computador tenha demonstrado ser uma ferramenta de grande importância no processo ensino/aprendizagem em diversas áreas do conhecimento humano, sua utilização na resolução de problemas deve ser feita de maneira criteriosa, de modo que o aluno possa correlacionar o prático e o teórico no decorrer do experimento. Não é o simples fato de resolver um problema, mas o modo como é resolvido. Deve-se destacar que o processo de condução das experiências por computador pode levar a dois extremos: Estimular o estudo quando a experiência pode ser detalhada de modo que haja uma participação do aluno na condução do processo, ou seja, ele é um agente ativo, por um outro lado, desestimular o aluno quando o processo é absolutamente mecânico, apenas digitação e obtenção dos resultados, tornando-o um agente passivo.

O objetivo deste projeto é desenvolver uma plataforma 'amigável', ou seja, que não exija nenhum pré-requisito em programação de computadores, mas que ao mesmo tempo necessite de uma participação ativa do aluno na condução, observação e obtenção dos resultados das experiências. Dentre os objetivos educacionais destacamos: *Desenvolvimento do Raciocínio Lógico* – Estimular o raciocínio lógico dos alunos à medida em que eles comparam os resultados obtidos nas experiências conduzidas com o auxílio do computador e com os resultados obtidos sem auxílio do computador, podendo então constatar efeitos na prática, muitas vezes desprezado; *Interdisciplinaridade* – Estabelecer um paralelo entre o prático (concreto) e o teórico (abstrato), bem como estudar conceitos de diversas áreas como: Informática, Matemática, Física (Eletricidade, Mecânica, Ótica), etc. e as relações entre elas; *Estímulo ao Planejamento* – Ao planejar a realização de uma experiência ele se prepara para estudar os resultados ao mesmo tempo que aprende aspectos relacionados à organização e disciplina; *Pesquisa* – Os resultados obtidos podem levar o aluno a questionamentos que só poderão ser elucidados com o seu empenho em pesquisar sobre o assunto em questão; *Criatividade* – Estimular o aluno a imaginar novas experiências, bem como a concepção de novos mecanismos de aquisição e manipulação de dados, que poderiam inclusive contar com o reaproveitamento de materiais, logicamente, sob a supervisão do professor.

Uma metodologia e uma plataforma de ensino está em desenvolvimento. A plataforma Chameleon baseada em uma arquitetura hw/sw codesign mostrou ser apropriada para este tipo de projeto, devido a sua flexibilidade, simplicidade de operação, facilidade de implementação de novos projetos e um custo acessível. O protótipo até aqui desenvolvido tem mostrado ser promissor e motivador na realização e implementação de experimentos de física.

Agradecimentos

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Applying Concept Maps in Education as a Metacognitive Tool

Tânia Barbosa Salles Gava[1] *and Crediné Silva de Menezes*[2]

Abstract — *This paper discusses the use of concept maps as a metacognitive tool in the educational context. It makes use of a reflection on ideas manifestation and its representation as maps. Besides it suggests three applications: 1) concept map as a tool for indexing contents of a virtual learning environment 2) as a support to bibliographic review, and 3) as a support to the development of learning project. Moreover, we point out some other possible applications where concept maps would bring good contributions by reducing the cognitive overload and amplifying our cognitive abilities.*

Index Terms — concept maps, knowledge organizers, computer in education.

Introduction

The teaching-learning process is carried out through several phases such as the student contact with the existing knowledge about his object of study (usually called content), the study and the analysis of that content, and the externalization of the student knowledge on a given subject. The student knowledge externalization is a process of changing his tacit knowledge into explicit knowledge. Because tacit knowledge is very difficult to be formalized, its transmission and sharing is also problematic. For example, conclusions, insights, and hints. On the other hand, the explicit knowledge refers to that knowledge easily transmissible in some formal or systematic language (NONAKA & TAKEUCHI, 1997).

The knowledge externalization may be done by different means as, for instance, the making of a synthesis where the student expresses his knowledge, reflections, and conclusions about the subject in question. There are many languages to represent knowledge but usually knowledge is represented in the form of a text. Concept map is another possible form to represent knowledge. We consider that in certain situations like, for instance, during the making of a synthesis, the use of concept maps has some advantages if compared with the classic text. The making of a text usually demands high cognitive overheads because it requires, besides the knowledge itself, sequential organization, adoption of a style, grammatical rules observance, care about form (font type, color, and size) etc. Moreover, its fragmented nature makes tacit knowledge very resistant to sequential organization.

This article presents our research path on the use of concept maps as a tool to support the knowledge verbalization. We are particularly interested in its pedagogic use.

What is a Concept Map?

Concept maps, as developed by Joseph Novak, are a tool to organize and to represent knowledge (NOVAK, 1977). They are used as a language to describe and to communicate concepts and their relationships. They were originally developed to give support to the *Meaningful Learning Theory* (AUSUBEL, 1968). Concept maps can, for example, be used to explain and to describe ideas people have about a given subject. They are graphic representations of concepts, similar to diagrams, in a specific domain of knowledge and constructed in a way that makes concepts and their relations very evident. In other words, they represent concepts and their links in a graph manner so that the points are concepts and the edges are relationships. These relationships are nominative, i.e., each relationship between two concepts forms a proposition. For example, in the sentence *whales are mammals*, "whales" and "mammals" are concepts that are connected by the relation "are". The simplest concept map would be constituted of two points connected by a link representing a proposition, i.e., "Bees visit Flowers". The Figure 2.1 shows the simplest form of a concept map, just as it defines what nodes are, what links are and the relationships between two concepts.

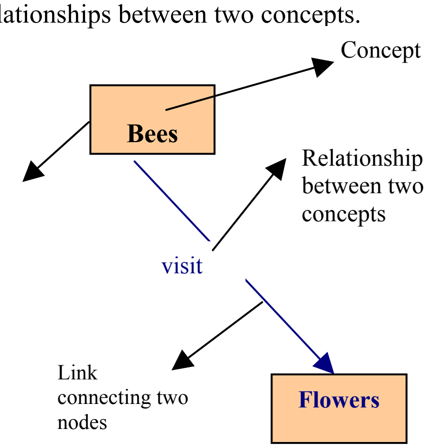

FIGURE 2.1
THE SIMPLEST FORM OF CONCEPT MAP

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Note that in this case the preposition is a simple sentence. But it is not always like that. Sentences and prepositions are different things. It may happen a case of a sentence embodying many propositions. For example: “whales live, like fishes, in the water, but they are mammals. From this unique sentence we can take the following propositions: 1. Whales are mammals. 2. Whales live in the water. 3. Fishes live in the water. 4. Animals 4) Animals can be mammals. 5. Animals can be fishes. Although the examples above show us very simple kinds of maps, they can be very large and may have a structure very personal to who is building it. Figure 2.2 presents one of a series of maps of the NASA’s MARS 2000 project, developed by the Institute for Human and Machine Cognition – IHMC (http://www.coginst.uwf.edu).

Editing Maps

Like in a hypermedia document, to each node (concept) we can associate different medias related to the concept, as long as we use suitable tools to map making. Two of these sort of tools are *CMap Tool* (http://www.coginst.uwf.edu), a map editor developed at the Institute for Human and Machine Cognition that allows to associate a node of a given map to other maps, to text, audio and video files, images and web pages. The *Software Inspiration* (http://www.inspiration.com) is another map editor with facilities to draw concepts, mapping thoughts, make diagrams, program studies and other activities, all that using a multimedia visual language that fosters creativity, lateral thinking, and user’s productivity. It was designed for the work with children. Figure 2.3 shows a map built with the CMap Tool.

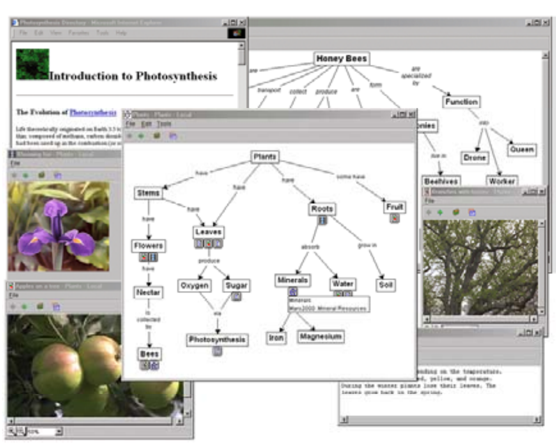

FIGURE 2.2
CONCEPT MAP BUILT USING THE CMAP TOOL SOFTWARE

Another important feature that must be observed when building concept maps is the inclusion of *cross-links*. They are relations between concepts of different sub-domains of knowledge of the map. Cross-links help us to see how some sub-domains represented in the map relate to one another. The following Figure shows an example.

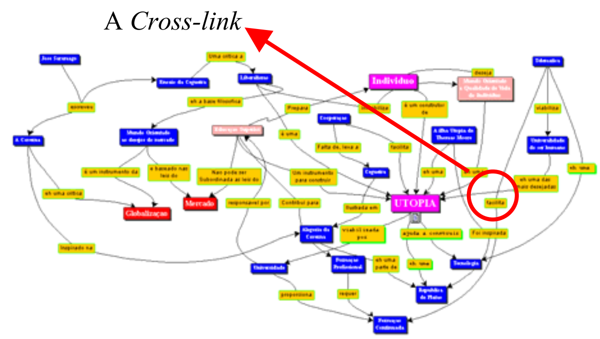

FIGURE 3.7
CONCEPT MAP WITH CROSS-LINKS

Expressing Ideas

When we are in a learning process, in several situations and in different moments, we need express our ideas (knowledge externalization). This task could be done in an oral way but usually it is necessary and important to record it. Recording can be done by different means such a text, a graph, an image, or a concept map. The expression of ideas may be to make a synthesis of a text, paper or article, to record any process such as a learning or research project, to produce texts that express our understanding of a given subject, or even to produce a speech. Regardless of the means to be used all demand a specific cognitive effort. But what is most remarkable is the fact that in all these situations there are important points, which we must highlight. In other words, we want to express the important concepts that were identified and the relations among them.

In such context we visualize the use of the maps to represent knowledge. As knowledge organizers, maps are represented by the concepts and their relationships identified in a subject. We understand that the construction of a map demands less cognitive effort than the construction a linear text does. This happens because when we construct a map we first identify the concepts we consider more important, no matter the order they were studied or they appear in the text. And this is a more natural process than to think of a text that demands a formalism and forces the ideas to be expressed in a sequential manner. After this reflection about the concepts it is enough to materialize the connections we see on these concepts. After that, we must observe the map constantly observing and make the required changes to reflect the constant changes that occur in our cognitive structure as we learn.

The Use of Concept Maps in Education

This section will present some applications of the concept maps in education as follows: the use of concept maps as content indexers, as a tool to support bibliographic review, and as a metacognitive tool in learning projects.

Using Concept Maps as Indexers of Content

By using software for edition of maps, it is possible to associate several resources to the nodes of a map. One of these resources is to associate a collection of documents (text, pages web etc.) to the maps, where each node, which represents a concept, can be associated to one or more documents of this collection. However, this association is free and it is under the responsibility of the user of these tools. Our proposal aims at improving this resource by associating the nodes of a map to a content indexation system, where we can associate a node to a search engine instead of associating it only to specific documents. This searching will be based on concepts and will find all documents of an available collection that are associated to the concept represented by the node. In this way, the concept map can be used as a great indexer of content. In this context, we used the CMap Tool to develop a small application to illustrate the content indexation regarding to just any theme. The chosen theme was "Computer in Education". This site makes several concept maps available. They were done based on the "Salto para o Futuro" Collection, that is a Virtual Library which possesses papers on Computer in Education. This Virtual Library is part of the PROINFO Project (http://www.proinfo.mec.gov.br). Each map of this collection presents the most important concepts approached in the papers and their respective relationships. Besides, each map possesses a link to the paper (in the HTML form) on which it was based and to other resources such as texts, papers, web pages and homepages. This site possesses an initial map on "Computer in Education", presenting the most important concepts of this theme (Figure 4). Starting from this initial map the user can browse other maps that were developed to this application.

Using Concept Maps as a supporting Tool for Bibliographical Review

The bibliographical review supposes some steps, such as: the reading, the analysis and the adequate registration of the most important annotations related to the revised documents. The concept maps, as knowledge organizers, can be used to represent knowledge of people on a certain subject. Based on this possibility and on the existence of tools for construction of maps we can use concept maps as a supporting tool to both teachers and students, this is, they can to represent the important concepts on a certain article, paper or text. In this way, the students can record their most important annotations in the form of maps. On the other hand, the teachers will have in hands another resource to verify the learning of students on the approached subjects. Besides that they can compare the several maps, built by the students, in order to identify the formation of the concepts, misconceptions, their your ideas and identified relationships among the concepts, following up the evolution of the students' knowledge. Using maps like that is still a good instrument to facilitate the discussion centered in the reading of texts. After reading a text, where the student progressively builds a map of his/her knowledge, the students can meet with one another to discuss about the subject, starting from the comparison of the maps and identifying concepts and connections that were noticed or not. They can still discuss about the noticed connections in a different way and, even, in conflicting situations. A brief reflection allows us to notice the advantages of this proposal on discussions based on isolated annotations.

Using concept maps as a support tool for the development of Learning Projects

The main idea of the use of maps in the evaluation of learning processes is to evaluate the student in relation to what he/she already knows, starting from the concept constructions that he/she can create, that is, the way that he/she structures, hierarchy, differentiates, relates, discriminates and integrates the concepts of a miniworld in observation, for instance. Once the maps are explicit representations of the cognitive structure, we can have a very approximate picture of the student's previous knowledge, which is a starting point for the meaningful learning. In the same way, by observing several pictures of different moments of the process (his/her several maps), we can accompany the cognitive growth of the student, so improving the feedback offered to him/her.

A Learning Project can be seen as a process that goes through some steps [SOUZA & MENEZES, 2000], such as: the choice of a theme, the identification of subjects that will be explored inside this theme, an inventory of knowledge of the student built in the beginning of the project (doubts and statements), the choice of the methodology and of work plan (consisting of work items) which will be followed in order to accomplish the proposed goals. Besides, at the end of each work item it is fundamental to do evaluations of the evolution of the student's knowledge. Along the process, the student looks for to clear his/her doubts and to validate his/her statements. During the exploration of the proposed project, it is very important properly to record the way the learning process occurred throughout the construction of the project, instead of just to publish the reached final results. It is suggested the use of concept maps to express the inventory of the knowledge of a workgroup member or of whole workgroup at different moments of the project. We suggest the construction of a map to express knowledge in such stages: in the beginning of a project, at the end of each work item (that demands the construction of a synthesis on its accomplishment) and at the end of all the work items, i.e., at the end of the project. In this way, through the analysis of these maps, we can clearly know all transformations happened in individual and workgroup knowledge, such as cleared doubts, validated statements, statements that became doubts, doubts that become statements, appearance of new doubts and statements etc. The use of appropriate conventions can facilitate the identification of the student's historic, synthesizing the evolution of his/her mental models through the collection of his/her maps. We propose a way to the student express his/her knowledge on the project theme, at different moments of the learning process, though concept maps. This knowledge consists of his/her statements and doubts and of his/her conclusions.

In concept maps, the relationships between two concepts express propositions. In the same way, the speech on any context can be completely expressed through propositions. In general, relationships have been used in Concept Maps to just register affirmative propositions. However, we can also use them to represent doubts. We identified some situations. They are: 1) We know that two concepts are related somehow, but we cannot identify which relationship that is. 2) One of the concepts of a relationship is not known. 3) We know the concepts but we are not sure of the relationship among them. 4) We identified the relationship between two concepts, but we do not have the scientific proof.

We visualized two possibilities to register the process of development of a project:

1) We can start with a map of doubts and statements, built in the beginning of the process. A map can also represent the synthesis of each investigation item. This second map should be accessible thought a link starting from the original questioning. The evaluation of the evolution of the knowledge can be accomplished through the browsing this group of maps.

2) Another alternative is the construction of several different maps, built in the beginning of the project, at the end of each investigation item and at the end of the project. In this case, each map is the evolution of the previous one, where the gaps are filled out. The evaluation of these maps will reflect the evolution of the student's knowledge, where one can observe the explanation of doubts, the validation of statements and the appearance of new doubts and statements.

Other Applications of Concept Maps

The nature of concept maps clearly turns them into a tool for multiple activities. After all, it has been long since human beings first sought for the use of non-linear languages to express their ideas with more flexibility and expressiveness. It is not by chance, therefore, that we can use these concept maps in all and any activity where we needed to organize our ideas. As examples, we can mention the preparation of a lecture, speech, article or paper. The technique suggested herein is to begin gathering the principal elements that we want to identify and gradually to construct important connections for the approached context, thus generating a map. In this way, it is easier to produce a text. In relation to a speech, we can construct a map to be a base for this speech. For instance, the map illustrated in the Figure 2.4 was prepared for a graduation speech to computer engineering students.

Another important activity, in the technological point of view, is the specification of product requirements, which is an intensive one in knowledge construction. Starting from interviews and from gathering data the specialist should produce a rigorous specification of the product. In general, the natural language brings countless problems. So, concept maps can be used with plenty advantage by several professionals such as architects, lawyers, software engineers, knowledge engineer, among others.

Final Considerations

This paper has presented the concept maps as a metacognitive tool that can be very useful in the education, especially for indexation of content, as support to bibliographical review and as support to the development of learning projects. We have been trying out all these activities in our graduate and post graduation courses.

As future perspectives, we have been developing a tool that will be part of the framework presented for knowledge organization and integration, that it will use concept maps as indexers of content for a collection of documents used by a learning community interacting inside a Virtual Learning Environment. Besides that, in July, 2002 we concluded a site that make concept maps available. These maps were built for the "Salto para o futuro" Collection, that is a Virtual Library of the Proinfo Project (http://www.proinfo.mec.gov.br). It is a collection of articles on Computer in Education.

This year we also have tried out the use of concept maps as a pedagogical tool in distance specialization courses, based on the pedagogy of learning projects. The maps are used for the construction of knowledge inventories, which consist of the doubts and statements of a student on his/her themes of project.

We have also intended to use them intensively as a tool for organization of ideas that precede the text production in elementary and high school.

Final Considerations

The purpose of this work is to present a Framework as a logical model for the organization and integration of the knowledge in virtual learning environments. The goal is to propose an ontology of knowledge in such environments. It is also our goal to propose solutions to the problems presented in the section 2, using metacognitive tools such as concept maps. To illustrate this Framework, a prototype will be developed approaching two aspects. The first one will be a tool for instanciation of courses in virtual learning environments, based on the ontology that will be developed. The second one will be a virtual environment that integrates the knowledge content of a virtual learning community.

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Um Framework Reutilizável para o Desenvolvimento de Objetos de Aprendizagem – o Projeto WEL (Web Engineering for Learning)

Carlos Fernando de Araujo Jr.[1], Ismar Frango Silveira[2]

Resumo *— O principal objetivo deste trabalho é apresentar um framework para a elaboração e gerenciamento de meterial didático digital que pode ser utilizado em educação a distância e em educação baseada em recursos tecnológicos. Este artigo é baseado no trabalho de pesquisa desenvolvido na Universidade Cruzeiro do Sul em trabalho em conjunto com o Núcleo de Pesquisa em Computação e Tecnologia da Informação e Núcleo de Educação a Distância, denominado Projeto WEL (Web Engineering for Learning). Os objetivos de pesquisa de pesquisa desse projeto pe desenvolver material didático digital e ferramentas genéricas, como simulações e sistema de avaliação direcionadas para o ambiente Web. Os fundamentos deste projeto de pesquisa e de seus resultados advém da Engenharia Web e do conceito de objetos de aprendizagem. Neste trabalho apresentamos um framework reusável que poderá ser utilizado em projetos de e-learning em larga escala para integração de outros recursos e objetos de aprendizagem.*

Palavras Chaves — Informática na Educação, Educação a Distância, Ensino de Computação, Objetos de Aprendizagem.

I. INTRODUÇÃO

O uso e aplicação das tecnologias de informação e comunicação (TIC) na educação tem se intesificado nos últimos anos, principalmente após o advento da Web. Novas formas e aplicações das tecnologias de informação e comunicação estão trazendo para os setores educacionais, nos seus diferentes níveis, uma crescente demanda seja no âmbito do e-learning ou do uso das TICs como uma ferramenta auxiliar à educação "tradicional" [1]-[4].

Na área de Computação e Informática tem-se realizado diversos estudos e pesquisas sobre uso e aplicação das TICs que têm contribuído para o melhor entendimento destas tecnologias e sobre sua efetividade no processo de aprendizagem e o desenvolvimento de novas tecnologias [5]. Dentro deste contexto surge o Projeto *WEL* (*Web Engineering for Learning*), que está sendo conduzido pelo grupo de pesquisa em Tecnologia da Informação da Universidade Cruzeiro do Sul em um trabalho conjunto com o NCTI (Núcleo de Pesquisa em Computação e Tecnologia da Informação) e NEAD (Núcleo de Educação a Distância)[6]. Um dos principais objetivos do Projeto *WEL* é o desenvolvimento um framework para produzir e gerenciar conteúdos digitais para serem utilizados em cursos on-line (e-learning) e material didático digital para disciplinas específicas da área de Computação e Informática. Dentro do escopo das pesquisas deste projeto está também a investigação sobre metodologias e ferramentas que possam ser utilizadas em ambientes virtuais de aprendizagem: avaliação on-line e simulações, por exemplo.

Neste trabalho apresentamos o resultado do desenvolvimento de um framework reutilizável para desenvolvimento de objetos de aprendizagem. O trabalho está dividido como segue: na seção II apresentamos nosso referecial teórico para o desenvolvimento de objetos de aprendizagem. Na seção III apresentamos o framework. Na seção IV apresentamos nossas conclusões e trabalhos futuros.

II. OBJETOS DE APRENDIZAGEM E ENGENHARIA WEB

As recentes pesquisas na áera de Engenharia Web e Objetos de Aprendizagem, têm contribuído na busca de padrões para o desenvolvimento de material instrucional e conteúdos digitais que sejam adaptáveis (reusáveis), genéricos e escaláveis além de ambientes de aprendizagem virtuais que suportem tais objetos de aprendizagem com suas propriedades e características. Dentro deste contexto, tem-se buscado padrões gerais e internacioanais para o desenvolvimento de objetos de aprendizagem e ambientes de aprendizagem para garantir interoperacionalidade.

Contudo, o que seriam e como poderíamos definir o que são objetos de aprendizagem? Em nossa definição consideramos objetos de aprendizagem como qualquer entidade digital que pode ser usada, reusada ou referenciada durante um processo de aprendizagem suportado pela tecnologia [7].

O conceito de objetos de aprendizagem é um conceito fundamental para o desenvolvimento de conteudos e material didático digital para ser usado em experiências e

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projetos de larga escala (envolvendo grande número de estudantes e disciplinas na educação formal convencional). A garantia da reusabiliade permite que um conteúdo ou parte dele seja usado em diferentes contextos o mesmo ocorrendo com sistemas de avaliação, simulações ou sistemas para desenvolvimento de simulações. Um repositório de objetos de aprendizagem que possua um esquema de metadados sobre esses objetos, bem definido, poderá ser utilizado para personalizar e individualizar o processo de aprendizagem através do uso de agentes baseados em computador. Um resultado desejável em larga escala é a economia e competitividade que poderá ser obtida através do uso deste conceito chave. Na Tabela I apresentamos os principais tipos de objetos de aprendizagem conforme Wiley[7].

TABELA I
TAXONOMIA PARA OBJETOS DE APRENDIZAGEM [7].

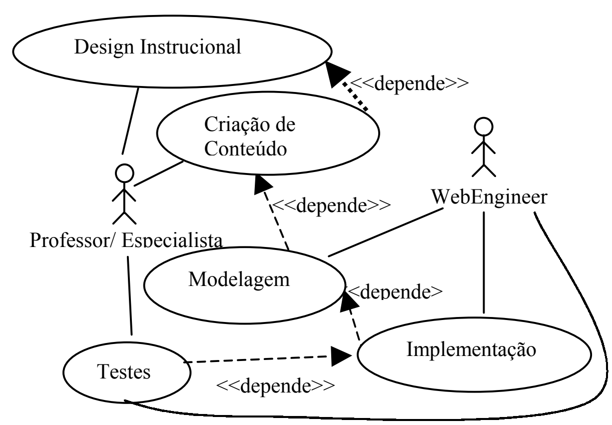
Tipo	Denominação	Descrição
1	Fundamental	Um recurso digital não combinado com qualquer outro.
2	Combinado-fechado	Um conjunto pequeno de recursos digitais combinados mas não acessíveis individualmente para reuso.
3	Combinado-aberto	Um conjunto grande de recursos digitais combinados em tempo de execução quando requisitado. Os objetos constituintes são acessíveis para reuso.
4	Gerador de apresentações	Possui lógica e estrutura para combinar e gerar objetos de aprendizagem de baixo nível (dos tipos 1, 2).
5	Gerador Instrucional	Possui lógica e mecanismos para combinar objetos de aprendizagem (dos tipos 1, 2 e 4), avaliar as interações dos estudantes com os objetos e instanciar estratégias e aprendizagem individuais e personalizadas

A característica principal do ambiente *Web* é sua tecnologia hipermídia, que, em linhas gerais, se caracteriza pela utilização de conteúdos multimídia, organizados sob uma estrutura de hiperdocumentos, estrutura esta difundida a partir dos primeiros sistemas de hipertexto. Baseado neste fato, a modelagem e desenvolvimento de conteúdo deve se utilizar dos recursos tecnológicos diversos quando da elaboração de conteúdo multimídia, uma vez que o uso não adequado torna o conteúdo modelado pobre em qualidade, mesmo que esse tenha sido adequadamente produzido por um especialista. Em se considerando a utilização do ambiente *Web* para fins educacionais é indispensável a utilização de estratégias e abordagens metodológicas (didático-pedagógicas) adequadas para cada conteúdo. Deste modo, o desenvolvimento de conteúdos digitais para educação em ambiente *Web* é uma tarefa complexa que envolve várias dimensões (conteúdo, metodologia , estratégias específicas e tecnologia). Neste *framework* que apresentamos um dos nossos objetivos é contribuir para o melhor entendimento desta complexidade.

Os princípios da Engenharia Web devem ser seguidos na modelagem e desenvolvimento de conteúdos para Web para um adequado acoplamento entre o conteúdo e a tecnologia. A modelagem de conteúdos então se define como sendo a forma de adequar o conteúdo produzido por um especialista ao modelo estabelecido utilizando-se critérios de design. Deste modo, os princípios de elaborados por Olsina [8], por exemplo, no contexto da qualidade de sites, podem servir de guia para essa tarefa: usabilidade, comunicabilidade, funcionalidade, eficiência e manutenibilidade [9]-[12]. O mapeamento do conteúdo desenvolvido para um ambiente virtual de aprendizagem pressupõe características de hardware e software, para cada item do material didático a ser utilizado (unidades, textos, figuras, exemplos, sons, imagens, simulação e avaliação, por exemplo). Esse mapeamento não é unívoco, pode ser realizado de diversas formas. O uso de ambientes comerciais impõem algumas restrições neste mapeamento que devem ser consideradas na etapa de modelagem.

III. O FRAMEWORK PARA DESENVOLVIMENTO DE OBJETOS DE APRENDIZAGEM

O framework, esquematizado nas Figuras 1 e 2 , possibilita um ponto de partida para grandes projetos que considere o uso das tecnologias de informação e comunicação na Educação ou em educação a distância (e-learning) para diversas áreas do conhecimento. O modelo desenvolvido com as premissas da Engenharia *Web* possibilita a



disponibilização de conteúdos em uma forma estruturada, adequada para as utilizações em Educação [13], [14].

FIGURA. 1
DIAGRAMA DE CASOS DE USO REPRESENTANDO UM PADRÃO DE PROJETO PARA DESENVOLVIMENTO DE CONTEÚDO.

A figura 1 mostra um diagrama UML de casos de usos[15] que que apresenta as principais regras realizadas por dois atores – o professor/especialista, responsável, principalmente, pela fase de design instrucional, quando o conteúdo a ser modelado é relacionado com os objetivos de aprendizagem desejados em um processo de aprendizagem

O outro ator, rotulado como *WebEngineer*, realiza boa parte dos papéis comumente atribuídos ao Engenheiro do Conhecimento em Sistemas Especialistas clássicos: implementação, modelagem e testes, sendo os testes executados com o participação do professor/especialista.

A Figura 2 mostra um Diagrama de Componentes UML [15] para duas fases da Figura 1: a Criação de Conteúdo (responsabilidade do Professor/Especialista) e a Modelagem deste conteúdo (responsabilidade do Web Engineer).

Na Figura 2, observa-se, ainda, o componente principal, nomeado "Conteúdo on-line", sendo especializado em dois outros componentes: "Conteúdo Estático" e "Conteúdo Dinâmico / Interativo" e sub-componentes destes.

processo de aplicação e pesquisas em projetos-piloto que estão em andamento atualmente. Sem dúvida um sistema dinâmico de educação a distância que busque métricas de qualidade e desempenho necessita de mecanismos (instrumentos e procedimentos) para análise da qualidade. Nosso objetivo, nesta primeira instância deste *framework*, estava restrita a modelagem para disponibilização de conteúdo Web.

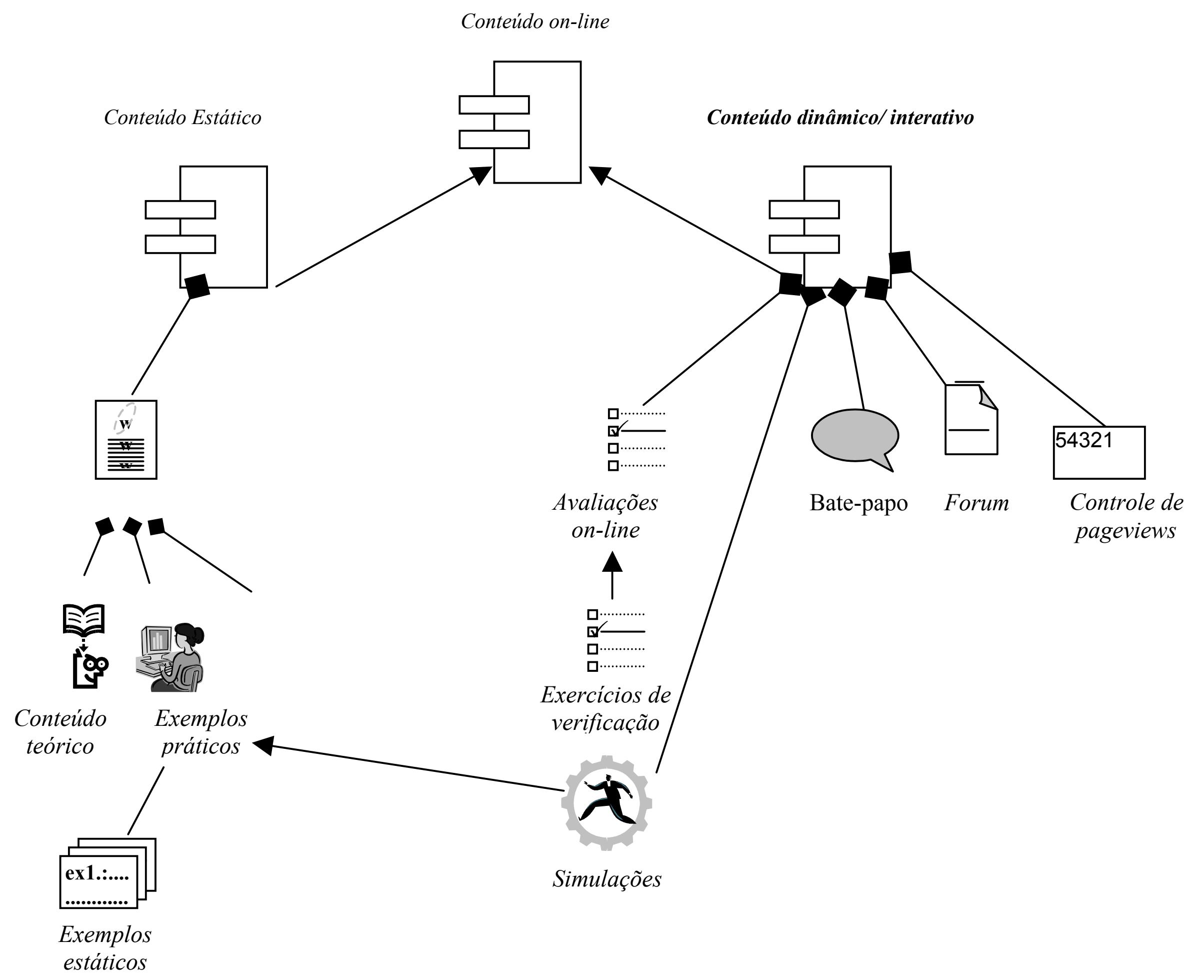


FIGURA. 2
DIAGRAMA DE COMPONENTES UML DO FRAMEWORK DE DESENVOLVIMENTO DE OBJETOS DE APRENDIZAGEM.

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IV. CONCLUSÕES

O framework proposto já foi neste trabalho já está em utilização em um projeto-piloto desenvolvido pelo NEAD-UNICSUL na oferta de algumas disciplinas dos cursos de Computação e Informática dessa Universidade, por meio do ambiente WebCT. Os resultados obtidos com a sua utilização é um menor tempo de desenvolvimento para conteúdos digitais e material didático de suporte as atividades virtuais e a possibilidade de ampliarmos o número de estudantes atingidos pela iniciativa. Em 2003 esperamos envolver 5000 estudantes em cerca 200 disciplinas das diversas áreas do conhecimento. As disciplinas serão ofertadas na modalidade simipresencial onde 50% das atividades serão realizadas presencialmente e 50% das atividades realizadas utilizando-se do ambiente virtual de aprendizagem.

Nossas pesquisas atuais encontram-se na fase de integração do objeto de aprendizagem de conteúdo desenvolvido através deste framework com outros objetos de aprendizagem a fim de obter processos e mecanismos de personalizar e individualizar o aprendizado via web.

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FACIO: An integrated proposal to virtual learning environment interactions

José Marques Pessoa[1], Hylson Vescovi Netto[2] and Crediné Silva de Menezes[3]

Abstract — *This work presents a proposal of an interface to virtual learning environments, no matter the general communication tools. It also presents a prototype called FACIO, which gather the most outstanding functionality from the general tools, present on the main CSCL environments. FACIO provides an integrated vision of the synchronous interactions, aiming to stimulate the participation and facilitate the coordination of activities in the virtual learning environments, without taking the possibilities of the asynchronous discussion away.*

Index Terms — *integration of Interface, Coordination, Interaction, Learning Virtual Environment.*

INTRODUCTION

The learning tasks are usually a collective labor. With the introduction of the computer network in the teaching and learning process, the students' and teachers' localization ceased to be a limitation and gained completely innovative aspects. Now it is already possible to talk about distance learning without renouncing cooperation, collaboration and collective strength to construct knowledge. However, to make these dreams come true, we have to turn them available, in a synchronous as well as asynchronous way.

The experiences indicate that the students learn better and more enthusiastically when they interact to one another and it is critical for the computer systems which support collaborative learning to have environments that make these interactions easy [8], [11].

Virtual learning support environments have been basically using general purpose communication tools, such as: email, discussion forum, chat, bulletin board and instant messages. While the use of these tools have been reported by its positive aspects [16], [10], an inadequate use might be observed: the lack of integration. It means that to interact with any of these tools, the learner must switch over many different applications, one at a time, with their own usage peculiarities. Such procedure makes it difficult for the people to participate, besides making the interaction flow also more difficult, and as a consequence dispersion occurs and the production of the collective knowledge gets shackled.

This work presents the proposal of an interactive interface independent of the general communication tools. The proposal comes true with FACIO, a communication tool which seeks to reunite some performances from the most popular applications, such as: email, discussion forum, chat, bulletin board, and instant message in one single application. The prototype was constructed to experience and validate the ideas discussed herein.

Therefore, the text is organized like this: Section 2 discusses the role of the communication on the learning process; Section 3 presents the most used communication tools in the virtual learning environments; Section 4 presents an integrated proposal of communication, based on the main conceptual elements; Section 5 presents FACIO, a prototype constructed to materialize, experiment and validate the ideas; Section 6 shows the internal architecture of the system and Section 7 makes the conclusions and indicates the perspectives of the future researches.

COMMUNICATION, COOPERAATION AND APPRENTICESHIP

According to Piaget, cooperation is an essential element to learning. The constructivism, proposed by him, highlights the learner interaction with objects of knowledge and with other individuals as the key element to construct knowledge. Still according to Piaget, cooperation is indispensable to reach intellectual abilities of higher level. Thus, cooperate is not goodwill, but before it is an essential attitude to take better advantage of our potentials.

In his many works, Pierre Lévy, a sociologist of the CIT (Communication and Information Technology), points out the fundamental role of the internet in order to produce a learning revolution. Lévy emphasizes that human intelligence depends greatly on the technology we use to register the knowledge and from this, make new inferences. To illustrate his point of view, Lévy, remind us of the advances that humanity has obtained on the intellectual field by the time the *printing-press* was invented. Still according to him, we are ready to a new revolution, able to overcome the previous ones.

The importance of the communication in the learning task has been reported in many works from the CSCL area (*Computer Suported Collaborative Learning*). Just to illustrate, the following opinions are shown below:

In [4] it is possible to read: "Computers provide the opportunity to learn to communicate, as well as they make it possible for communication to improve the learning experience."

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To [11], the apprenticeship is stimulated by communication and the computers may help in three ways: making human-to-human communication easier, stimulating the production of ideas and helping to organize them.

[5] adds that "the verbalization growth compels the cognitive restructuring", essential to the individual and collective construction of the knowledge.

[3] indicates that "the encouragement of the discussions between pairs in real as well as in virtual situations reinforce the apprenticeship" quoting accounts from many researches.

Therefore, learning is not just an active task, in the sense of doing it alone, but before it is an interactive, in the sense of doing it together [7]. Yet, [15] points out that the social interaction in virtual environment cannot be taken for granted. After all, it is not guaranteed even in the real world! It is up to the learning support computational environments a much more important role. One which goes beyond the grasp of mere facilitators of social interaction. And, for sure, it is necessary to stimulate those interactions.

Next the most used communication tools in the learning support telematic environment are briefly discussed.

USUAL COMMUNICATION TOOLS

Collaboration and communication are the main objectives of the virtual learning environments [11]. To make them feasible a variety of tools, synchronous and asynchronous, of general purpose, are being used for such environment. With this it becomes possible to have the communication, the experience exchange, and the interaction among students and knowledge mediators. Such tools might be divided, according to its return time, into synchronous (when the communication return is immediate, also called "alive communication" or online) and asynchronous (when the communication return can delay for an indefinite time.

Asynchronous Communication Tools

The most used asynchronous communication tools in virtual learning environments are: electronic mail (email), thematic discussion forum, bulletin board (mural) and FAQ.

- **Electronic Mail (e-mail)**

It is a messages and documents transmission service between individuals. An extension of this concept is the discussion group (mailing list/e-group) in which a group of individuals subscribe in order to receive and send messages to the same group.

- **Discussion Forum**

In an discussion forum, the messages about a certain topic/issue keeps organized under hierarchical order, showing the chained-answer tree, making it easier to browse.

- **FAQ (Frequently Asked Questions)**

Frequently asked questions. *Site* with a list of questions and its respective answers, related to the most common doubts about a certain subject.

Synchronous Communication Tools

The most used asynchronous communication tools in virtual learning environments are: *Chat* and *Instant Messages*.

- **Chat (Internet Relay Chat)**

It is a virtual meeting room where people get together in order to talk in real time (*online*). It allows a message to be sent to a person or to all the people in the chat room.

- **Instant Messages**

The instant message services, *ICQ* for instance, make it possible that online meetings occur occasionally, while the users just have to be online at the time of the conversation. The service will take care of notifying each of the participants about each others' presence, allowing sudden meetings on real time.

Conclusions of the Section

The use of this variety of applications for communication reveals that none of them satisfies the needs of virtual learning environments alone, thus justifying the use of them all by the important differentiation that each one has and which sums up to the whole process of social interaction aiming the collective construction of the knowledge. It is important to point out that the set of those applications does not configure one single educational environment. They came up at different times, according to the available technology and imitating existing metaphors. Moreover, if they get summed up to a use, in cyberspaces, they tend to bring about knowledge dispersion and cognitive overload.

The cognitive overload goes through the choosing of the tools to be used, the theme to be discussed and the best pair of students to interact to one another.

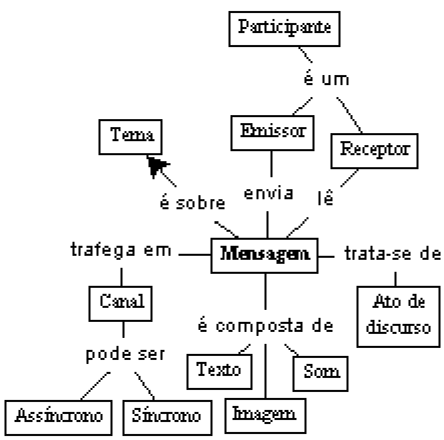
The knowledge dispersion might be characterized as built-in an specific tool, for example, the message exchange among the various pairs (be it in a chat, or in an instant message) often suffers the lost of context [14], because of the lack of connection in-between the subjects and the visibility, due to privacy with which the conversations are held between pairs. But dispersion can also be explicit when the same subject/theme is treated/discussed simultaneously in different spaces and tools.

AN INTEGRATION PROPOSAL FOR COMMUNICATION IN VIRTUAL ENVIRONMENTS

In the virtual learning environments communication is the social interaction way which contributes to knowledge construction. Here knowledge construction is understood as a continuous process which stands on the existence of an environment to encourage people to communicate and take part of it. A communication can be synchronous or asynchronous, taking effect through a means of communication, among a group of people (participants) who are transmitters and/or receivers. It is a public broadcast, when the transmitter addresses to all the receivers. Or a restrict one, when the transmitter restrict to a set of receivers. A communication is based on the context (theme/subject). The subject of a communication might be a text, a sound, a image, or even a combination of those formats. A text message might incorporate an speech act [1], [17].

We propose to gather the outstanding functionalities from some conventional tools, like the theme based discussion, presence notification and exchange of synchronous and asynchronous in a single application. The proposal goes far beyond when it allows an innovative view of the synchronous interactions what, according to accounts from [6] and [2], "multiplies participation and make the coordination of the activities on the virtual learning environment easier", without taking the chances of asynchronous discussions away.

Picture 1 presents a map of the main conceptual elements identified on the communication process.



PICTURE 1
CONCEPTUAL MAP

On the map, we used the following conceptions: theme, channel, participant and messages, with the following meaning:

Theme: Relates to the subject which is being discussed. A theme might be created by any participant. The theme is discussed by a group of participants, synchronously as well as asynchronously. A theme can be inspected so that it is possible to know what happened there at the last hour, day or week. It is also possible to relate a theme to a set of images or sounds or even to a bulletin board (mural).

Participant: Individual who takes part of the discussions of one (or more) themes. The participant is associated to his profile and also to a picture of his. The center of attention might be focused on a participant, in order to get his last hour, day or week interactions better known.

Channel: means of communication to transmit the message between the sender and the receiver. A channel can be synchronized so that it is possible to know its content at that very moment, or it can be inspected in order to know what might have happened there during the last period of time (i.e. on the last hour, last week, etc.).

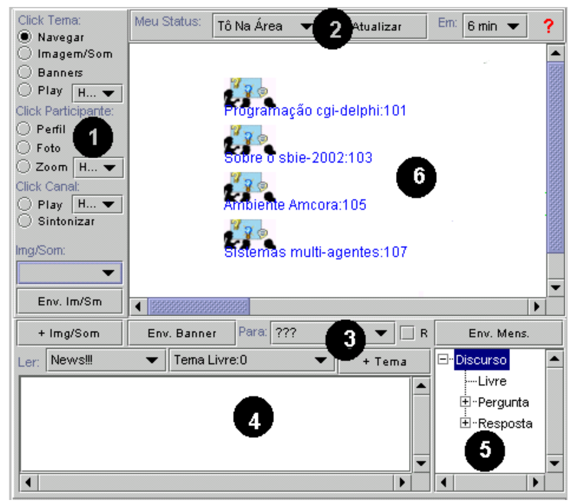
Message: The content of a communication unit. It can be a text, a sound, an image, or even the combination of these formats. A text message might incorporate an speech act (information, opinion, suggestion, etc.).

FACIO – The Prototype

FACIO is an application that runs on web browsers, developed with an *applet* technology (java language).

INTERFACE ELEMENTS WITH THE USER

Picture 2 presents FACIO's interface. The black numbered spots indicate the main interface elements.



PICTURE 2
FACIO

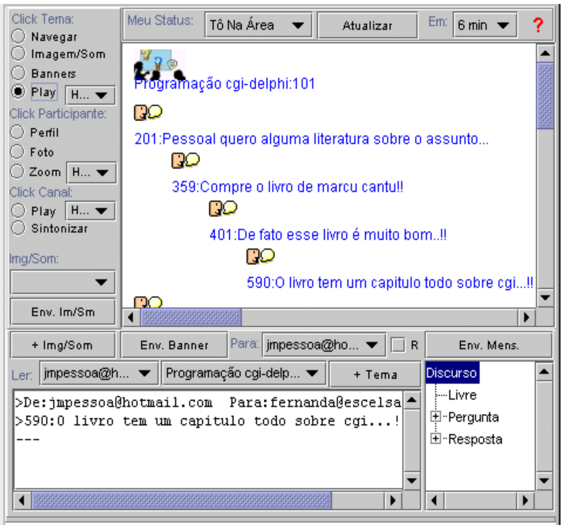
On panel 1 there is an option menu which sets the mouse-click function over the interaction view panel (Panel 6). On panel 2, the first list offers a user's status option (I'm free for chat, I'm away, I'm busy, etc.). Each status has a corresponding icon. The "Refresh" bottom updates the screen information and the following list manually configures the interval of refreshments of the view panel (panel 6). Panel 3 presents the reading and exchange messages controls (From, To, Theme, Send, Reserved). Panel 4 is the editing and reading space of the messages. Panel 5 configures the speech connotation elements (Free, Question, Answer, etc.), clues that may be used by intelligent routines in order to automatically extract the knowledge [17]. Panel 6 allows the access to the content about a theme previously discussed and also to the participants interaction diagram, with a click of the mouse.

Utilization Scenarios

FACIO's basic utilization scenarios follow the conceptual elements: Theme, Participant, and Channel.

Executing a theme (Theme/Play)

The discussion of a theme might be tracked since the last hour, day, or week. Picture3.



PICTURE 3

DISCUSSED CONTENT ON A THEME

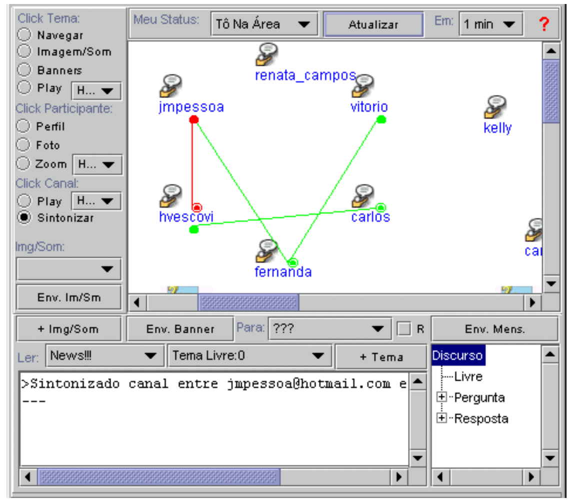
A theme being discussed by a Group (browse)

Configuring the mouse-click to Theme/Browse and by clicking on a certain theme it is possible to see the group of participants who are performing the discussion. Picture 6.

Each icon represents an individual participating on the discussion theme and the lines between the icons indicate the conversation channels. An user may configure his icon to denote his *status* on that very moment, like: "I'm free to chat.", "I'm out.", "I'm busy." Etc. So that the other participants can understand his disposition to participate on any synchronous discussion [9].

Tuning in to a Channel (Channel/Tuning)

A discussion channel between two participants can be tuned in, so that it becomes possible to attend or even participate to the conversation. A reserved message keeps its content secret, but the interaction is always public. Picture 4.



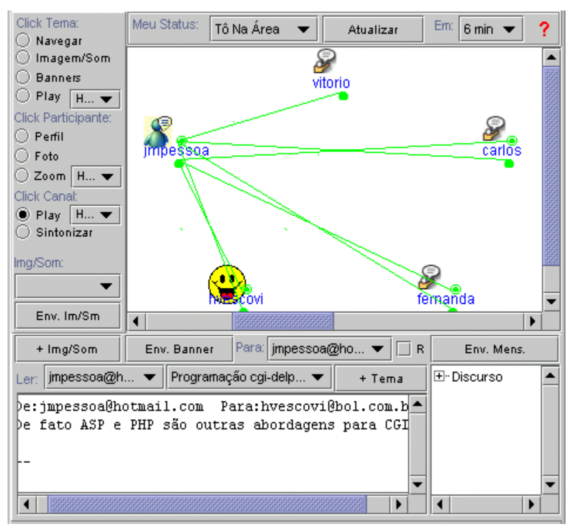
PICTURE 4

TUNING A COMMUNICATION CHANNEL

Still, a channel may be run (Channel/Play) in order to know the content of a conversation which happened there on a certain time intervale (last hour, day, or week.).

Broadening the interactions with a participant (Participant/Zoom)

The participant grasp can be broadened over many subjects and themes. Picture 5 presents a *Zoom* on the participants interaction.



PICTURE 5

THE INTERACTIONS DIAGRAMS OF A PARTICIPANT

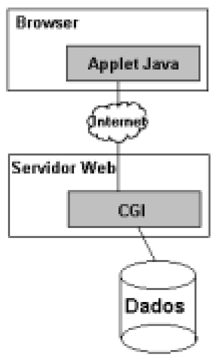
Under any circumstance in which a conversation is going on line (happening), the other participants may tune in to it, in order to attend and/or take part of the discussion.

Sending and receiving messages

FACIO automatically notifies the user about new income messages and to each opened message, it synchronizes the theme and the addresses to the answers. A message might be sent with "reserved" or "public" status and still it may incorporate a speech act.

FACIO'S INTERNAL ARCHITECTURE

FACIO is a www application based on the browser-host web paradigm. The client is a java *applet* who communicates, over the internet with a *CGI application,* data server. Picture 6 illustrates this architecture.



PICTURE 6
FACIO'S INTERNAL ARCHITECTURE

FUTURE PERSPECTIVES AND CONCLUSIONS

This work has presented an integrated communication proposal, made come true by communication tools which aims to put some functionalities of the most popular applications, such as: email, discussion forum, chat, bulletin board, instant message together in one single application. FACIO tries to put the outstanding devices from those tools together, but it goes beyond when it allows an innovating view of the synchronous interactions, aiming to stimulate the participation and making the task coordination on virtual learning environments easier, although without taking the possibilities of asynchronous discussion away.

At the moment our researches are focusing the FACIO's integration with the AmCorA environment [12]. That means we intend to make FACIO a single interface to the various communication spaces used nowadays. This includes the integration of conventional services such as: forum, chat, instant messages, bulletin board (mural) and FAQ, together with the intelligent addressing service *Qsabe* [13]. Thence we expect to correct some dispersion aspects of the knowledge and stimulate the interactions.

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FAmCorA: A Framework to Construct Intelligent Learning Environments on the Web

José Marques Pessoa[1], Hylson Vescovi Netto [2] and Crediné Silva de Menezes[3]

Abstract *— The development of new virtual learning environment demands such an amount of resources which makes it very difficult for innovative proposals to arise. As a consequence there is a huge gap between the theoretical conceptions and the actually implemented work.*
The present job presents a framework proposal to develop applications of the CSCL type. Be it by the reuse of the service providers(web services), implemented in the framework, or be it done by the sharing of applications among many systems.

Index Terms — Virtual Environment to Learn, Cscl, Cscw, Framework, amcora, Application Composition.

INTRODUCTION

Telematic environments to support collaborative learning, consist of one of the most prominent innovations due to modern information technology and communication. The computer networks, particularly the internet, have broaden the possibilities to construct cooperative environments, in which researchers, teachers and students relate to each other aiming to exchange and acquire knowledge.

According to Bonk & King, referred in [1] a network can: i)change the way learners and teachers interact; ii) enhance the opportunities to the collaborative learning; iii) facilitate discussions; iv) shift the process of study from an isolated one to a more sociable and dynamic activity.

Even so, in the nowadays state of the art, the development of learning environment of CSCL type on the web, has been proving to be a complex task, either for the theoretical point of view, or to the technical one. And of an extremely high cost to most the institutions/schools intentions, which are interested in the use and exploration of this new technology into the teaching and learning process.

According to [2] from the theoretical point of view "the collaborative learning variables have been extensively studied, however, it is safe to say that we are still on the first step towards the design and development of CSCL- *Computer-Supported Collaborative Learning*". Cook [3] has written: "We still don't have enough detailed knowledge about the relations between theory, empirical work and the implementation of leaning environment".

In practice, it is possible to observe, in [1,2,4,5], that typical telematic environment of web learning backing, support a standard set of functionality: hypertext, specific areas for file sharing (*upload/download*), messages distribution (*email*), synchronous conversation (*chat*), discussion forums, boards (advice boards), news notification service, presence notification to exchange instant messages (*IM*) and a Frequently Asked Questions Service (*FAQ*). No doubt, there are still many other functions belonging to each system.

Despite the clear intercession of the basic set from the tool/ application used in these systems, due to technological issues and to the scope of the problem domain, the construction of a new environment almost always requires the re-implementation of each of those tools. This work proposes a framework to the development of cscw/cscl applications, emphasizing the reuse of *ready to run applications*, and not of source code (beans, activex, etc). The purpose is to make cscl/cscw portals creation on the web an authoring activity within the grasp of educators and teachers in general, instead of being an exclusive expert-programmer job.

The text is organized like this: Section 2 presents a brief introduction to some technologies of reuse; Section 3 treats the motivation of this work; Section 4 talks about the aims of the cscls environments; Section 5 discusses the aspects which must be solved on a reuse-based architecture; Section 6 proposes an architecture based on the composition of applications, the FamCorA; Section 7 consider the implementation of the proposal and last, but not least, Section 8 presents the conclusions and perspectives.

WEB ENVIRONMENT DEVELOPMENT REUSE TECHNOLOGIES

The technologies to develop *groupware* applications on the *web,* emphasizing the reuse, have been indicating three directions: Components (modules pre-compiled), class library and service composition (web services).

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[3] Crediné Silva de Menezes, PPGEE/ UFES, Av. Fernando Ferrari, S/N, 29060-900, Goiabeiras, Vitória, ES, Brazil, credine@inf.ufes.br

Component Based Solutions

[6] presents a methodology to develop *groupware* environment based on pre-fabricated components. Such components are understood as self-contained elements, with well defined objectives and with the capacity to be used both isolated as well as in composition with other components. Likewise [7] presents the *COGAM* (C*omponent-based Groupware Architectural Model*) architecture constructed specifically to the Windows plataform and its COM objects (*Common Object Mode l*).

Programming Environment Based Solutions

Some *frameworks* are specific to a certain programming environment, for example, *GroupKit* [8] offers a developing framework to *groupware* environment, based on the *Tcl* programming language. Habanero [9] is a Java language based framework.

Service Based Solutions

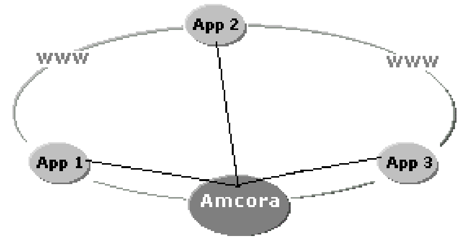
A service oriented architecture (SOA)[10] combines the ability to invoke remote objects and functions (called "services") with tools for dynamic service discovery, placing an emphasis on the interoperability. Examples of service-oriented architectures include HP's E-Speak, Sun's Jini and ONE and Microsoft .NET. Recently such technologies have been converged to a W3C standard called Web Services[11].

What those three approaches have in common is the fact that the proposed reuse occurs in relatively low level, in all of them, because class libraries, pre-fabricated components (*building blocks*), and services are the pieces of software which still require a meaningful implementation struggle to the "gluing" of the various parts which will result into a cscl/cscw application *ready do run*! And in this sense, far from the [12]'s request: "what we need to reuse is the actual stuff of which our products are made: executable software".

REVISITING THE WEB: HYPERLINK APPLICATION COMPOSITION

In this work we advocate a solution which observe the necessary reuse of the available services on the web, but that goes far beyond, when proposing the reuse of entire applications, including their interfaces.

Considering the hypertext paradigm on the web and taking App1, App2 and App3 as typical applications used in virtual learning environments, picture 1 presents a possible composition of those applications, giving birth to a learning support portal.



Picture 1. ***Amcora***'s composition.

At the most *hyperlink* web style, the ***Amcora*** application (a acronym for Cooperative Learning Environment) is a unification spot (Thus the name portal) for the access to the App 1, App 2 and App 3 services.

However, in real situations, the nowadays technologies and paradigms used in the development of general web applications, the complexity, and the domain needs of the support environment to the cooperative work (CSCW), specially of those aiming the teaching and learning process (CSCL), make the construction of new environments, with the simple reuse of hypertext model on the web, impossible.

COMPUTER SUPPORTED COLLABORATIVE LEARNING

To [13], the computer supported collaborative learning environments were greatly benefited by the internet. Such environments have proven to be very expressive, as much on the cognitive as on the social aspects.

According to [14] the CSCL environment type shall give support to:

a) Communication/interaction between participants;
b) Information Sharing and
c) Tasks / Interactions analysis;

Aiming to help the collective knowledge construction.

Nevertheless, as [15] enphasizes "there are few resources which provide insights (both technical and theoretical) to the development of such an environment".

E2HDL: UMA NOVA FERRAMENTA DE SÍNTESE PARA IMPLEMENTAR EQUAÇÕES ALGÉBRICAS EM FPGA

Adriano dos Santos Cardoso[1], Alexandre César Rodrigues da Silva[2] e Aparecido Augusto de Carvalho[3]

Resumo *— O desenvolvimento de ferramentas de síntese automática permite que projetistas gerem uma descrição de Hardware sem a necessidade do conhecimento profundo da tecnologia em que o sistema será implementado. Este artigo apresenta uma ferramenta de síntese para projetos de sistemas digitais denominada E2HDL (Equação para Linguagem de Descrição de Hardware). Com a especificação dos parâmetros da equação, a ferramenta desenvolvida gera um modelo em linguagem de descrição de hardware, podendo ser a AHDL ou a VHDL, que implementa a equação desejada. Esta ferramenta em conjunto de ambientes de síntese comerciais possibilita a configuração, em FPGA, de uma grande quantidade de formas de ondas, utilizando somente recursos digitais. Para avaliar a sua eficiência implementou-se em FPGA uma grande variedade de formas de ondas como, por exemplo, seno, sigmoide, gaussiana e muitas outras. Diferentes especificações puderam ser avaliadas. A ferramenta, apresentou-se como uma poderosa contribuição para a criação automatizada de circuitos digitais.*

Palavras Chave — Ferramenta de Síntese, FES, FPGA, VHDL.

INTRODUÇÃO

Com a evolução dos processos de produção tecnológicos, os sistemas de integração de circuitos se tornaram mais complexos. O mercado demanda por circuitos mais eficientes e pela redução nos prazos de desenvolvimento. Esses fatores, justificam a utilização cada vez mais freqüente da automação dos processos de desenvolvimento dos projetos.

Circuitos com centenas de elementos apresentam uma dificuldade enorme de serem implementados com ferramentas CAD (*Compiter Aid Design*), baseadas em captura de esquemático. Atualmente, os projetos vêm sendo desenvolvidos com ferramentas com níveis mais altos de abstração, usando HDLs (*Hardware Descripton Language*) e métodos de detalhamento e refinamento automático.

Os sistemas e processos digitais podem ser representados em função de um domínio e, em cada domínio por um nível de abstração.

A representação de um modelo que contém os níveis de abstração e os domínos de descrição de um sistema digital foi proposta pela primeira vez por Gajski e Kuhn [1], o chamado Diagrama Y, apresentado na Figura 1.

FIGURA 1.
ELEMENTOS PRIMITIVOS DE CADA NÍVEL DE ABSTRAÇÃO NO DIAGRAMA DE GAJSKI E KUHN (DIAGRAMA Y).

Neste diagrama, os níveis de abstração (Nível de Dispositivo, Nível Lógico, Nível RTL, Nível de Arquitetura) são identificados pelas suas distâncias do centro do diagrama, enquanto os segmentos de reta radiais correspondem a domínios de descrição. Por exemplo, um diagrama de esquemáticos de portas lógicas TTL é uma descrição estrutural lógica, estando, portanto, localizado na intersecção do eixo rotulado Domínio Estrutural com o nível lógico de abstração.

A Figura 2 representa o diagrama de Gajski da ferramenta desenvolvida. A E2HDL leva do nível de abstração de Equações Algébricas para o nível de Equações

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Booleanas. O ambiente de projeto MAX + Plus II leva o nível de portas lógicas (Compilador) e, finalmente, para o nível de Planta Baixa (Configurador de FPGA).

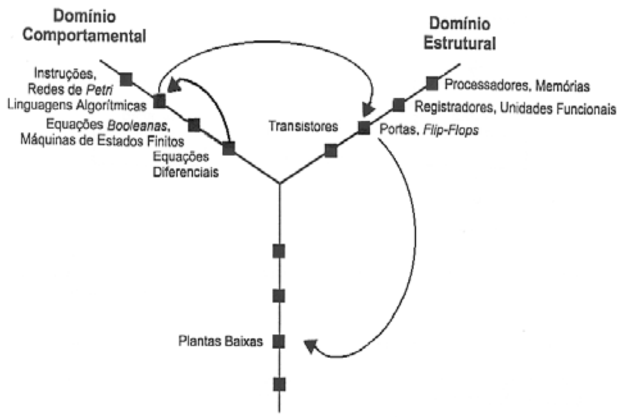

FIGURA 2.
REPRESENTAÇÃO DAS TRANSIÇÕES OCORRIDAS COM A E2HDL.

Uso de Lógica Programável

O uso de Lógica Programável (LP) está ligada intrinsecamente com o uso de tecnologias digitais, ou seja, criar um projeto com tecnologia FPGA (que é a LP escolhida), é criar um projeto digital. Projetos digitais podem-se utilizar de equipamentos variados como microprocessadores, tecnologia discreta e tecnologia de lógica programável, entre outros. A utilização do FPGA é decorrente de algumas vantagens tais como:

- Arquitetura em Hierarquia de Projeto;
- Paralelismo, o que leva a vários processos ou projetos simultâneos;
- Relógio (Clock) Elevado;
- Reutilização de Programas;
- Grande número de E/S (*I/O*);
- Fácil Roteamento;
- Possibilidade de Sistemas-on-Chip;
- Ferramentas de projeto;
- Utilização de funções parametrizáveis;
- Grande número de Células Programáveis.

CRIAÇÃO DE DECOFICADORES DIGITAIS UTILIZANDO FERRAMENTAS DE SÍNTESE AUTOMÁTICA

SISTEMAS DIGITAIS

Um sistema digital é um sistema discreto, isto é, transforma valores discretos de entrada em valores discretos de saída. Ele trabalha aplicando operações ou transformações nos valores de entrada. Os resultados dessas operações são passados a outras operações e, finalmente, para o valores de saída.

A descrição através de uma interpretação funcional do sistema é chamado de Descrição Comportamental. Em linguagem de descrição de hardware, a descrição comportamental é diretamente integrada na linguagem. Assim, pode-se trabalhar em uma descrição com um nível mais alto de abstração.

As ferramentas de síntese, trabalham em torno de modelos funcionais que representam algum conjunto de funções.

Um dos modelos que se pode trabalhar nessas ferramentas são os decodificadores. Estes, representam funções booleanas. Assim, cada um dos pinos de saída é uma função de todas as entradas.

Um decodificador de 7 segmentos representa bem esta ideia, ele possui 4 entradas (A, B, C, D) e 7 saídas (a, b, c, d, e, f, g) e a saída "a", pode ser transcrita como:

$$a = F(A,B,C,D) = \\ = \Sigma(0,2,3,5,6,7,8,10,12,14,15) \qquad (1)$$

Extrapolando para as outras saídas, determina-se as funções b, c, d, e, f, g e aplica-se os processos de minimização (fornecidas pelo ambiente de projeto Max + Plus II da Altera).

IMPLEMENTAÇÃO DE FORMAS DE ONDA ANALÓGICAS

O intervalo de valores possíveis de um contador, depende da quantidade de flip-flops que se está trabalhando, ou de outra forma, do número de bits. Assim, um contador de n = 8 bits, por exemplo, apresenta em função da contagem, valores em sua saída entre 0 e 255, ou seja, $2^n - 1$, onde n é o número de bits. Desta forma, a cada pulso de relógio a contagem aumenta em uma unidade percorrendo todos os valores de forma crescente. Acoplando-se a saída do contador a um decodificador com o mesmo número de bits, a cada valor de contagem, tem-se no barramento de saída do decodificador valores em função da contagem atual do contador. A freqüência de saída do sistema, depende do número de bits e do relógio conforme (2). A Figura 3, representa o sistema que gera uma onda analógica partindo de recursos digitais.

$$fsinal = \frac{fclock}{2^n} \qquad (2)$$

Onde:
n = número de bits do contador;
fclock = freqüência do relógio (entrada);

fsinal = freqüência do sinal (saída).

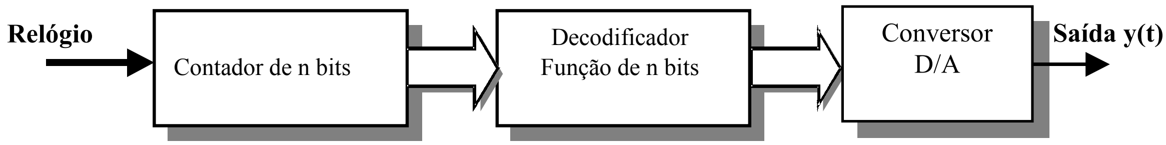

FIGURA 3.
GERAÇÃO DE SINAL ANALÓGICO UTILIZANDO DECODIFICADOR

FERRAMENTAS DE PROJETO BASEADAS EM SÍNTESE AUTOMÁTICA

Métodos de síntese automatizada ótima para equações Booleanas datam das décadas de 50 e 60 e não tinham a capacidade de resolver sistemas muito complexos. A necessidade de manipular quantidades crescentes de informações durante o projeto de sistemas digitais exigia a consideração constante de novas ferramentas. Estas deveriam transcender as atividades de facilitar a captura e de exercitar descrições, passando a ser capazes de gerar novas descrições de forma automatizada e corretas por construção, baseadas nos mesmos requisitos manipulados pelos projetistas. O estilo de projeto estabelecido por estas novas ferramentas baseia-se no uso de ferramentas computacionais e guia o processo de projeto. A ferramenta central possui embutido um conjunto de modelos de síntese, e é capaz de gerar uma descrição correta por construção, bem como uma avaliação do desempenho desta descrição. O laço de realimentação é fechado pelo projetista, que julga os resultados da síntese e aceita a descrição, ou a rejeita e escolhe um novo modelo de síntese para ser usado. Essa escolha pode ser feita com o auxílio de outras ferramentas distintas e apropriadas no processo de validação.

As ferramentas de simulação podem, ainda, ser empregadas, visando fornecer mais detalhes sobre a implementação. Freqüentemente, o sintetizador gera uma descrição a partir dos requisitos, e refina esta descrição através de técnicas de otimização. Somente a descrição resultante deste processo é fornecida ao projetista.

ESTIMULAÇÃO ELÉTRICA FUNCIONAL E FORMAS DE ONDA

A estimulação elétrica funcional (FES) vem sendo aplicada para restaurar e manter a atividade muscular de pacientes paralisados que sofreram lesão medular. Várias formas de onda de corrente e tensão vêm sendo aplicadas com sucesso na recuperação destes pacientes. Equipamentos desenvolvidos comercialmente, entretanto, apresentam de forma geral, serias restrições quanto à variação dos parâmetros do sinal aplicado (freqüência, forma de onda, amplitude, número de pulsos em modulação tipo Burst, tempo de repouso, etc.) o que abre a possibilidade do desenvolvimento de equipamentos mais completos e versáteis.

Uma grande variedade de aparelhos está comercialmente disponível para aplicações eletroterapêuticas. A instrumentação na eletroterapia está se proliferando rapidamente com aos avanços da engenharia, dos desenvolvimentos na pesquisa de eletroterapia e do alcance ampliado dos problemas tratados pela eletroterapia.

Muitos aparelhos projetados antes do início dos anos 80 incluíam geradores de forma de onda capazes de produzir somente um tipo de forma de onda a partir de um único aparelho.

Hoje, contudo, muitos estimuladores disponíveis comercialmente são capazes de produzir várias formas de onda distintas, mas, muitos dos parâmetros de controles não estão disponíveis. Esta dificuldade, abre a possibilidade do uso de novas tecnologias e da introdução de equipamentos com mais recursos, possibilitando uma geração de pulsos mais adequada do ponto de vista fisiológico ao paciente e, também, mais confortável.

Este trabalho apresenta o desenvolvimento de uma ferramenta de síntese automática para a geração de circuitos digitais com o uso de tecnologia de lógica programável. Os circuitos gerados, representam formas de onda de diferentes tipos de especificações e utilizam somente componentes digitais. A ferramenta tem como entrada os principais parâmetros de uma equação.

MATERIAIS E MÉTODOS

A ferramenta foi desenvolvida em linguagem C, e trabalha com funções analógicas para serem implementadas em hardware. A ferramenta gera um arquivo de HDL e para gerar um arquivo bastante pequeno, optou-se pela AHDL (*Altera Hardware Description Language*) da empresa Altera.

As formas de onda são parametrizadas com diferentes especificações, a ferramenta possui parâmetros de entrada para definir a quantidade de bits que o sinal digital deverá possuir e, também, a quantidade de pulsos necessários para percorrer-se um ciclo do sinal. Assim, se uma forma de onda tiver 8 bits de entrada e 12 bits de saída, tem-se uma forma de onda que necessita de um conversor D/A de 12 bits e 256 pulsos de relógio para completar um ciclo.

A ferramenta de síntese E2HDL gera o arquivo texto HDL.

O ambiente de programação MAX + Plus II da Altera simula e compila os arquivos HDLs e gera vários arquivos de reportagem e de interface com outros ambientes de programação.

O aplicativo TBL2M, foi desenvolvido para interpretar dados do arquivo .TBL (arquivo de simulação) e convertê-los em um arquivo gráfico do MatLab.

E, de forma geral, podemos descrever os passos para a geração de formas de onda como:

- Descrição da forma de onda (análise espectral);
- Utilização de uma das ferramentas de síntese para gerar o arquivo HDL (AHDL ou VHDL);
- Compilação, Simulação;
- Criação do Arquivo de Simulação TBL;
- Execução do Programa TBL2M;
- Visualização da forma de onda proposta no MatLab;
- Validação do Circuito;

Resultados

A forma de onda escolhida para implementação em FPGA foi a onda denominada farádica. Esta onda tem como característica um pulso de breve duração seguido de um período de decaimento exponencial. A equação farádica, foi modelada de acordo com as especificações da literatura de eletroterapia [7]. A Figura 4, apresenta a onda farádica simulada com 8 bits de entrada e 8 bits de resolução. Na figura, além da forma de onda, são mostrados os valores dos contadores em função do tempo.

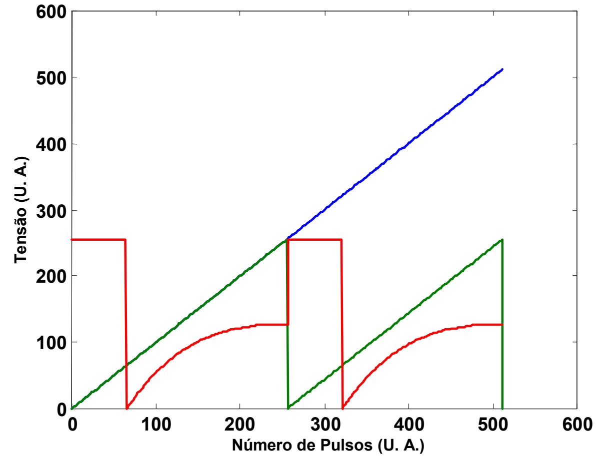

FIGURA 4.
FORMA DE ONDA IMPLEMENTADA EM FPGA

A Figura 5, apresenta a mesma forma de onda plotada com 5 períodos.

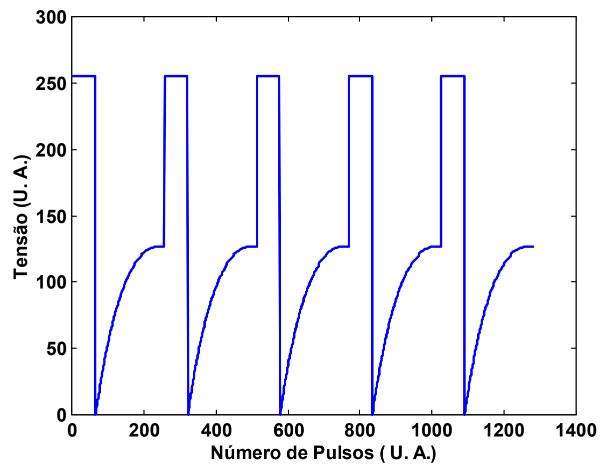

FIGURA 5.
FORMA DE ONDA IMPLEMENTADA EM FPGA

Conclusões

As ferramentas de síntese automática apresentaram-se como poderosas ferramentas para a geração de circuitos digitais.

A estrutura em hierarquia de projeto permite que, uma vez necessária a modificação da forma de onda previamente descrita, a fácil substituição desta por uma outra mais adequada dentro do projeto.

As freqüências de trabalho realizadas nas medições e simulações, permitem a implementação física das formas de onda, já que o objetivo é a aplicação em sistemas de Estimuladores Neuromusculares onde a freqüência de trabalho é quase sempre menor que 10 KHz.

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ASPECTS OF CSCL

The web allow us to talk about a FOA/applications oriented framework, going beyond the code based, components, and even service paradigm. However, as in the objects oriented modeling, the complexity in relation to the system/domain partition, remains. In general, a partition aims to establish the responsibilities of each piece of the system in a certain domain of the problem. Nevertheless, it is observed that some properties of the system "cross-cutting" many parts of them. In AOP-Aspect Oriented Programming such proprerties are called *aspects* [16].

To the purposes of this work, a survey of the cscl/cscw aspects to be considered, is presented.

Community Organization Aspects

In the modeling of cooperative/collaborative learning and working support environment, the following aspects must be observed:

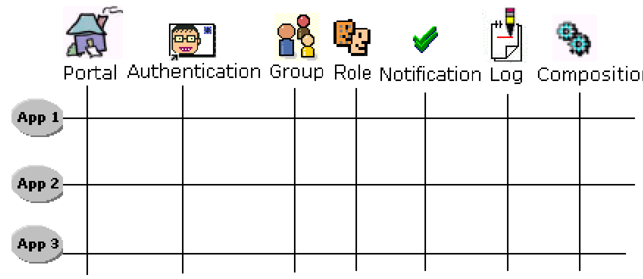
Portal: The term "Portal" is used to designate a comprehensible spot of access to the information (categorizing and seeking), applications (desktop integrated) and people (collaboration) in a virtual community on the web.
Authentication: Most of the cscl environments require that the user identifies himself.
Group: [17] mentioning (Johnson & Johnson) says that "the basic component of the collaborative learning is the group learning".
Role: The capacity of an application to adapt to the role performed by the user in the environment. Which besides being an organizational aspect, opens excellent pedagogical opportunities.

Interoperability Among Applications Aspects

The following interoperability aspects are required in cscl environment:

Notification: Aiming to have the applications and their users updated about facts, preferences, incidents and events which occur in the environment the cscl/cscw systems implement some notification mechanism.
log: [14] argues it is essential that the virtual learning environments store the history (log) of the individual and the group activities, in order to help the analysis and coordination of the job.
Composition: The composition concerns the connection between an application and the framework, and a plug-in-agent and a application. A plug-in-agent, together with the role, open opportunities to the adaptation/specialization of an application to the pedagogical needs.

Picture 2 shows the "orthogonality" among those aspects and the applications in a cscl environment.

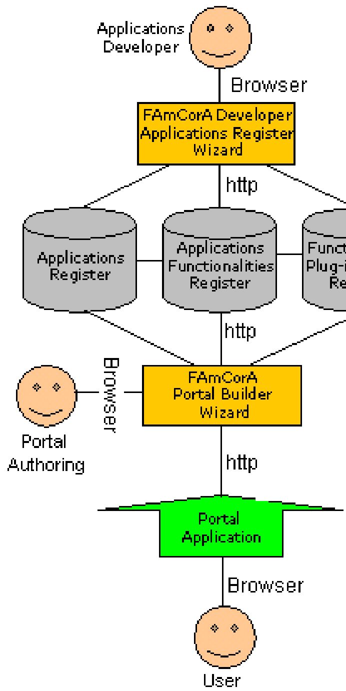


Picture 2. Aspects x Applications in CSCL/CSCW environment

According to [18] there are three basic approaches to addressing the process of separation of concerns : i) On the linguistic approach, relevant concerns are identified at the problem domain and are translated to aspectual constructs and later integrated with the functionality-decomposed program via well-defined interfaces; ii) Within the OO view, two main alternatives for handling aspects are frameworks, where concerns are materialized as aspectual classes either at the framework level or at the user-application level and reflective architectures; iii) the architecture-oriented approach, ***followed in the present work***, proposes an early identification of concerns using architectural organizational models. In this approach concerns are initially mapped to architectural constructs, instead of coding them using framework or language constructs.

FAMCORA ARCHITECTURE

The FAmCorA treats the aspects issues from the architecture point of view. Picture 3 presents a macro vision of the FAmCorA. The architecture concerns three kinds of users: application developer, portals author and end user. The mediation between the framework and its users is done through the web. The application programmer uses an assistant (Applications Register Wizard) to register applications and plug-in-agents. The portals author uses the information basis (Applications Register, Applications Functionalities Register e Functionalities Plug-ins Register) and an assistant (Portal Builder Wizard) to construct teaching and learning support environment on the web (Portal Application) in such a direct way as in those offered by environments called RAD (Rapid Application Developer). The end-user is the uppermost beneficiary of this construction endeavor.



Picture 3. FamCorA Architecture.

In picture 3, the Portal Builder Wizard module is the responsible for the portals catalog (portal aspect). The Portal Application module is responsible for the group catalog (group aspect), users (authentication aspect) e roles (role aspect). The aspects related to the interoperability (notification, log) are solved through communication protocols. A notification is sent through Passport Protocol and the Log of activities through xLidex (Extensible Learning Interactions Data Exchange Protocol). The composition between an application and the framework is given through an application class interface. Yet the composition between an application and a plug-in-agent occurs through the Plug-in-agent Protocol.

A FAMCORA IMPLEMENTATION

An implementation of the ideas discussed here is under development in the GAIA's laboratory (Computer Learning Application Group) from the Federal University of Espírito Santo, Brazil. The main concern of the project is to make the development of cscl environments an easy task, avoiding the need of expert programmers and turning it into an authoring assignment, giving educators and teachers the opportunity to create virtual environments to support the teaching and learning process.

The authoring of an educational portal in the FAmCorA is attended by a wizard, following the RAD paradigm. A mouse-click generates the basic nucleus of the system, instantly installed and ready to work on the web portal.

As the portals author logs on the environment, picture 4, he already has three groups at his disposal to administer: "Community" which is the portal's master group, where all the users are filed. The "Individual_Space" which is a template that concerns the personal space of each future user from the portal. When active, this space is assigned by the icon (Ayrton Senna's helmet – the F1 pilot) and has the same name as the user's email. In our case it refers to the author's cockpit, already equipped with two basic tools: xLidexManager, assigned by the icon (mobile-phone), it is a mechanism which communicates with all the FamCorA application, through the xLidex protocol, searching information about the users activities in the environment. GroupManager, assigned by the icon (wheel), it is the basic tool to drive around the portal, with it the author can: 1) create groups and their roles; 2) choose which tools will be available to the group users , according to the role taken by each one of them; 3) Include new users in a group.

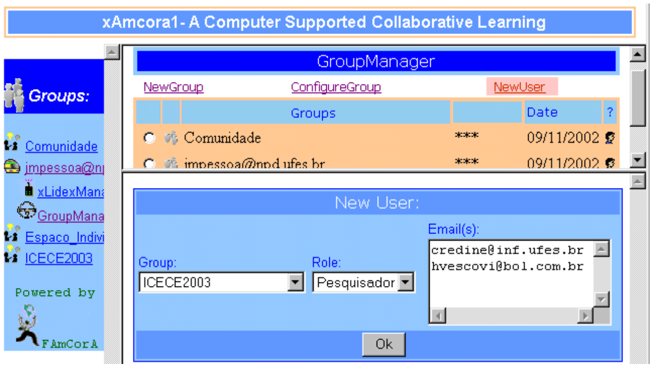
To create a new group, using the GroupManager, the author just have to select a "father group", afterwards he edits the name of the new group, for instance ICECE2003, and the roles of the individuals in this group, in the example "researcher" and "student".

Still on the GroupManager, the author uses a list to select, among the many tools, made available by the FAmCorA developers community, those which will be in the work area (windows desktop) of the new group, when the user is, for example, a "researcher". When the author chooses a tool, for instance "ExpressCalculator", he is offered the opportunity to customize or adapt its use, through a menu which presents the many available functionalities. To each functionality, a plug-in-agent may be selected, or not.

As an example, ExpressCalculator is a conventional application of general purpose, able to evaluate math expressions. However, as any well designed FAmCorA application, its performance might be adapted, depending solely on a plug-in-agent existence. In particular, the functionality "NewExpression" can be configured to generate typical expressions of some knowledge area as Physics, Chemistry, etc.

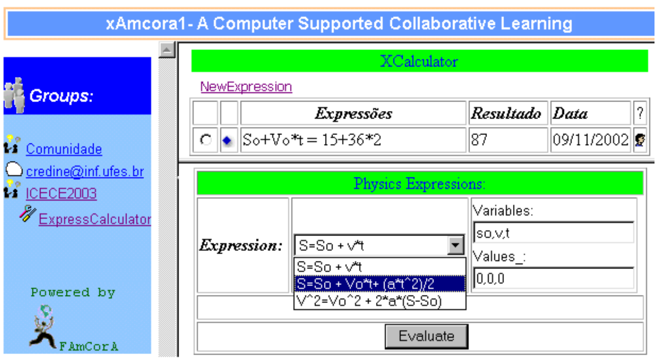
After the application, the functionality, and the adaptation (plug-in-agents) have been set to each role in the group, there is only the task of registering the users to turn the portal useful, picture 4.

Picture 5, presents the login of the user "credine@inf.ufes.br", newly registered with the role as a researcher in the group ICECE2003.



Picture 4. Cockpit and GroupManager

See, in picture 5, how a plug-in-agent choice has changed the specialized calculator ExpressCalculator into Uniformly Varied Movement Formulas (Physics), for the users whose role is to act as researchers in the ICECE2003 group.



Picture 5. An adaptive Calculator.

Perspectives and Conclusions

The Group Construction Support System, the so called e-groups, are not new on the web. Anyway, as being of general purpose, they lack convenient requisites and applications to the cooperative work activities required in cscw/cscl environments. They still miss intelligent and adaptive mechanisms to keep track, help and notify the interactions/tasks developed by the individuals in the various roles.

The FAmCorA architecture focus the resuse and the interoparationability among applications. In our point of view this has an important meaning: An application or a plug-in developed to a portal can be used in others, just by pointing it to a *link*. This strategy is crucial for the arising of new approaches to the educational environment, simply because now we can easily construct them, through means of application composition already existing in different domains, under different pedagogical conceptions.

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NaTIEng: New Technologies of Information and Communication in the Teaching of Engineering

Edson Pereira Cardoso[1], Crediné Silva de Menezes[2], Jaime Roy Doxsey[3]

Abstract -- *Education in general and, in particular Higher Education, faces today a great challenge to form a citizen that will live appropriately in a society of knowledge. The pedagogic approaches (learning and evaluation) and the educational technologies have been shown as inadequate, thus motivating research efforts at the international level. In this article we present a project for insertion of new technologies of information and communication (**TIC**) in the modernization of the engineering courses of the Technological Center of the Federal University of the Espírito Santo (**UFES**). The project contemplates all the courses and will have a hybrid vocational capacity to assist not only the students and basic disciplines, as well as the professional disciplines, in respect to the use of modern technologies of information. It will also attempt to facilitate the students' integration in the community, to create the conditions for the practice of learning and of cooperative work and to support the traditional classroom teaching through the use of virtual learning environment*.

Index Terms: distance education, Internet and education, virtual learning environment

INTRODUCTION

Education in general and, in particular Higher Education, faces today a great challenge to form a citizen that will live appropriately in a society of knowledge. The pedagogic approaches (learning and evaluation) and the educational technologies have been shown as inadequate [1], thus motivating research efforts at the international level.

In Brazil, these concerns are constant, which can be verified by the appearance of projects as Program **REENGE** (**CAPES**, **FINEP**, **CNPq**), created in 1996, whose conception can be summarized in the following way:

> ***REENGE*** *has a main objective to restructure higher education, motivating the accomplishment of different teaching experiences such as the implantation of virtual learning modules, the use of computer resources, research activities and experimental development, in the constant requalification of professionals. The main motivation for the reformulation of the Engineering curriculum was the rapid speed of the technological progress and the growing computerization of the means of production.* [2]

In the **REENGE** project, the Technological Center of The UFES had significant participation, through six sub-projects intertwined by the conjugated effort in the appropriation and use of computer systems [3], [7].

More recently, those concerns are present in the higher educational system, as in the case of a recent proclamation of the National Fund of Telecommunications (**FUNTTEL**) where the higher education institutions are invited to form competence nets in the Information and Communication Technologies, in association with companies of the telecommunications section [4].

In the ambit of the Federal University of Espírito Santo (**UFES**), there is a growing concern with the use of these new technologies to amplify the potential of the University as an agent of State development, as exemplified by the creation of its Center for Open and Distance Education, which will make intensive use of the Communication and Information Technologies in a proposal to expand free public higher education throughout all municipalities in the state [5].

Within this context, the Technological Center of the **UFES** decided to participate, institutionally, in the collective effort of discussion and development of methodologies for learning and evaluation. It therefore instituted the NaTIEng project, designed to focus on research and development of pedagogic practices mediated by telematic platforms. The project seeks not only the insertion of these new technologies but also the evaluation of the impacts of the pedagogic results of the implantation of those learning platforms.

The project contemplates all the courses at the Technological Center: Civil, Mechanical, Electrical Engineering, Computation Sciences, and also the Masters Program in Computation Science and the Mechanical Technology Course. It will have a hybrid vocational capacity to assist not only the students and the basic disciplines, as well as the professional disciplines. It also should facilitate the students' integration in the professional community. The project intends to create the conditions for the practice of learning and of cooperative work and to support the traditional classroom teaching through the use of virtual environment of learning.

This article presents the conception of the project and its current stage of development.

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THE INFORMATION SOCIETY: PEDAGOGIES AND TECHNOLOGIES

The exercise of the professions, considered in this project, is understood as a group of intellectual activities that can be grouped in the following categories: analysis, modeling, simulation, project and calculations. Underlying all these activities is the manipulation of a valuable that we denominate as information.

For information we can understand the description of facts (the weight to be calculated for concrete structures, for example), scientific laws, processes (the sequence of steps to project a thermal machine), diagnoses (the identification of flaws in a system of energy transmission) and description of engines (the architecture of a computer, the project of a machine, the plan of the first floor of a building, etc.).

According to Dertouzos [6], we are entering an information era based on 5 pillars, of the which the first three are:

- The information can be represented by numbers;
- Any number can be represented by sequences of 0 (zeros) and 1 (one);
- The computers transform the information when treating those numbers arithmetically.

The growing and accelerated increase of the complexity of problems treated by the different areas of engineering, turns undesirable and, who knows in a very close future, until impracticable, engineering practices without the presence of modern tools for the treatment of the information for which the computer is the base.

The remaining pillars are:

- Communication systems transport the information when moving those numbers;
- Computers and communication systems combine to form networks of computers. Those networks constitute the base of the infrastructure of the information of the future.

The appearance of these networkss created what we call the information community. A community of information can be understood as a group of individuals that use the resources of the network to change correspondence, to buy or sell services, to cooperate to diagnose a problem, to project an engine, etc. These communities create the conditions for a new praxis of social production, at the same time cooperative and distributed and, theoretically on planetary scale. It is predictable, therefore, that the treatment of great problems can accomplished more and more in a distributed way. The engineer today needs to be prepared for a reality where the cooperative and distributed work prevails. He/she must be capable of freeing him/herself of temporal and space limitations.

On the other hand, recent discoveries within the sciences of cognition reveal the most varied cognitive profiles of students. Different profiles imply the need for different learning practices that, certainly, are unattainable for the classic pedagogic strategies centered in the class room. We maintain that the teacher's work will be much more effective if it can be facilitated, in different academic practices, through the use of the computer and of the technologies associated to the computer.

The act of learning is a complex process that is developed by means of: the observation of phenomenon, the collection of data, analysis, synthesis, formalization and validation. Each learner builds his knowledge within the rates and strategies of his own reasoning. Therefore, in a group, each student will execute all the above stages differentially over time, that is to say, each learner in his own rhythm. The impossibility of corresponding to that demand by the teacher, contributes to a treatment of students in a standardized and canonical way, which unavoidably leads to the construction of a not very flexible knowledge with relationship to its use in the resolution of problems and the development of a learner with few creative resources, essential for a more autonomous learner.

There are innumerable tools that we can use in education mediated by computer. The tools for analysis, simulation, synthesis and communication deserve proeminence. The three first give support to the learning activities cited above. They can be used individually or in groups. Those of the last type facilitate the practice of the "inquiry pedagogy". They make cooperative learning possible and facilitate the extra-class attention and interaction. Besides giving them a dimension which is not face-to-face and asynchronous, those tools, when endowed with resources of artificial intelligence, allow the reintroduction of work/tasks produced previously.

Today there are countless possibilities for access to knowledge. We lived immerged in a world of information and, therefore, constantly we learn through a processing of what we are presented by different agents. These sources are more attractive and overcome the traditional school in the dispute for our attention.

The school we know today, which limits physically and in time a section of the teaching-learning process, has inherited the practices of a time in which the source of information was centered principally on the figure of the **teacher**.

The education needs to appropriate of the modern instruments of the generation and diffusion of information so that it can also integrate itself into the daily reality. We estimate that only in that way education can appropriately play its part in the preparation of the individual for a critical exercise of his or her activities in an economic society more and more centered in the services sector.

It is in this direction the world net of computers (Internet), becomes as indispensable partner. With the network we can build telematic supports which activate our classroom-based courses and, at the same time, prepares us, teachers and students, for the use of information technology as a mechanism which mediates of distance education. The Internet integrates the different well-known media and adds to them the capacity of processing of information, what activates and stimulates the teacher-student interaction. We know this interaction is fundamental in the teaching-learning process, and does not manifest itself adequately through the isolated use of the other media.

EDUCATION WITHOUT DISTANCES

The insertion of the computer in the pedagogic practices is being pointed out as a powerful instrument capable to reduce many difficulties found in general in education and, in particular, in higher education. Today, countless universities of recognized quality at the national and international level [8] seek the introduction of information and communication technologies to revitalize their courses. The forms of usage, in spite of many diversities, concentrate in two main groups: tools to support the interaction with objects of the knowledge (simulation, conceptual maps etc.) and tools to support the social interaction, indispensable for the construction of the individual and collective knowledge.

Social interaction from the educational point of view are the interactions that an individual accomplishes with partners in a learning community (teachers, classmates, former classmates, monitors, projects colleagues, people from the community). This interaction has as its main objectives – clarification and the exercise of critical observations, fundamental activities for the development of intellectual abilities of the student. The students' need, as soon as possible, to enter the labor market hinders the exchange of experiences among colleagues. In spite of not lacking free time for studies, study activities happen in different times and places for each individual. Those circumstances contribute to an increasing decline in the quality of learning and even in the increase of dropout rates.

The use of a cooperative environment for support of learning, made possible by networks of computers, and globally practiced through the Internet, has been show as effective in the recuperation of the practices of social interactions, reducing barriers imposed by time and geography [9]. Today we can say that the telematic ambient of a group is its encounter point, where those interactions can be practiced in a synchronous and asynchronous form, resulting in what comes being called education without distances.

From a general point of view, we seek the study, planning and insertion of new pedagogic approaches (learning and evaluation) supported in the Information and of Communication Technologies. We therefore understood the necessity for training and awareness of students and faculty in an integrated and critical use of **TIC** in their respective professional life and learning practices.

Within this viewpoint, we are developing the following actions:

- Production and availability of instructional material in digital media, besides the new forms of content presentation such an as hypertext and conceptual maps;
- Production and availability of support tools for simulation and the construction of the knowledge;
- Support for extra-class attendance which facilitates that teacher-student and student-student interaction take place, in a distance and asyncronous mode, mediated by telematic support;
- Support to the student and teacher integration with the greater community (society).

ACTUAL PRACTICES

In one way or another, students and teachers from the Technological Center already use the Internet, including in their school activities. We needed to identify these pedagogic practices, to systematize them, to compare them with those practiced in another institutions and re-elaborate them in a collective way, thus building a modern approach more tuned in with the peculiarities of our institution. With this purpose in mind, we carried out two diagnostic activities. Initially, involving the coordinators of each course and department chairperson, interviews were realized in an attempt to capture the institutional feeling with regard to the main problems encountered in the development of the undergraduate courses. Later we conducted a survey of professors in the use of **TIC** in their classroom and laboratory procedures.

As a result of the interviews with the coordinators and department chairpersons, it was verified that there is an growing concern with the evaluation of the current methodological aspects of the engineering teaching and with the transformation of the students' profile in regard to the use of the information and communication technologies. In addition, it was noticed that great importance is given to the incorporation of **TIC** in the learning process, as element that can result in improvements in the quality of the learning.

From the collected data with professors regarding of use of **TIC** in the engineering teaching, we can verify that there is a moderate use of the e-mail for attending to student needs outside of class and the availability of didactic material through personal web pages. It was verified, however, a low use of virtual environment for the cooperative work or learning. We also could verify that all the respondents use the e-mail for its personal communication and about 90% demonstrated interest in participating of the **NaTIEng** Project. In our understanding these two aspects are fundamental for the success of the proposal.

CT-ONLINE: A VIRTUAL LEARNING ENVIRONMENT

Based upon the information collected regarding the identified practices a initial structure for the CT-online was conceived - a virtual environment for support to the didactic activities of the courses of graduation of the Technological Center.

In this conceived learning environment we give emphasis to the following elements:

a) public communication, by the professor for the students, through a bulletin-board of announcements;
b) public communication, among all the participants, through virtual forums;
c) private communication, through e-mail;
d) digital library, that promotes available didactic materials (texts, computer programs, orientations, etc);
e) webliography, that allows the cataloguing of references of interest for each discipline;
f) posting of the students' production.

We highlight three aspects, which are understood as representing a great differential from other similar proposals. In the CT-Online, the participants can access the complete bibliographical material, independent of the class group in which that are registered and the professors possess a free access to all the ongoing forums and discussions. In addition, the materials stay in the system, as long as they demonstrate importance, giving therefore a sense of continuity to the academic life, instead of reducing it to each new scholastic period.

The learning platform was materialized through a tool produced by **MEC (Brazilian Educational Ministry)**, denominated ***eproinfo*** [10], which has been used in courses for teachers qualification, in the distance modality. In the Figure 1 we can observe a list of course offered by UFES using the eproinfo environment.

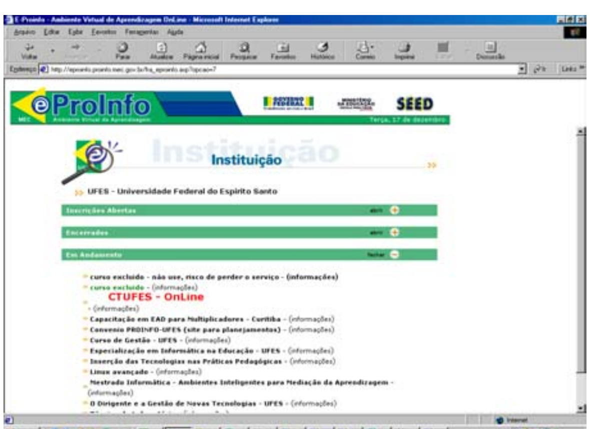

Figure 1: A list of courses offereded by UFES

In the Figure 2 we can observe the list of lesson groups established in the CT-Online environment. The students can access their groups just clicking in the group name.

Figure 2 : List of lessons groups at CT-Online

In the figure 3 is showed a forum page for a specific group. The forum is organized by theme and sub-themes. To each topic of interest the teacher starts a new theme.

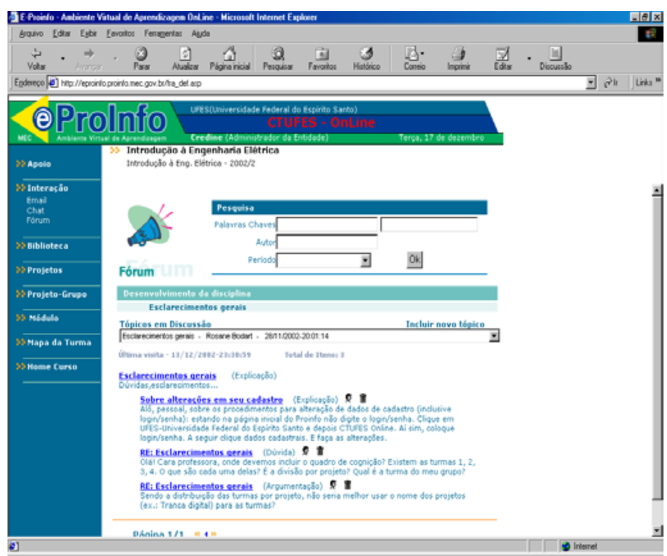

Figure 3: The forum for a specific lesson group

The students can publish their productions using a a file system with an special interface. The teacher can access the student assignment just clicking in their names, at the list of student ilustred in Figure 4.

Figure 4: A list of students name for an specific lesson group

FINAL CONSIDERATIONS

The system is in operation since the second semester of 2002 and the strategy that we adopted is to begin with a promotion of the professor's awareness. The results of the survey of the pedagogic use of telematic practices are being introduced to the teachers through specific meetings, when we also present the CT-online. The insertion of a new discipline in the learning platform is made by the teacher's adhesion, accomplished by a request to the coordination of the project.

During this first semester of system use, we are collecting data to carry out a quantitative and qualitative evaluation of the use of the platform. Platform improvements will be made through this evaluation.

It is desirable also that the activities of the courses in the virtual environment come to involve, besides professors and students, former-students of the discipline, other teachers and the professionals in most the diverse companies which apply the knowledge organized in the discipline. Conviviality in the virtual environment, therefore, will constitute a new learning practice where students of the most varied levels and styles cooperate for improve their knowledge and understanding. This, certainly, will plant the seeds of a culture of permanent and integrated education in the **CT-UFES**, through virtual learning communities. We already have experiences with teacher qualification courses where students from several places, at different levels of knowledge, cooperate using eproinfo environment. In Figure 5 we presents a page of a work group which develops a learning project.

The use of virtual learning platforms and the knowledge built through them can contribute to improve the opportunities in the on-campus, face-to-face courses. On the other hand, the use of the CT-online can hopefully contribute to the creation of a culture of distance education that will allow to evaluate, plan and adopt this education modality, at the undergraduate and masters level, when there are evidences of the advantages that distance education and the new technologies can proportion.

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Figure 5: A group of teacher attending a qualification course at UFES

AMBIENTES INFORMÁTICOS BASEADOS EM REALIDADE VIRTUAL COMO INSTRUMENTO DE APRENDIZAGEM PARA PESSOAS PORTADORAS DE DEFICIÊNCIAS

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Resumo *— Na evolução dos estudos realizados com Pessoas Portadoras de Necessidades Educacionais Especiais são evidenciadas as dificuldades relacionadas à aquisição da escrita e da leitura, por se tratar de habilidades cuja abstração é fator preponderante em seu desenvolvimento cognitivo. Nesse sentido, este trabalho apresenta o projeto AIA, o qual enseja proporcionar a essas pessoas oportunidades para superar suas deficiências neste campo e tornar possível o afloramento das suas capacidades, utilizando como recurso metodológico as Tecnologias Digitais, com destaque para os ambientes baseados em Realidade Virtual.*

Palavras Chaves – leitura e escrita, portadores de deficiencies, realidade virtual.

INTRODUÇÃO

A informática aplicada à educação surge em um momento de muitos questionamentos a respeito dos métodos tradicionais aplicados à educação que geraram a exclusão de alunos com insucesso escolar, dentre eles as Pessoas com Necessidades Educacionais Especiais (PNEs), desrespeitando os diferentes ritmos de aprendizagem.

Neste contexto, a informática oferece uma metodologia inovadora e atrativa aos educandos estimulando os profissionais/professores a se reciclarem e buscarem novas alternativas visando o pleno desenvolvimento de seus alunos.

É preciso ressaltar que não se trata de ignorar ou substituir os métodos tradicionais de ensino/aprendizagem da leitura e escrita, mas sim de fazer uso da tecnologia digital para enriquecer a prática pedagógica.

O ambiente informatizado de aprendizagem privilegia a interação entre sujeitos em um clima colaborativo e extremamente desafiador, os quais constroem seus conhecimentos a partir das suas vivências e de acordo com seus diferentes ritmos de aprendizagem, mediados pelo professor.

Teoricamente não há limites para a aprendizagem humana e todas as pessoas, independente de suas condições, possuem potencialidades, desde que lhes sejam dadas oportunidades e espaço para que se desenvolvam, ou como propõe Vygotsky, que haja uma atuação do educador na Zona de Desenvolvimento Proximal (ZDP).

O grande desafio resume-se em criar ambientes que oportunizem a todos o acesso a educação e que contemplem o desenvolvimento integral do ser humano sem excluir ou discriminar.

O atual momento histórico caracteriza-se pelo fracasso das diversas modalidades de organização social, gerados por sua incapacidade de organizar a sociedade em torno de objetivos que visem a liberdade, a igualdade e a solidariedade. Fracasso este, gerado, ainda, por diferentes regimes políticos, que secundarizam as políticas de bem-estar social evidenciadas nos indicadores de desemprego, marginalização e deterioração dos serviços públicos de saúde e de educação.

Este cenário é resultado de práticas históricas que reproduzem os valores existentes em uma sociedade onde não há lugar para todos, principalmente quando se refere ao progresso tecnológico que marginaliza uma parcela significativa da população.

Em decorrência da democratização do ensino e conseqüente garantia em oferecer a todos igualdade de oportunidade para aprender, torna-se necessário pensar uma prática educativa inserida no contexto das relações sociais globais, que considere a realidade viva do educando e a realidade viva da sociedade.

O novo paradigma tecnológico tem provocado profundas transformações na realidade social que impõe, por sua vez, novas exigências para o processo educacional e, em particular, para a educação escolarizada.

Na evolução dos estudos realizados com Pessoas Portadoras de Necessidades Especiais (PPNE) freqüentemente são evidenciadas as dificuldades relacionadas à aquisição da escrita e da leitura, por se tratar de habilidades cuja abstração é fator preponderante em seu desenvolvimento cognitivo

Nesse sentido, este trabalho enseja proporcionar a essas pessoas oportunidades para superar suas deficiências neste campo e tornar possível o afloramento das suas capacidades, utilizando como recurso metodológico as Tecnologias Digitais, com destaque para os ambientes baseados em Realidade Virtual (RV).

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Como uma experiência inovadora em nossos trabalhos no Núcleo de Desenvolvimento Infantil (NDI), do Centro de Educação da Universidade Federal de Santa Maria (UFSM), criamos um laboratório o qual denominamos “AIA” - Ambiente Informatizado de Aprendizagem - para o atendimento de Pessoas Portadoras de Necessidades Especiais (PPNE) objetivando o desenvolvimento de suas capacidades e potencialidades em leitura e escrita, através das tecnologias digitais.

Em parceria com o Departamento de Eletrônica e Computação do Centro de Tecnologia da UFSM, este projeto vem sendo desenvolvido por uma equipe de seis profissionais, constituída por dois professores orientadores, uma recreacionista e quatro acadêmicos dos Cursos de Educação Especial, Pedagogia e Informática.

Atualmente atendemos a um grupo de seis alunos com diferentes deficiências (Síndrome de Down, Síndrome do X - Frágil e outras deficiências mentais), em idades que variam de 15 a 28 anos. Por se tratar de um projeto de pesquisa, a extensão desse atendimento foi delimitada a poucos participantes, dada a natureza dos sujeitos envolvidos (PPNE), que exigem, por parte da equipe de profissionais, um atendimento individualizado, considerando os diferentes tipos de deficiências destes alunos.

O uso da Telemática e de ambientes de RV como recurso educativo, insere-se em um contexto pedagógico *mediatizado*, através da concepção de metodologias e estratégias de ensino centradas no aluno e mediadas por instrumentos tecnológicos, que potencializam ao máximo uma aprendizagem individual e coletiva; interativa e cooperativa.

Essa nova forma de aprender utilizando a tecnologia como instrumento mediatizador baseia-se nos fundamentos teóricos de Vygotsky apud Oliveira [8], que define a mediação como “(...) o processo de intervenção de um elemento intermediário numa relação; a relação deixa, então, de ser **direta** e passa a ser **mediada** por esse elemento”.

A definição apontada para *mediatizar*, neste trabalho, é muito bem caracterizada por Belloni [2]. Para essa autora,

> (...) mediatizar significa conceber metodologias de ensino e estratégias de utilização de materiais de ensino/aprendizagem que potencializem ao máximo as possibilidades de aprendizagem autônoma. Isto inclui desde a seleção e elaboração dos conteúdos, a criação de metodologias de ensino e estudo, centradas no aprendente, voltadas para a produção de materiais, até a criação e implementação de estratégias de utilização destes materiais e de acompanhamento do estudante de modo a assegurar a interação do estudante com o sistema de ensino.

Assim, neste novo contexto de aprendizagem, novas bases epistemológicas, novas metodologias e novos ambientes interativos de aprendizagem são requeridos, a fim de que possam ser desvelados no sujeito aprendente sua multidimensionalidade e integrá-lo na sociedade que o exclui.

Na perspectiva de se desenvolver uma metodologia mediatizada por recursos informáticos, que sejam interdisciplinares e integradores das aprendizagens já constituídas ou por se constituírem, entre as ações desenvolvidas no projeto **AIA,** procuramos proporcionar às PPNE um ambiente que seja diferenciado das classes tradicionais, que estimule o pensamento simbólico e operacional concreto destes educandos, proporcionando-lhes a construção do conhecimento e o desenvolvimento de conceitos abstratos, a partir de situações virtuais concretas, praticadas em ambientes baseados em Realidade Virtual, como campo exploratório de simulação interativa.

Para que esses educandos superem suas “dEficiências” e evidenciem suas “Eficiências”, este projeto ao utilizar recursos tecnológicos que propiciem a aquisição da leitura e escrita, tem por objetivos:

a) Proporcionar aos portadores de necessidades especiais (PNE) a interação em ambientes baseados em Realidade Virtual que ofereçam situações nas quais possam desenvolver suas capacidades de representar e compreender idéias abstratas e conceitos lingüísticos.

b) Desenvolver atividades de comunicação oral e escrita de forma colaborativa e interativa, utilizando as ferramentas de comunicação tais como: *e-mail, MSChat, ICQ, Netmeeting, EquiText,* entre outros, que promovam a apropriação e produção de conhecimentos, através de um aprendizado autônomo, crítico e criativo;

c) Oportunizar o intercâmbio de mensagens e trabalhos cooperativos entre os alunos participantes do “AIA” e outros educandos, tanto portadores de Necessidades Educativas Especiais de outras instituições, quanto pessoas interessadas em manter interação com os mesmos, através de *chats* programados a partir de temas previamente definidos.

d) Explorar os recursos da Internet através de suas possibilidades de navegação no ciberespaço, buscando estratégias de interação e motivando os alunos para o desenvolvimento de atividades relacionadas à leitura e à escrita;

e) Construir com os alunos suas *Home-Pages* como repositórios dos trabalhos produzidos.

PARADIGMAS TEÓRICO/METODOLÓGICOS

A questão teórico/metodológica deste projeto insere-se em uma base construtivista que tem como ponto central a análise dos saberes e necessidades do educando e do contexto sócio-educativo ao qual ele pertence, caracterizando-se pelo estabelecimento de um programa integrador das aprendizagens já realizadas ou por se realizarem.

A esse propósito, esta metodologia tem como preocupação tanto a reprodução como a produção de conhecimentos, em um processo dialético onde a reprodução deve ser sempre superada, por incorporação, no processo de produção. A reprodução e a superação do saber existente efetivam-se a partir da produção dos novos conhecimentos em uma apropriação racional e crítica do saber já elaborado.

Esta postura construtivista co-existe com uma postura democrática na qual procura-se desenvolver no aluno sua autonomia, propiciando-lhe condições de reflexão sobre suas idéias e interação com seus parceiros e o objeto de sua aprendizagem.

Na concepção Vygotskiana a relação homem/mundo é uma relação mediada. O homem se constrói através das relações que estabelece com o meio, sendo um ser em constante transformação.

O sujeito se constitui como tal através da sua relação com o mundo e das vivências com seu grupo cultural, que lhe fornece um ambiente estruturado e uma interação mediada para essa constituição, sendo, dessa forma, responsável pelo seu desenvolvimento.

Partindo dessas premissas, buscamos desenvolver um trabalho utilizando a telemática como uma metodologia diferenciada daquela desenvolvida na escola regular. Uma metodologia que propicie o desenvolvimento integral dos PNE como indivíduos, considerando seu universo sóciocultural e que possa inseri-los no mundo virtual através da aprendizagem digital.

O ambiente de aprendizagem computacional oportuniza, para esses alunos, espaços para a construção do conhecimento e oferece diferentes ferramentas e recursos de comunicação, que os desafiam e motivam para a aprendizagem da leitura e da escrita, em uma construção conjunta com outras pessoas, tornando-os ativos no processo e abrindo novos caminhos para a construção do conhecimento, de outra forma que não seja a sala de aula convencional.

A utilização das TICs em ambientes informatizados de aprendizagem, como espaço de comunicação, favorece a inclusão social dos PNEs, pois esse novo ambiente instaura um clima de segurança, enfatiza a ação conjunta/cooperativa e colaborativa, que resulta em uma maior autonomia e independência dos educandos, incentivando-os a desinibição e iniciativa face à realização das atividades. Os educandos, nesta nova maneira de aprender, sentem-se motivados a buscar novos conhecimentos, tornam-se mais persistentes e fortalecidos em sua auto-estima através da interação com os outros.

Neste clima de cooperação, os alunos mais experientes desempenham o papel de mediadores, auxiliando os colegas na realização das atividades. Essa tarefa proporciona grande satisfação, pois os educandos passam a ter consciência das suas potencialidades. O uso de ferramentas informáticas lhes dá a chance de ampliar seus conhecimentos e superar suas dificuldades, favorecendo a participação de todos em um trabalho conjunto, no qual podem observar **o como** e **o porquê** escrevem.

Estas questões nos remetem a um dos instrumentos mais eficientes para o professor assumir com autonomia as suas ações que é o planejamento. O homem é o único ser capaz de sonhar, projetar, optar, enfim, ser o autor da sua própria história. Através do planejamento ele redimensiona o que faz, avalia e, se necessário for, modifica todo o processo. Para o êxito deste planejamento optamos por um método que determina a metodologia, as prioridades e a interação entre os sujeitos

As atividades têm, portanto, uma intenção definida e contemplam as necessidades, potencialidades e interesses dos alunos PNEs, principalmente no que se refere ao uso dos recursos/ferramentas existentes em rede.

As ações planejadas têm a preocupação de disponibilizar situações que mobilizem a comunicação/cooperação entre esses usuários, com vistas ao seu aprendizado, bem como, oferecer uma gama de informações que proporcionem a democratização desses instrumentos digitais, para a sua inserção no mundo virtual, tendo como instrumento de mediação ambientes de realidade virtual.

Para tanto, nosso esquema de trabalho propõe aos educandos uma freqüência ao "AIA" de duas vezes por semana, duas horas por dia, por um período determinado pelo seu desempenho e avaliação satisfatória, uma vez que não há prazo para que deixem o projeto.

A cada encontro são feitos registros das observações efetivadas durante o processo e a avaliação tem como dinâmica considerar o **"antes"** e o **"depois"** de cada aluno, isto é, o que já conseguem fazer sozinhos (nível de desenvolvimento real) e o que podem realizar com a ajuda de alguém (nível de desenvolvimento potencial), atuando na ZDP de cada um, considerando, ainda, sua história, sua cultura e sua linguagem, a partir dos fundamentos teóricos que dão suporte à prática pedagógica desenvolvida neste ambiente de aprendizagem.

Neste conjunto de propósitos o presente trabalho destaca, dentre os recursos telemáticos utilizados, os **Ambientes Baseados em Realidade Virtual,** nos quais os educandos têm as possibilidades de desenvolver sua fantasia, sua imaginação, sua capacidade de criação e de reelaboração dos conhecimentos.

Nesse sentido, é preciso, ainda, investigar as várias propriedades de cada ambiente na promoção da aprendizagem conceitual, como as atividades "*sense making",* ou seja, não apenas treinar e praticar experiências, é necessário, também, compreender os elementos dos sistemas de RV, que levam os estudantes a não apenas realizar tarefas de "execução tranqüila", mas se envolver em atividades que requeiram explanação e extrapolação.

A PRODUÇÃO DE TEXTOS POR PPNE A PARTIR DAS EXPERIÊNCIAS REALIZADAS EM AMBIENTES BASEADOS EM REALIDADE VIRTUAL

Um ambiente imersivo de aprendizagem, para ter sucesso, deve fornecer sistemas de ensino de domínios diversos, representando as experiências requeridas no mundo real, fornecidas pela RV, podendo resultar na otimização de uma ferramenta direcionada ao ensino. De acordo com os pesquisadores Burdea [3] e Jacobson [4], pode-se dizer que a RV é uma técnica avançada de interface, onde o usuário pode realizar imersão, navegação e interação em um ambiente sintético tridimensional, gerado por computador, utilizando canais multi-sensoriais.

A RV também pode ser considerada, de acordo com Pinho [9], como a junção de três idéias básicas: imersão, interação e envolvimento. Isoladamente, essas idéias não são exclusivas de realidade virtual, mas aqui elas coexistem.

A qualidade que faz superior o ambiente de aprendizagem utilizando RV é a possibilidade do uso da tecnologia para superar as estratégias tradicionais do ensino, favorecendo a construção do conhecimento pelo aprendiz, atendendo, ainda, as características individuais dos sujeitos na aprendizagem,conforme conceitua Camacho [5]:

> (...) uma das grandes virtualidades dos sistemas de Realidade Virtual é a sua capacidade em apresentar e representar, através de sons e imagens, idéias abstratas e conceitos de difícil representação. A Realidade Virtual torna-se, então, uma espécie de transdutor sensorial, que traduz idéias e conceitos para sensações visuais, auditivas e tácteis que, depois de percebidas e processadas se transformam na informação que permitirá a compreensão dessas idéias e conceitos, de outra forma, inacessíveis.

No contexto deste referencial, um ambiente baseado em Realidade Virtual visa, assim, permitir que usuários possam expressar suas idéias e sentimentos, aperfeiçoar progressivamente suas potencialidades cognitivas e alcançar maior compreensão da realidade social, ou seja, conquistar sua liberdade formativa, intelectual e política.

Situações simuladas em RV propiciam a produção cooperativa de textos em que o retrato sócio-cultural dos usuários é promovido em situações sociais e de ação - ação que não ocorre fora das situações sociais - pois, ao mesmo tempo em que o indivíduo vivencia uma determinada situação, relaciona-a com a realidade, também a emprega na análise da situação social, objeto de sua aprendizagem, utilizando a língua e a linguagem de forma concreta.

É importante considerar ainda, que a RV aplicada à educação tem mostrado, segundo Medina et al [6]:

> (...) que o *fazer-agir, o inter-agir, o aprender, o conhecer sentir* assumem novos contornos: é como se, neste mundo, o que é da ordem do pensamento – *portanto imaterial-singular-subjetivo, inacessível ao outro que não o próprio pensador* – pudesse deslizar para um exterior-objetivo, para ser manuseado, transformado, compartilhado; mas que tendo deslizado, ainda assim permanece interior, imaterial; e toda interação se desse, neste mundo, no âmbito da imaterialidade, do incorpóreo; um mundo desabitado de corpos, em que tudo existe sem existir, em que tudo é puro efeito de realidade.

Com base nessa perspectiva, produzir textos a partir de experiências em ambientes baseados em RV tem o sentido de não se limitar apenas à prática lingüística, como um fim em si mesma, como afirma Alonso et al [1], mas:

> (...) sua tarefa é a de ir mais além, é a de propiciar condições para a formação de conceitos com os quais os usuários possam pensar e desenvolver a capacidade de analisar, generalizar e assimilar formas mais complexas de reflexão sobre os fenômenos da realidade; de organizar de uma nova maneira a sua percepção; de adquirir a capacidade de tirar conclusões das suas próprias observações; de conquistar todas as potencialidades do pensamento, superando, assim, suas limitações.

No cenário epistemológico atual, que não se contenta mais com verdades pré-estabelecidas, vale pensar, também, sobre a idéia da aprendizagem ativa a respeito do "aprender fazendo". Este aprender normalmente se concretiza através da produção textos escritos, que não são simples transcrições, mas, produtos de uma reflexão, reorganização e reformulação de conceitos, num complexo processo de descobertas.

A produção de textos por alunos PNEs, inserida em um contexto significativo, funcional, desafiador e com objetivos que atendam aos seus interesses e expectativas tem mostrado mudanças positivas no que diz respeito às suas atitudes em relação à própria escrita e, conseqüentemente, na aquisição de conhecimentos e ampliação de seu universo cultural e social.

As experiências realizadas por PNE com RV nos têm surpreendido no que se refere ao potencial destes educandos, que estão compreendendo seu mecanismo e interagindo no ambiente com expectativas e motivações. A RV tem auxiliado nossos alunos a compreender melhor a realidade, o outro e a si próprio como parte do sistema ao qual está inserido, tornando-os abertos ao pluralismo e à relatividade do observador, confirmando as palavras de MEDINA et al [7] quando diz que:

> (...) se o nosso modo de *conhecer-sentir-aprender* é um, ou não, entre outros; e se, assim como outrora tivemos que construir um mundo de objetos e sujeitos para nos construirmos enquanto sujeito de cultura, auto-consciente, podemos, agora, construir e coordenar **múltiplos modos de produzir sentido, múltiplos modos de conhecer-sentir-aprender-interagir,** inaugurando formas de entendimento calcadas num processo de estranhamento do *Real-Social,* conquistado pela mediação virtual.

O objetivo a que a RV se propõe neste projeto é oferecer situações onde os PNE possam desenvolver suas capacidades cognitivas de abstração, através de sua interação com o outro, com o meio físico, social e simbólico-cultural-tecnológico, que propiciam a construção de suas estruturas mentais, possibilitando que o conhecimento *subjetivo* se torne *objetivo* pela capacidade dedutiva que se instaura no processo das múltiplas possibilidades impostas pela RV.

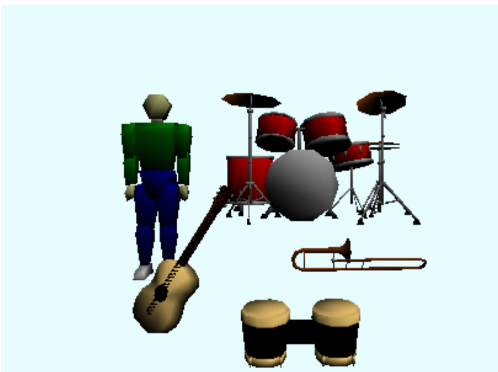
As questões acima colocadas podem ser observadas nos textos produzidos coletivamente pelos alunos participantes do projeto, a partir dos cenários de RV experienciados, dos quais mostramos alguns exemplos abaixo junto às respectivas cenas:

Figura 1 – Cena de lojas

Estamo paseado na rua vendo as loja. E colorido. Gostei atavesar parede não me maxuquei. Entrei na lojas. O guri esta camihnando na cauçada perdido. Qeum escreveu e o Tiago e a Katia vai crever agora.

Quero lanchar no restaurante que é bom. a comida é gostosa. estou voando emcima das lojas. Como é bom voar. vou trazer minha irma para voar. Euuu sou a adrianaaa e vou pegaar o gguriii que esta voado. Fim.

Figura 2 – Interior da loja de instrumentos



Fui em sam Paulo com meus amigos.

Eu sou Ronaldo. Toqeui bateria fes muito baruhlo. Vamos faze uma banda. E agora qeum vaescrever eo vitor.

Eusoo Vctor e vo com compra uma giutara. Daniel toca bateria e gosta Dniel atista qe canta CD.

Agorae Daniel .eu Daniel gosta do cator Daniel e vou coprar uCD

Vamosembora. Tcahu. FIM

Figura 3 - Cena 3

Minha namorada vai comprar ingreso para ver o chouda Xuxa. Ela e minha namorada. Eu quero casa co ela. E te muitos filhos. Estamos namorado no café brihlante e comendo bolo.

Quando o Ronaldo comprar bolo eu tambem quero comer bolo e refri. Eu sou a Kátia. fim

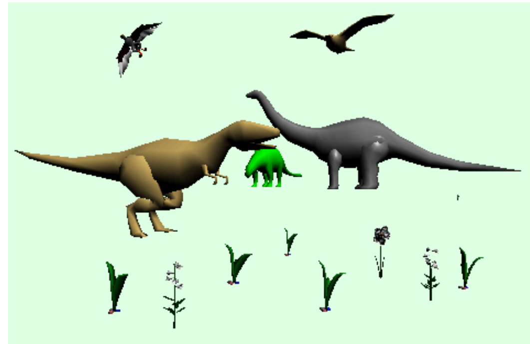


Figura 4 – Parque dos dinossauros

Etamos paseando em Porto Alegure ena rua da paia.

La bhlietria parconprar engreso pver paque dinsauru. Eu gosto denosaro Rex que e carnivo

Hoje vou ver denosauro. Como estou felis. Voutamos para casa de alto com Adriana e Kátia o Vitor tambem vai. Ele vai com a bandera dogremio.

Passsei com osdinossss. Pasei deeetro do dino. Ele não mordeuuu.

CONCLUSÃO

Apesar de os alunos PNE participantes do Projeto AIA já terem experiências no manuseio de ferramentas informáticas, em suas primeiras inserções nos mundos de RV tiveram um impacto, principalmente quando perceberam que poderiam visualizar os diferentes ângulos das cenas, atravessar os objetos, movimentá-los, produzir sons, etc., o que não os intimidou a continuar explorando o mundo virtual e a escrever sobre suas experiências apaixonadamente.

Suas produções revelam criatividade e um pouco da personalidade individual, possibilitando observar suas capacidades de atenção, memória, imaginação e organização de idéias.

Ressaltamos que é preciso levar em consideração o processo de construção do conhecimento de cada aluno, seus esforços, a superação de algumas dificuldades, enfim, toda a evolução da aprendizagem. Consideramos todo e qualquer progresso dos alunos, por menor que possa parecer e comemoramos como grandes conquistas. É preciso, ainda. considerar as limitações de cada um deles e o seu grau de comprometimento, assim como a vontade de progredir e superar os próprios limites.

Os textos evidenciam a originalidade de conteúdo, conduzindo-nos a refletir sobre a importância de assumirmos a postura de mediadores, estimulando a construção do conhecimento e, principalmente, proporcionando atividades de escrita com objetivos definidos pelos autores, no sentido de encontrar prazer em escrever e não apenas o fazer por obrigação, como uma tarefa a ser cumprida ou como rotina de uma aula de alfabetização.

Dessa forma, percebemos os alunos PNE como seres singulares e dotados de capacidades, que possuem valores e uma história de vida que deve ser considerada. Cabe a nós, educadores, impulsioná-los para que alcancem seus objetivos, através de outros mundos possíveis, via artefatos tecnológicos para que superem seus limites de aprendizagem.

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Hiper-Animações - Teoria Hipermídia Aplicada em Animações

Roges Horacio Grandi[1] e Paulo Fernando Blauth Menezes[2]

Resumo *— As animações são seqüências de imagens individualmente concebidas, acompanhadas ou não de sons, que objetivam simular um movimento. A teoria hipermídia é baseada na liberdade oferecida ao usuário de um determinado sistema computacional de escolher a ordem da apresentação de conteúdos diversos. Tradicionalmente, animações são construídas através de uma seqüência de quadros estáticos ou, então, de uma seqüência de transformações gráficas. Se oferecermos ao usuário a possibilidade de seguir, interativamente, não somente uma seqüência predeterminada de quadros ou transformações, oferecendo seqüências alternativas, estaremos criando hiper-animações, cujas potencialidades tecnológicas na informática, educação e engenharia estão para serem exploradas. Este artigo propõe a utilização de autômatos finitos com saída para uma forma de criar e controlar hiper-animações e demonstra sua aplicabilidade em educação à distância através de um exemplo de um simulador animado de um autômato que expressa uma determinada gramática de uma linguagem formal como exercício de teoria da computação.*

Palavras-chave — animações, hipermídia, teoria dos autômatos, educação à distância, padrões de projeto, UML.

INTRODUÇÃO

Antes do advento da eletrônica, o conhecimento da humanidade era registrado, basicamente, em livros. Uma sinfonia de Mozart, uma novela de Dostoievski, um fato histórico, um princípio filosófico, uma conclusão científica, que melhor maneira de armazenar e passar para gerações seguintes um conhecimento além de um bom livro?

A eletrônica, porém, permitiu expressivas diminuições dos custos e do espaço necessário para o armazenamento do conhecimento, conforme previra Vannevar Bush na década de 1940. Além disso, surgiram novos meios de comunicação que tornaram a troca de informações muito mais rápida e eficaz.

A busca seqüencial e indexada, características dos livros tradicionais tornaram-se insuficientes para a busca e associação de informações correlatas, exigindo a criação de alternativas mais diretas de acesso e relacionamento. O próprio Vannevar Bush, ao discutir essa questão, já propôs um mecanismo de associação e busca direta de informações que denominou Memex, um aparelho que funcionaria tal e qual uma extensão da memória humana. Esse aparato tornou-se a base de inspiração para a hipertecnologia, uma área de pesquisa da informática que se preocupa em propor formas alternativas de associação e busca entre informações além da seqüencial e da indexada [1].

Hoje, devido ao *boom* de informações gerado, a hipertecnologia é uma necessidade crescente e está se tornando uma característica funcional padrão dos sistemas de informação.

As primeiras implementações da hipertecnologia visaram permitir leitura não seqüencial de textos e foram denominadas hipertexto por Theodor Nelson em 1965. Outras formas de mídia (imagens, sons, animações, etc.) podem ser igualmente desejados em uma leitura não seqüencial. Por não se tratarem tais mídias de um texto puro Nelson também cunhou o termo hipermídia para definir a hipertecnologia multimídia [2].

ANIMAÇÕES GRÁFICAS E SISTEMAS HIPERMÍDIA BASEADOS EM AFS

Sendo, essencialmente, a hipertecnologia uma rede de informações, buscou na teoria dos grafos e em outros fundamentos matemáticos formas e propriedades para apresentar suas características, modelagens e implementações. Os autômatos finitos com saída (AFS) baseiam sua forma nos grafos. O Laboratório de Fundamentos da Computação (LFC) da Universidade Federal do Rio Grande do Sul (UFRGS), do qual os autores participam, tem realizado pesquisas propondo os AFS como base matemática e de modelagem de sistemas hipertexto, que tem gerado implementações bem sucedidas e de qualidade e podem ser vistas no sítio (site) do laboratório [3]. Uma dessas pesquisas, denominada Animação Gráfica baseada em Autômatos Finitos (AGA), propõe a montagem e gerenciamento de animações bidimensionais de tempo real modelando-as como AFS especializados, contendo alfabetos de entrada e de saída, fitas, estados e funções, onde os atores – objetos que participam da animação - são definidos através dos autômatos e as fitas definem seus comportamentos.

"Independente da dimensão, os sistemas de animação por computador também podem ser classificados, segundo o critério de modo de produção, em sistemas de tempo real ou quadro a quadro [4,5].

Os sistemas de animação em tempo real geram a imagem final para visualização no momento de sua

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apresentação. Esta abordagem favorece principalmente as animações interativas, onde a imagem visualizada deve corresponder às ações instantâneas tomadas pelo usuário [4 apud 6]". Sendo uma das características básicas da hipertecnologia - a interatividade - e sendo que a abordagem de tempo real a favorece, mais uma vez podemos perceber um elevado potencial de integração entre as duas tecnologias.

Uma vez que a base matemática dos AFS, utilizados no AGA, é a teoria dos grafos, a mesma que baseia a hipertecnologia, percebemos uma interseção natural de propriedades permitindo-nos supor que a inserção de características hipermídia no AGA, do ponto de vista matemático, é um tanto facilitada e natural. O LFC já implementou alguns sistemas hipermídia baseados em AFS: o Hyper-Automaton, para apresentar cursos na Web [7] e as Provas Adaptativas, um modelo hipermídia de construção de avaliações eletrônicas [8]. Dessa maneira, já estão definidos sistemas hipermídia e, também, um modelo de animação todos baseados em AFS.

INSERINDO HIPERTECNOLOGIA EM ANIMAÇÕES

Podemos classificar os diversos tipos de mídia de forma independente em textos, sons, imagens, filmes e multimídia, sendo o último uma composição dos anteriores [9]. Outra classificação possível é, inicialmente, dividir diversas mídias em sons, que estimulam o senti

do da audição, e em imagens, que estimulam o sentido da visão. As imagens, por sua vez, podem ser especializadas em gráficos e textos, conforme a presença ou não de elementos gramaticais. Filmes e animações são composições seqüenciais de mídias visuais sendo as suas formas de aquisição, respectivamente, por fotografias ou concepção individual. Podem incluir, opcionalmente, seqüências de elementos sonoros. Um exemplo de animação contendo seqüências de imagens e textos combinados são as animações legendadas. A sincronização ou não de sons com imagens permite-nos mais uma vez classificar filmes/animações em "falados" ou "mudos". Animações podem, também, ser inseridas em filmes, à exemplo das produções cinematográficas que contém efeitos especiais produzidos por animações [10]. Classificando-se desta maneira, filmes e animações podem ser considerados como produtos multimídia, uma vez que possuem a capacidade de absorver mais de um tipo de mídia. Se formos mais específicos, podemos aindaé subdividir as imagens em bi e tridimensionais. O escopo deste trabalho são as imagens bidimensionais, sendo que o LFC pretende dar continuidade a esta pesquisa contemplando a tridimensionalidade.

Por fim, mídias podem contemplar hipertecnologia, se desejado. Qualquer mídia, seja auditiva ou sonora, podem servir de âncora hipermídia. Com a tecnologia atual, entretanto, somente imagens podem servir como elementos clicáveis servindo como opção interativa para determinar seqüências de execução através de hiperligações. Textos podem ter, por exemplo, características funcionais semelhantes à uma referência hipertexto em HTML[3]. Da mesma forma, tendo como base a WWW/Internet, sistema hipertexto mais popular atualmente, uma imagem pode ser definida como um mapa clicável.

Um diagrama de classes escrito em UML[4], produto desta forma de classificar, pode ser visto na Fig. 1. Observa-se no diagrama a aplicação do padrão de projeto orientado a objetos Composite [11].

Animações em tempo real podem permitir que várias mídias sejam transformadas simultânea e concorrentemente, disponibilizando textos, sons e imagens em uma mesma composição. Se tais características multimídia tiverem, adicionalmente, características hipermídia, cremos que a semântica operacional poderá ser fortemente enriquecida. É nesse intuito que se propõe o estudo de animações em tempo real com características hipermídia, formando hiper-animações.

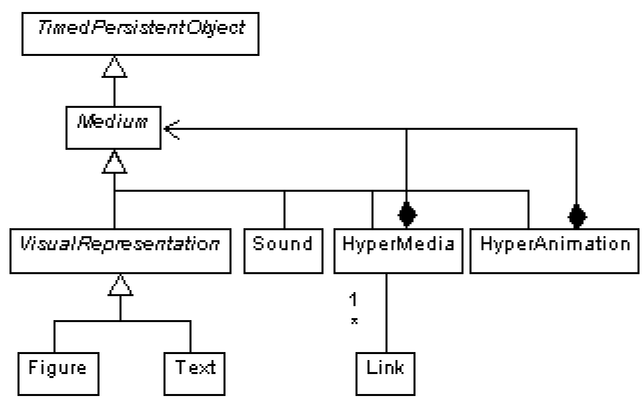

FIGURA 1
Diagrama de classes em UML especificando uma taxionomia de mídias contemplando hipertecnologia.

HIPER-ANIMAÇÕES BASEADAS EM AFS

Um padrão de projetos comportamental bastante útil para se modelar interações homem-máquina, principalmente quando a mudança de estados na máquina é bem controlada, é o *State*, uma vez que elimina a necessidade de formação de grandes estruturas condicionais, explicita as transições e os estados e permite que os objetos referenciados sejam reaproveitados interna e externamente, através da interação com outros sistemas [11].

Tal abordagem, conforme já comentado, é adotada pelo LFC através da implementação de AFS em vários projetos e apresenta-se igualmente útil para modelar hiper-animações. A fim de integrar a modelagem das hiper-

[3] Hypertext Markup Language. Linguagem de marcação utilizada pela World-Wide Web na Internet.
[4] Unified Modeling Language. Linguagem de especificação padrão de fato em sistemas computacionais orientados a objetos.

animações (Fig. 1) com a modelagem de um AFS, podemos montar uma máquina de Mealy[5] [12] especializada. A estrutura básica de uma máquina de Mealy, para este caso, inclui os conceitos de estado, transição, alfabetos de entrada e de saída e função parcial programa. Dentre algumas especializações, as palavras de saída são mídias hiper-animadas que, para tecnologia Internet, podem ser referenciadas por URL[6].

. Por objetivar a construção de uma aplicação persistente, pode-se aplicar também o padrão de projeto *PersistentObject* [13], a partir do qual todos os objetos persistidos possuem um identificador e, por conveniência de publicações, podem ter também um nome e um autor. O resultado é o diagrama de classes UML da Fig. 2.

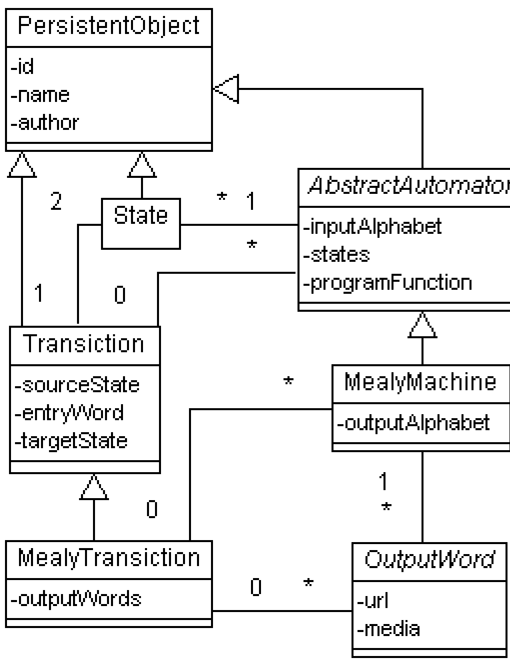

FIGURA 2
Diagrama de classes em UML especificando uma taxionomia de mídias contemplando hipertecnologia.

Um autômato abstrato reúne os conceitos básicos de coleção de estados, alfabeto de entrada e função parcial programa. Concretizando-se o autômato abstrato em uma máquina de Mealy, sua função programa é especializada passando a gerar palavras de saída a casa transição, no nosso caso palavras vazias, mídias simples ou compostas.

SIMULADOR ANIMADO

Hiper-animações podem ser aplicadas em diversas áreas, dentre elas a da educação à distância (EAD). Um simulador animado de um autômato que expressa uma determinada gramática de uma linguagem formal é um exemplo de sua aplicação em cursos eletrônicos sobre teoria da computação, disponibilizados via Internet. A Fig. 3 mostra uma instância desse tipo de autômato equivalente à expressão regular `(a|b)*(aa|bb)(a|b)*`.

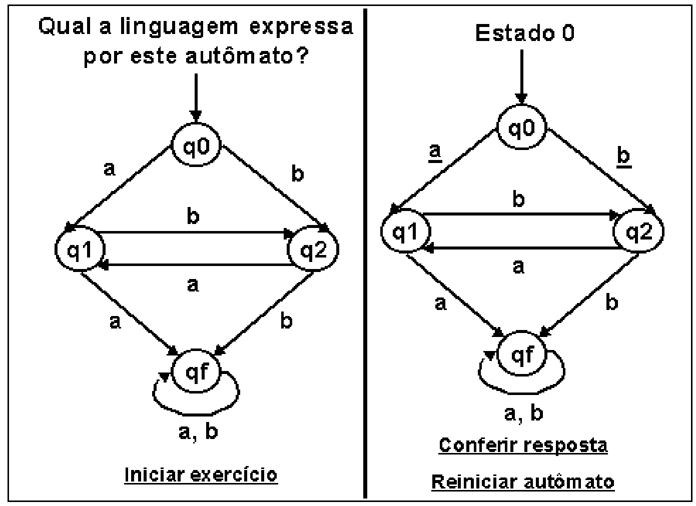

FIGURA 2
Exemplo de hiper-animação aplicada em ensino de teoria da computação

Neste exemplo, o aluno pode optar como controlar a simulação. Após ser introduzido ao problema proposto, quadros seguintes da animação, acionadas pela hiperligação "Iniciar exercício" permitem que o aluno, a partir do estado zero (representado por `q0`) interaja com o autômato experimentando-o com as hiperligações `a` e `b`, ou, opcionalmente, com as hiperligações "Conferir resposta" ou "Reiniciar autômato". Note-se que a animação não segue, necessariamente, uma seqüência específica de quadros. Esta é determinada pela vontade do aprendiz que pode experimentar vários quadros seguintes (estados 1, 2 e f), conferir diretamente a resposta, caso já a tenha abstraído, ou reiniciar o autômato (reiniciar a animação). Esta liberdade de escolha de seqüência de apresentação de mídias é desejada pela hipertecnologia e sua programação, bem como sua documentação, são facilitadas pela presença das hiperligações e, também, por sua modelagem utilizando-se os padrões de projeto supra citados.

CONCLUSÕES

Conforme demonstrado no exemplo aplicado em educação à distância, as hiper-animações possuem um forte potencial de simplificação de programação, aprimoramento de documentação e, também, de reaproveitamento tanto de análise como dos produtos gerados, se utilizados padrões de projeto corretos.

[5] Autômato finito que gera uma palavra de saída para cada transição.
[6] Uniform Resource Locator

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Implementação de um sistema de desenvolvimento para microcontroladores 8051

João Pereira de Brito Filho[1], Remy Eskinazi Sant'Anna[2]

Resumo *— Este trabalho apresenta a implementação de um sistema de desenvolvimento para hardware e software, baseado no microcontrolador 8051, desenvolvido para ser utilizado cursos técnicos de nível médio, graduação e pós-graduação de Eletrônica.. Paralelamente, é apresentada uma metodologia de implementação de projetos, utilizando-se técnicas de particionamento para hardware e softwar. Através de um sistema operacional, o sistema de desenvolvimento em microcontrolador, apresenta facilidades de acesso aos recursos de um microcontrolador 8051 standard, bem como de interfaceamento com memória e dispositivos de E/S externos, além de armazenamento e execução de programa externo, em uma operação de download de programa. Para permitir estas operações de descarga de programa em memória externa do protótipo, de forma que este permanecesse executável, foi implementado também um programa de interface em ambiente gráfico, de modo a permitir a edição de diversos programas em Assembler do microcontrolador, chamadas para compilação e verificação de erros além da operação de download do programa compilado.O protótipo construído apresentou-se perfeitamente operacional, atendendo as especificações iniciais de projeto.*

Palavras chave — Microcontroladores 8051, Metodologias de projeto, Particionamento Hardware/Software, Protótipo.

Introdução

Atualmente, podem ser observados diversas aplicações, equipamentos e sistemas de controle baseados em microcontroladores. Notadamente os dispositivos da família 8051 são bastante populares , apesar de utilizarem barramentos de 8 bits, o que na verdade torna-se vantajoso para aplicações de pequeno e médio porte, que são a maioria das aplicações encontradas [5].

Apesar deste grau de utilização e popularidade, este dispositivo ainda não é estudado com profundidade e atenção merecidas, pelos cursos da área de Engenharia Eletrônica e de nível médio (UPE – Escola Politécnica e CEFET-PE), mais ainda, existem poucos ou nenhum recursos práticos para ensino que possam dar acesso à potencialidade deste dispositivo, proporcionando um maior e melhor nível de concernimento à utilização pratica, projetos e desenvolvimento de *hardware* e *software* [7].

Outro aspecto que merece atenção é o fato de que praticamente não existam sistemas de treinamento semelhantes a disposição com nível de informações de *hardware* e *software* abertos ou seja, que seja possível e permitido o melhoramento de suas características e potencialidades funcionais pois na maioria das vezes estes sistemas estão protegidos de alguma forma por *copyrights*. Alem disso, com freqüência, os sistemas importados tornam os custos de expansão e até mesmo de aquisição, proibitivos ao passo que o desenvolvimento de um sistema deste tipo no âmbito da UPE teria como vantagens imediatas uma maior flexibilidade de sistema , maior índice de informações de *hardware* e *software*, além de ser facilmente duplicável através da aquisição de componentes no mercado local [8].

O presente trabalho de pesquisa tem como objetivo o desenvolvimento de um sistema de treinamento e ensino em microcontroladores da família 8051 que possa ser utilizado posteriormente nos cursos de graduação e pós graduação de eletrônica, de forma que este permita, por possuir uma arquitetura aberta, deixar a disposição todas as facilidades de expansão de hardware e de software, e melhoramento de sua operacionalidade e recursos implementados.

Outro ponto observado no projeto é como sistemas deste tipo podem ser implementados. Freqüentemente, durante a execução de um projeto baseado em microcontrolador, ocorrem diversos erros de implementação por *hardware* ou *software*. As etapas de correção de erros, freqüentemente chamadas pelos projetistas como fase de *debug*, consomem bastante tempo de projeto. Estas etapas de *debug* podem ser minimizadas caso seja adotada uma metodologia de particionamento do projeto a ser implementado. Isto quer dizer que operando-se em módulos bem especificados e pequenos e, posteriormente promovendo-se a interação entre estes módulos, sejam estes em *hardware* ou *software*, se tem maior probabilidade de acerto na montagem final do projeto. O presente trabalho de pesquisa enfoca paralelamente, a utilização desta metodologia para implementação do sistema de desenvolvimento, bem como para projetos baseados em microcontroladores.

Sendo assim, os temas abordados no presente artigo são os seguintes:

- Implementação de um sistema de desenvolvimento em microcontroladores, aberto, de baixo custo, que

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possa ser utilizado no âmbito dos cursos Eletrônica de nível médio, graduação, pós-graduação e atividades de pesquisa;

- Estudo de uma metodologia de implementação prática, através de particionamento de *hardware* e *software* de modo a facilitar o desenvolvimento de circuitos microcontrolados;

- Aprimoramento das técnicas de implementação de projetos baseados em controle por microcontroladores.

Metodologia de implementação de projeto baseado em microcontrolador

Apesar de se enfatizar aplicações da metodologia para microntroladores 8051, ela poderá ser aplicada, em grande parte, para qualquer sistema baseado em determinado dispositivo controlador, ou seja, aprenta-se uma metodologia de desenvolvimento de *hardware* e *software* que pode ser aplicada como técnica de projeto de sistemas microcontrolados. Neste ponto, pode-se estabelecer o que será denominado de etapas de desenvolvimento de um sistema baseado em microcontrolador. Estas etapas unificadas podem gerar na verdade um processo cíclico, ou seja, quando na etapa final de testes não forem alcançados os objetivos traçados na etapa inicial, o processo poderá ser revisto ou retornado em algum ponto.

Pode-se estabelecer pelo menos os seguintes pontos como etapas de desenvolvimento de sistemas [1]:

- Requerimentos funcionais do sistema;
- Especificações de projeto do sistema;
- Particionamento;
- Modularização de *hardware* e *software;*
- Integração de *hardware* e *software;*
- Elaboração da documentação de projeto;
- Verificação funcional e avaliação do sistema.

Estas etapas serão adaptadas às características do sistema a ser desenvolvido. Tem-se a seguir, uma descrição generalizada de cada etapa de desenvolvimento.

Requerimentos funcionais do sistema

Nesta etapa é confeccionada a documentação que descreve exatamente as capacidades, características e modo funcional do sistema quando terminado. Esta documentação deve conter, por exemplo, uma relação de todas as tarefas que o sistema deve realizar para o usuário final. Nesta etapa, deve existir um intercâmbio entre projetistas e usuários finais do sistema de forma a gerar os requerimentos funcionais de maneira a mais definitiva possível (que será o alicerce para todas as outras etapas de desenvolvimento) de forma consistente e viável.

Especificações de projeto de sistema

Uma vez que estejam definidos os requerimentos funcionais do sistema, devem ser feitas as especificações do projeto do mesmo. Isto quer dizer que, nesta etapa, deve-se decidir como o sistema deverá interagir com o usuário bem como especificar as entradas e saídas dos dispositivos envolvidos. Talvez seja fundamental, a confecção de uma relação das funções que o sistema deve realizar de forma a implementar as tarefas definidas pelo usuário.

Desta forma pode-se estabelecer que enquanto os requerimentos funcionais do sistema devem mostrar o *que* o dispositivo final deve fazer, as especificações de projeto do sistema devem detalhar *como* o sistema deve operar de forma a realizar as tarefas especificadas na etapa anterior.

Particionamento

Uma vez estabelecidas as especificações de projeto, poderá ser feito o particionamento entre *hardware* e *software,* ou seja, quais as funções do sistema que serão realizadas por *hardware* e *software*. Para cada projeto sempre ocorrerá situações em que uma função do sistema deve ser implementada apenas em *hardware* (ou *software*). Caso exista a possibilidade de a função ser implementada de outra maneira, devem ser levados em consideração outros aspectos, tais como, custo ou tempo requerido de implementação da nova solução. Existe nesta etapa, dependendo da complexidade do projeto, a possibilidade de ser preciso realizar um estudo de *hardware*/*software* codesign.

Modularização de *hardware e software*

Após a definição das funções que serão implementadas por *hardware* e por *software* no sistema, o projeto pode tomar dois caminhos distintos, geralmente dependentes da sua complexidade:

- Desenvolvimento de *hardware* e *software* por apenas um projetista;
- Desenvolvimento de *hardware* e *software* paralelo por projetistas ou equipe de projetos distintos

A primeira situação ocorre com freqüência em projetos de baixa complexidade que envolvem ciclos de implementação curtos e custo reduzido. Sistemas mais complexos como projetos de instrumentação ou controle de sistemas distribuídos, exigem um particionamento (até mesmo integração) de projeto em *hardware* e *software*. Em ambos os casos existe então a modularização do projeto de *hardware* e *software* ou seja, o projeto de *hardware* é dividido em módulos, cada qual implementando uma ou mais funções de *hardware*. O *software* também é particionado em uma hierarquia de módulos, cada um dos quais implementa uma ou mais tarefas. Estes módulos podem posteriormente ser divididos em *procedures* que seriam rotinas para realizar funções específicas. O módulo final de *software* consistiria de grupos de *procedures* que estariam ligadas umas as outras.

Integração de *hardware* e *software*

A integração entre *hardware* e *software* pode ser vista como a etapa de compatibilidade entre os dois projetos especialmente se estes forem implementados de maneira paralela. Isto é possível de ser implementado normalmente pela instalação de uma memória não volátil com o sistema de *software* desenvolvido, adicionado ao *hardware* e fazendo posteriormente um teste de desempenho do sistema. Neste caso, deverá também ser implementada uma interface entre o *hardware* e o *software* ou seja, algum programa que permita a operação do *software* sobre o *hardware* projetado. Como exemplo desta interface, pode-se ter um módulo anterior ao *software* a ser integrado que identifique quais as funções ou recursos de *hardware* que estão implementados e que deverá interagir com o *software*. Outra possibilidade seria a utilização de um emulador do microcontrolador utilizado para verificação de funcionalidade do *software*.

Elaboração da documentação de projeto

Uma etapa não menos importante seria a geração de relatórios e anotações das tarefas realizadas e resultados obtidos durante o ciclo de desenvolvimento do projeto. Posteriormente, a unificação destes relatórios de forma lógica e ordenada formaria a documentação do sistema. A importância deste ponto pode ser percebida em um caso particular de desenvolvimento de um projeto de grande complexidade. Se as anotações estão incompletas ou escritas de forma não clara, surgirá a dificuldade de manutenção de *software* o que muitas vezes podem alcançar grandes percentuais de custos de desenvolvimento de *software*. Em resumo, técnicas bem direcionadas de projeto associadas a documentação de desenvolvimento e a objetivos bem definidos de projeto, conduzem a facilidades de implementação e menor custo de manutenção do sistema em desenvolvimento.

seja, a detecção de erros em qualquer ponto significa o retorno para o ponto anterior do ciclo. A Fig. 1 mostra um fluxograma do processo de execução de projeto:

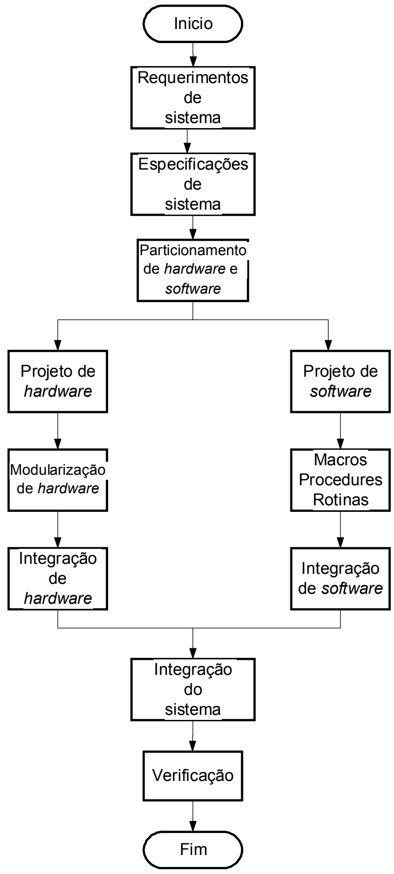

FIGURA 1 – METODOLOGIA DE IMPLEMENTAÇÃO DE PROJETO

As etapas para desenvolvimento do *hardware* [3] podem ser colocadas em um fluxograma como o ilustrado na Fig. 2, como considerações a serem observadas no desenvolvimento do *hardware* que atenda as especificações do sistema alvo.

Verificação e avaliação do sistema

Finalmente, a ultima etapa seria a avaliação completa do sistema para a verificação dos requerimentos funcionais idealizados na primeira etapa. Pode-se perceber que todo processo de execução do projeto é interativo, ou

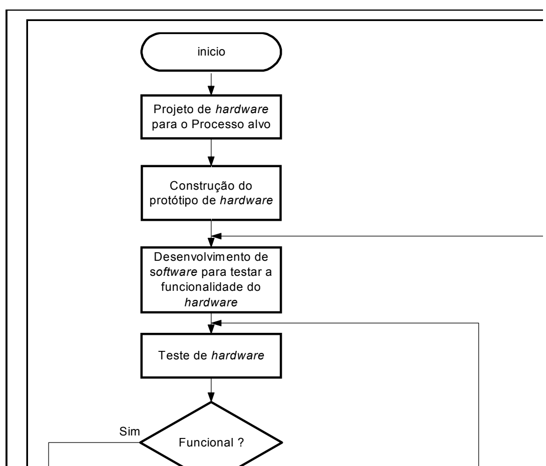

FIGURA 2 – METODOLOGIA DE IMPLEMENTAÇÃO DE *HARDWARE*

Para o desenvolvimento do sistema opracional foi utilizada uma metodologia Top-Down de particionamento de software. Neste tipo de implementação, as funções do sistema são especificadas e o projeto é dividido em subfunções onde, inclusive, podem ocorrer outros níveis mais abaixo destas subfunções. Como cada subfunção está especificada, isto limita e define as suas propriedades. Desta maneira, as propriedades das funções em níveis mais baixos tem uma maior probabilidade de integração nas etapas onde o *hardware* e *software* vão ser integradas. Percebe-se que o projeto procede das considerações dos maiores para os menores níveis ou do mais generalizado para os mais específicos. As funções de níveis mais subalternos deverão ser especificadas posteriormente às de maior nível, quando ficar claro de que maneira será a interação com estes módulos de níveis mais elevados, sendo que a implementação das funções de menor nível não poderá ocorrer , até que o processo de particionamento esteja completo.

Pode-se então fazer algumas considerações de como se apresenta em linhas gerais, um programa estruturado na metodologia "*top-down*". Na realidade existe normalmente um arranjo hierárquico de todas as rotinas do *software* desenvolvido. No nível de topo, existe uma rotina principal, freqüentemente chamada de rotina ou programa principal. A função desta rotina principal é gerenciar o fluxo de todo o programa sendo que as tarefas que devem ser executadas são implementadas como uma série de subrotinas ou *procedures*. O programa principal inicializa o sistema e então ele realiza entradas, *poolings* e *loops* de programa que examinam as entradas e controles do sistema, muitas vezes por subrotinas específicas para tal. Estas condições são testadas e se necessário, o programa principal chama as rotinas adequadas para realizar a tarefa necessária. Em sistemas mais complexos, o programa principal pode chamar uma das diversas subrotinas e muitas das procedures que estão operando, podem ter suas próprias subrotinas em níveis mais baixos. Em qualquer caso, o fluxo do programa ocorre a partir do programa principal para as subrotinas ou subdivisões destas e sempre retorna para o programa principal. A Fig. 3 mostra uma metodologia de implementação "*top-down*" [2].

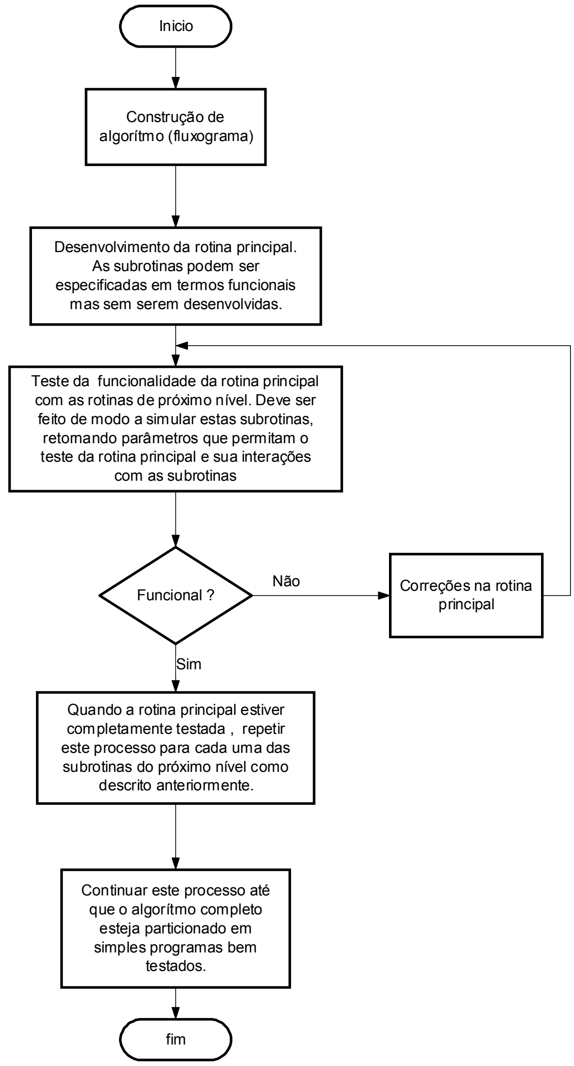

FIGURA 3 – METODOLOGIA DE IMPLEMENTAÇÃO DE *SOFTWARE TOP -DOWN*

Implementação do sistema de desenvolvimento

A partir dos requerimentos para um sistema de desenvolvimento para microcontrolador 8051, foram feitas as especificações e o diagrama em blocos, mostrado na Fig.4:

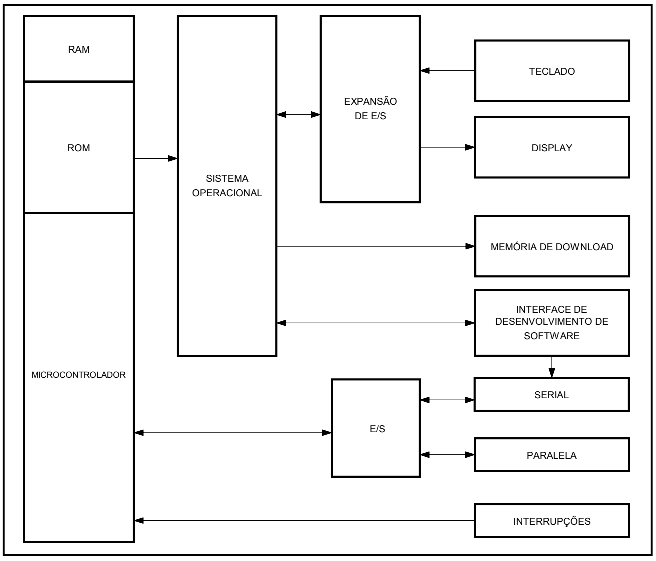

FIGURA 4 – DIAGRAMA EM BLOCOS DO HARDWARE DO SISTEMA

Implementação do sistema operacional

O sistema operacional foi implementado de acordo com os requerimentos do sistema, para atender a 8 funções básicas como pode ser visto na Fig. 6.

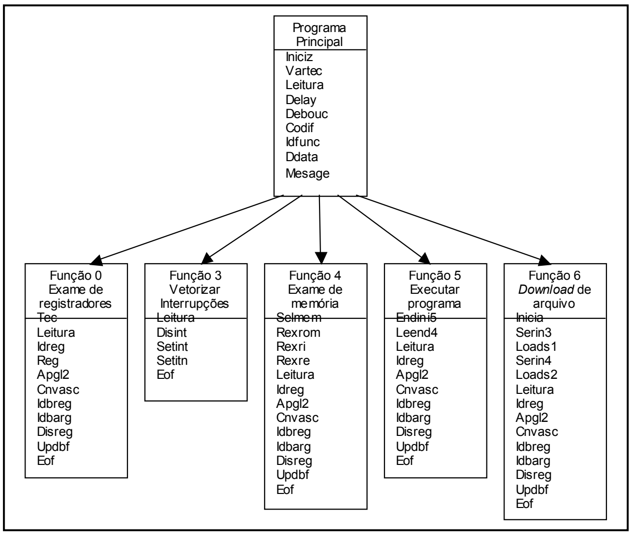

FIGURA 5 – PARTICIONAMENTO DO SISTEMA OPERACIONAL

As funções 1 e 2 estão reservadas a expansão pelo usuário. A função 7 está reservada para finalizar as outras funções e remeter o S.O. ao estado de reset. A figura mostra o particionamento do S.O com as principais subrotinas utilizadas de acordo com a metodologia Top-Down.

Implementação da Interface de Desenvolvimento

Este programa foi desenvolvido em Delphi, de forma a disponibilizar ao usuário a edição, chamada para compilação e download de arquivos binários para o sistema de desenvolvimento em ambiênte gráfico. A Fig. 7 mostra a tela do programa com 2 arquivos sendo editados.

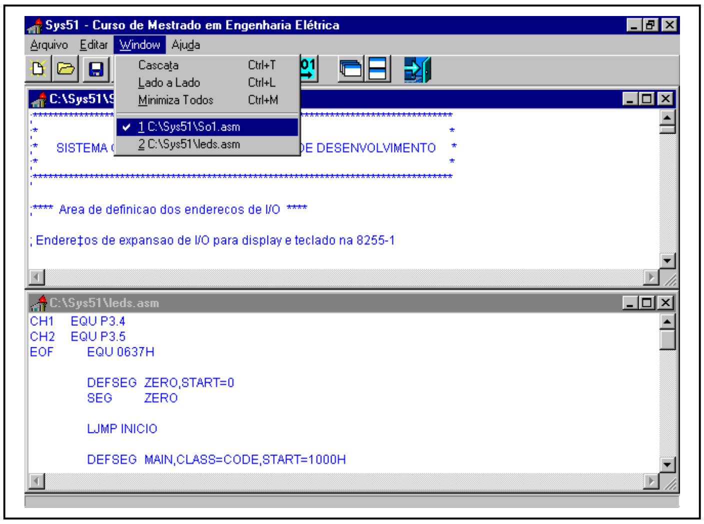

FIGURA 6 – TELA DA INTERFACE DE DESENVOLVIMENTO

Atualmente está sendo implementado uma interface de simulação do microcontrolador 8051, que ainda não se encontra disponível, dentro da filosofia deste sistema ser aberto a melhoramentos e modificações dentro do ambiente acadêmico. Desta forma, os programas poderão ser simulados antes de serem executados na plataforma de desenvolvimento.

Conclusões

A implementação deste sistema de desenvolvimento para microcontroladores 8051, sendo um sistema aberto, trouxe vantagens imediatas no processo de ensino-aprendizagem nas disciplinas correlacionadas a projetos com microcontroladores. Mesmo não apresentando uma arquitetura tão moderna, este microcontrolador (ou algum dos seus variantes) ainda é encontrado fartamente em aplicações de controle.

Com as informações de projeto disponibilizadas, o sistema tende a se desenvolver com diversos melhoramentos que podem ser implementados. A metodologia de projeto ora apresentada, sendo bastante simples e generalista, pode ser empregada em qualquer projeto que envolva o uso de microcontrolador, mesmo aquelas de arquitetura distinta (RISC por exemplo) [4].

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Fluxo de Carga versus Fluxo de Carga Continuado Parte III: Fluxo de Carga Desacoplado Rápido

Dilson A. Alves[1] *e Rogério R. Matarucco* [1]

Resumo — *Os métodos de fluxo de carga de Newton e Desacoplado Rápido convencionais são considerados inadequados para a obtenção do ponto de máximo carregamento* (*PMC*) *de sistemas de potência, devido à problemas de mal-condicionamento das matrizes usadas pelos métodos, neste ponto crítico e na sua vizinhança. Neste ponto a matriz Jacobiana do método de Newton torna-se singular e considera-se que não são mais válidas as hipóteses de desacoplamento P-V e Q-θ utilizadas para a formulação do método fluxo de carga Desacoplado Rápido. Os métodos da continuação são ferramentas eficientes para se obter o PMC. Nestes, técnicas de parametrização são utilizadas para evitar a singularidade da matriz Jacobiana e assim eliminar o mal-condicionamento das matrizes utilizadas nos métodos desacoplados. Neste trabalho são apresentados e avaliados os métodos de Fluxo de Carga Desacoplado Rápido convencional e propostos, considerando as variações de cargas numa única barra.*

Palavras - Chave — Fluxo de carga desacoplado rápido, métodos da continuação, ponto de máximo carregamento.

INTRODUÇÃO

A ampla utilização do método desacoplado rápido tradicional, no que diz respeito ao cálculo de FC, se deve às suas características de velocidade de convergência e pequeno espaço de memória necessário. Em função destas vantagens, há um interesse por parte das empresas na sua utilização nos algoritmos de continuação visando, com isso, a redução do tempo de CPU necessário para o traçado das curvas PV. A não utilização dos métodos desacoplados se deve ao fato de se acreditar que o desacoplamento não possa ser usado próximo ao PMC, e que somente as soluções de alta tensão podem ser obtidas. Os objetivos deste trabalho são os de introduzir os conceitos básicos dos métodos Desacoplados Rápidos propostos para a solução de fluxo de carga (FC) e demonstrar que, uma vez adequadamente equacionados, qualquer um deles pode ser usado para a obtenção do PMC de um sistema de potência. Os métodos estão subdivididos de acordo com as curvas a serem traçadas: PV, QV, e SV. Ao final de cada grupo demonstra-se que os métodos utilizados no traçado das curvas PV e QV podem ser considerados como casos particulares do usado para o traçado da curva SV. As expressões analíticas apresentadas na parte I [1] são usadas para convalidar os resultados obtidos pelos métodos desacoplados rápidos, existente e propostos, considerando as variações de cargas numa única barra. Conforme concluiu-se na parte II [2], todos os métodos aqui apresentados são casos particulares do método da continuação com preditor secante de ordem zero [3].

OBTENÇÃO DAS CURVAS QV, PV E SV PELO FLUXO DE CARGA DESACOPLADO RÁPIDO

A seguir apresentam-se os métodos Desacoplados Rápidos utilizados para o traçado das curvas QV, PV, e SV, para o caso de variação de potência em apenas uma única barra.

Fluxo de Carga Desacoplado Rápido Convencional

As simplificações introduzidas por Stott e Alsaç [4] na matriz Jacobiana do fluxo de carga pelo método de Newton deram origem ao método de FC Desacoplado Rápido (FCDR), descrito por:

$$\begin{aligned} B'\Delta\theta &= \Delta P/V \\ B''\Delta V &= \Delta Q/V \end{aligned} \qquad (1)$$

A versão proposta em [4] é atualmente conhecida como versão XB. Outras versões foram implementadas e testadas por Van Amerongen [5], sendo uma delas a versão BX. A diferença básica entre as versões está nos elementos das matrizes *B'* e *B"*. As matrizes são constantes e de dimensões diferentes em virtude da exclusão das barras do tipo *PV* da matriz *B"*. Monticelli *et al.* [6] apresentaram uma justificativa analítica e unificada, que possibilitou uma melhor compreensão do bom desempenho dos métodos desacoplados rápidos (BX e XB), a qual era até então desconhecida. Em [6] mostra-se que os algoritmos das versões BX e XB podem ser deduzidos a partir da equação do método de Newton (equação (34), parte I [1]), considerando-se V = 1 p.u. e θ = 0 grau, e assumindo que o sistema seja constituído por ramos com a mesma razão r/x ou seja radial. Mesmo quando o sistema não apresenta uma destas características, os algoritmos BX e XB continuam a ser uma boa aproximação para fins práticos. No geral, a versão BX apresenta melhor desempenho que a XB, em virtude das aproximações extras (desconsideração dos efeitos das barras *PVs* e dos elementos *shunts* na matriz de sensibilidade P-θ) necessárias para a obtenção da última.

O FCDR foi utilizado para o traçado da mesma curva PV da Figura 1 parte II [2], utilizando o mesmo sistema da Figura 1 parte I [1], e o mesmo procedimento usado no caso do método de Newton [2]. Os resultados mostram que, embora seja possível obter os mesmos pontos, o número de

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meias iterações necessárias é muito alto, em torno de 100, enquanto que para o método de Newton tem-se 10 iterações [2]. Interrompendo o processo de cálculo com um número menor de iterações a potência máxima alcançada será proporcionalmente menor. Por exemplo, para 15 meia iterações o valor máximo de Pg_2 foi de 94,15 MW pelo FCDR usando a versão XB, enquanto que pelo método de Newton Pg_2 foi de 95,15 MW para 3 iterações [2].

Fluxo de Carga Desacoplado Rápido Modificado

Os métodos FCDR modificados (FCDRM) foram obtidos a partir dos respectivos métodos de Newton modificados usando o mesmo procedimento mostrado em [6]. O sistema considerado para a obtenção dos FCDRM pode ser visto na Figura 1 a seguir.

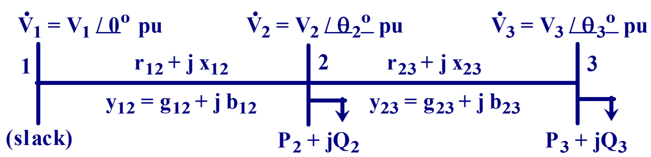

FIGURA 1
SISTEMA DE TRÊS BARRAS

Os valores numéricos adotados para os componentes deste sistema foram os seguintes: $\dot{V}_1 = 1{,}19\angle 0^{o}$ p.u., z_{12} = (1/3)×(0,3 + j 1,0) p.u., z_{23} = (2/3)×(0,3 + j 1,0) p.u., e $P_2 + jQ_2$ = 0 + j 0. Estes valores, bem como a tolerância de 10^{-5} p.u. adotada para a convergência dos *mismatches* e o esquema de iteração padrão, são usados em todos os exemplos que se seguem para os métodos desacoplados, excetuando os casos para os quais for especificado de forma diferente. Entende-se por esquema de iteração padrão aquele que, após a convergência de um dos subproblemas, iterações sucessivas podem ser realizadas no outro subproblema, até que ambos atinjam a convergência ou, o que pode ocorrer, o subproblema convergido divirja [4].

Curvas QV e PV

Para se obter as curvas QV e PV segue-se o mesmo procedimento apresentado em [2]. No caso da curva QV, com a especificação da tensão V_k eliminam-se a linha e a coluna k da matriz *B"*, procedimento similar ao utilizado para as barras *PV*. Para cada tensão especificada V_k executa-se um programa de FCDRM e obtém-se a potência reativa Q_k necessária para se manter o nível preestabelecido de tensão. Da mesma forma, para se obter a curva PV pode-se especificar o ângulo da tensão da barra k. A barra é redefinida como sendo do tipo $Q\theta$. Com isso, θ_k deixa de ser uma variável dependente e, consequentemente, pode-se eliminar as respectivas linha e coluna k da matriz *B'*. Para cada valor especificado de θ_k obtém-se a respectiva potência ativa P_k. Nestes dois casos, excetuando a eliminação da linha ou da coluna k em função do parâmetro (V_k ou θ_k) do método considerado, não há alterações nas leis de formação das matrizes *B'* e *B"*, e ambas as versões BX e XB podem ser utilizadas em suas formas convencionais.

Entretanto, a obtenção das curvas QV e PV por meio da especificação de θ_k e V_k, respectivamente, conduzem a leis de formação para as matrizes *B'* e *B"* um pouco diferentes das da convencional. A seguir é apresentado o desenvolvimento da versão XB para a obtenção da curva QV com θ como parâmetro, e BX para a obtenção da curva PV com V como parâmetro. A equação correspondente de Newton para o sistema da Figura 1, considerando $V_2 = V_3$ = 1 p.u. e $\theta_2 = \theta_3 = 0$, torna-se:

$$\begin{bmatrix}\Delta P_2\\ \Delta P_3\\ \Delta Q_2\\ \Delta Q_3\end{bmatrix}=\left[\begin{array}{cc|cc}-(b_{12}+b_{23}) & b_{23} & (g_{12}+g_{23}) & -g_{23}\\ b_{23} & -b_{23} & -g_{23} & g_{23}\\ \hline -(g_{12}+g_{23}) & g_{23} & -(b_{12}+b_{23}) & b_{23}\\ g_{23} & -g_{23} & b_{23} & -b_{23}\end{array}\right]\begin{bmatrix}\Delta\theta_2\\ \Delta\theta_3\\ \Delta V_2\\ \Delta V_3\end{bmatrix} \quad (2)$$

Versão XB para a Obtenção da Curva QV

Para a obtenção das matrizes *B'* e *B"* da versão XB, para o caso da curva QV, utilizando θ_3 como variável independente, o sistema (2) deverá ser posto na seguinte forma:

$$\begin{bmatrix}\Delta P_2\\ \Delta Q_3\\ \Delta Q_2\\ \Delta P_3\end{bmatrix}=\left[\begin{array}{c|c|cc}-(b_{12}+b_{23}) & b_{23} & (g_{12}+g_{23}) & -g_{23}\\ \hline g_{23} & -g_{23} & b_{23} & -b_{23}\\ \hline -(g_{12}+g_{23}) & g_{23} & -(b_{12}+b_{23}) & b_{23}\\ b_{23} & -b_{23} & -g_{23} & g_{23}\end{array}\right]\begin{bmatrix}\Delta\theta_2\\ \Delta\theta_3\\ \Delta V_2\\ \Delta V_3\end{bmatrix} \quad (3)$$

o qual após a eliminação da linha e coluna correspondente à θ_3 conduz a:

$$\begin{bmatrix}\Delta P_2\\ \Delta Q_2\\ \Delta P_3\end{bmatrix}=\left[\begin{array}{c|cc}-(b_{12}+b_{23}) & (g_{12}+g_{23}) & -g_{23}\\ \hline -(g_{12}+g_{23}) & -(b_{12}+b_{23}) & b_{23}\\ b_{23} & -g_{23} & g_{23}\end{array}\right]\begin{bmatrix}\Delta\theta_2\\ \Delta V_2\\ \Delta V_3\end{bmatrix},$$

$$=\left[\begin{array}{c|c}H_\theta & N_\theta\\ \hline M_\theta & L_\theta\end{array}\right]\begin{bmatrix}\Delta\theta_2\\ \Delta V_2\\ \Delta V_3\end{bmatrix} \quad (4)$$

e que corresponde ao sistema da equação (3.35) para $V_2 = V_3$ = 1 p.u. e $\theta_2 = \theta_3 = 0$. Usando o mesmo procedimento de [6], obtém-se a matriz *Heq*:

$$Heq_\theta = H_\theta - N_\theta \times L_\theta^{-1} \times M_\theta, \quad (5)$$

a qual após a substituição e devidas manipulações conduz a:

$$Heq_\theta = \left[\frac{1}{x_{12}} + \frac{1}{x_{23}} + g_{23}\left(\frac{g_{23}}{b_{23}} - \frac{g_{12}}{b_{12}}\right) + b_{23}\left(\frac{g_{12}}{b_{12}}\frac{b_{23}}{g_{23}} - 1\right)\right]. \quad (6)$$

Para sistemas com topologia radial e relação *r/x* idênticas tem-se:

$$Heq_\theta = \left[1/x_{12} + 1/x_{23}\right]. \quad (7)$$

Observa-se que a matriz Heq_θ = *B'* da versão XB do método convencional, e, consequentemente, a mesma lei de formação. Observa-se que neste caso, a matriz *B'* não apresentará a linha e a coluna da variável (θ_3) que foi escolhida como parâmetro. Já a matriz *B"* terá a lei de formação diferente da correspondente do método convencional apenas na linha correspondente a V_3, cujos elementos não diagonais correspondentes a b_{3i} devem ser substituídos pelos respectivos $-g_{3i}$, enquanto que o elemento da diagonal $B_{33} = \Sigma(-b_{3i})$ deverá ser substituído por $G_{33} = \Sigma(g_{3i})$. Uma outra observação importante é que agora, no cálculo de V_3, é usado o *mismatch* de P_3 e não o de Q_3.

Versão BX para a Obtenção da Curva PV

Para obter as matrizes *B'* e *B"* da versão BX, usada no traçado da curva PV, considerando V_3 como variável independente, parte-se da mesma matriz do sistema (3). Entretanto, a linha e coluna eliminadas são as correspondentes a V_3, ou seja, a última linha e a última coluna. O sistema matricial resultante será:

$$\begin{bmatrix}\Delta P_2\\ \Delta Q_3\\ \hline \Delta Q_2\end{bmatrix}=\left[\begin{array}{cc|c}-(b_{12}+b_{23}) & b_{23} & (g_{12}+g_{23})\\ g_{23} & -g_{23} & b_{23}\\ \hline -(g_{12}+g_{23}) & g_{23} & -(b_{12}+b_{23})\end{array}\right]\begin{bmatrix}\Delta\theta_2\\ \Delta\theta_3\\ \hline \Delta V_2\end{bmatrix},$$

$$=\left[\begin{array}{c|c}H_V & N_V\\ \hline M_V & L_V\end{array}\right]\begin{bmatrix}\Delta\theta_2\\ \Delta\theta_3\\ \hline \Delta V_2\end{bmatrix} \quad (8)$$

e que corresponde ao sistema (2) da parte II [2] para $V_2 = V_3 = 1$ p.u. e $\theta_2 = \theta_3 = 0$. Conforme [6], a matriz Leq_V é dada por:

$$Leq_V = L_V - M_V \times H_V^{-1} \times N_V\ , \quad (9)$$

e que após as substituições e manipulações algébricas produzem exatamente a mesma expressão da obtida para a matriz Heq_θ em (6). Com as mesmas considerações feitas para a (6), pode-se obter:

$$Leq_V = \left[1/x_{12} + 1/x_{23}\right], \quad (10)$$

ou seja, para se obter a matriz $Leq_V = B"$ da versão BX do método convencional, a qual, consequentemente, apresenta a mesma lei de formação, diferindo apenas na sua dimensão devido à eliminação da linha e coluna da variável (V_3) escolhida como parâmetro. A matriz *B'*, por outro lado, terá a lei de formação diferente da correspondente do método convencional apenas na linha correspondente a θ_3 cujos elementos não diagonais correspondentes a b_{3i} são substituídos pelos respectivos g_{3i}, enquanto que o elemento da diagonal $B_{33} = \Sigma(-b_{3i})$ é substituído por $G_{33} = \Sigma(-g_{3i})$. Aqui também deve se observar que é usado o *mismatch* de Q_3, e não o de P_3, no cálculo de θ_3.

Versões XB e BX para a Obtenção das Curvas PV e QV

Uma forma mais geral de se obter a lei de formação das matrizes *B'* e *B"* para todas as possíveis versões (XB e BX), seria considerar a matriz completa representada por (2), obter as matrizes *Heq* e *Leq*, e, em seguida, obter as versões a serem usadas na obtenção dos valores máximos de *P* e *Q*. Procedendo dessa forma para o sistema da Figura 1, no caso da versão XB obtém-se:

$$Heq = \begin{bmatrix}(1/x_{12} + 1/x_{23}) & -1/x_{23}\\ 1/r_{23} & -1/r_{23}\end{bmatrix}, \quad (11)$$

e para a versão BX:

$$Leq = \begin{bmatrix}(1/x_{12} + 1/x_{23}) & -1/x_{23}\\ -1/r_{23} & 1/r_{23}\end{bmatrix}. \quad (12)$$

No caso mais geral de uma barra *k* qualquer, considerando o uso de θ_k para a obtenção da curva QV, pode-se obter as matrizes das respectivas versões XB e BX como segue:

- Versão XB: para se obter *B'*, elimina-se a respectiva linha e coluna correspondente a θ_k na matriz *Heq*, como p. ex., no caso de (11), da qual se obtém a (7) após a eliminação da linha e da coluna 3. Portanto, a sua lei de formação será a mesma da matriz *B'* da versão XB do método convencional, exceto, conforme já mencionado, pela eliminação da linha e coluna correspondente a θ_k. Por outro lado, a lei de formação da matriz *B"* é diferente da correspondente do método convencional apenas na linha correspondente a V_k, cujos elementos não diagonais correspondentes a b_{ki} são substituídos pelos respectivos $-g_{ki}$, enquanto que o elemento da diagonal $B_{kk} = \Sigma(-b_{ki})$ é substituído por $G_{kk} = \Sigma(g_{ki})$. Outra observação importante é que agora é usado o *mismatch* de P_k, e não o de Q_k, no cálculo de V_k.
- Versão BX: a matriz *B'* tem a mesma lei de formação da matriz *B'* (que é a mesma da matriz H) da versão BX do método convencional, exceto pela eliminação da respectiva linha e coluna correspondente a θ_k. A lei de formação da matriz *B"* é igual à da matriz *Leq*, similar à (12), ou seja, a mesma lei de formação da matriz *B"* da versão BX do método convencional, excetuando a linha correspondente a V_k, cujos elementos não diagonais correspondentes a $-1/x_{ki}$ são substituídos pelos respectivos $-1/r_{ki}$, enquanto que o elemento da diagonal $B_{kk} = \Sigma(1/x_{ki})$ é substituído por $\Sigma(1/r_{ki})$. Também, neste caso, é usado o *mismatch* de P_k, e não o de Q_k, no cálculo de V_k.

Já no caso de se considerar o uso de V_k para a obtenção da curva PV, pode-se obter as matrizes das respectivas versões XB e BX como segue:

- Versão XB: para se obter *B"*, elimina-se a respectiva linha e coluna correspondente a V_k na matriz *L*, obtendo-se com isso, a mesma lei de formação da matriz *B"* da versão XB do método convencional, exceto pela eliminação da linha e coluna referida anteriormente. A lei de formação da matriz *B'* é igual à da matriz *Heq* (similar à (11)), ou seja, apresenta a mesma lei de formação da matriz *B'* da versão XB do método convencional, excetuando a linha correspondente a θ_k, cujos elementos não diagonais correspondentes a $-1/x_{ki}$ serão substituídos pelos respectivos $1/r_{ki}$, enquanto que o elemento da diagonal que é igual a $\Sigma(1/x_{ki})$ é substituído por $\Sigma(-1/r_{ki})$. Outra observação importante é que agora é usado o *mismatch* de Q_k, e não o de P_k, no cálculo de θ_k.

- Versão BX: para se obter *B"*, elimina-se a respectiva linha e coluna correspondente a V_k na matriz *Leq*, similar ao procedimento que se faz para obter a (10) a partir de (12). Portanto, a sua lei de formação é a mesma da matriz *B"* da versão BX do método convencional, a menos das referidas linha e coluna eliminadas. A matriz *B'* tem a lei de formação diferente da correspondente do método convencional apenas na linha correspondente a θ_k cujos elementos não diagonais correspondentes a b_{ki} são substituídos pelos respectivos g_{ki}, enquanto que o elemento da diagonal $B_{kk} = \Sigma(-b_{ki})$ é substituído por $G_{kk} = \Sigma(-g_{ki})$. Aqui também observa-se que agora é usado o *mismatch* de Q_k, e não o de P_k, no cálculo de θ_k.

FCDRM para a Obtenção das Curvas SV

Da mesma forma que foi feito para o método de Newton [2], pode-se obter um algoritmo mais geral para o FCDR, sendo que os anteriores passam a ser uma particularidade. Assim sendo, para o sistema de três barras da Figura 1 p. ex., no caso de usar-se a tensão da barra *3* (V_3) como parâmetro a equação ficaria:

$$\begin{bmatrix}\Delta P_2\\ \Delta P_3\\ \hline \Delta Q_2\\ \Delta Q_3\end{bmatrix}=\left[\begin{array}{cc|cc} -(b_{12}+b_{23}) & b_{23} & (g_{12}+g_{23}) & 0\\ b_{23} & -b_{23} & -g_{23} & -K_pS_3\cos\varphi\\ \hline -(g_{12}+g_{23}) & g_{23} & -(b_{12}+b_{23}) & 0\\ g_{23} & -g_{23} & b_{23} & -K_qS_3\,sen\,\varphi\end{array}\right]\begin{bmatrix}\Delta\theta_2\\ \Delta\theta_3\\ \hline \Delta V_2\\ \Delta\lambda\end{bmatrix}. \quad (13)$$

Procedendo como nos casos anteriores pode-se obter a matriz *Leq*, a qual terá a seguinte forma:

$$Leq=\begin{bmatrix}(1/x_{12}+1/x_{23}) & -K_pS_3\cos\varphi(g_{12}/b_{12}-g_{23}/b_{23})\\ -\dfrac{1}{x_{23}} & -K_qS_3\,sen\,\varphi+(g_{23}/b_{23})K_pS_3\cos\varphi\end{bmatrix}, \quad (14)$$

a qual, nos casos em que a rede do sistema apresentar a relação *r/x* idêntica para todos as linhas, se reduz a:

$$Leq=\begin{bmatrix}(1/x_{12}+1/x_{23}) & 0\\ -1/x_{23} & -K_qS_3\,sen\,\varphi+(G_{33}/B_{33})K_pS_3\cos\varphi\end{bmatrix}, \quad (15)$$

onde os termos G_{33} e B_{33} correspondem aos elementos diagonais da matriz *H* e *N* calculadas na condição $V_2 = V_3 = 1$ p.u. e $\theta_2 = \theta_3 = 0$, vide a matriz de (2). Portanto, as aproximações consideradas são as mesmas feitas para um sistema não radial conforme em [6]. O algoritmo da versão BX é o mesmo do apresentado em [6], exceto que a na formação da matriz *B"* as diferenciais correspondentes à variável V_3, e que agora é um uma variável independente (especificada), são substituídas pelas diferenciais com relação à nova variável λ, ou seja, todos os elementos da coluna 3 são nulos a menos do elemento diagonal L_{22} que é igual a $[-K_q S_3 sen\varphi + (G_{33}/B_{33}) K_p S_3 \cos\varphi]$.

No caso de usar o ângulo da tensão da barra *3* (θ_3) como parâmetro a equação resulta:

$$\begin{bmatrix}\Delta P_2\\ \Delta P_3\\ \hline \Delta Q_2\\ \Delta Q_3\end{bmatrix}=\left[\begin{array}{cc|cc} -(b_{12}+b_{23}) & 0 & (g_{12}+g_{23}) & -g_{23}\\ b_{23} & -K_pS_3\cos\varphi & -g_{23} & g_{23}\\ \hline -(g_{12}+g_{23}) & 0 & -(b_{12}+b_{23}) & b_{23}\\ g_{23} & -K_qS_3\,sen\,\varphi & b_{23} & -b_{23}\end{array}\right]\begin{bmatrix}\Delta\theta_2\\ \Delta\lambda\\ \hline \Delta V_2\\ \Delta V_3\end{bmatrix}. \quad (16)$$

Analogamente, como no caso anterior pode-se obter a matriz *Heq*:

$$Heq=\begin{bmatrix}(1/x_{12}+1/x_{23}) & -K_qS_3\,sen\,\varphi((g_{12}/b_{12})-(g_{23}/b_{23}))\\ -1/x_{23} & -K_pS_3\cos\varphi-(g_{23}/b_{23})K_qS_3\,sen\,\varphi\end{bmatrix}, \quad (17)$$

a qual, nos casos em que a rede do sistema apresentar a relação *r/x* idêntica para todos as linhas, se reduz a:

$$Heq=\begin{bmatrix}(1/x_{12}+1/x_{23}) & 0\\ -1/x_{23} & -K_pS_3\cos\varphi-(G_{33}/B_{33})K_qS_3\,sen\,\varphi\end{bmatrix}, \quad (18)$$

onde os termos G_{33} e B_{33} correspondem aos elementos diagonais da matriz *H* e *N* calculadas na condição $V_2 = V_3 = 1$ p.u. e $\theta_2 = \theta_3 = 0$, vide a matriz da equação (2). O algoritmo da versão XB é o mesmo do apresentado em [6], exceto que a formação da matriz *B'* deve levar em conta a nova variável λ, ao invés de θ_3, e com isso, a correspondente coluna tem todos os seus elementos iguais a zero excetuando o elemento diagonal H_{22} que é igual a $[-K_p S_3 \cos\varphi - (G_{33}/B_{33}) K_q S_3 sen\varphi]$. Observe que da mesma forma que no caso do método de Newton [2], as curvas PV (*fp* = 1, isto é, $K_p = 1$ e $K_q = 0$, Figura 2(a) [2]) e QV (*fp* = 0, isto é, $K_p = 0$ e $K_q = 1$, Figura 2(b) [2]) passam a ser casos particulares da metodologia empregada para traçar a curva SV.

As Figuras 2 e 3 a seguir apresenta as curvas SV obtidas pelos métodos FCDR propostos considerando variações de potência aparente na barra *3*, para vários *fp*, isto é, várias relações entre K_p e K_q. Também são apresentados os números de iterações gatos para cada um dos casos. As curvas foram obtidas através de incrementos sucessivos de potência aparente na barra *3*. Também, encontram-se ilustrados nas figuras os casos particulares das Figuras 2(a) e 2(b) apresentadas em [2] .

A análise das expressões analíticas permitem o perfeito entendimento das dificuldades de convergência apresentadas pelos métodos numéricos. A extrapolação dos métodos de Newton e desacoplado rápido, para variações de carga por todo o sistema, é feita a partir da parametrização por λ, usado na obtenção das curvas SV. Considera-se que a carga varia não em apenas uma única barra, mas por todo o sistema, e que a variação de potência ativa das cargas é assumida não somente pela barra *slack*, mas por todas as barras de geração disponíveis. O conjunto das equações do FC, em sua forma mais geral, apresentará a seguinte forma:

$$G(V,\theta,\lambda)=0, \quad (19)$$

a qual pode ser rescrita como:

$$\begin{aligned}&\lambda P^{esp}-P(V,\theta)=0 \quad \text{para barras } PQ \text{ e } PV\\ &\lambda Q^{esp}-Q(V,\theta)=0 \quad \text{para barras } PQ,\end{aligned} \quad (20)$$

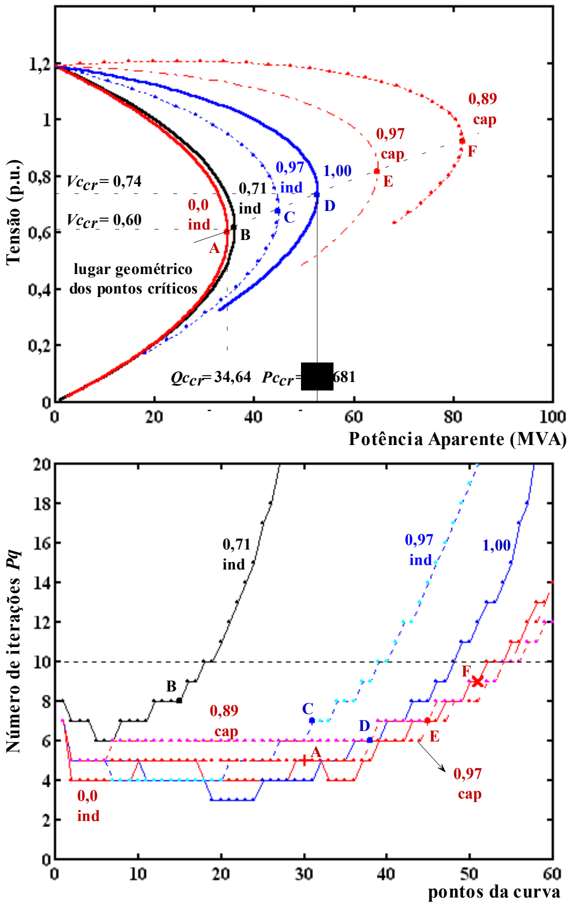

FIGURA 2
CURVAS SV PARA O SISTEMA DE TRÊS BARRAS DA FIGURA 1, UTILIZANDO V_3 COMO PARÂMETRO.

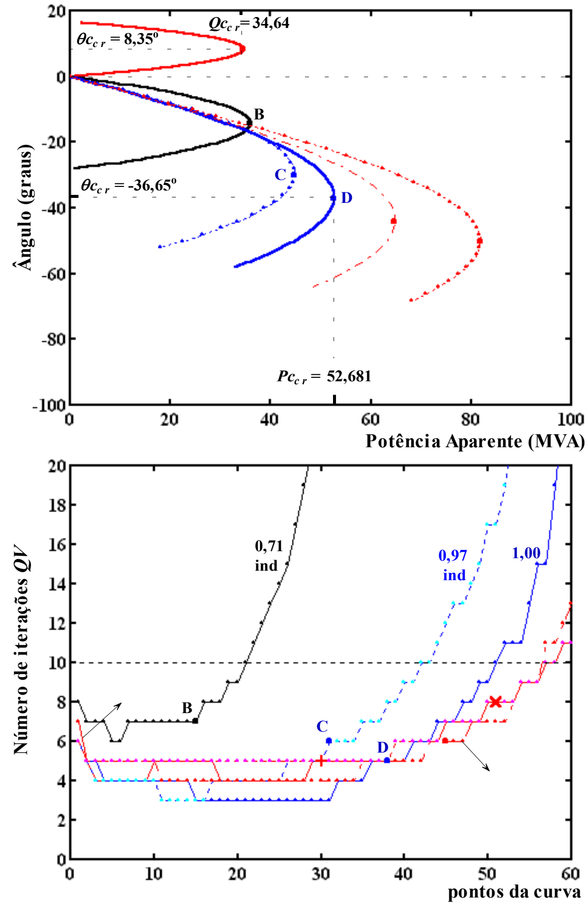

FIGURA 3
CURVAS SV PARA O SISTEMA DE TRÊS BARRAS DA FIGURA 1, UTILIZANDO θ_3 COMO PARÂMETRO.

onde $P^{esp} = P_g^{esp} - P_c^{esp}$ é a diferença entre as potências ativas gerada e consumida nas barras de carga (*PQ*) e de geração (*PV*), $Q^{esp} = Q_g^{esp} - Q_c^{esp}$ para as barras *PQ*, e λ = 1 corresponde ao carregamento do caso base. Na resolução de (20) usa-se ou o método de Newton ou o desacoplado rápido, de forma similar ao usado para as curvas SV.

CONCLUSÕES

Neste trabalho são apresentados e avaliados os métodos de Fluxo de Carga Desacoplado Rápido convencional e propostos, considerando as variações de cargas numa única barra. Estes métodos permitem o traçado completo das curvas PV através de simples modificações dos métodos convencionais de Newton [2] e FCDR [4]. Além disso, mantêm suas vantagens características. Dos resultados pode-se concluir que ambas as versões, BX e XB, do FCDR modificado são adequadas para o traçado completo da curva PV. Além disso, essas versões modificadas do FCDR também permitem obter soluções na parte inferior da curva PV, contradizendo a noção de que as versões desacopladas sempre fornecem as soluções da parte superior da curva PV.

Como conclusão geral comprova-se que todas as metodologias propostas para a solução de um sistema simples de 2 barras, conduzem à mesma curva de solução.

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O LOGO COMO FERRAMENTA AUXILIAR NO DESENVOLVIMENTO DO RACIOCÍNIO LÓGICO – UM ESTUDO DE CASO

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Abstract - *This article describes an experiment carried out with the students of the first year of a computer science course using the LOGO Language as a support methodology for the development of a logical reasoning for computers programming. This is a interdisplinar proposal of integration of Mathematics and Algorithms.*

Index Terms - LOGO, logical reasoning, programming.

Resumo - Este artigo apresenta um experimento realizado com os alunos do primeiro ano do curso de Ciência da Computação empregando a Linguagem LOGO como metodologia de apoio ao desenvolvimento do raciocínio lógico para programação em uma proposta de integração de conteúdos das disciplinas de Matemática e Algoritmos na forma de um projeto de contexto interdisciplinar.

Palavras-Chave: LOGO, raciocínio lógico, programação.

1. Introdução

O problema da compreensão e aplicação da lógica é muito comum nas disciplinas de programação e bem conhecido nas graduações dos cursos de informática e computação [02][06]. Não raro essa grande dificuldade apresentada pelos alunos é uma das maiores causas das reprovações e desistências no decorrer do curso, seja em instituições de ensino públicas ou privadas. É uma dificuldade que se apresenta já nas primeiras atividades das disciplinas de Matemática, Álgebra e, principalmente, Algoritmos.

Quando não solucionada a tempo traz prejuízos imensos aos discentes e docentes da instituição no cumprimento dos programas disciplinares do curso, tornando morosa a formação acadêmica do aluno e muitas vezes incompatível com o nível de atividades práticas e intelectuais que lhe serão exigidas ao longo da graduação.

Essa deficiência tem sido verificada pelos professores nas cinco turmas que ingressaram no curso de graduação em Ciência da Computação das Faculdades Integradas de Rondonópolis – FAIR. Assim a instituição optou por oferecer aos ingressos do último concurso vestibular de 2002 um curso de extensão de Matemática Básica [13]. Baseado em projetos que auxiliem a minimizar deficiências de formação [04][07] a exemplo do curso de extensão, a linguagem de programação LOGO foi oferecida, na forma de um experimento com atividades em laboratório sob acompanhamento dos professores de Matemática e Algoritmos, como mais uma alternativa para buscar solucionar os problemas e as deficiências no desenvolvimento e na aplicação da lógica para programação.

A intenção do trabalho foi realizar um experimento no laboratório de informática, observando a reação dos alunos do primeiro ano do curso utilizando a linguagem de programação LOGO, que possui características pedagógicas reconhecidas, como ferramenta no desenvolvimento da lógica matemática e da sistematização do raciocínio na abstração e resolução de problemas de pequena complexidade. O trabalho teve ainda como objetivo demonstrar a possibilidade de empreender um projeto interdisciplinar a partir do uso da linguagem LOGO. Foi utilizado o ambiente de programação SuperLOGO 3.0 por ser uma distribuição livre da linguagem e pelos recursos do ambiente que favorecem sua utilização em projetos de outras disciplinas como Estruturas de Dados e Inteligência Artificial.

Como os alunos em questão já estavam fazendo uma recuperação do programa de matemática do ensino médio, foram utilizados alguns conteúdos de geometria e uma revisão em paralelo dos conteúdos já abordados pela disciplina regular de Algoritmos da graduação.

A análise dos resultados obtidos com esse experimento em conjunto com os professores das referidas disciplinas, estes foram considerados satisfatórios, possibilitando a implementação do SuperLOGO 3.0 como metodologia auxiliar para promover atividades de interdisciplinariedade, a priori, entre os conteúdos das disciplinas de Algoritmos e

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Matemática na graduação do curso de Ciência da Computação.

Entre os aspectos da avaliação da ferramenta SuperLOGO3.0, que a metodologia proposta esperava observar, podemos destacar as seguintes:

- Verificação de evidências na melhora do desenvolvimento e do aprimoramento do raciocínio lógico e matemático dos alunos;
- Possibilitar uma dinamização do contexto da recuperação dos conteúdos de Matemática do ensino médio e, de Algoritmos, como revisão e fixação de conceitos introdutórios;
- Verificação de evidências na melhora do desenvolvimento da capacidade de abstração de problemas e na sistematização do raciocínio das soluções desses problemas;
- Possibilitar uma introdução menos traumática do aluno iniciante e inexperiente a um ambiente de programação;
- Verificação de uma melhora na recuperação e nivelamento dos alunos com deficiências nas disciplinas de Algoritmos e Matemáticas na graduação em Ciência da Computação;

Durante as seções que seguem serão descritas com maiores detalhes o modelo aplicado no experimento, as características que levaram a escolha da linguagem LOGO para composição da metodologia, bem como os resultados observados e as considerações finais sobre o experimento realizado.

2. Metodologia

Durante os meses de abril e maio de 2002, foram feitas reuniões para delinear as formas de aplicar a ferramenta SuperLOGO 3.0 a partir da avaliação de estudos similares como os descritos em [02] adequando a metodologia e o modelo do projeto executado à realidade da instituição, de maneira a maximizar os resultados da recuperação dos alunos nos conteúdos do curso de extensão de Matemática Básica, dinamizando e otimizando essa recuperação pela revisão em paralelo dos conteúdos introdutórios de Algoritmos e de Matemática e promover uma atividade de caráter interdisciplinar entre os conteúdos abordados.

Foi tomado o cuidado de esclarecer que, embora todos os docentes estivessem empolgados com as perspectivas positivas do experimento, era preciso reduzir um pouco essas expectativas devido a diferenças eminentes nos projetos, levando em consideração a qualidade do público alvo, os objetivos propostos e a forma de desenvolvimento das atividades.

Durante esse período foram envidadas atividades individuais de análise da Linguagem LOGO e de experimentação da ferramenta SuperLOGO3.0 pelos docentes [01][03] e realizada a confecção de listas de exercícios, bem como a preparação das instalações do laboratório de informática e a formalização de um convite aos alunos para que participassem do experimento.

As listas de exercícios preparadas não continham apenas os exercícios, também traziam especificados os objetivos e os conhecimentos a serem gerados, numa forma de indicar ao aluno que o que estava sendo realizado, embora a primeira vista pudesse parecer trivial, não era uma brincadeira sem sentido. Haviam vários conhecimentos implícitos como elaboração de fórmulas, uso de variáveis e contastes e uso de estruturas de controle a cada atividade apresentada.

Dessa forma foram elaboradas três listas de exercícios a serem aplicadas, cujos os conteúdos abordavam respectivamente: reforço da capacidade de abstração para a confecção de algoritmos, movimentação pelo plano cartesiano, rotinas para construção e manipulação de polígonos básicos e noções de geometria; uso de estruturas de controle e escrita de procedimentos.

Uma das exigências da instituição para viabilizar a execução do experimento era justamente que não houvesse a necessidade de aquisição de nenhum equipamento ou programa que implicasse em custo adicional, procurando fazer uso de material já disponível. Assim sendo, a ferramenta utilizada e que implementaria a linguagem LOGO em um ambiente de programação bastante acessível do ponto de vista didático-pedagógico, uma vez que integra sabiamente módulos de desenvolvimento dos canais visual, auditivo e textual foi o SuperLOGO3.0, ambiente traduzido e disponibilizado pelo Núcleo de Informática Aplicada a Educação – NIED/UNICAMP, que tem como característica ser um software de distribuição livre.

Em uma primeira análise foi possível lançar mão de uma ferramenta como a linguagem de programação LOGO para diminuir as dificuldades encontradas por professores e, principalmente, por alunos em relação a lógica, tal como foi realizado em [02], porque ela trás muitas vantagens. Para os docentes permite uma maior dinamização no contexto dos conteúdos a serem abordados, facilitando o processo de nivelamento e recuperação dos alunos com deficiência nas áreas de matemática, lógica e algoritmos em função da simplicidade com a qual exercícios podem ser implementados nessa ferramenta e, por viabilizar a aplicação de um modelo interdisciplinar e/ou multidisciplinar da construção do conhecimento. O docente teria uma forma de estruturar com maior eficiência medidas adicionais ou corretivas de reger o processo de recuperação do aluno [10].

Por outro lado, o LOGO proporcionaria ao discente uma metodologia que acrescentaria a este medidas alternativas de aprendizagem. Pelas características próprias de trabalho da linguagem, o aluno poderia evoluir mais efetivamente no processo de construção do seu conhecimento, em seu próprio ritmo, desenvolvendo e aperfeiçoando sua capacidade de abstração pela verificação do erro sob uma outra perspectiva [11].

É nesse sentido que o aluno com dificuldades no aprendizado das disciplinas pode sair ganhando em tomar contato primeiramente com uma linguagem como o LOGO que notoriamente favorece a construção e o exercício do raciocínio lógico. Suas características permitem ainda que o aluno vá além e se exercite na elaboração de rotinas de programação que trazem também um contato prévio com um ambiente de programação. Porém nesse ambiente a ocorrência do erro é menos traumática e mais saudável por possibilitar a promoção de conhecimentos gradualmente. O aluno passa a ser um agente mais ativo na recuperação de suas deficiências e falhas.

Na próxima seção serão apresentados detalhes sobre do experimento.

3. O Experimento

O ambiente SuperLOGO 3.0 foi apresentado aos alunos paulatinamente, ao longo de 08 horas de atividades, divididas em 05 aulas de aproximadamente 01h 30min de duração. As atividades no laboratório se realizaram duas vezes por semana em horário anterior ao início das aulas regulares, a partir das 17h 30 min indo até as 18h 50min.

As listas de exercícios abrangendo considerações sobre comandos do ambiente e os conteúdos de geometria associados aos conceitos básicos da construção de algoritmos foram resolvidas pelos discentes a cada aula e, ao final do curso, um pequeno projeto individual foi implementado e entregue para avaliação.

A resolução das listas de exercícios foi efetuada sob acompanhamento dos professores das duas disciplinas que observaram a reação dos alunos durante essas atividades e durante as atividades em sala de aula das disciplinas de Matemática e Algoritmos. Foram elementos muito observados pelos professores: comportamento dos alunos com relação a fixação dos conteúdos apresentados no experimento e os apresentados em sala de aula, as dificuldades apresentadas no ambiente SuperLOGO 3.0 e nos exercícios das listas, bem como o desempenho por eles demonstrado nas disciplinas da graduação.

Ao final de cada atividade no laboratório era realizada uma verificação informal junto aos alunos questionando-os sobre as atividades desenvolvidas no dia e uma identificação das perspectivas destes em relação ao curso como um todo.

Todos esses elementos eram alvos de análise e discussão entre os professores ao final de cada atividade no laboratório e ao final do experimento, a razão de verificar a eficácia da ferramenta nos objetivos específicos propostos.

Em função de não se tratar de um curso de extensão nos moldes definidos pela instituição e, dada a capacidade das instalações utilizadas não suportarem o total de alunos do primeiro ano, pois comportavam apenas vinte máquinas, e estes foram convidados pelos professores a freqüentar o curso. A intenção era ter um aluno por máquina para melhor observar suas reações. Todos os participantes estavam cientes de que a presença não era obrigatória e que a participação no experimento não implicava na distribuição de pontos de bonificação para qualquer das disciplinas de Algoritmos ou Matemática.

A seguir são apresentados os resultados obtidos com a realização do experimento.

4. Resultados

As atividades começaram a ser realizadas com um número de participantes bastante razoável nas primeiras aulas. Na segunda aula, por exemplo, o número de participantes foi bastante elevado, sendo necessário a acomodação de dois alunos por máquina, o que foi constatado como em [02] não muito produtivo, uma vez que a operação da máquina ficava delegada, quase sempre, a apenas um dos alunos da dupla. Ocasionalmente, alunos em dupla se envolviam em tal nível com a atividade que dois comportamentos eram notados: ou eles se integravam na busca pela solução do exercício, ou acabavam discordando a tal ponto que torna-se necessário a separação da dupla e a realocação dos alunos em nova composição de parceria.

A partir da terceira aula, um problema de ordem médica obrigou um dos professores ao afastamento por aproximadamente uma semana, provocando a suspensão das atividades por esse período. Ao retorno, na semana seguinte, notou-se uma redução expressiva no número de participantes.

Observou-se também que o horário escolhido para a realização das atividades, antes do início das aulas, acabou por tornar-se inconveniente. Foi constatada uma sobrecarga de atividades nos alunos devido ao término das aulas do curso de extensão de Matemática Básica e, também, devido a proximidade da semana de provas bimestrais.

Ficou constatado que poucos alunos do total esperado estavam participando e, destes, apenas uma parcela reduzidíssima dos que iniciaram as atividades chegaram efetivamente ao final do experimento. Além do percentual de participação dos alunos ter sido bastante reduzido, também pudemos observar que os alunos não exploraram todo o seu potencial criativo durante as atividades, limitando-se a resolução dos exercícios e prendendo-se aos temas já apresentados.

Apesar da presença não ser obrigatória, de qualquer forma, todas as aulas tiveram listas de freqüência para acompanhamento dos níveis de participação e evasão como especificados na tabela abaixo:

TABELA I
Índice de Participação dos Alunos.

	N º DE PRESENTES	(%)*
Aula 1	15	23
Aula 2	21	37
Aula 3	08	12,7
Aula 4	08	12,7
Aula 5	05	7,7

O fato das atividades não oferecerem algum tipo de bonificação e, devido ao reduzido número de alunos que

* Calculado em relação ao total de alunos matriculados no primeiro ano.

entregaram de fato os trabalhos, a avaliação destes foi realizada de maneira conceitual, levando em consideração a criatividade e a perícia do aluno em solucionar o problema a partir do tema proposto para o projeto, pois não se tratava de um curso formal do currículo, e isso pode ter também contribuído para a falta de participação dos alunos e para que a evasão ocorresse.

Em termos de programação LOGO, os resultados corresponderam razoavelmente ao nível que se esperava na metodologia. O desenvolvimento das atividades demonstraram uma reação positiva quanto a metodologia e a ferramenta SuperLOGO3.0, porém existe uma necessidade maior de tempo e um número maior de atividades para que os alunos cheguem a um nível onde os recursos do ambiente tais como a técnicas de recursão e o trabalho com vetores, listas e arquivos possam ser explorados com maior abrangência. Contudo foi possível perceber entre os alunos que realizaram o experimento até o final, mudanças comportamentais interessantes.

Em primeiro lugar, uma das mudanças mais evidentes foi a apresentação de uma reação mais pró-ativa dos alunos em relação as atividades sugeridas pelas disciplinas regulares do curso. De um modo geral, foi notada uma postura menos reativa às exigências decorrentes dos problemas aplicados em sala de aula, pois estes passaram de problemas "impossíveis de resolver" para problemas "difíceis de resolver" na perspectiva desses alunos. No âmbito específico da disciplina de Algoritmos, percebeu-se uma melhora na atitude desses alunos que passaram a ser mais dedicados e menos propensos a desistência, mesmo que o resultado em termos de nota não tenha correspondido ao esperado pelo aluno.

Em segundo lugar, observou-se que esses alunos começam a encarar o trabalho com o computador de maneira diferente. Estavam mais conscientes de que a atividade de programar necessita da compreensão da natureza e especificações dos problemas, para poderem então solucioná-los, e da habilidade de raciocinar e aplicar a lógica, isto é, a solução computacional começa no programador e não na máquina.

Embora persista a atitude, muito comum nos alunos, de associar à máquina qualidades humanas, onde ela deveria apresentar uma postura mais "colaborativa" no sentido de efetuar as correções necessárias para que os programas e comandos se executem de maneira correta, percebeu-se que esse atitude vem sendo substituída por uma maior racionalidade do aluno com relação as suas atribuições enquanto programador.

Por fim, notou-se que as dificuldades desses alunos com relação a compreensão e emprego dos conceitos básicos da construção de algoritmos tais como a utilização de variáveis, constantes, estruturas de repetição, o trabalho com ângulos, implementação e desenvolvimento de funções matemáticas e a visão espacial foram bastante minimizadas.

Ao final dos trabalhos, devido aos imprevistos decorrentes por nos encontrarmos dentro do período de provas bimestrais, foi realizada uma avaliação verbal com questionamentos sobre as expectativas e impressões dos alunos e pudemos observar uma empatia tanto com relação a ferramenta SuperLOGO 3.0 quanto com a metodologia aplicada.

5. Conclusão

As razões que levam a presença dessa dificuldade na aplicação da lógica na programação nos cursos de graduação de informática podem remeter a alguns fatores críticos pelos quais passam o ensino nacional. Um desses fatores está fundamentado nas deficiências de formação observadas no ensino médio e fundamental, trazida a tona a partir da necessidade dos governos de instaurar e participar de exames de avaliação das qualidades de ensino de âmbito nacional e internacional. Dois exemplos claros dessa prática é a realização do ENEM e do PISA.

O ENEM (Exame Nacional do Ensino Médio) [13], instituído pelo Ministério da Educação e realizado anualmente a partir de 1998, com adesão facultativa dos alunos que estão concluindo ou já concluíram o ensino médio no país, com o objetivo de verificar o desempenho do aluno ao término da escolaridade básica (ensino fundamental e médio), visando aferir o desenvolvimento das competências e habilidades necessárias ao exercício pleno da cidadania.

O PISA (Programa Internacional de Avaliação de Alunos)[12], desenvolvido e coordenado internacionalmente pela Organização para Cooperação e Desenvolvimento Econômico (OCDE), que é realizado de três em três anos a partir de 2000 com a adesão do Brasil e de outros 35 países é um programa de avaliação comparada e tem por finalidade avaliar o desempenho de alunos a partir de 15 anos de idade, produzindo indicadores sobre a efetividade dos sistemas educacionais dos países participantes.

A análise dos últimos resultados observados nessas provas de qualificação bem como os resultados dos próprios vestibulares de várias universidades do país sugerem que o ensino de segundo grau, não só mas principalmente no Brasil, não vem atingindo com efeito o seu objetivo na formação intelectual do jovem, demonstrando um número cada vez maior de estudantes ingressando, ou tentando ingressar, no ensino universitário despreparados, sem os conhecimentos básicos necessários e bem fundamentados, além de competências fundamentais pouco ou pobremente desenvolvidas. E não estamos falando apenas das deficiências de conhecimento de conteúdos e da aplicação do raciocínio lógico, incluímos também nessa lista aquelas deficiências que decorrem da dificuldade na concatenação de idéias e da construção do pensamento crítico.

Outro fator que temos observado contribuir para o número de desistentes dos primeiros anos de graduação tem haver com o desconhecimento, por parte dos vestibulandos, das características e do perfil de aluno que os cursos da área de computação e informática exigem. Muitas vezes o estudante não tem a mínima idéia do que vai encontrar na graduação e, não é de admirar que ao se deparar com as perspectivas do curso opte por deixá-lo, especialmente se sua expectativa quanto ao currículo não condiz com o seu perfil.

Também não podemos deixar de indicar como fator importante, que deva ser considerado, o formato dos processos de seleção executados bem como a qualidade da clientela atendida pelas instituições que oferecem cursos de graduação em informática e computação.

Todos esses fatores tem particularidades que, em conjunto, contribuem para o cenário de deficiências apresentado pelas graduações em informática e, em separado, são passíveis de produzirem discussões mais abrangentes sobre suas causas e efeitos.

Contudo, o problema do raciocínio lógico, pelo que se tem observado, não é um problema isolado desse ou daquele tipo de instituição e, esforços tem sido despendidos em estratégias de nivelamento e recuperação na grande maioria dos cursos de computação do país, talvez devido a não ser comum nas graduações a inclusão, em seus currículos, de disciplinas introdutórias que focalizem formas de melhor explorar os métodos de solução de problemas. Essa é uma habilidade extremamente necessária a formação e ao bom desempenho do discente durante o curso.

Estudos recentes indicam que os índices de reprovação e desistências nos primeiros anos dos cursos de graduação em informática e computação têm sido muito elevados, motivando uma série de preocupações e discussões entre professores e coordenadores [06]. A conclusão a que se tem chegado para justificar esses índices é simples: as características de um aluno de graduação em informática passam, indubitavelmente, pela capacidade deste de abstrair, organizar e aplicar a lógica.

Programar, aprender a programar e, principalmente, ensinar a programar não são atividades fáceis de realizar. Para uma parcela pequena da população de discentes dos cursos de computação e informática programar, ou melhor, solucionar problemas utilizando linguagens de programação com consciência científica e metodológica do que é programar[08], seja talvez uma habilidade natural mas para a grande maioria essa consciência da natureza dessa atividade e da habilidade de abstração no uso de uma ferramenta de programação não está clara. É preciso esforço e paciência, do docente e do discente, envolvidos no processo da análise e compreensão da natureza dos problemas, no levantamento de seus requisitos, na elaboração e refinamento das idéias que possibilitarão chegar a solução e, principalmente, é preciso obedecer o ritmo de cada um no desenvolvimento dessas competências. Quando todo esse processo não faz parte da natureza ou não está totalmente claro para o indivíduo é preciso construir essa perspectiva dentro dele. Talvez esse seja o maior problema relacionado ao ensino de programação.

Embora, erroneamente, o LOGO seja associado por alunos e professores ao ensino infantil e fundamental, alguns trabalhos [02][09] provam sua viabilidade e aplicabilidade no ensino superior. Por ser uma ferramenta de características reconhecidas no desenvolvimento de múltiplas habilidades de conhecimento, suas várias versões cobrem do ensino de crianças até o de adultos, e tem sido empregado com sucesso em projetos que vão da alfabetização até o aprendizado de noções de física e matemática, sendo uma ótima alternativa ao propósito da lógica de programação.

É sabido que muitas vezes o aluno que apresenta deficiência de conteúdo se sente inferiorizado em não se adequando ao ritmo e evolução dos conteúdos em sala de aula ministrados, utilizando o modelo tradicional de ensino de programação a partir do paradigma imperativo. Como na graduação em computação, toda a evolução do aluno dentro do curso vai ser baseada na qualidade com que seus conhecimentos na disciplina de Algoritmos sejam bem absorvidos e, como esta disciplina requisita em quase sua totalidade conhecimentos matemáticos fortemente esclarecidos e ampliados, não é difícil observar porque os rendimentos nas duas disciplinas, Algoritmos e Matemática, é muitas vezes sofrível. E, não raro, no caso de Algoritmos venham a ser desastrosos, pois leva ao aluno a um desânimo contundente, o que resulta em um número muito elevado de reprovações e, consequentemente, em desistências.

Desde a muito tempo vêm sendo apresentados a comunidade acadêmica pesquisas direcionadas a amenizar a problemática do emprego da lógica no ensino da programação. Muitas pesquisas, com especial atenção a atividade de programar, especificam novas metodologias de ensino atentando para o fato de que o ensino de programação envolve muito mais que o domínio de uma ferramenta ou linguagem.

O domínio da ferramenta de programação só poderia ser devidamente iniciado quando a capacidade de abstração e o exercício do raciocínio estiverem devidamente fundamentados no aluno. O aluno já deveria ingressar no curso com total domínio para exercer essa capacidade de abstração e exercício da lógica, como herança desenvolvida no ensino fundamental, porém os resultados das provas qualitativas, como o ENEM, e dos vestibulares comprovam que em muitos casos essa competência ou não foi desenvolvida ou o foi muito precariamente.

O surgimento de novas metodologias no ensino de programação que levam em consideração as deficiências de formação estão se popularizando e sendo reconhecidas como medidas do mais alto nível na construção do conhecimento, pela adoção de abordagens que levam em consideração estratégias e formas de promover e capacitar o aluno a solucionar problemas adequadamente. Solucionar problemas adequadamente é raciocinar adequadamente.

Muitos autores [02][05][06][08] propõe o emprego de novas metodologias e ferramentas de auxílio ao ensino da programação, incluindo em seus estudos algumas sugestões interessantes, como a aplicação do paradigma de programação declarativo pelo emprego de ferramentas da Programação Funcional, inclusive o LOGO. O modelo tradicional de ensino de programação pelo paradigma imperativo é mantido, mas em virtude de atender a necessidade de melhorar ou desenvolver no aluno a capacidade de solucionar problemas, a programação funcional é introduzida primeiro, com o objetivo de promover um nivelamento tornando o paradigma imperativo menos traumatizante e o aluno menos propenso a desistência.

Analisando as perspectivas iniciais do experimento e comparando os resultados obtidos podemos concluir que o experimento obteve um resultado positivo em relação aos objetivos propostos pela metodologia, apesar dos problemas decorridos durante as atividades, entre os quais podemos destacar a evasão dos alunos.

Ao que parece essa evasão pode ter sido ocasionada em função do período de aplicação do experimento não ter sido o mais propício, pois os alunos se encontravam sobrecarregados pelo curso de extensão e a proximidade da semana de provas bimestrais; e, também favorecida pelo afastamento ocorrido durante o inicio dos trabalhos, que acabaram por quebrar o ritmo das atividades e obrigaram a alterações e adequações constantes na metodologia empregada.

Verificou-se que muitos alunos não estavam totalmente conscientes dos vários conceitos computacionais explorados durante a realização dos exercícios, deixando a desejar no que tange ao aprimoramento e recuperação de suas deficiências. Uma das grandes características da linguagem LOGO é possibilitar ao aluno estar mais ativo no processo ensino-aprendizagem imprimindo nesse processo o seu ritmo de absorção de conteúdo e transformação deste em conhecimento.

No entanto, uma grande maioria se aproximou do experimento movido mais pela curiosidade, como pode-se observar na tabela de freqüência de aulas, sendo que alguns chegaram a entrar no laboratório pela primeira vez na última aula para "ver", e não encararam a ferramenta com a devida seriedade, confirmando o pré-conceito de que ela estaria única e exclusivamente relacionada ao ensino infantil, deixando alguns, por esse motivo, de freqüentar as atividades.

Para os professores envolvidos no projeto, apesar da evasão ocorrida durante o experimento, uma certa melhora no nível e atitude dos alunos foi realmente percebida, por um posicionamento mais ativo e mais consciente do quão importantes são as atividades de recuperação no aprimoramento e desenvolvimento de sua formação, e, espera-se que o experimento tenha contribuído para facilitar aos alunos a introdução de um ambiente de programação imperativo como a Linguagem Pascal.

Entretanto foi consenso entre eles de que para uma melhor análise quanto a eficácia da metodologia seria melhor que esta fosse readequada e ampliada em alguns aspectos, de modo que ela pudesse ser reaplicada em um período menos conturbado no terceiro ou quarto bimestre senão no próximo ano. Entre as alterações discutidas foram especificadas:

- Ampliar o conteúdo das listas de exercícios para abranger além de geometria e conceitos básicos de algoritmos, explorar mais conteúdos de Matemática, de Algoritmos e recursos da ferramenta SuperLOGO 3.0;
- Ampliar da carga horária de 08 para 40 horas, configurando ao experimento características de um projeto educacional na modalidade de curso de extensão tal como o de Matemática Básica;
- Incluir nas atividades exercícios que possibilitem a correlação entre o ambiente de programação LOGO e sua implementação na linguagem Pascal;
- Especificar um índice de bonificação das atividades efetuadas durante o curso para incentivar e aumentar o índice de participação dos alunos;

Para os alunos que participaram do experimento até o final, as impressões foram bastante positivas e ultrapassaram as expectativas, pela intenção declarada destes em participarem novamente do experimento se este fosse realizado no segundo semestre.

A boa impressão indicada por alunos e professores sobre a ferramenta SuperLOGO 3.0 reforça a certeza de que o experimento chegou a resultados positivos quanto a aplicabilidade do LOGO como ferramenta para promoção de projetos de interdisciplinaridade, não apenas aplicada ao caso da lógica de programação como também na possibilidade de aplicação em conhecimentos mais avançados tratados por outras disciplinas como Linguagem de Programação e Inteligência Artificial.

De um modo geral a proposta de desenvolver atividades com caráter interdisciplinar dos conteúdos das disciplinas de Algoritmos e Matemática aplicando a ferramenta SuperLOGO 3.0 foi alcançada e, o presente trabalho trouxe resultados que contribuirão para que esse projeto seja efetivado na instituição.

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ESTANDES - A COMUNICAÇÃO VISUAL GERADORA DE NEGÓCIOS EM EXPOSIÇÕESINDUSTRIAIS

(Mercado Business to Business)

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Resumo

A comunicação visual como ferramenta geradora de negócios insere-se numa discussão muito atual sobre a revolução estética em nossa sociedade. Diversos são os aspectos que sua denominação abrange. E neste estudo, que aborda um mercado essencialmente técnico, algumas destas denominações serão mostradas. Acreditamos que neste mercado técnico e de relacionamentos fechados, as exposições industriais abriram um grande espaço para transformar seus maquinários em peças atrativas e modernas. Estes contrastes são apresentados em espaços denominados estandes, que são elaborados para expor uma imagem que, na verdade, é o reflexo da própria empresa.

Neste estudo, avalia-se a eficácia da comunicação visual dos estandes em exposições industriais (mercado business to business), como fator de influência na geração de negócios.

Palavras-chave

1. Estandes 2. Exposição Industrial 3. Comunicação Visual

Por que a imagem estabelecida pelas empresas em eventos industriais, através de seus estandes, podem gerar negócios? Até que ponto a linguagem visual encanta o target de exposições industriais?

Este trabalho visa avaliar a comunicação visual praticada por empresas no mercado *business to business*, através de estandes em exposição industrial, como a real fonte geradora de negócios. Apresentando o significativo relacionamento visual das empresas, em um segmento – industrial – onde o relacionamento é extremamente técnico.

A comunicação visual dos estandes influencia consumidores industriais na geração de negócios no período posterior a exposição, fixando esta imagem até o próximo evento, que ocorre anualmente. Isto é, o comprador ao visitar a exposição depara com uma realidade visual muito agressiva, ou seja, tem um impacto visual imediato muito forte devido às diversas formas e apelos visuais e à medida que percorre a feira sente-se mais atraído por alguns destes apelos visuais. Sendo assim, as nuances estéticas que diferenciam os projetos de estandes influenciam o comprador a estabelecer um contato com a empresa naquele instante da feira, no momento de opção para fornecimento e também na decisão do negócio, que ocorre em sua maioria no período posterior à exposição.

Mercado e Marketing - conceituações

Para definirmos *marketing* é fundamental explicarmos que sua prática é datada de milhares de anos, contudo só se concretizou na segunda metade do século XX. Sua incompreensão no significado ainda é grande, pois sua prática interfere diretamente em todos os segmentos do mercado, não havendo espaço para fundamentações teóricas a respeito.

O que é mercado *business to business*?

Denominado no Brasil de mercado empresarial, industrial ou organizacional, é a prática de empresas de vender bens ou serviços a outras empresas e é formado por uma variedade de diferentes compradores comerciais e institucionais. Desenvolveu-se extraordinariamente, a partir da década de 50 quando as empresas de bens de consumo adotaram uma orientação para marketing. O marketing começou a dominar as operações de

eficiência da produção, para melhor atender às exigências do consumidor. Nas indústrias de base tecnológica, o desenvolvimento de novos produtos tornou-se uma atividade importante. O direcionamento do foco sobre os mercados e os produtos dominou a preocupação com o potencial dos lucros futuros. Alguns aspectos, com o decorrer do tempo (principalmente nos anos 70 e 80) foram observados neste mercado, como a passagem gradativa da produção de bens para a economia de serviços, a distinção da classe de profissionais e de técnicos, a gestão do desenvolvimento técnico e o controle normativo da tecnologia, o foco na tecnologia intelectual. Aspectos que definem a passagem da sociedade industrial para a pós-industrial.
O mercado industrial, em face da emergência de mercados mundiais, alargou o seu enfoque sobre os tradicionais mercados industriais para os mercados mais amplos de negócios a negócios.

A orientação para o marketing ou conceito de marketing é uma filosofia de negócios segundo a qual vendas lucrativas e retornos satisfatórios serão alcançados quando da adequação de produtos ou serviços às necessidades e desejos dos consumidores, por parte da empresa. A prática, e até mesmo o reconhecimento desta filosofia, ainda está distante de ser aquilo de que a sociedade necessita. Grande parte das empresas ainda se orienta no posicionamento de seus produtos e serviços, deixando de lado a evolutiva orientação para o marketing societal.

Na sociedade pós-industrial, onde tecnologia intelectual é fator de diferenciação, as empresas passam a atuar com ferramentas milenares, como a estética, para através de fundamentações técnicas, aliadas a aspectos sociais e psicológicos, estarem alcançando a tão cobiçada necessidade dos consumidores.

Nos dias atuais, nomenclaturas como "Dreamketing" ou marketing dos sonhos, postulam que para se diferenciar, as empresas devem interpretar e materializar os sonhos mais profundos dos clientes. Em um mercado onde empresa vende para empresa, é possível aplicar este conceito que já esta em uso no mercado de varejo.

Na verdade, não é uma tarefa fácil, porém deve-se interpretar que neste mercado produtos e serviços são um meio de estimular os desejos dos clientes. Uma nova aplicação para a máquina, um projeto diferenciado para a nova linha de produtos e assim por diante. E tudo isso deve ser vendido para o cliente, e de que forma? Como um sonho. Neste instante a estética, não só dos produtos, mas de suas embalagens e empresas, passam a ser um fator de diferenciação, pois fazem parte do sonho do cliente. Este processo estético pode ser avaliado em uma exposição industrial, onde formas e estruturas, texturas, cores, iluminação, paisagismo e produtos dão existência a uma empresa que é construída buscando atender aos sonhos de seus clientes. Tudo isso só pode ser compreendido se avaliarmos como a comunicação ocorre neste processo.

O processo de comunicação no mercado business to business

Indiscutivelmente, o desenvolvimento tecnológico de um produto, sua composição de custo competitivo e disponibilidade no mercado são aspectos relevantes, entretanto, se não possuirmos um plano de comunicação eficiente e eficaz com o mercado tendemos ao declínio. Na área de *marketing*, é costume citar que comunicação é o ponto final do processo estratégico. Na verdade, um modelo utilizado pelos profissionais da área de marketing estabelece que o processo de comunicação é a transmissão de uma mensagem de um emissor para um receptor, de modo que ambos entendam da mesma maneira

Neste estudo estabelecemos um novo parâmetro de avaliação do que denominamos "instalações", aqui representadas pelos estandes. Partimos do princípio que estes espaços, através de uma minuciosa preparação, criam um elo direto de identificação com o mercado consumidor, fazendo com que haja relações comerciais e sociais adequadas às partes.

Este circuito faz crer que estamos trabalhando com um modelo de diálogo, um fluxo de informação em duas direções. No livro Comunicação e Pesquisa, Lúcia Santaella, ressalta um modelo de comunicação circular, enfatizando que na sociedade pós-industrial com difusão da teoria de sistemas, que tem por objetivo pensar *"a globalidade, as interações dos elementos, mais do que a causalidade, apredendo a complexidade dos sistemas como conjuntos dinâmicos de relações múltiplas e cambiantes"* (A. e M. MATTELART, ibid.:62), associado ao crescimento acelerado dos mecanismos de comunicação, que trouxeram o conceito de retroalimentação de informações (feed-back), estabelecem parâmetros coerentes com o estudo que esta sendo desenvolvido. Todo este processo de comunicação circular, de uma empresa precisa ser planejado, o que auxilia a continuidade no processo de vendas.

As etapas para este desenvolvimento da comunicação são: a identificação do público-alvo, a determinação dos objetivos da comunicação, elaboração da mensagem, seleção dos canais de comunicação, estabelecimento do orçamento, o mix de comunicação, a mensuração dos resultados e gerenciamento do processo de comunicação integrada de marketing. Conforme a definição da American Association of Advertising Agencies, comunicação integrada de marketing é: *um conceito de planejamento de comunicação de marketing que reconhece o valor agregado de um plano abrangente que avalie os papéis estratégicos de uma série de disciplinas da comunicação – por exemplo, propaganda geral, reposta direta, promoção de vendas e relações públicas – e combine-as para oferecer clareza, coerência e impacto máximo nas comunicações por meio de mensagens discretas integradas de maneira coesa.*

No mercado industrial não é diferente, o plano de comunicação, através das estratégias e táticas de comunicação, é o momento de explicar como sua empresa será vista no mercado. Primeiro descobrindo a linguagem a ser adotada e depois os meios para que a mensagem atinja os clientes. Neste instante deve-se montar um conjunto de decisões relativas à comunicação, o qual se denomina de composto de promoção. Cujos os objetivos são:

- Informação – que aspectos da empresa / produtos devem ser levados ao conhecimento do cliente. Normalmente estes itens são extraídos dos planejamentos estratégicos das empresas, os quais são de responsabilidade da alta administração.

- Persuasão – direcionamento da mensagem e da imagem propostas pela empresa, para atingir o público-alvo.
- Lembrança – efeito desejado na persuasão.

No mercado industrial a "venda pessoal" é o principal instrumento, a "promoção e "publicidade" vêm em seguida e a propaganda auxilia o trabalho do vendedor.
Os profissionais de *marketing* desejam que os receptores de mensagens respondam comprando os produtos, serviços ou marcas oferecidas e, para obter este resultado, é necessário que a comunicação influencie os clientes de diversas maneiras.

Por estarmos trabalhando exposições industriais, a correlação estabelecida entre os objetivos da promoção industrial, o processo da adoção dos produtos e as tarefas do modelo AIDA (**A**tenção / **I**nteresse / **D**esejo / **A**ção) de McCarthy (Marketing-Rio: Campus, 1982), torna-se muito relevante pois a promoção é um fator chave para o cliente visualizar e decidir sobre o produto, que aliados as tarefas descritas geram o resultado desejado.

Atenção e **interesse**, são os primeiros pontos trabalhados pelos expositores em uma feira. Estabelecem a forma, definem as cores e tons, cercam-se de acessórios pertinentes ao evento e buscam o interesse do visitante. Com o cliente no estande demonstram sua experiência, através do atendimento técnico e social, da demonstração do produto, na busca de uma avaliação positiva.

Despertam o **desejo** do cliente que dentro deste processo já esta passível de decisões. Cabe à empresa direcionar este desejo para a ação, estabelecer os primeiros “acordes” de um processo de negociação, que em grande parte ocorre no período pós-feira, onde é confirmado o pedido. A **ação** é concretizada desde o momento primeiro do estande e confirmada pela lembrança, um dos objetivos promocionais. É o impacto da imagem causado durante o evento que tornará a empresa viva na mente do comprador e é exatamente o feed-back que este cliente dará a empresa que garantirá o sucesso deste processo, completando o ciclo deste modelo circular de comunicação.

É significativo neste processo, o posicionamento do cliente. Durante a exposição ele recebe uma carga muito grande de informações e códigos visuais. Para alguns, a reação é imediata, demonstrando preferência por estar em um espaço (empresa) específico. Porém, a maior fatia destes clientes, vivência o momento do evento, recebendo os estímulos visuais e somente ao retornar para seu ambiente de trabalho, passam a fazer ponderações sobre o que viram. E na maioria das vezes, não conseguem definir exatamente a codificação destes estímulos, porém sabem que foram impactados. A partir daí, é possível selecionar o fornecedor a ser procurado no momento da cotação. Isto ocorre, exatamente entre uma exposição e outra. Por outro lado, a empresa expositora parte neste mesmo período, para a manutenção da imagem formada junto ao cliente. Fazendo visitas ou simplesmente mantendo um contato, sempre utilizando o referencial “estande”. Sendo assim, neste modelo circular o feed-back é a ferramenta chave na comprovação do efeito causado no cliente e avaliado pelas empresas.

Todas as atividades estratégicas da empresa são planejadas pelo marketing, afim de que a mesma ingresse em uma exposição industrial adequadamente. Em razão disto, nasce uma comunicação visual que, através da união de aspectos estéticos, estabelece um vínculo com o mercado, capaz de fixar esta imagem na mente do consumidor e ser influenciadora de negócios.

Planejamento – A base

Após a Segunda Guerra Mundial houve uma grande expansão econômica e as mudanças ocorridas foram o foco de diversos estudos. Na essência nascia uma sociedade industrial mais rica e num processo contínuo de evolução, uma forma mais avançada da sociedade industrial. Alguns fatores marcaram este novo período: o dinamismo tecnológico; o emprego maciço de capital; a combinação de conhecimento, competência e especialização; e organização eficiente (empresa planejada). A especificidade das ações e a instabilidade dos mercados estabelecem uma das principais atividades estratégicas do novo sistema industrial, o **planejamento**, que é a determinação dos objetivos ou metas de um empreendimento, como também da coordenação de meios e recursos para atingi-los.

O sucesso das empresas depende em grande parte da eficiência dessa atividade, pois, aliado à ascensão da capacitação e competência dos profissionais, se tornou a prerrogativa de quem detém ou controla o fator estratégico da produção. O planejamento delimita e norteia a atividade de marketing, que deve ser compreendida através das diferentes “gerações” passadas por este processo.

A busca e manutenção da imagem são as grandes metas das empresas, no mercado atual. E trabalham com planejamento para alcançá-la. Este planejamento define estratégias de *marketing* que atinjam seus objetivos, satisfazendo as necessidades dos clientes.

Exposições industriais

Ao afirma-se que a imagem da empresa é estabelecida por um plano de marketing e dele origina-se toda a estratégia de comunicação, podemos destacar que o trabalho de promoção por meio de exposições é uma das principais ferramentas no mercado industrial.

Para validarmos esta afirmação devemos ressaltamos que a prática de comércio em feiras é datada dos primórdios da humanidade, quando exerciam atividades de trocas, ainda sem o uso da moeda. O aprimoramento levou ao surgimento de lojas e em seguida de grandes conglomerados comerciais, aonde era possível adquirir os mais diversos produtos, como ocorria nos mercados do Império Romano. Com a decadência do mesmo, as lojas desapareceram e deixaram o comércio ser exercido somente nas feiras. Neste momento surge a utilização de símbolos para identificação do comércio e conseqüentemente a fácil assimilação pelo cliente. Estas feiras eram realizadas em diferentes localizações, gerando os primeiros conceitos de posicionamento, para melhor sobressair-se para o cliente. Com o passar dos tempos, houve o retorno natural das lojas e bem depois, dos grandes conglomerados. Para chegar cada vez mais perto do consumidor, a lojas passaram usar a decoração como ferramenta de promoção dos seus produtos. Na verdade, esta exposição coloca o consumidor em contato direto com a empresa e também estabelece a oportunidade de comparações com a concorrência.

Até agora, todo o processo avaliado diz respeito à comercialização dos produtos de varejo, ou seja, produtos direcionados ao consumidor final. No mercado industrial, este tipo de promoção difere do executado no mercado de varejo, em sua essência. O processo de compra é diferenciado devido à relação ser entre duas empresas e não com o consumidor final; desse modo, o campo de observação do consumidor industrial é além do produto, a imagem que a empresa apresenta.

A preparação de um evento para o mercado industrial movimenta hoje um elevado número de profissionais em todo Brasil, com maior concentração em São Paulo e Rio de Janeiro. Muitas são as empresas prestadoras de serviço nesta área e até mesmo algumas associações específicas também exercem esta função. Preparar um evento significa antes de qualquer coisa, conhecer bem as necessidades do mercado alvo, sendo assim, os idealizadores devem estar vivenciando o mercado em questão, para recolher o máximo de informações.

As exposições industriais ocorrem em cada setor de atuação com intervalos de um ano ou dois. No Brasil é muito usual acontecer o evento anualmente. Exposições como Fispal (Indústria Alimentícia), ABTCP (Associação Brasileira Técnica de Celulose e Papel), FIEPAG (Indústrias de Embalagem, Papel e Gráficas) são exemplos de eventos anuais, assim como, temos a Feira da Mecânica a cada dois anos. Mesmo diante de um grande investimento para participação em eventos deste tipo, as empresas deparam com uma realidade tipicamente brasileira, isto é, o fato de não existir a cultura de negociação durante as exposições industriais, principalmente as de bens de capital (equipamentos feitos sob encomenda). Sendo assim, o que realmente atrai a alta administração de uma empresa manter e investir cada vez mais em exposições? Em estandes que elevem a imagem da empresa? Talvez o fato de reconhecer que a imagem (institucional) de sua empresa esta sendo cada vez mais fixada no mercado consumidor. Vale lembrar que uma imagem institucional engloba a empresa como um todo, inclusive com toda a sua linha de produtos. Isto posto, se temos uma imagem institucional por intermédio dos estandes e sabemos que as organizadoras divulgam potenciais de vendas durante os eventos, que números são estes? Qual a origem?

Os números são projeções que as empresas preparam para o próximo ano, e a origem dos dados esta no próprio mercado. Estes valores são repassados às organizadoras que divulgam como uma projeção de negócios durante o evento.

Se o pedido não esta sendo fechado, o cliente não esta levando sua "mercadoria" durante o evento, o que o faz procurar a empresa após o evento para realizar a compra desejada? Exatamente, a imagem construída pela equipe de *marketing* através do estande. O cenário onde este cliente pode perceber seus desejos e necessidades serem atingidos. Por este motivo, o estande pode ser considerado como uma comunicação visual geradora de negócios em eventos industriais.

Comunicação visual geradora de negócios

A visualização de como a empresa se apresentará durante um evento, exposição ou feira é de responsabilidade da área de *marketing* , que procura associar toda a estratégia estabelecida pela alta administração, pela sua identificação visual como, logotipia, papéis, cores escolhidas etc., às tendências atuais de mercado. Estando inclusas nestas tendências, as necessidades do mercado comprador e também os aspectos mais relevantes de comunicação visual, *design*. Estabelecer uma imagem para a empresa não é um simples "toque" de decoração. O estande é o espaço destinado à criação da imagem da empresa, onde os produtos e/ou serviços são mostrados, expostos e comunicados visualmente para atrair os possíveis compradores, ou seja, o público-alvo. A comunicação visual do estande define-se pela conceituação de Design, que significa projetar, compor visualmente ou colocar em prática um plano intencional. Plano que produz, no estande, efeitos desejados pelos consumidores e que dependem de diversos fatores, como: materiais estruturais adequados, iluminação, definição do espaço de circulação, entre outros.

O estande é um cenário construído pela empresa expositora, onde o artista principal é o comprador. Neste espaço é permitido ao atuante encenar seus desejos e buscar o atendimento de suas necessidades. Cabe, então, a empresa estabelecer uma relação cenográfica adequada à imagem que quer estabelecer no mercado em que atua. Por este enfoque, concorda-se com Sylvia Demetresco, que, ao estudar as vitrines, afirma que *as cenarizações são complexas encenações articuladas para atuar sobre as ordens sensoriais do consumidor a partir de um trabalho estético que estrutura o discurso, seja a proposta de venda ou somente a atração do observador".* As formas de arte expressam um pensamento, uma visão do mundo que de alguma maneira provocam inquietude em quem vivência, buscando uma sensação diferenciada, uma contemplação, admiração ou comunicação. Estes aspectos fazem parte de uma experiência estética. Por isso, podemos dizer que o consumidor industrial estabelece uma relação com a empresa expositora através de sua experiência estética. Isto ocorre porque o projeto de um estande procura acompanhar as tendências estéticas do mercado nacional e internacional. Estas tendências na verdade seguem um processo histórico da arte que na modernidade apresentou-se através de movimentos como cubismo, futurismo, construtivismo, dadaísmo, suprematismo, neoplasticismo e o minimalismo, que procuravam romper com as tradições.

Por trás de todo este cenário institucional, está o produto, o grande potencial da empresa. Sendo assim, a construção de um estande busca a identificação do produto junto à imagem da empresa. Quando se monta um estande a principal razão é despertar desejos, criar expectativas e uma sensação de prazer nos consumidores, tudo isso através da comunicação visual estabelecida por formas, linhas, cores, texturas, entre outros aspectos. Neste espaço, é permitido à fantasia da empresa em relação ao seu dia-a-dia.

Um outro trecho do livro da Sylvia Demetresco, A Vitrina, retrata bem este posicionamento: *é o cenário que contém uma mensagem englobadora de vários elementos, significados e efeitos de sentido, tudo isso para mistificar um produto, objeto-valor, no qual valores são investidos a partir da edificação da encenação com todos os seus itens construídos, para definir identificar e marcar a relação sujeito-objeto.*

Um cenário construído para um período máximo de até 05 dias, onde seu design e estética são os geradores de transformações a ponto de fixar esta imagem na mente dos compradores, na verdade, uma sequência de imagens a cerca dos visitantes atuando como espelhos, observando seus íntimos, trazendo a tona seus segredos.

Estamos falando da função do marketing como planejador e determinador da imagem da empresa, e sua relação direta com design e estética, na composição de um estande para exposições industriais. Cabe ressaltar que esta relação ocorre porque sempre deve ser avaliada a composição da imagem que será passada durante uma exposição, na intenção de que a mesma seja um espelho aonde o visitante visualize a satisfação de suas necessidades e a partir daí entregue-se ao composto de artifícios que englobam o espaço denominado estande.

Todas as atividades de marketing visam estabelecer um forte relacionamento entre a empresa vendedora e a compradora, afim de que a negociação seja proveitosa, para ambas às partes. É sabido que a empresa compradora precisa e muitas vezes depende fazer bons negócios que ajudem a alcançar as metas globais da empresa. Por este motivo, os profissionais destas organizações freqüentam eventos, como as exposições industriais, visando ampliar relacionamentos e constatar novas tecnologias e oportunidades na participação da empresa vendedora.

A imagem e o símbolo continuam sendo os principais meios de comunicação e, dentre eles, só o visual pode ser mantido em qualquer circunstância prática. Isso é tão verdadeiro hoje quanto tem sido ao longo da história. Mas as implicações da natureza universal da informação visual não se esgotam em seu uso como substitutivo da informação verbal. Não há nenhum conflito entre os dois tipos de informação. Cada uma tem suas especificidades, mas o modo visual ainda não foi utilizado em sua plenitude. Esta abertura para o mercado movimenta um grande número de profissionais que transformam as exposições industriais em um canal de comunicação direcionado, em função da temática do evento.

As empresas expositoras estabelecem sua imagem a partir da uma forma determinada para elaborar seu estande. Na linguagem visual, a forma é estabelecida por linhas que são pontos (unidades simples e mínimas de comunicação visual) em movimento. As formas podem ser geométricas, já conhecidas pela geometria ou orgânicas que são encontradas nos objetos ou em manifestações naturais. O estudo das formas conduz a formas que resultam da acumulação de duas ou mais formas iguais. A forma determinada pela empresa é uma expressão da cultura empresarial da mesma, associada a valores estéticos e padrões de construção vigentes no mercado. O profissional que visita a exposição é impactado por diversos fatores, e com certeza a forma do estande é uma delas. Os estandes refletem a criatividade dos designers que operam as cores em sintonia com a ciência e a indústria. Para eles as cores corretas são as próprias dos materiais com que são produzidos os objetos, pois elas têm uma função simbólica muito importante e transmitem idéias ou conceitos. A diferenciação entre empresas com o mesmo perfil de cores, está no grau de luminosidade produzido pelos diversos tons empregados na estrutura, assim como, a textura dada às paredes, que é um elemento visual que com freqüência serve de substituto para as qualidades de outro sentido, o tato. A combinação de texturas diferentes produz efeitos interessantes e surpreendentes. É indiscutível a associação entre a estrutura e a cor empregada nos estandes, e é esta mescla que faz o visitante parar, observar, entrar e se encantar.

O grande desempenho na estruturação de um estande esta na dimensão ou espaço, um aspecto visível, e na movimentação, um aspecto implícito que a empresa demonstrará ao seu cliente. Estabelecida à área, cabe a montadora apresentar o projeto com uma circulação adequada, prevendo o número de visitantes que poderão por ali passar. A associação é responsável pela divulgação do evento na mídia especializada e também nas empresas do setor.

A classificação construtiva não difere nos mercados de varejo e industrial, ou seja, os estandes podem ser: padrão, básico, misto e construído.

A linguagem visual aqui, tem sido um constante aprimoramento dos itens abordados, provocando o efeito proposto pela comunicação, que é atingir diretamente o público-alvo daquele evento que a empresa esta participando. Para isso é fundamental que se destaque que todos expressam e recebem mensagens visuais em três níveis, o primeiro é aquilo que vemos e identificamos com base no meio ambiente e na experiência, isto é de forma representado. O segundo é o nível abstrato, ou seja, a qualidade sinestésica de um fato visual reduzido a seus componentes visuais básicos e elementares, enfatizando os meios mais diretos, emocionais e mesmo primitivos da criação de mensagens. E finalmente, o vasto universo de sistemas de símbolos codificados que o homem criou arbitrariamente e ao qual atribuiu significados (linguagem verbal). Todos esses níveis de resgate de informações são interligados e se sobrepõem; no entanto, é possível estabelecer distinções suficientes entre eles, de tal modo que possam ser analisados tanto em termos de seu valor como tática potencial para a criação de mensagens, quanto em termos de sua qualidade no processo da visão. É importante destacar que a geração desta comunicação é estreitamente ligada ao plano estratégico da empresa. A cada evento nota-se que existe uma constante preocupação das empresas na forma de se apresentarem ao mercado, inovando na construção de seus estandes, nas cores e materiais promocionais. Este crescimento na forma de comunicação com o mercado é que esta sendo avaliado neste estudo.

O estudo está baseado no enfoque dos "Expositores", por serem os responsáveis pelo planejamento e determinação da imagem que será lapidada para a criação do estande, sua empresa, durante a exposição industrial. Foi escolhida uma das exposições industriais mais importantes no setor de celulose e papel e dela extraídos alguns expositores que auxiliaram na pesquisa. Para melhor analise dos resultados foram destacados três blocos, o primeiro enfatizando o perfil do público e modelo dos estandes; o segundo como é tratada a comunicação visual nos estandes e a terceira a expectativa de geração de negócios a partir da imagem construída.

Foi concluído que os fatores estéticos aliados às estratégias de marketing na elaboração de projetos para estandes em exposições industriais, estabelecem uma comunicação circular capaz de despertar os desejos dos clientes, fazendo com que os mesmos busquem a concretização de negócios em andamento ou novos, no período posterior ao evento.

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UM CLASSIFICADOR DE SINAIS PROJETADO COM PRINCÍPIOS DAS REDES NEURAIS ARTIFICIAIS PARACONSISTENTES

Maurício Conceição Mário[1] e *João Inácio da Silva Filho*[2]

Resumo *- Neste artigo, com base nos conceitos teóricos da Lógica Paraconsistente Anotada, apresentamos um Sistema capaz de classificar sinais. A lógica paraconsistente Anotada LPA, conforme apresentada em [1] é uma classe de Lógica Não Clássica que permite manipular sinais contraditórios sem trivialização. Em [5] foram apresentadas Células Neurais Artificiais Paraconsistentes construídas com Algoritmos baseados na LPA onde ficou demonstrado sua capacidade de aprender e desaprender determinados sinais em forma de funções aplicados em suas entradas. A partir dos algoritmos das Células foram feitas conexões e agrupamentos entre os algoritmos para se criar um Sistema Paraconsistente Classificador de Sinais – SPCS. O SPCS é capaz de aprender quatro tipos de sinais diferentes. Depois do aprendizado dos quatros sinais o SPCS pode reconhecer se o sinal apresentado na entrada pertence ou não ao grupo de sinais aprendido anteriormente. Os resultados obtidos com o SPCS demonstram que os algoritmos das Células Neurais Artificiais Paraconsistentes interligados desta forma se transformam em um Sistema Paraconsistentes Classificador de Sinais robusto indicado para utilização em vários campos da área de Inteligência Artificial como os Sistemas Especialistas e de Reconhecimento de palavras e imagens.*

Palavras chaves: lógica paraconsistente, lógica paraconsistente anotada, redes neurais, redes neurais paraconsistentes, neurocomputação.

1 – INTRODUCÃO

Do ponto de vista de engenharia, sinais são funções ou seqüências que transportam informações de uma fonte de mensagens a um destinatário. As características específicas dos sinais dependem do canal de comunicações utilizado para o transporte do sinal. Um canal de comunicações é definido pelo tipo de distorção que introduz nos sinais, podendo esta ser do tipo: a) determinística linear (limitação da banda de freqüência dos sinais); b) determinística não linear (existência de saturações); c) aleatória (presença de ruídos) [9].

Em sistemas eletrônicos de comunicação a fonte geradora de informação, o canal de comunicação, o canal de comunicação e o destinatário são elementos pré-definidos, geralmente com características bem especificadas.

Em outras situações, como nos processos de medição em investigação científica, a fonte de mensagens e o canal de comunicações poderão estar apenas parcialmente caracterizados. Sinais bioelétricos como o eletrocardiograma (EKG), o eletroencefalograma (EEG), o eletromiograma (EMG) ou o eletroneugrama (ENG) são estudados há décadas com a finalidade de se extrair informação sobre estados patológicos de órgãos, sem que se tenha muitas vezes a certeza de que tal informação é de fato transportada por estes sinais.

Os sinais que constituem a voz humana codificam uma variedade de informações: sobre a semânticado que está sendo dito, sobre a identidade do locutor, etc [9].

1.1. CLASSIFICAÇÃO DE SINAIS

Dado o sinal representado pela equação:

$$\mathbf{y(t)=f(t,A)+n(t)}$$

Supondo que o sinal y(t) possa pertencer a categorias $\{Cj\}^{M,\quad j=1}$, conforme o valor do parâmetro **A** e particularizando para o caso, por exemplo, da tentativa de se diagnosticar condições cardíacas patológicas a partir de traçados de EKG, então para cada categoria diagnóstica *j* é escolhida uma coleção de traçados representativos:

$$\{y_{i,j}(t)\}^{Nj,\ i=1}\ \ j=1,2...M$$

Conforme exposto em [9] uma tentativa de classificação de sinais pode ser feita fazendo-se uma abordagem direta com técnicas de Redes Neurais. Neste caso é feito o treinamento em uma rede neural multicamada **N**(W) que terá como entradas todos os **N** pontos das séries temporais associadas a cada um dos sinais, e como saídas as **M** categorias em que se pretende classificá-los, como mostrado na figura 1:

Um problema para este tipo de abordagem é que cada série temporal é representada por cerca de 500 pontos amostrais para cada ciclo de EKG, o que impõe uma dimensão grande à rede, mesmo havendo poucas categorias de classificação.

Uma abordagem mais econômica é procurar reduzir a dimensão dos sinais a uma coleção menor de parâmetros que representem adequadamente os sinais originais e, implementar uma classificação neural para estes parâmetros.

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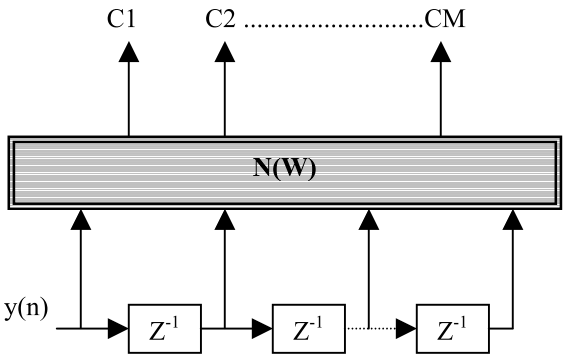

Fig.1 Rede Neural Artificial Multicamada na Classificação de Sinais.

A literatura apresenta vários métodos de classificação de sinais como em [9] onde se faz a parametrização e efetua as medições de amplitudes de pontos fiduciais (ondas P, Q, R, S, T, U) no traçado, áreas associadas, durações e separações. Um método muito estudado é o proposto por Halliday [7], onde a coleção de todos os sinais é modelada por um processo aleatório Y(t) do qual cada traçado individual é uma particular função amostra. Neste processo é feita uma classificação de modo aleatório e em seguida é representado por uma expansão ortonormal como o de Kahrunen-Loeve. Por esta expansão, determinam-se a seguir funções ortonormais $\{\Phi_i(t)\}$ chamadas de autofunções da função de covariança associada ao processo, tais que:

$$\int^T_0 \Phi_i(t)\ \Phi_k(t)dt = \partial(i,k)$$

$$y_k(t) = \lim_{n\to\infty} \Sigma^n_{i=1} a_{ki}\Phi_i(t)$$

e os coeficientes associados a cada um dos sinais são calculados por: $a_{ki}=\int^T_0 y_k(t)\ \Phi_i(t)\ dt$

Ordenando as médias destes coeficientes calculadas sobre toda a população de sinais em ordem decrescente dos seus valores absolutos, pode-se aproximar cada sinal individual apenas pelas L autofunções mais significativas:

$$\ddot{y}_k(t)= \Sigma^L_{i=1} a_{ki}\Phi_i(t)$$

Deste modo, espera-se que o vetor de coeficientes $\mathbf{a_k}$ de dimensão L<<N represente adequadamente cada sinal com um erro de reconstrução suficientemente pequeno.

Com este modelo matemático que foi utilizado em [7] para a classificação de traçados VCG's (vector cardiogramas), pode-se implementar uma rede neural multicamada de dimensão mais viável, que, utilizando apenas estes coeficientes a_k, classifique adequadamente os sinais nas J categorias.

Neste trabalho apresentamos uma nova metodologia onde um Sistema Paraconsistente Classificador de Sinais construído com base na Lógica Paraconsistente Anotada [5] utiliza Células Neurais Artificiais Paraconsistente devidamente configuradas para aprender e classificar sinais usando Algoritmos muitos simples e capazes de ser controlado para efetuar classificação de categorias de sinais.

2 – A LÓGICA PARACONSISTENTE ANOTADA COM ANOTAÇÕES DE DOIS VALORES - LPA2v

As contradições ou inconsistências são comuns quando descrevemos partes do mundo real. Os sistemas de análises e tratamento de sinais utilizados em Inteligência Artificial funcionam em geral com base na lógica convencional, onde a descrição do mundo é considerada por dois estados: Falso ou Verdadeiro. Estes sistemas binários não conseguem tratar adequadamente as situações contraditórias. As Lógicas Paraconsistentes nasceram da necessidade de se encontrar meios de dar tratamento não trivial às situações contraditórias. Os estudos e propostas das Lógicas Paraconsistentes apresentaram resultados que possibilitam considerar as inconsistências em sua estrutura de um modo não trivial [4] e [1], e por isso, se mostram mais propícias no enquadramento de problemas ocasionados por situações de contradições que aparecem quando lidamos com o mundo real.

A Lógica Paraconsistente Anotada LPA é uma classe de lógica Paraconsistente Evidencial que faz tratamento de sinais representados por anotações permitindo uma descrição e equacionamento por meio de Algoritmos.

Na Lógica Paraconsistente Anotada LPA as fórmulas proposicionais vêm acompanhadas de anotações. Cada anotação, pertencente a um reticulado finito τ , atribui valores à sua correspondente fórmula proposicional. Uma Lógica Paraconsistente Anotada LPA pode ter como reticulado finito, o de "quatro estados", conforme a figura 2.

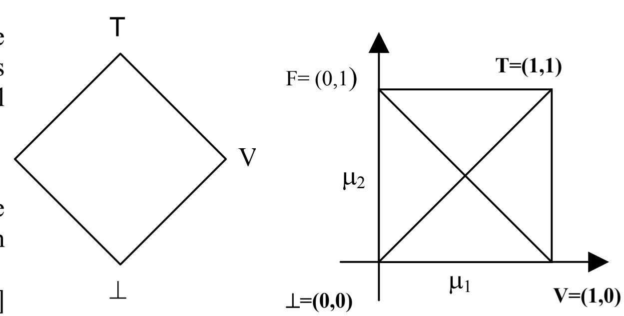

Fig.2 Reticulado finito e Quadrado no Plano Cartesiano.

A Lógica Paraconsistente Anotada com anotação de dois valores - LPA2v é uma extensão da LPA e pode ser representada através de um reticulado de quatro vértices [2] onde podemos estabelecer algumas terminologias e convenções, do seguinte modo:

Seja $\tau = < |\tau|, \leq >$ um reticulado finito fixo, onde:

1. $|\tau| = [0, 1] \times [0, 1]$
2. $\leq = \{((\mu_1, \rho_1), (\mu_2, \rho_2)) \in ([0, 1] \times [0, 1])^2 \mid \mu_1 \leq \mu_2$ e $\rho_1 \leq \rho_2\}$ (onde $\leq$ indica a ordem usual dos números reais). Tal reticulado denomina-se *reticulado de valores-verdade*.

3 – AS CÉLULAS NEURAIS ARTIFICIAIS PARACONSISTENTES

Na análise paraconsistente o objetivo principal é saber com que medida ou grau de certeza podemos afirmar que uma proposição é Falsa ou Verdadeira. Portanto, é considerado como resultado da análise apenas o valor do grau de certeza G_c. O valor do grau de contradição G_{ct} é um indicativo que informa a medida da inconsistência. Se houver um baixo valor de certeza ou muita inconsistência o resultado é uma indefinição. Estes valores podem retornar em dois eixos sobrepostos representando a reticulado finito, agora com valores, conforme a figura 4 abaixo:

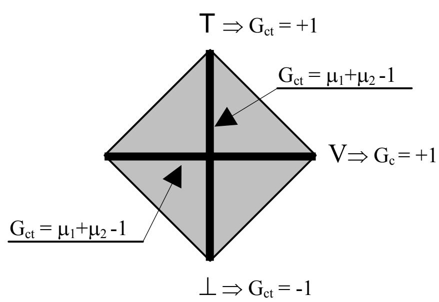

Fig.3 Reticulado finito da LPA2v com valores.

Os valores de controle ajustados externamente são limites que vão servir como referência na análise.
Podemos descrever a análise paraconsistente utilizando apenas as equações originadas no Quadrado Unitário do Plano Cartesiano.
Uma descrição do reticulado utilizando os valores obtidos pelas equações resulta no Algoritmo denominado "Para-Analisador" [5]. Este algoritmo é elaborado com base na descrição do reticulado e pode ser escrito na sua forma reduzida expressando assim uma Célula Neural Artificial Paraconsistente básica CNAPb conforme é descrito a seguir:

/Definições do valores ajustáveis/
V_{scc}=C_1 ***/Valor superior de controle de certeza*/***
V_{icc}=C_2 ***/ Valor inferior de controle de certeza*/***
V_{scct}=C_3 ***/Valor superior de controle contradição*/***
V_{icct}=C_4 ***/Valor inferior de controle contradição*/***
/Variáveis de entrada/
μ_1, μ_2
/Variáveis de saída
Saída Digital = S_1
Saída analógica = S_{2a}
Saída analógica = S_{2b}
*/Expressões matemáticas */
sendo : $G_{ct} = \mu_1 + \mu_2 - 1$
e $G_c = \mu_1 - \mu_2$
*/determinação dos *estados lógicos extremos* */
Se $G_c \geq C_1$ então S_1 = V
Se $G_c \leq C_2$ então S_1 = F
Se $G_{ct} \geq C_3$ então S_1 = T
Se $G_{ct} \leq C_4$ então S_1 = ⊥
Senão S_1 = I -Indefinição
$G_{ct} = S_{2a}$
$G_c = S_{2b}$

*/ *FIM*/

Denomina-se *Célula Artificial Paraconsistente básica* (CAPb) o elemento capaz de, composto de quando um par de graus de crença e descrença *(u_{1a}, u_{2a})* for apresentado na sua entrada fornecer um resultado na sua saída na forma de uma tripla dada por: G_{ct} = *grau de contradição* resultante, G_c = *grau de crença* resultante e X = constante de anotação resultante Indefinido. A figura 4 mostra a representação de uma CNAPb.

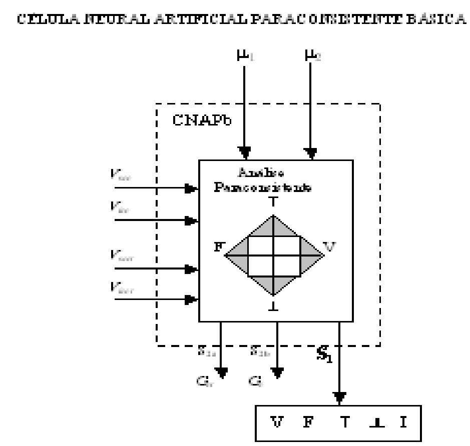

Fig.4 A Célula Neural Artificial Paraconsistente Básica CNAPb.

Na Célula Neural Artificial Paraconsistente básica CNAPb representada pelo algoritmo "Para-Analisador", foram considerados todos os valores envolvidos nas equações, sendo assim, se os valores dos graus de certeza e de contradição estiverem fora dos valores impostos pelos limites ajustáveis, a saída é um estado denominado de *não-extremo*, sendo a este atribuído um valor indefinido *I*.
A partir da *Célula Artificial Paraconsistente básica* (CAPb) foram criadas outras Células as quais denominamos de *Células Neurais Artificiais Paraconsistentes* (CNAP's).

Os estudos das CNAP deram origem a uma família de Células Neurais Artificiais Paraconsistentes que constituem os elementos básicos das *Redes Neurais Artificiais Paraconsistentes* (RNAP's). Neste trabalho para elaboração do Classificador de Sinais foram necessários apenas três tipos [5] de Células denominadas: Célula Neural Artificial Paraconsistente de Aprendizagem CNAPap que consegue aprender e memorizar um padrão aplicado em sua entrada, uma Célula Neural Artificial Paraconsistente de Conexão Lógica Simples de Maximização - CNAPLs que determina a sua saída pelo maior valor aplicado na entrada e uma Célula Neural Artificial Paraconsistente de Decisão - CNAPd que determina a saída final resultante da análise Paraconsistente.

5. O CLASSIFICADOR PARACONSISTENTE DE SINAIS

Neste trabalho o Classificador Paraconsistente de Sinais é composto por módulos básicos denominados de Unidade Neural Artificial Paraconsistente de Comparação de Padrões – UNAPCP que armazenarão sinais para serem comparados com aqueles que serão aplicados na entrada. Cada Unidade – UNAPCP é composta, por sua vez, de três Células Neurais Artificiais Paraconsistentes; uma Célula Neural Artificial Paraconsistente de aprendizagem CNAPCa, uma Célula Neural Artificial Paraconsistente de Conexão Lógica Simples de Maximização - CNAPLs e uma Célula Neural Artificial Paraconsistente de Decisão - CNAPd. O diagrama em blocos da figura 5 mostra como se compõem o Classificador Paraconsistente de Sinais.

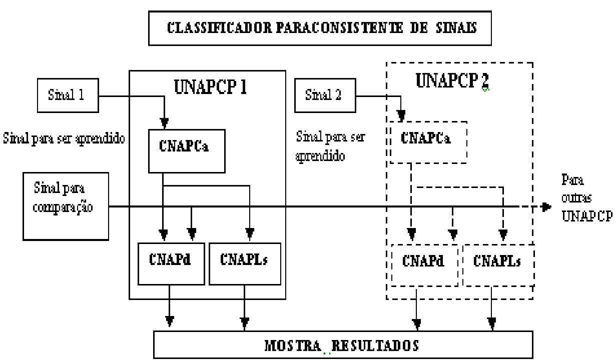

Fig.5. Diagrama mostrando interconexões dos módulos do Classificador paraconsistente de Sinais.

Neste trabalho optamos por construir um Classificador que permite comparação com quatro tipos de sinais, portanto com quatro módulos de Unidade Neural Artificial Paraconsistente de Comparação de Padrões – UNAPCP, no entanto mais módulos podem ser agregados para expandir a capacidade do Classificador. A quantidade de módulos vai depender da natureza da aplicação do projeto.

3.CÉLULA NEURAL ARTIFICIAL PARACONSISTENTE DE APRENDIZAGEM-CNAP-Ap

A Célula Neural Artificial Paraconsistente de aprendizagem CNAPap é uma Célula Neural Artificial Paraconsistente Básica com uma saída μ_{1r} interligada à entrada do grau de descrença complementado μ_{2c}. Conforme pode ser visto no Algoritmo sucessivos valores aplicados à entrada do grau de crença μ_1 resulta no aumento gradativo no grau de crença resultante da saída μ_{1r}. Esta Célula pode funcionar de dois modos, para aprendizado do *padrão de verdade*, onde são aplicados valores μ_1=1 sucessivamente até o grau de crença resultante na saída chegar à μ_{1r}=1, e para o aprendizado do *padrão de falsidade* onde são aplicados valores μ_1=0 até o grau de crença resultante chegar à μ_{1r}=1, neste caso a entrada do grau de crença é complementada μ_{1c} conforme mostra a figura 6

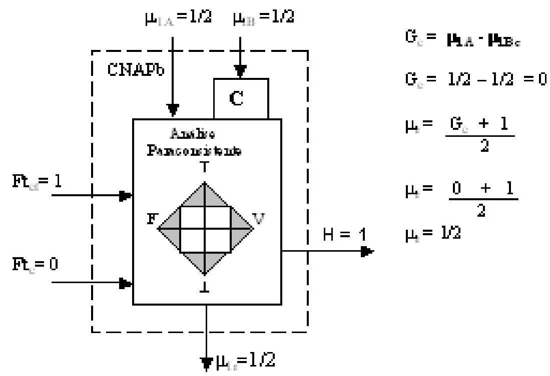

Fig 6- Célula Neural Artificial Paraconsistente de aprendizagem pronta para receber padrões.

Algoritmo completo de Aprendizagem da Célula Neural Artificial Paraconsistente - CNAPa

1- Início: μ_r = 1/2 */Célula virgem */
2- Defina: F_A= Valor onde: $F_A \geq 1$ */ Entra com o valor do Fator de aprendizagem */
3- Defina: F_{DA}= Valor : $F_{DA} \geq 1$ */ Entra com o valor do Fator de desaprendizagem */
4- Defina: P */ Padrão de entrada , $0 \leq P \leq 1$ */
5- Faça: G_{ci}= P -μ_{2c} */ Calcula o Grau de crença inicial*/
6- Se $G_{ci} < 0$ Faça: μ_1 =1 - P */ O grau de crença é o complemento do padrão */
7- Se $G_{ci} > 0$ Faça: μ_1 = P */ O grau de crença é o Padrão */
8- Faça : $\mu_2 = \mu_r$ */ Conecta a saída da célula na Entrada do grau de descrença */
9- Faça: μ_{2c} =1 - μ_2 */ Aplica o Operador Complemento no valor da entrada do grau de descrença */
10- Faça: G_c= μ_1 - μ_{2c} */ Calcula o Grau de crença */
11- Se $G_c \geq 0$ faça $C_1 = F_A$
12- Se $G_c < 0$ faça $C_1 = F_{DA}$
13- Faça: $\mu_r = \{(G_c \times C_1) +1\} \div 2$ */ Encontra o grau de crença resultante da saída pela EEB */
14- Enquanto $\mu_r \neq 0$ retorne ao passo 8
15- Se $\mu_r = 0$ Faça: $\mu_{1r} = 1$ e $\mu_1 = 1 - P$ */ Aplica o Operador NOT e complementa o grau de crença */

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16- Retorne ao passo 8

6. RESULTADOS PRÁTICOS

Com base na teoria exposta foi elaborado um software Classificador Paraconsistente de Sinais capaz de aprender sinais e compara-los com padrões inseridos na entrada. A figura 7 mostra a tela principal do Classificador Paraconsistente de Sinais proposto neste trabalho com as legendas explicativas.

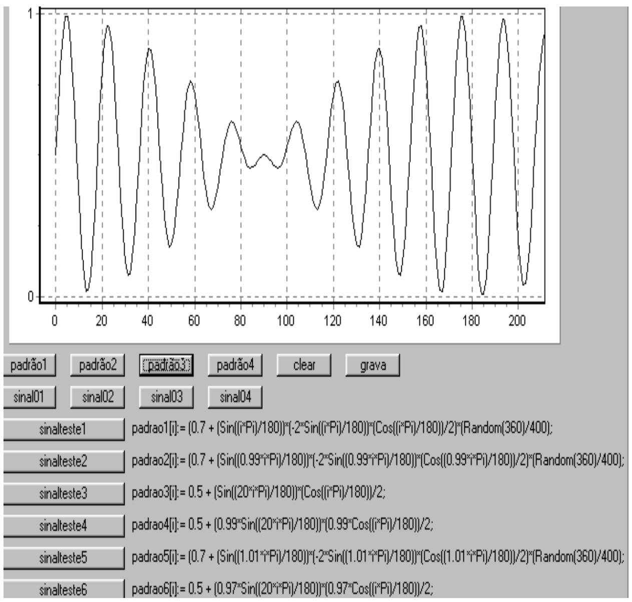

Fig 7- Tela principal do Classificador de Sinais

Os botões na janela do Software permite que o classificador aprenda 4 tipos de sinais com as equações correspondentes. Na análise o software reconhece apenas o sinal apreendido anteriormente, conforme mostra a figura 8.

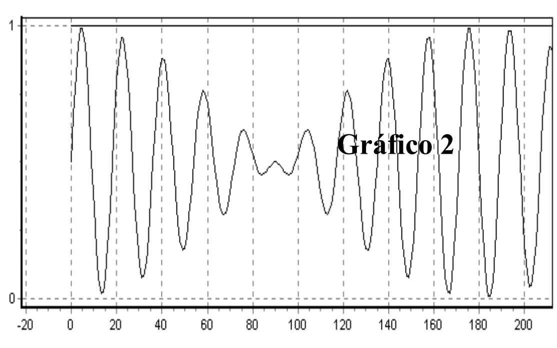

Fig 8- Forma de Onda reconhecida pelo Classificador de Sinais

O exemplo exposto na figura mostra apenas o sinal padrão 3 sendo desnecessário a apresentação dos outros sinais aprendidos.

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USO DE SIMULAÇÕES MATEMÁTICAS DE PROCESSOS NO ENSINO DE ENGENHARIA DE MATERIAIS

Antonio Augusto Gorni[1] *e Regina Zayat Gorni*[2]

Abstract — *O atual ensino de engenharia deve, tanto quanto possível, promover a familiarização dos alunos com os processos industriais que eles encontrarão ao desempenhar sua profissão. Uma das maneiras mais eficazes de lhes ensinar as correlações entre os parâmetros desses processos e seus resultados finais está na execução orientada de programas computacionais que simulem fidedignamente tais processos. Este artigo mostra dois exemplos práticos desse tipo de abordagem na engenharia de materiais, mais especificamente na laminação a quente de aços. Um deles consiste no cálculo do balanço térmico de um forno para reaquecimento de placas destinadas à laminação a quente de chapas. O segundo trata da determinação da evolução microestrutural de aços processados num laminador de tiras a quente. Para que tal abordagem seja bem sucedida o professor deve garantir a representatividade e consistência tanto dos modelos matemáticos como dos dados empregados nas simulações matemáticas.*

Palavras-Chave — *Engenharia de Materiais, Laminação a Quente, Modelo Matemático, Simulação*

INTRODUÇÃO

As vertiginosas e contínuas mudanças tecnológicas, econômicas e políticas do mundo moderno também devem se refletir no ensino de engenharia de forma que seus alunos tenham plenas condições de enfrentar um mercado extremamente competitivo e que apresenta condições de trabalho altamente mutáveis. As sugestões para se atingir esse objetivo são das mais variadas, incluindo-se aí a famosa abordagem sobre "ensinar como se deve aprender", já que o aprendizado contínuo é uma realidade que parece ter vindo para ficar.

Entre esses vários avanços que vêm se verificando no ensino de Engenharia pode-se incluir o uso de simulações computacionais de processos industriais e sua aplicação na sala de aula. A aplicação de interfaces gráficas amigáveis e interativas permite que tais simulações sejam executadas sem entediar o aluno. Dessa forma podem ser feitos exercícios extensivos que têm como objetivo demonstrar o efeito de variações nos parâmetros de processo sobre seu resultado final. O objetivo aqui é familiarizar o aluno com a realidade que encontrará no chão de fábrica enquanto ele ainda se encontra na escola. Isso contribuirá para que seu período de integração técnica na empresa seja encurtado, fazendo com que o recém-formado rapidamente se torne útil à empresa.

Obviamente este é um campo muito vasto, dadas as várias modalidades de engenharia existentes e a miríade de processos industriais associados em cada uma delas. Este artigo mostrará como exemplo de simulação industrial dois casos ligados à engenharia de materiais, mais especificamente sobre laminação a quente de aços: o balanço térmico de fornos e a evolução microestrutural observada ao longo da laminação de tiras a quente.

BALANÇO TÉRMICO DE FORNOS

O balanço térmico é uma das ferramentas mais eficazes para se diagnosticar o nível de desempenho energético para qualquer tipo de forno. Como se sabe, ele nada mais é do que a identificação de todas as fontes de entrada e saída de calor de um determinado forno, juntamente com os respectivos cálculos de sua magnitude. Sua aplicação na área siderúrgica é mais comum em altos-fornos e conversores LD, onde é parte obrigatória do próprio processo metalúrgico. Em outras aplicações, como no caso dos fornos de reaquecimento usados em laminações, ele é relegado a segundo plano, pois já não é vital ao processo. Além disso, a quantidade de energia envolvida é menor, particularmente quando se trata de fornos de tratamento térmico e recozimento. Contudo, a não-execução do balanço térmico faz com que se perca uma excelente oportunidade para se fazer uma auditoria contínua no forno do ponto de vista energético, identificando seus pontos fracos e até quantificando os ganhos decorrentes de sua eliminação. E, obviamente, ganhos energéticos se refletem na lucratividade da empresa, como também ajudam a poupar recursos não-renováveis e reduzem o nível de agressão ao meio ambiente.

Como se pode observar, todas essas vantagens decorrentes do cálculo do balanço térmico de um forno tornam sua simulação dentro de um curso de engenharia de materiais bastante interessante. Neste trabalho será apresentado um exemplo desse cálculo para fornos de reaquecimento de placas a serem processadas por laminação a quente numa usina siderúrgica integrada.

Como se sabe, a laminação a quente de produtos planos inicia-se com o reaquecimento de placas até uma temperatura da ordem de 1200°C. Cada placa de aço - na verdade uma chapa extremamente grossa, com espessura

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entre 180 e 250 mm - pesa tipicamente entre 8 e 12 toneladas. Cada forno de reaquecimento possui capacidade de reaquecer até 100 toneladas de placas por hora, o que dá uma idéia da enorme quantidade de energia envolvida no processo.

Nos fornos de reaquecimento de placas as fontes de calor disponíveis para o processo são basicamente a queima de combustível, o ar pré-aquecido da combustão e o calor decorrente da formação de carepa na placa. Já as saídas de calor ocorrem através das próprias placas reaquecidas, pelos fumos aquecidos que saem pela chaminé, a água de refrigeração dos skids, o calor irradiado pelas paredes do forno e outras perdas menores. As equações necessárias foram codificadas numa planilha Excel usando-se a linguagem de macro Visual Basic. Maiores detalhes sobre o desenvolvimento do algoritmo de cálculo desse balanço térmico podem ser encontrados em [1].

Os resultados de um balanço térmico típico de um forno de reaquecimento de placas, calculados a partir de dados industriais reais, podem ser vistos nas tabelas I e II.

TABELA I

ENTRADAS DE CALOR DE UM BALANÇO TÉRMICO EFETUADO NUM FORNO DE REAQUECIMENTO DE PLACAS.

Entradas de Calor	Mcal/t aço	%
Calor de Combustão do Gás	612,3	74,2
Calor Sensível do Ar	194,0	23,5
Calor de Formação da Carepa	18,7	2,3
Calor Sensível das Placas	0,0	0,0
TOTAL	824,9	100

TABELA II

SAÍDAS DE CALOR DE UM BALANÇO TÉRMICO EFETUADO NUM FORNO DE REAQUECIMENTO DE PLACAS.

Saídas de Calor	Mcal/t aço	%
Calor Absorvido pelas Placas	192,2	23,2
Calor Sensível dos Fumos	449,1	54,4
Calor de Refrigeração do Forno	138,2	16,8
Calor Perdido pelas Paredes	33,7	4,1
Outros	11,6	1,4
TOTAL	824,9	100

Já nesta primeira demonstração há várias informações técnicas muito úteis e interessantes para os alunos. Como seria de se esperar, a maior contribuição ao aquecimento veio da combustão, com 612 Mcal/t de aço reaquecido, o que corresponde a 74% do aporte térmico total. O calor sensível do ar de combustão veio em segundo lugar, com 194 Mcal/t ou 24% do total. A contribuição da reação exotérmica de oxidação do ferro foi mínima, 19 Mcal/t ou aproximadamente 2% do total. Portanto, o aporte térmico específico foi de 825 Mcal/t de aço.

A análise sobre as saídas de calor revelou um resultado intrigante: a maior parte do calor - 449 Mcal/t de aço ou 54% do calor total fornecido - saíram na forma de fumos aquecidos! Somente 192 Mcal/t de aço (apenas 23% do calor total) realmente foram aproveitados de forma útil, ou seja, no reaquecimento das placas de aço até 1200°C. Além disso, 138 Mcal/t (17%) são levados pelo sistema de refrigeração do forno e 34 Mcal/t (4%) são irradiados pelas paredes do forno para o ambiente externo. Como se pode observar, ainda se faz necessário um grande trabalho de engenharia para se melhorar o rendimento energético desses fornos. O maior desafio aqui consiste na identificação de aperfeiçoamentos economicamente compatíveis com a atual realidade industrial e econômica.

Os efeitos dos diversos parâmetros técnicos e operacionais sobre o desempenho térmico do forno de reaquecimento de placas foram determinados a partir de múltiplas execuções do software de balanço térmico aqui descrito. Cabe aqui ao professor orientar os alunos sobre quais parâmetros devem ser alterados e como a modificação deve ser executada, como num verdadeiro trabalho de diagnose técnica. A tabela III mostra resumidamente as oportunidades para economia de energia que foram identificadas e hierarquizadas dessa forma.

TABELA III

OPORTUNIDADES PARA ECONOMIA DE ENERGIA IDENTIFICADAS E HIERARQUIZADAS PELAS SIMULAÇÕES EFETUADAS USANDO-SE A PLANILHA DO BALANÇO TÉRMICO.

Alteração	1° Caso [Mcal/t]	2° Caso [Mcal/t]	Redução [Mcal/t (%)]
Taxa ar-gás 7:1	612	477	135 (22)
Placa a 250°C	612	514	98 (16)
Placa a 400°C	612	447	159 (27)

Já foi identificada neste estudo específico a perda significativa de calor através dos fumos que saem pela chaminé. Os dados coletados para o cálculo deste balanço térmico revelaram o uso de uma relação média ar-gás combustível igual a 12,8:1 durante a operação do forno. Trata-se de um valor exageradamente alto, pois sabe-se que uma boa combustão do gás de coqueria normalmente usado como combustível nas siderúrgicas integradas requer que a relação ar-combustível se situe entre 6,5:1 e 7:1. Ao se recalcular um balanço térmico hipotético, assumindo-se uma relação ar-combustível de 7:1 e todas as demais condições constantes ocorre, em primeiro lugar, um considerável aumento da eficiência do equipamento: o calor derivado da queima de combustível cai de 612 para 477 Mcal/t - ou seja, uma apreciável redução de 22% no consumo energético! De fato, as quantidades de calor que saem contidas nas placas reaquecidas e nos gases de combustão passam a ficar praticamente iguais, evitando o sério desbalanceamento verificado anteriormente: 192 Mcal/t (33%) e 207 Mcal/t (36%), respectivamente.

Uma conseqüência colateral é a ligeira queda na participação do calor sensível do ar de combustão préaquecido no aporte térmico ao forno, que passou para 83

Mcal/t (14%), pois agora é necessária menor quantidade de ar para a combustão. Aqui há um benefício secundário, mas não desprezível: menores vazões de ar de combustão significam menor consumo de energia elétrica nos sopradores de ar, além de menor esforço (e correspondente desgaste) nesse equipamento. Por outro lado, a combustão teria de ser monitorada com mais cuidado, uma vez que passaria a haver uma menor disponibilidade de oxigênio. Uma eventual elevação no poder calorífico inferior da mistura gasosa combustível poderia produzir combustão incompleta, com liberação de fumaça preta pelas chaminés. Esta ocorrência leva a risco de multa pelas entidades que fiscalizam a emissão de poluentes.

O enfornamento a quente de placas – ou seja, sua introdução no forno de reaquecimento imediatamente após sua produção na máquina de lingotamento contínuo - também é outra contramedida que pode garantir boa economia de energia, apesar do grande problema que representa em termos de planejamento de produção e logística. Por exemplo, o enfornamento de placas a 250°C, um objetivo relativamente modesto, reduziria o calor necessário para o aquecimento das placas de aço de 192 Mcal/t para 164 Mcal/t; em termos globais, o consumo energético do forno cairia de 612 Mcal/t para 514 Mcal/t, ou seja, uma queda de 16%. A economia de energia seria ainda maior se o enfornamento fosse realizado a 400°C: o consumo energético cairia para 447 Mcal/t.

Ainda há várias outras possibilidades para se reduzir o consumo energético como, por exemplo, aumentando-se a temperatura do ar fornecido para a combustão. Outra possibilidade a ser considerada seria a redução da quantidade de calor extraída do forno pelo seu sistema de refrigeração, que é função do jogo entre a vazão e as temperaturas inicial e final da água que circula em seu interior. Ambas as sugestões requerem grandes alterações em termos de equipamento; portanto, a solução desse exercício requereria também um estudo sobre os custos ligados à implementação das modificações que se fariam necessárias.

EVOLUÇÃO MICROESTRUTURAL NA LAMINAÇÃO DE TIRAS A QUENTE

As propriedades mecânicas de chapas laminadas a quente dependem primordialmente de sua microestrutura ou, mais precisamente, de seu tamanho de grão. Esta, por sua vez, é função da composição química do material e também é grandemente influenciada pelos parâmetros usados no seu processo de laminação a quente. Por esse motivo já foram elaborados diversos modelos matemáticos para se correlacionar os parâmetros aplicados na laminação a quente com as características obtidas no produto final [2,3].

Um desses modelos matemáticos, próprio para o processo de laminação de tiras a quente [2], foi tomado como base para o desenvolvimento de uma planilha Excel acoplada a uma macro escrita em Visual Basic. Este algoritmo de cálculo determina a evolução do tamanho de grão austenítico durante a laminação a quente de um esboço plano de aço ao carbono-manganês num trem acabador constituído de seis cadeiras de laminação, bem como o correspondente tamanho de grão ferrítico conseguido no material ao final do processo.

Esse modelo matemático permite que se determine, de forma quantitativa, o efeito de diversos parâmetros de processo na evolução microestrutural do material. Entre esses parâmetros se encontram:

- Temperatura de início de laminação;
- Tamanho de grão inicial do esboço;
- Esquema de passes;
- Velocidade de laminação;
- Grau de deformação total placa/tira;
- Evolução da temperatura durante a laminação a quente;
- Temperatura final de laminação;
- Taxa de resfriamento imposta ao laminado ao final da laminação a quente.

Observa-se a partir daqui que há um grande campo de exploração para os estudantes da área de metalurgia de materiais, já que os parâmetros podem ser modificados de forma isolada ou em combinações, permitindo a determinação de seus efeitos sobre a microestrutura do material. Em função das limitações de espaço, serão aqui discutidas apenas algumas das possibilidades que este programa oferece para desenvolver esse tipo de exercício.

O primeiro exemplo a ser visto mostra o efeito da deformação total sobre a evolução do tamanho de grão austenítico da tira a quente. A figura 1 mostra essa evolução para dois laminados, cada um com espessura diferente (2,3 mm e 9,8 mm), laminadas a partir de esboços com a mesma espessura inicial (30 mm).

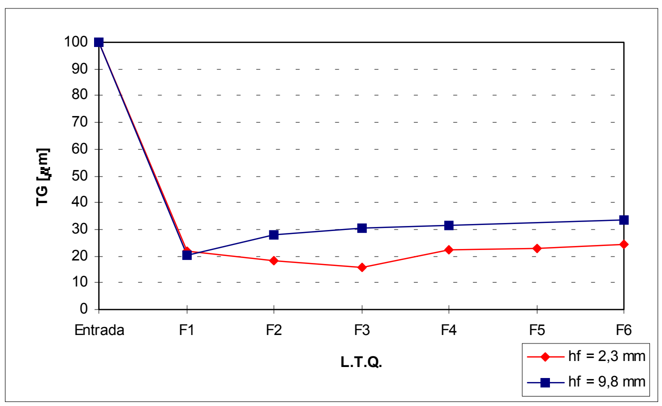

FIGURA 1
EVOLUÇÃO DO TAMANHO DE GRÃO AO LONGO DA LAMINAÇÃO DE TIRAS A QUENTE PARA DOIS ESBOÇOS, CADA UM COM ESPESSURA DIFERENTE (2,3 MM E 9,8 MM).

Pode-se observar que ambos os laminados apresentaram tamanho de grão similar na primeira cadeira de laminação (F1), da ordem de 20 a 22 µm. Esse valor é bem menor que o tamanho de grão inicial (100 µm). Este significativo refino de grão pode ser atribuído ao fenômeno da recristalização dinâmica: o encruamento na microestrutura provocado pela deformação a quente é eliminado no próprio momento em que ela é aplicada. Esse fenômeno é favorecido pelas condições típicas de conformação a quente aplicadas nessa cadeira, ou seja, baixa velocidade de deformação e temperatura relativamente elevada do material.

A partir daí as evoluções de tamanho de grão observadas variam para os dois esboços. O material mais fino, com espessura de 2,3 mm, sofre deformações mais pesadas nas demais cadeiras; por esse motivo, passa novamente por recristalização dinâmica na segunda e terceira cadeiras (F2 e F3, respectivamente) o que contribuiu para refinar adicionalmente seu tamanho de grão. Nas demais cadeiras ocorre apenas recristalização estática parcial, o que levou a um ligeiro aumento no tamanho de grão. Já o laminado mais espesso, com espessura de 9,8 mm, apresenta leve crescimento de tamanho de grão já na cadeira seguinte (F2) e nas demais, devido ao menor grau de deformação nelas aplicado, o qual não foi suficiente para provocar a recristalização dinâmica. Dessa forma, neste caso só se verificou a ocorrência de recristalização estática entre uma cadeira de laminação e outra. Além disso, não foi aplicada deformação na quinta cadeira (F5).

Por esse motivo, houve ligeira diferença no tamanho de grão austenítico final dos dois materiais: 24 µm para a tira com 2,3 mm de espessura e 34 µm para o material com 9,8 mm - uma diferença de 42%. Após a transformação da austenita em ferrita, que ocorre durante o resfriamento do material após sua laminação e resfriamento forçado, houve grande diminuição nessa diferença: o tamanho de grão ferrítico desses materiais foi de 8 e 10 µm respectivamente, passando a diferença a 25%.

O efeito do tamanho de grão inicial sobre a evolução microestrutural do esboço que está sendo processado no Trem Acabador é um parâmetro de grande interesse metalúrgico. Se houver recristalização dinâmica na primeira cadeira, como foi o caso anterior, ele não influi na evolução do tamanho de grão do laminado durante sua conformação, uma vez que o tamanho de grão obtido na primeira cadeira de laminação (F1) independerá do seu valor anterior. Contudo, ao se laminar chapas com espessura relativamente alta usando-se todas as cadeiras do Trem Acabador a redução por cadeira diminui, reduzindo-se as chances de ocorrência de recristalização dinâmica na primeira cadeira do trem. Neste caso o refino do tamanho de grão ocorre somente através de recristalização estática, que apresenta efeito bem menor nesse sentido.

Esta é a situação que será abordada no próximo exemplo, mostrado na figura 2. Trata-se de esboços com a mesma espessura inicial e final (30 e 4,9 mm, respectivamente) mas, que por algum motivo, apresentaram diferentes tamanhos de grão iniciais: 200 e 100 µm.

Ao contrário do que havia sido observado no caso anterior (ver figura 1), o refino de grão na primeira cadeira de laminação não foi tão radical, uma vez que aqui não houve a ocorrência de recristalização dinâmica durante o processamento dos dois laminados. Por outro lado, no laminado com tamanho de grão inicial igual a 100 µm, as sucessivas recristalizações estáticas entre passes ao longo das várias cadeiras foram eficazes o suficiente para promover um grande refino de grão já na terceira cadeira (F3), tendo sido atingido um valor de tamanho de grão da ordem de 25 µm. No caso do laminado com tamanho de grão inicial de 200 µm o resultado obtido foi surpreendente: a recristalização estática observada após a laminação na primeira cadeira do trem acabador (F1) não foi completa. Em conseqüência desse fato o material foi conformado na segunda cadeira (F2) contendo ainda alguma deformação residual a qual, acumulada com essa nova deformação, permitiu a deflagração de recristalização dinâmica. Isso proporcionou intenso refino microestrutural a esse laminado, o que resultou na obtenção de um tamanho de grão menor do que o valor calculado para o outro material, invertendo a situação que estava sendo observada desde o início da laminação.

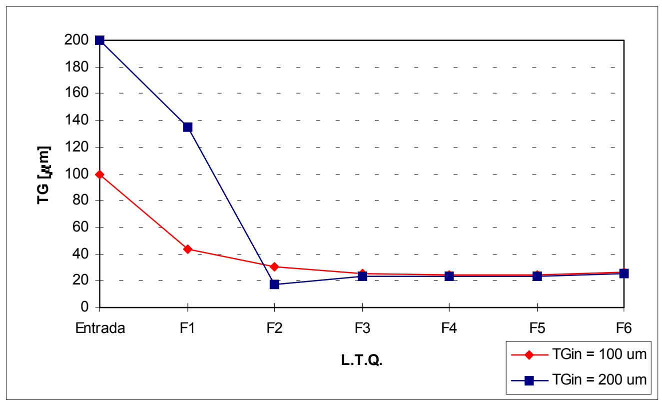

FIGURA 2

EVOLUÇÃO DO TAMANHO DE GRÃO AO LONGO DA LAMINAÇÃO DE TIRAS A QUENTE PARA DOIS ESBOÇOS COM 4,9 MM DE ESPESSURA, MAS COM DIFERENTES TAMANHOS DE GRÃO INICIAIS (100 E 200 µM).

Essa nova tendência se manteve até o final da laminação, quando foram atingidos valores de tamanho de grão iguais a 26 e 25 µm para os laminados com tamanho de grão inicial igual a 100 e 200 µm respectivamente. Essa ligeira diferença desapareceu com a transformação da austenita para ferrita, quando o valor de tamanho de grão ferrítico de ambos os materiais situou-se por volta de 8 µm.

Como se pode observar, o uso de um modelo matemático integrado para a determinação da evolução microestrutural dos esboços processados no Trem Acabador do Laminador de Tiras a Quente é extremamente oportuno, uma vez que a complexidade dos fenômenos envolvidos pode gerar resultados contrários ao que se poderia supor em termos meramente conceituais. Neste caso é interessante que os alunos expliquem detalhadamente as causas que estão por trás da obtenção de resultados contraditórios ou aparentemente inconsistentes, analisando detalhadamente o algoritmo de cálculo e os fundamentos físicos por trás dele.

CONCLUSÕES

Este trabalho mostrou alguns exemplos do uso de modelos para a simulação de processos metalúrgicos no ensino de engenharia de materiais. Eles permitem o desenvolvimento de exercícios com o objetivo de fazer com que o aluno entenda melhor a correlação entre os parâmetros de processo aplicados e os resultados finais obtidos. Por outro lado, para que essa prática efetivamente alcance os objetivos propostos, cabe ao professor oferecer modelos e dados que sejam efetivamente representativos da prática industrial moderna, bem como orientar os alunos sobre como usá-los de forma racional e sistemática. Caso contrário os resultados obtidos estarão fora da realidade e contribuirão mais para confundir ao invés de orientar os alunos.

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ASPECTOS DE ENSINO DE ALGORITMOS E PROGRAMAÇÃO COM MATHCAD[1]

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Resumo *— O conteúdo da disciplina de Algoritmos e Programação é de suma importância para a formação de alunos na área de Ciência da Computação. Daí surge a necessidade de se repensar em formas de ensino desta disciplina a fim de facilitar o processo de ensino-aprendizagem. Neste trabalho é apresentada uma experiência baseada no uso do software Mathcad no ensino de algoritmos e também são discutidos caminhos e questões com o objetivo de minimizar alguns problemas detectados nesta prática docente.*

Palavras-chave — algoritmos, ensino de programação

INTRODUÇÃO

Muitos dos alunos ingressantes no primeiro semestre do curso de Bacharelado em Ciência da Computação encontram dificuldades em disciplinas da área de Matemática e na área de Construção de Algoritmos. Algumas destas são comuns a estes dois campos de conhecimento e estão relacionadas principalmente à compreensão de abordagens abstratas e ao desenvolvimento do raciocínio lógico-dedutivo.

Durante o processo de ensino e aprendizagem da disciplina de Algoritmos e Programação, são detectados alguns problemas didático-pedagógicos, um dos principais relaciona-se ao ambiente computacional. O uso de ferramentas de programação sofisticadas logo no início desta primeira disciplina de programação leva os alunos a se concentrarem em aspectos específicos de implementação e desviarem a atenção de questões fundamentais relacionadas ao aprendizado de algoritmos.

O objetivo principal deste trabalho é encontrar métodos de ensino de algoritmos que minimizem estes e outros problemas detectados. Como primeira tentativa foi adotado o software Mathcad nas aulas da disciplina de Algoritmos e Programação já que ele oferece um ambiente interativo e interpretado para a construção de algoritmos. Além disso, este software apresenta alta conformidade com a notação matemática formal. Através desta experiência, pretende-se analisar o seu uso no ensino de algoritmos e as conseqüências desta aplicação no processo ensino-aprendizagem.

Desta forma, um ponto chave deste trabalho é o uso de uma ferramenta de programação de alto nível num primeiro momento na disciplina de algoritmos. A justificativa para o uso de uma ferramenta de programação com tal particularidade reside na tentativa de adiar alguns detalhes específicos de programação, que não são relevantes na implementação de algoritmos ministrados neste curso introdutório.

Este trabalho teve como base a experiência didático-pedagógica desenvolvida na disciplina de Algoritmos e Programação ministradas no período matutino no primeiro e segundo semestres de 2002 na Faculdade SENAC de Ciências Exatas e Tecnologia.

O documento aqui apresentado é organizado da seguinte forma: primeiramente é relatado um breve histórico do uso do software Mathcad na instituição, depois é descrita a experiência da aplicação desta ferramenta na disciplina de Algoritmos e Programação seguida por uma análise dos resultados de pesquisas realizadas junto aos alunos; na última seção são apresentadas as conclusões e levantadas algumas questões.

HISTÓRICO DO USO DO MATHCAD

Com base na prática docente são observadas dificuldades, por parte dos alunos, em assimilar o conteúdo da disciplina de Algoritmos e Programação. Estas questões tornaram-se preocupantes quando foi observado que não somente os alunos em curso (isto é, que estão cursando a disciplina), mas também alunos que já foram aprovados na mesma, não conseguiam aplicar seus conhecimentos em outras disciplinas como, por exemplo, em Cálculo Numérico e Cálculo Diferencial e Integral.

Para tentar diminuir a dificuldade demonstrada por estes alunos, algumas disciplinas adotaram o software Mathcad como instrumento de desenvolvimento de atividades e projetos. As atividades se iniciaram nas disciplinas de Álgebra Linear (oferecida no segundo período do curso) e Cálculo Numérico (oferecida no quinto período do curso). Na primeira o trabalho se deu muito bem, devido à proximidade da linguagem utilizada pelo software com a usual. Já na segunda, apesar dos problemas diminuírem, o resultado ainda não foi o esperado, houve muita resistência

1 Mathcad é uma marca registrada da MathSoft Engineering & Education, Inc.

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por parte dos alunos já "viciados" em algumas dificuldades desnecessárias, como declaração de variáveis e, se envolvendo nestes detalhes, não percebiam que a questão fundamental relacionava-se à elaboração de algoritmos e não em traduzi-los para a linguagem de programação do Mathcad.

No segundo semestre de 2001, foi desenvolvido um projeto interdisciplinar com os alunos das disciplinas de Cálculo Integral e Diferencial I e Geometria Analítica que envolvia alguns aspectos de algoritmos. Em função de um bom resultado nesta experiência, foi decidido usar este software na disciplina de Algoritmo e Programação no primeiro semestre de 2002 com os seguintes objetivos:

- Auxiliar o aluno na tarefa de construção de algoritmos;
- Mostrar caminhos para a implementação de uma abordagem multidisciplinar no ensino de algoritmos num primeiro momento e de uma abordagem interdisciplinar num segundo momento;
- Avaliar o uso do software Mathcad no ensino de algoritmos;
- Avaliar o aprendizado de uma linguagem de programação estruturada com base numa experiência anterior em Mathcad.

No segundo semestre de 2002 estas atividades se repetiram com algumas alterações descritas na seção a seguir. Além da disciplina Algoritmos e Programação, o software continua sendo adotado por várias outras disciplinas do curso.

RELATO DA EXPERIÊNCIA

Algoritmos e Programação é uma disciplina oferecida no primeiro período do curso de Ciência da Computação cujo objetivo é ensinar os alunos a construir algoritmos e a colocá-los em prática na forma de programas de computadores.

Nesta disciplina, usualmente é ensinada uma linguagem para descrição de algoritmos como: Pseudocódigo, Português Estruturado, Fluxograma ou diagrama N-S. Numa segunda fase é utilizada uma linguagem de programação estruturada como C, C++ ou Pascal para a codificação do algoritmo. Em alguns casos, estas duas fases ocorrem simultaneamente.

Nesta experiência é utilizado o Mathcad para o ensino de aspectos básicos de programação: construção de funções, uso de estruturas de condição e repetição. Este software é voltado para soluções matemáticas e, por outro lado, apresenta uma própria linguagem de programação. Além disso, ele oferece um ambiente de programação de alto nível e fácil uso. Outro ponto interessante é que ele faz uso da linguagem matemática, que foi usada pelos alunos desde o ensino fundamental e assim espera-se quebrar uma barreira inicial na aprendizagem de algoritmos que é uso de uma linguagem extremamente técnica e longe da realidade dos alunos. Espera-se que ao usar uma ferramenta de programação de alto nível, o foco da atividade seja o problema e a construção de algoritmos, desviando a atenção dos detalhes de programação.

Num segundo momento passa-se a usar uma linguagem de programação, no caso específico a linguagem C++. Nesta fase é mostrado como converter uma função em Mathcad numa função em C++. Ao se ensinar C++ o docente estabelece uma outra ordem na exposição dos conteúdos onde o primeiro tópico a ser apresentado é a construção de funções (conceito avançado no curso tradicional de Algoritmos e Programação). Seguindo este roteiro o primeiro curso de programação já enfoca a construção de software modular.

Em resumo, esta experiência consiste em desenvolver atividades em um ambiente de programação mais próximo do aluno, livre de detalhes específicos de programação e adequado a um primeiro contato com funções, seqüência de comandos, estruturas de condição e de repetição. De tal forma que os alunos sejam motivados a descobrirem por si próprios estas estruturas desconhecidas por eles até então. Após este primeiro contato, passamos a utilizar uma linguagem estruturada, no caso, a linguagem C++.

Este método foi aplicado nos dois semestres de 2002. Ao final do primeiro semestre de 2002 na disciplina destacam-se alguns aspectos positivos e outros negativos que são listados a seguir:

Pontos Positivos do uso do Mathcad no ensino de programação:

- Rapidez na implementação e teste do algoritmo;
- Interface homem-máquina mais amigável;
- Detalhes específicos de aspectos de programação são adiados num primeiro momento;
- Similaridade com a linguagem matemática;
- Abordagem multidisciplinar: Algoritmos e Matemática.

Dificuldades encontradas inicialmente no uso de Mathcad no ensino de programação:

- Dificuldades no uso do software por parte dos alunos num primeiro momento;
- Falta de experiência dos professores com manejo do software;
- Excessiva facilidade talvez dificulte no aprendizado de uma linguagem de programação "real" por parte dos alunos;
- Instabilidade do software, que costuma apresentar problemas com uma certa freqüência.
- Assim, para o segundo semestre de 2002 foram tomadas algumas medidas, como:
- Conhecimento aprimorado do uso do software por parte dos professores;

- Aula introdutória ao software onde são desenvolvidas atividades que ainda não estão diretamente relacionadas a aspectos de programação;
- Troca da versão do Mathcad por uma mais estável.

A linha mestre deste trabalho baseia-se na seguinte diretriz: os conteúdos abordados nas aulas práticas são superiores aos ministrados na aula teórica, assim pretende-se estimular o aluno a buscar soluções, conhecimento e desenvolver a sua própria autonomia.

ANÁLISE DA PESQUISA REALIZADA JUNTO AOS ALUNOS

Foi feita uma pesquisa junto aos alunos da disciplina de Algoritmo e Programação do primeiro e segundo semestre de 2002 no período matutino.

Com base nesta pesquisa, alguns resultados já começam a se evidenciar, levantando alguns pontos que serão discutidos a seguir. Alunos que já tiveram contato com programação anteriormente (seja porque reprovou a disciplina ou porque fez colegial técnico em informática) têm mais dificuldades em trabalhar com o Mathcad do que com uma linguagem estruturada. A maioria destes alunos não se adapta ao software e acham que o problema está no programa e não percebem suas falhas na disciplina. Muitas vezes, eles acreditam que saibam programar, enquanto os professores afirmam o contrário. Por outro lado, alunos que nunca tiveram contato com programação anteriormente assimilam com mais facilidade e rapidez do que aqueles que aprenderam a programar com o método tradicional.

Ao se comparar os dados da pesquisa respondida pelos alunos do primeiro e segundo semestre observou-se uma maior aceitação na segunda edição da disciplina. Isto deve-se ao fato dos docentes estarem mais familiarizados com o software e de já possuírem uma experiência acumulada na primeira edição da disciplina. Outra questão relevante é que na segunda edição o software encontrava-se mais estável, causando uma melhor impressão por parte dos alunos. Mesmo assim, observa-se ainda algumas falhas que devem ser retificadas numa próxima edição do curso:

- Necessidade de material didático adequado;
- Necessidade de contextualizar as atividades com Mathcad à realidade dos alunos.

Em conversas informais com os alunos de turmas de disciplinas que não envolvem programação (como Cálculo, Álgebra Linear, entre outras) a reação dos alunos tem sido excelente, mas ainda não foi feito um levantamento formal destes dados.

Com relação à aceitação do uso do software em disciplinas mais avançadas que utilizam algoritmos, há uma expectativa do resultado, já que os alunos que passaram por esta experiência inicial ainda não as alcançaram. Por exemplo, Cálculo Numérico é uma das disciplinas onde o professor relata muita dificuldade por parte dos alunos e aonde houve rejeição ao software. Mas isto se deu em turmas que nunca haviam tido contato anterior com ele e, como também não haviam atingido maturidade matemática e "computacional" esperada, é compreensível tal atitude. A expectativa agora é o resultado da disciplina quando esta for cursada por estudantes que já trabalharam com o Mathcad na disciplina de Algoritmos e Programação.

CONCLUSÃO

O professor preocupado com a aprendizagem de seus alunos deve estar sempre empenhado em utilizar procedimentos que se mostrem eficientes nesse propósito. Tais procedimentos vão além das classificações teóricas, importando apenas que se mostrem facilitadoras da integração entre o conteúdo em estudo e as experiências e conhecimentos prévios dos alunos.

Adotando uma atitude dialética o professor poderá ser muito dinâmico e transformador por intermédio de suas aulas expositivas. A questão não está em se rotular essa técnica como tradicional e rejeitá-la como meio de ensino. Ocorre que professores mediadores mostram-se capazes de levar seus alunos a reelaborar ou produzir conhecimentos por meio de suas aulas práticas.

Numa perspectiva crítica, a aula prática com o Mathcad pode se transformar numa técnica que estimula a atividade e a iniciativa dos alunos sem prescindir da iniciativa do professor; favorece o diálogo entre professor e aluno, e dos alunos entre si, sem cair numa prática permissiva; e considera os interesses e experiências dos alunos sem desviar-se da sistematização lógica dos conteúdos previstos no programa de ensino.

Com esta nova abordagem houve a necessidade de se repensar o curso de Algoritmos e Programação, não somente com relação à ordem de exposição de conteúdo, como também à metodologia usada nas aulas teóricas e nas aulas práticas. Como o ambiente de programação Mathcad aborda conteúdos que extrapolam a ementa tradicional de um curso de Algoritmos e Programação, houve a necessidade de se aprofundar no binômio teoria-prática, na tentativa de modificar a conduta pedagógica tradicional da teoria para prática e invertê-la para da prática para teoria.

Esta experiência ainda está em andamento e pretende-se futuramente responder às seguintes questões:

Como o Mathcad pode ser usado em disciplinas de modo a facilitar um ensino significativo de matemática e programação?

Como o professor, com o auxilio do Mathcad, pode ajudar o aluno a construir com significado seu conhecimento?

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APLICAÇÃO DE ALGORITMOS GENÉTICOS NA ADAPTAÇÃO DE UM AMBIENTE MULTIAGENTE INTERATIVO DE APRENDIZAGEM NA INTERNET

Sidnei Renato Silveira[1], Dante Augusto Couto Barone[2]

***Resumo -** Este artigo apresenta o trabalho que está sendo desenvolvido como proposta de tese de Doutorado em Ciência da Computação no PPGC-UFRGS. A idéia inicial enquadra-se na definição de uma arquitetura de agentes que será integrada a um ambiente multiagente adaptativo de aprendizagem. Estes agentes serão modelados com algoritmos genéticos. O objetivo principal consiste no estabelecimento de uma arquitetura multiagente, buscando definir comportamentos e estratégias de ação destes agentes. A arquitetura de agentes será integrada ao ambiente utilizado no Projeto AMIA-CNPq.*

***Palavras-Chave -** Algoritmos Genéticos, Sistemas Multiagentes, Ambientes Inteligentes de Aprendizagem.*

1. INTRODUÇÃO

O trabalho em desenvolvimento tem por objetivo principal, definir uma arquitetura de agentes para um ambiente multiagente interativo de aprendizagem, utilizando a modelagem dos agentes através de algoritmos genéticos, no contexto do Projeto AMIA.

O Projeto AMIA – Ambiente Multiagente Interativo de Aprendizagem, financiado pelo CNPq[3], é formado por um consórcio entre a Universidade Luterana do Brasil – ULBRA (Faculdade de Informática e Curso de Especialização em Informática na Educação), pela Universidade Federal do Rio Grande do Sul – UFRGS (PGIE – Pós-Graduação em Informática na Educação e PPGC – Programa de Pós-Graduação em Computação) e pela PROCERGS – Companhia de Processamento de Dados do Rio Grande do Sul.

Entre os objetivos propostos pelo projeto está a constituição, a partir de uma plataforma de *software* livre, de um ambiente adaptativo multiagente para a formação continuada a distância de professores na área de Informática na Educação. Um dos sub-projetos que compõem o projeto AMIA envolve a utilização de agentes em ambientes adaptativos de ensino e aprendizagem, tendo como principais objetivos a definição de uma arquitetura de agentes, que modifiquem o ambiente de acordo com as características extraídas do modelo de aluno. Estes agentes utilizarão técnicas de hipermídia adaptativa para implementar as adaptações do ambiente ao perfil do aluno. A hipermídia adaptativa trata do estudo e desenvolvimento de sistemas com técnicas capazes de modelar a adaptação de hiperdocumentos ao perfil, metas, necessidades, expectativas, preferências e nível de conhecimento de seus usuários.

Neste sentido, pretende-se estudar e implantar uma arquitetura multiagente em um ambiente interativo de aprendizagem. A modelagem do comportamento e das estratégias dos agentes deste ambiente serão realizadas através de algoritmos genéticos.

A principal motivação para a realização deste trabalho é o estudo de uma modelagem de agentes utilizando algoritmos genéticos convencionais (com cromossomos binários e/ou com números reais) e algoritmos genéticos não-convencionais, cuja representação deve possibilitar o armazenamento de informações tais como estratégias de ensino, soluções para um determinado problema, dados do aluno, entre outras informações. Estes dados serão utilizados para acompanhar a aprendizagem do aluno.

O presente artigo está estruturado da seguinte forma: na seção 2 são abordados alguns aspectos sobre os Sistemas Multiagentes; na seção 3 apresentam-se algumas considerações sobre os Algoritmos Genéticos, na seção 4 apresenta-se a proposta de trabalho a ser implementada. Finalizando o artigo, apresentam-se as considerações finais e as referências bibliográficas.

2. SISTEMAS MULTIAGENTES

Os Sistemas Multiagentes preocupam-se com a atividade de um agente autônomo em um ambiente multiagente. Um agente autônomo é uma entidade inteligente, cuja existência não depende da existência de nenhum outro agente [5]-[6]-[8]. Os agentes "inteligentes" são entidades de *software* capazes de demonstrar um comportamento autônomo orientado a um objetivo, dentro de um ambiente computacional heterogêneo. Segundo Bond & Gasser [2], uma das razões para se utilizar a abordagem de agentes é que em alguns domínios o conhecimento é inerentemente distribuído e um problema pode ser

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decomposto, na maioria das vezes, em pequenas partes, para facilitar a sua resolução. Além disso, esta abordagem pode facilitar o desenvolvimento e gerenciamento de sistemas, permitindo adaptabilidade, especialização, aumento da eficiência ou velocidade, autonomia e alocação otimizada de recursos. Bond & Gasser [2] também colocam que as atividades humanas envolvem mais do que uma única pessoa, que podem ser simuladas/realizadas por uma coleção de agentes inteligentes. Segundo Castelfranchi [3], os agentes baseados em modelos de organização social humana são denominados agentes sociais. Estes agentes possuem conhecimento de outros agentes e podem seguir uma hierarquia ou dividirem-se em grupos.

Segundo Stone & Lester [12], a utilização de agentes em ambientes de ensino e aprendizagem oferece um potencial significativo para modificar o processo de ensino e aprendizagem, principalmente pelo fato de que os estudantes recebem um *feedback* constante do ambiente utilizado, aumentando efetivamente a aprendizagem. Akhras & Self [1] colocam que o ambiente necessita adaptar a instrução às características individuais do estudante, durante o processo de ensino e aprendizagem.

3. ALGORITMOS GENÉTICOS

Os algoritmos genéticos são uma técnica de busca baseada na teoria da evolução de Darwin. Esta técnica baseia-se nos mecanismos de seleção de indivíduos utilizados na natureza, onde apenas os indivíduos mais aptos de uma população sobrevivem, adaptando-se mais facilmente às mudanças que se produzem no meio ambiente [4]-[9]-[11].

Foram inicialmente propostos pelo Prof. John Holland, em 1975, na Universidade de Michigan. A idéia de Holland foi tentar imitar algumas etapas do processo de evolução natural das espécies incorporando-as a um algoritmo computacional. O ponto de referência foi gerar, a partir de uma população de cromossomos, novos cromossomos com propriedades genéticas superiores às de seus antecedentes, onde os cromossomos são as possíveis soluções de um problema. Os AG's têm se mostrado como uma técnica eficaz de resolução de problemas de otimização. São muito eficientes na busca de soluções "ótimas". Os AG's são utilizados em diversas áreas, tais como: mercado de ações (definir que ações devem ser compradas ou vendidas), indução e otimização de bases de regras, simulação de modelos biológicos, evolução interativa de imagens, composição musical e análise de trajetória, entre outros.

As principais características de um AG, segundo Davis [4] e Mitchell [9], são:

- manter uma população de soluções para um determinado problema;
- possuir um processo de seleção de indivíduos, baseado no grau de adaptação de cada um;
- possuir operadores genéticos para gerar novos indivíduos para a população.

Estas características são implementadas em três módulos distintos, formando a estrutura básica de um AG [4]-[9]-[11]:

- Módulo de avaliação: determina o grau de adaptação (*fitness*) de cada indivíduo ao problema em questão;
- Módulo de população: responsável pela escolha da população inicial;
- Módulo de reprodução: responsável pela aplicação dos operadores genéticos aos indivíduos.

4. TRABALHO PROPOSTO

No trabalho proposto, pretende-se definir os aspectos que envolvem a modelagem dos agentes com algoritmos genéticos, incluindo a forma de representação das informações (conhecimento, estratégias de ensino, entre outras), a função de avaliação e os operadores genéticos, que possibilitem a evolução de estratégias dos agentes inseridos no ambiente em desenvolvimento.

O ambiente proposto para o Projeto AMIA é o *TelEduc* [13], desenvolvido pelo NIED-Unicamp. Este ambiente está sendo estudado e utiliza uma plataforma de *software* livre, um dos pré-requisitos do Projeto AMIA. Constitui-se em um ambiente colaborativo/cooperativo para Educação a Distância. Integrada ao ambiente *TelEduc*, propõe-se a construção de um ambiente multiagente interativo de aprendizagem, através da inserção de uma arquitetura de agentes que acompanharão o processo de ensino e aprendizagem dos alunos, via *web*.

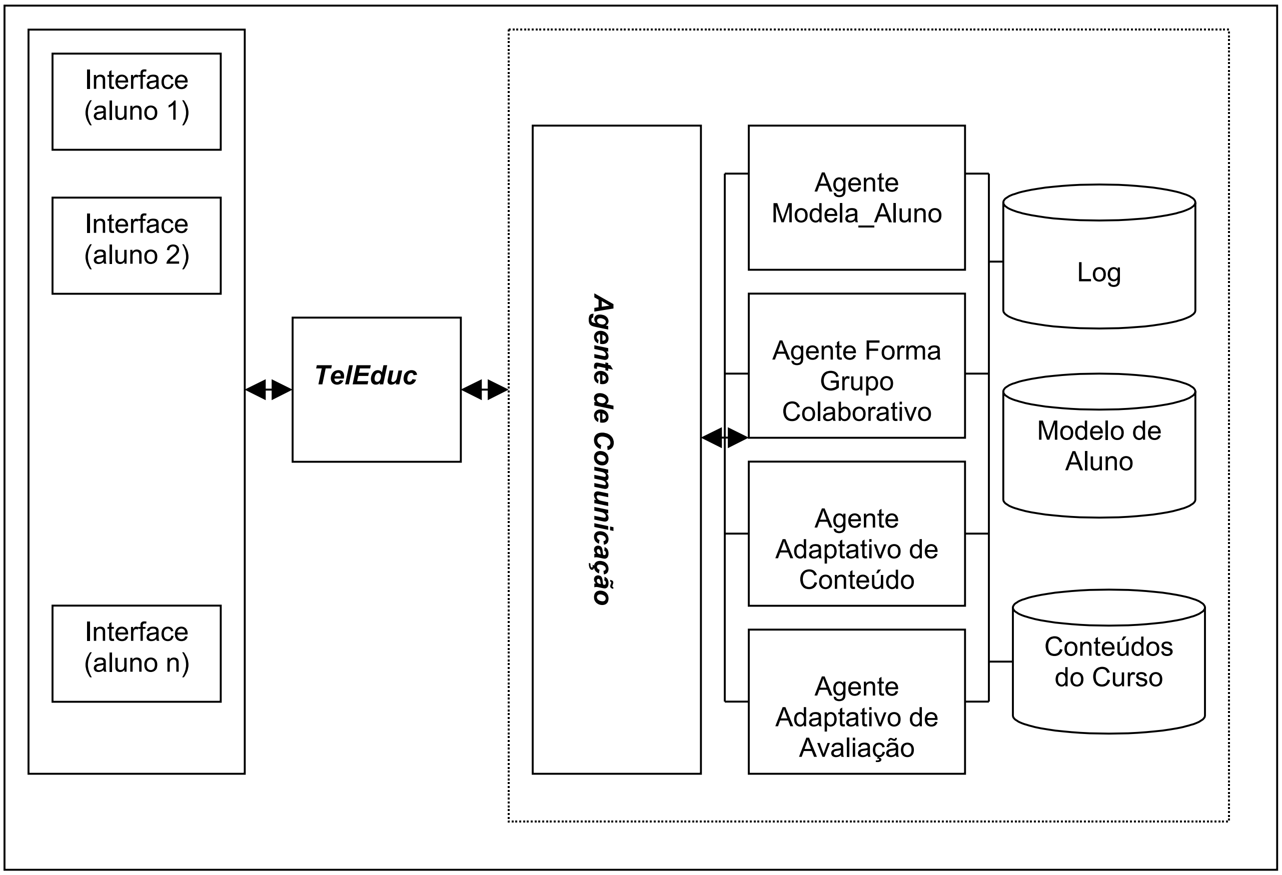
A partir da definição do modelo de aluno proposto para o ambiente, os agentes adaptarão o conteúdo a ser fornecido ao aluno, de acordo com um algoritmo genético. Segundo Giangrandi & Tasso [7], o modelo do aluno descreve o conhecimento do estudante num domínio específico e é utilizado para que o ambiente adapte-se às características individuais do usuário. Em um modelo de aluno podem ser armazenadas diversas informações, entre elas: nível de conhecimento, objetivos, planos, capacidades, atitudes e conhecimento ou crenças [10]. As adaptações serão realizadas através de técnicas de hipermídia adaptativa. O modelo de aluno encontra-se em fase de desenvolvimento, através da aplicação e tabulação de um questionário interativo (via *web*) que identificará o perfil do aluno. Através deste perfil os demais agentes adaptarão o ambiente para facilitar a aprendizagem dos alunos. Na figura 1 demonstra-se a arquitetura proposta para o ambiente, onde um dos agentes será responsável pelas tarefas inerentes ao modelo de aluno.

Na arquitetura inicialmente proposta, tem-se cinco agentes, cujas funções são:

- *agente modela aluno*: responsável por gerenciar as informações que dizem respeito ao modelo de aluno e disponibilizá-las aos demais agentes de forma dinâmica;
- *agente adaptativo de conteúdo:* responsável por adaptar o conteúdo de acordo com o perfil do aluno (informado pelo agente *modela aluno*). Este agente será modelado com algoritmos genéticos;
- *agente adaptativo de avaliação:* este agente será encarregado de adaptar o processo de avaliação de acordo com o perfil do aluno, disponibilizando as ferramentas mais adequadas dentro do ambiente;
- *agente forma grupo colaborativo:* responsável pela formação de grupos de estudo através de critérios definidos pelo professor, de acordo com o perfil dos alunos, estabelecido no modelo de aluno;
- *agente de comunicação:* será o responsável por gerenciar o processo de comunicação entre os agentes integrantes da arquitetura.

4.1 Protótipo em Desenvolvimento

Inicialmente, estão sendo implementados os agentes de comunicação, modelo de aluno e o agente adaptativo de conteúdo. Este último, através do modelo do aluno, disponibilizará o conteúdo de diversas formas (texto, demonstração, gráficos, locução, vídeos, imagens). As formas de apresentação estão ligadas ao perfil do aluno e a técnicas de hipermídia adaptativa. A partir do perfil do aluno, serão definidas as técnicas de hipermídia adaptativa mais adequadas.



Os algoritmos genéticos serão aplicados de duas formas: 1) geração de técnicas de hipermídia adaptativa; 2) criação de grupos colaborativos.

1) geração de técnicas de hipermídia adaptativa: a definição das técnicas de adaptação a serem utilizadas serão realizadas da seguinte forma:

- os alunos serão divididos em grupos, de acordo com o perfil definido pelo modelo de aluno;
- para cada grupo de alunos, o agente adaptativo de conteúdo gerará um conjunto de técnicas de adaptação mais adequadas ao perfil deste grupo.

2) criação de grupos colaborativos: A criação dos grupos colaborativos será realizada da seguinte forma:

- o professor define as características desejáveis para a criação de um grupo colaborativo (estas características são identificadas através do modelo de aluno);
- o agente *forma grupo colaborativo*, formará o "melhor grupo" de alunos, seguindo as características previamente estabelecidas.

A utilização dos algoritmos genéticos justifica-se pela grande quantidade de alunos que poderão participar dos cursos dentro do contexto do Projeto AMIA. O público alvo dos cursos são os professores das Escolas Estaduais do Estado do Rio Grande do Sul. Segundo informações da Secretaria Estadual da Educação (SEC-RS), existem 85.849 professores estaduais. Seria praticamente inviável que o ambiente fosse adaptado individualmente para cada um destes alunos. Sendo assim, o ambiente será adaptado de acordo com o grupo no qual se encaixa o aluno. A definição deste grupo estará a cargo do modelo de aluno e o algoritmo genético, através das características estabelecidas para cada grupo de alunos, combinará as técnicas de hipermídia adaptativa, visando encontrar o conjunto mais adequado ao perfil proposto.

5. Considerações Finais

Atualmente, estão sendo desenvolvidos os agentes de comunicação, modelo de aluno e o agente adaptativo de conteúdo, visando validar a arquitetura proposta através de testes, utilizando como base um Curso de Microinformática Básica e Utilização da Internet, proposto como um dos trabalhos que estão integrados ao Projeto AMIA. Os agentes estão sendo implementados segundo as diretrizes do ambiente *TelEduc* e da plataforma estabelecida no projeto AMIA, utilizando-se a linguagem PHP e o banco de dados *MySql*.

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SEMIÓTICA SUBLIMINAR:TECNOLOGIAS DE INSERÇÃO DE SIGNAGENS SUBLIMINARES NOS COMPUTADORES E REDES TELEMÁTICAS

Flávio Mário de Alcântara Calazans[1]

Resumo *— Pesquisa sobre tecnologia subliminar nos computadores e redes telemáticas, presença dos sinais subliminares. Em 1990, no "Laboratório de Telemática da Unisantos", foi desenvolvido e implantado um experimento de pesquisa empregando o "Know-How" (Savoir Faire) adaptando ao "logiciel" (programa de computador) da rede Videotexto (antecessora francesa da Internet) algumas destas tecnologias com o objetivo pragmático de aumentar a interatividade da rede. Em 2002 há tecnologia de inserção de sinais subliminares com o comando DELAY e Layers em softwares como Flash 4.0, Fire-Works, Giff Animator, 3-D Studio Max, Director e linguagens como HTML ou Javascript, para websites da Internet e CDROMS. .*

Palavras Chave — Computação, Internet, Subliminar.

INTRODUÇÃO

Objetiva-se efetuar um panorama do Estado da Técnica das tecnologias audiovisuais midiáticas presentes em programas de computadores que poderiam ter por objetivo a transmissão de mensagens contendo estimulação subliminar cuja signagem (devido ao tempo de exposição, ritmo, sobreposição ou distribuição cromática-espacial-de escala) encontre-se dissimulada ou aparente pretender impossibilitar uma leitura consciente por parte do receptor.

A metodologia empregada será Hipotética-Dedutiva, em conformidade epistemológica com o "Modus Tolens" de Popper, buscando falsear a hipótese de tipologia intuitiva proposta da "inexistência de toda e qualquer propaganda subliminar no decorrer do Século XX", falseada por meio da coleta, identificação e análise de espécimes midiáticos oriundos da Videosfera (Mídia Eletrônica), recorrendo-se a subsídios do referencial teórico dos paradigmas: Midiologia, Semiótica, Hermenêutica, Cibernética, Gestalt etc., em ESTUDO de CASOS, acrescidos da metodologia Antropológica da Observação Participante no decorrer de quinze anos de pesquisa acadêmica isolando a variável do objeto "Propaganda Subliminar" nas comunicações e artes segundo um enfoque multimídia aplicado à metodologia científica do estudo de casos.

PROPAGANDA SUBLIMINAR MULTIMÍDIA

Definição de Propaganda Subliminar.

"...considera-se subliminar qualquer estímulo que não é percebido de maneira consciente, pelo motivo que seja: porque foi mascarado ou camuflado pelo emissor, porque é captado desde uma atitude de grande excitação emotiva por parte do receptor, (...) porque se produz uma saturação de informações ou porque as comunicações são indiretas e aceitas de uma maneira inadvertida" [Ferrés. "Televisão subliminar" p.14].

Por definição, subliminares são as mensagens que são enviadas dissimuladamente, ocultas, abaixo dos limites da nossa percepção consciente (medidos pela Ergonomia) [12] e que hipoteticamente pretenderiam influenciar nossas escolhas, atitudes, motivar a tomada de decisões posteriores[1-30]; fazem-se necessárias algumas digressões e recapitulações no intuito de esclarecer melhor alguns aspectos do corpo teórico que baseia a Tecnologia Subliminar [8].

Histórico das Teorias sobre Subliminares

A Semiótica Subliminar [4] tem seus precursores no filósofo grego Demócrito (400 A.C.) que primeiro afirmou que nem tudo o que é perceptível pode ser claramente percebido, tema continuado por Platão no "Timeu" e detalhado por Aristóteles na obra "Perva Naturalia" com a teoria dos "Umbrais da Consciência", continuado até por Montaigne em 1580 e Leibniz em 1698 com as "Percepções inadvertidas que tornam-se óbvias por meio de suas conseqüências" , sendo que os estímulos subliminares começam a ser mensurados quantitativamente pelo contemporâneo de Freud, Doutor Otto Poetzle , que em 1919 estabelece a relação estatística de causa-efeito entre estímulo subliminar e reação fisiológica; seguidos de Teóricos da Comunicação de Massas como os canadenses Marshall MacLuhan e Wilson Brian Key, e europeus como o italiano Umberto Eco ; até mesmo no Brasil, pesquisadores do porte e reputação do físico Mário Shemberg e do Filósofo das Novas Tecnologias Vilém Flusser abordam as tecnologias subliminares em suas obras [3]

Entretanto, apenas em junho de 1934 a tese de doutorado de Collier em Psicologia Experimental detalhou publicamente os esquemas de construção de um projetor de diapositivos de alta velocidade , o Taquicoscópio (Táquion em grego significa veloz e escópio é visor-projetor) cujas imagens chegam a 1/3000 de segundo, causando reações fisiológicas ao sinal subliminar [1-24], hoje a tecnologia de editoração de imagens por ilhas de edição computadorizadas

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e outros recursos da informática permite inserções sem a necessidade de hardware próprio (apesar de processadores sillicon graphics transmitirem imagens televisivas reconstruindo digitalmente a imagem quase ao vivo-em tempo real, com delay de meras frações de segundo) .

Por outro lado, a Midiologia Subliminar [6] teve o primeiro registro histórico entre os Meios de Comunicação de Massa na Videosfera com a mídia eletrônica urbana Cinema, em 1956, quando a firma de Jim Vicary , "Subliminal Projection Company" fez uso do taquicoscópio projetando a cada 5 segundos sobre o fime "Picnic" a frase "Beba Coca", na velocidade de 1/3000 de segundo cada vez, aumentando em 57,7% as vendas no intervalo, um experimento que já assumiu as proporções de "Lenda Urbana" internacional entre professores e pesquisadores da Comunicação mal-informados ou preconceituosos [9].

Somente em 1974 houve o registro de adaptação da tecnologia subliminar à Televisão com objetivos comerciais, quando a frase "Compre-o" foi inserida sobreposta a um "frame" (1/30 de segundo) por 4 vezes durante o comercial de 30 segundos do jogo para crianças "Kusker Du" nos Estados Unidos da América [1].

Entretanto, nos anos 1980-1990 grandes empresas colocaram vírus nos computadores que fazem piscar na tela (efeito flicker em ritmo taquicoscópico) frases como "trabalhe mais rápido" para aumentar a produtividade dos empregados. Também supermercados instalam som ambiente com as frases "sou honesto" e "roubar é errado" alegando obter bons resultados mensuráveis estatisticamente (O processador MARK VI alega Ter reduzido em 30% o índice de furtos em uma rede com 81 supermercados em 4 estados dos USA); e bancos agiriam de forma semelhante para estimular aplicações financeiras [1-53].

Um depoimento pessoal sobre a eficácia das Tecnologias Subliminares

Aqui cabe inserir um depoimento pessoal meu a respeito da eficácia midiológica dos sinais subliminares, pois ainda em 1990, no "Laboratório de Telemática da Unisantos", desenvolvi e implantei com a equipe (Prof. Silvio Ênio Bergamini Filho e a jornalista Paula Prata Vandenbrande) uma experiência de pesquisa empregando o "Know-How" (Savoir Faire) desenvolvido durante 10 anos de pesquisa sobre tecnologias subliminares (incluindo minha dissertação de mestrado e tese de doutorado em Ciências da Comunicação na ECA-USP).

Adaptamos ao "logiciel" (programa de computador) da rede Videotexto (antecessora francesa da Internet) algumas destas tecnologias com o objetivo pragmático de aumentar a interatividade da rede, cujo potencial dialógico era sub-utilizado, sendo lida monologalmente como as mídias de massa da época .

Desta maneira, com a inserção das signagens subliminares (Sintaxe de Pisca-Pisca de frases e cores, sobreposição rápida de três telas batizada TRITELA e que hoje sabemos ter sido precursora da tecnologia de LAYERS) obtivemos um aumento mensurado de acessos na ordem de 550% em relação aos meses anteriores, subindo de 200 acessos/mês em fevereiro de 1991 para 1.100 acessos/mês em abril , mantidos em maio, comprovando assim os efeitos mensuráveis da Midiologia Subliminar [5 CF. Relatórios Estatísticos Telesp do Videotexto do Brasil, março a maio de 1991 e o website http://www.calazans.ppg.br).

Casos atuais envolvendo Tecnologias Subliminares no final do Século XX

A revista GEEK número 9, ISSN 1516-9650, Digerati editorial, São Paulo, Fevereiro de 2001, dedicou matéria ao tema das signagens subliminares em softwares, entrevistando um Professor Doutor da Unesp e publicando três boxes com textos de autoria dele. No segundo box, página 50 o pesquisador Calazans explica:

“Na INTERNET, há um software produzido pela Macromídia, o mais popular programa de animação entre os Webmasters no ano 2000, o "Flash 4.0", um programa vetorial que executa cálculos velozes.No "Ambiente Flash" há comandos que permitem a possibilidade de inserir quadros coloridos cuja leitura-varredura na tela dos computadores chegue aos 30 quadros por segundo, inserindo um quadro com a mensagem subliminar entre os outros 29 do GIFF animado no "Flash 4.0" .Há outras ferramentas para inserir subliminares: Fire-Works, Giff Animator, 3-D Studio Max, Director e muitos outros softwares, e digitando direto em HTML ou Javascript é possível medir o comando "Delay" (tempo de leitura-permanência da tela em velocidades vertiginosamente taquicoscópicas).Tanto Websites, Home-Pages ou CD-Roms que empreguem tais ferramentas podem inserir signagens subliminares, e em uma animação de 300 ou 400 quadros, além de imperceptível, ficaria muito trabalhoso rastrear cada imagem e em cada quadrante dela para vistoriar subliminares, tornando os "webdesigners" seguros para cometer subliminares anti-éticos ou mesmo que enquadrem-se tipificados como crime (incitando a preconceito racial ou religioso, à práticas sexuais pedófilas, violência, etc..)".

Em setembro de 2000, no decorrer da campanha presidencial norte-americana, o candidato republicano à eleição, George Bush, em um filme de televisão veiculou críticas ao programa do candidato democrata Al Gore.Ao criticar o sistema de reembolso de remédios, a equipe de publicitários de Bush (chefiada por Alex Castellano, que anteriormente já tinha empregado subliminares para o candidato Bob Dole em outra eleição presidencial) inseriu, em um "frame" (uma divisão de tempo de varredura da tela equivalente a uma parte entre trinta divisões de um segundo, 1/30 de segundo em ilha de edição computadorizada) a palavra "RATS" (ratos) sobreposta à frase "bureaucrats decide".

Alex Castellano declarou ao jornal NEW YORK TIMES que a insersão em um frame foi "acidental".O filme foi veiculado 4.400 vezes em cobertura nacional antes de ser denunciado e cancelado, e teve um custo aproximado de US$2,5 milhões.

Tal expediente de Signagem Subliminar teria sido empregado objetivando recuperar a queda de Bush nas pesquisas, à época, empatado com Gore.

Segundo Osmar Freitas, correspondente em Nova York, na revista "ISTO É", n.1616 de 20 de setembro de 2000, página 118: "Caracterizava-se, assim, um dos mais clamorosos exemplos de propaganda subliminar jamais descobertos".

Este fato foi amplamente noticiado e documentado em rádio e televisão brasileira, incluindo matérias em jornais conceituados como "O ESTADO DE SÃO PAULO" ("Bush é acusado de usar propaganda subliminar" 13 de setembro de 2000, A15) e "FOLHA DE SÃO PAULO" ("Bush é acusado de propaganda subliminar" 13/9/200), ambas matérias distribuídas pela renomada e fidedigna agência de notícias Reuters.

Outro caso com muito destaque na mídia foi a inserção de dois fotogramas com fotos de uma mulher com os seios nus no desenho animado da Disney "Bernardo e Bianca", conforme a Folha de São Paulo de 15 de janeiro de 1999, "Pela primeira vez na história da companhia, a Disney admitiu ter encontrado imagens subliminares num de seus filmes de animação".

A cena acontece aos 28 minutos do filme e é imperceptível sem que se pare no quadro a quadro.Dois sites da internet iniciaram a polêmica, um deles foi http://www.entertainium.com/francais/video/rescuers2.html , graças a eles, a Disney foi obrigada a recolher 3,4 milhões de fitas em locadoras de vídeo nos USA.

Segundo o jornal A FOLHA DE SÃO PAULO de domingo, 8 de setembro de 2002, p. C-1 e c-3 :"Treze dias antes de a publicidade de cigarro ter sido banida das TVs no Brasil, o que ocorreu em 1º de janeiro de 2001, a Souza Cruz aceitou retirar do ar uma campanha do cigarro Free que o Ministério Público de Brasília considerou ilegal porque estimularia crianças e adolescentes a fumar. Ao decompor o anúncio quadro a quadro, os psicólogos encontraram o que consideram ser "propaganda subliminar". Na definição deles, propaganda sublimar é "qualquer estímulo realizado abaixo do limiar da consciência, que produz efeitos na atividade psíquica e mental do indivíduo". As mensagens subliminares são "remetidas automaticamente ao nosso cérebro, em nível involuntário, inconsciente". Por três décimos de segundo, ou seja, numa fração de tempo imperceptível para os olhos humanos, aparece uma mulher fumando. Logo em seguida, também por três décimos de segundo, aparece outra pessoa fumando.

Se os eventuais efeitos da chamada propaganda sublimar são cada vez mais questionados, a dúvida de Fernandes Neto não é desprezível: "Por que a Souza Cruz incluiu no comercial imagens que não dá para ver? Certamente, há alguma razão para isso".

A Souza Cruz alega que a responsabilidade sobre o comercial é das diretoras do filme, Daniela Thomas e Carolina Jabor. Daniela, porém, afirma não se lembrar dessa imagem e diz que, se ela existir, teria a função de dar ritmo às imagens.

A ADESF (Associação em Defesa da Saúde do Fumante) acha que o Ministério Público pegou um peixe grande.".

Assim, o parecer judicial dos psicólogos, como perícia técnica, define oficialmente na jurisprudência brasileira esta edição de imagens de três décimos de segundo como SUBLIMINAR, ora, na edição de televisão há 30 imagens (Frames) por segundo, e com a internet pode-se editar em velocidades de mais de 60 frames por segundo, como o já antigo SHOWSCAN, uma mídia subliminar [CF. 1-61].

Estes, entre tantos casos, comprovam a existência de Signagens Áudio-Visuais denominadas ora como Signos Subliminares, ora como Mensagens Subliminares, ora como Propaganda Subliminar e demonstram que há um emprego destas tecnologias de manipulação do inconsciente na Mídia Internacional eletrônica digitalizada.

CONSIDERAÇÕES FINAIS

Com estes exemplos acima, (espécimes recolhidos na Midiosfera brasileira no decorrer do Século XX e início do XXI, submetidos à metodologia de estudo de caso, elencados e analisados detalhadamente), fica FALSEADA a hipótese da inexistência de Signagens Subliminares nas Mídias Áudio-Visuais no decorrer do Século XX, comprovando-se que, contrariando a hipótese, há existência de signos denominados como propaganda subliminar veiculados fartamente documentada; desde o desenho animado da Disney (Disney que admite haver signagem subliminar e recolhe as fitas) até em Campanha Eleitoral Presidencial dos USA denunciada em diversos periódicos, e em parecer de psicólogos peritos em processo judicial contra propaganda tabagista.

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"POLARIZATION MODE DISPERSION – PMD" UM ESTUDO SOBRE OS EFEITOS DO FENÔMENO EM LABORATÓRIO, ATRAVÉS DE SISTEMAS DE SIMULAÇÃO

Sandra Maria Dotto Stump [1], Maria Lucia M.Carvalho Vasconcelos [2] and Paulo Sérgio Milano Bernal [3]

Abstract *— Este trabalho permitiu explorar as possibilidades didático-pedagógicas dos modelos de simulação para a resolução de problemas complexos, envolvendo fenômenos de propagação em fibras ópticas, mais especificamente a "Dispersão Modal por Polarização" (PMD), cujo estudo dos efeitos e medição, em condições reais, tornaram-se extremamente difíceis na prática, devido à falta de acesso a longos enlaces de fibras ópticas (acima de dezenas de quilômetros), bem como à indisponibilidade de instrumentos de medição. Portanto, como forma de contorno para o problema mencionado, passamos a utilizar métodos de simulação em Laboratório. Estes por sua vez, uniram professores-orientadores e seus alunos em busca da aprendizagem efetiva, porque real. Se tecnicamente a experiência aqui relatada se apresenta como positiva, do ponto de vista da utilização de novos métodos de ensino, encontramo-nos diante de um novo paradigma, que já se apresenta indispensável ao ensino de Engenharia.*

Index Terms *— Inovações em Laboratório, Instrução Integrada com Uso de Laboratório, Differential Group Delay, Polarization Mode Dispersion.*

Este trabalho explora as possibilidades didático-pedagógicas dos modelos de simulação para a resolução de problemas complexos, envolvendo fenômenos de propagação em fibras ópticas, cujo projeto e medição, em condições reais, tornam-se extremamente difíceis na prática, devido à falta de acesso a longos enlaces de fibras ópticas (acima de dezenas de quilômetros), bem como à falta de disponibilidade de instrumentos de medição.

Tais métodos de simulação em Laboratório torna viável, tanto o desenvolvimento de solução para os problemas teóricos, quanto a medição simulada em condições próximas à real, contribuindo, assim, para o desenvolvimento e a formação dos alunos usuários deste Laboratório, que podem efetivar uma experiência transformadora dos procedimentos didáticos na área.

O uso educacional da tecnologia da simulação permite ao educando, diante de uma situação-problema, testar alternativas de ação, buscando a mais adequada sem, no entanto, causar danos ou prejuízos, que em uma situação real poderiam ocorrer.

Os processos de simulação de medições apresentados aqui foram desenvolvidos no Laboratório de Telecomunicações e Computação do Programa de Pós-Graduação em Engenharia Elétrica, da Universidade Presbiteriana Mackenzie, através do software de simulação de enlaces de fibras ópticas denominado VPI (Virtual Photonics Inc), em experiências que uniram professores-orientadores e seus alunos em busca da aprendizagem efetiva, porque real.

Se tecnicamente a experiência aqui relatada se apresenta como positiva, do ponto de vista da utilização de novos métodos de ensino, encontramo-nos diante de um novo paradigma, que já se apresenta indispensável ao ensino de Engenharia.

Do ponto de vista da utilização da tecnologia com fins educacionais, que apresenta, com clareza, a derrubada de padrões anteriormente utilizados, porque agora considerados obsoletos, deve-se ressaltar que a necessidade de mudança nas formas didático-pedagógicas de se trabalhar em sala de aula e/ou laboratório, devem voltar-se não só ao apelo tecnológico, que é instrumental, voltado para a competência do manejo dos meios, assim como para o desenvolvimento da capacidade individual do aluno raciocinar, organizando suas ações, de maneira crítica e analítica. [1]

Apesar de todos os avanços nas últimas duas décadas, visando eliminar, ou pelo menos atenuar significativamente, os efeitos de dispersão nos sinais ópticos propagados em enlaces de fibras ópticas, o crescimento do tráfego de comunicações forçou o aumento das taxas de sinalização de pulsos ópticos, aplicados nos cabos de fibras até então instalados. Conseqüentemente, alguns efeitos, até então não significativos, tornaram-se importantes, pois passaram a afetar a capacidade de transmissão de bits. Estes novos efeitos de dispersão, que se constituíam como objeto de pesquisas, foram sendo devidamente compensados através de novos processos de fabricação de fibras ópticas e pelo uso de novos tipos de LASER emissores de sinais. Como última

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medida, foram desenvolvidos compensadores externos, que começaram a serem implantados nos enlaces de cabos de fibras instalados.

Dentre os efeitos que causam sérias limitações nos projetos de enlaces de fibras ópticas, a Dispersão Modal por Polarização (PMD) tornou-se uma das mais importantes limitações da capacidade de transmissão de informações, pois os efeitos decorrentes da PMD impõem limitações na recuperação das informações moduladas ou codificadas, tanto nos sistemas de comunicação óticos analógicos (CATV), como nos sistemas digitais de longa distância, cujas taxas de bits encontram-se acima de 10Gbps.

Nos anos oitenta, com a popularização das fibras monomodo, a principal preocupação quanto à dispersão em enlaces de fibras ópticas para telecomunicações passou a ser a Dispersão Cromática. Porém, com a criação das fibras "*Dispersion-Shifted"* e das fontes de sinal baseadas em Laser "*Single-frequency*", o problema da Dispersão Cromática foi contornado, o que levou diversos pesquisadores a concentrarem esforços para o entendimento, caracterização e compensação dos efeitos da PMD.

O efeito da PMD é particularmente importante nos sistemas multigigabits de longa distância, pois causa a perda de polarização e o espalhamento dos pulsos ópticos transmitidos, o que dificulta a detecção das informações nos receptores, ocasionando o aumento significativo da taxa de erros (BER) [2][3].

Com a introdução comercial dos sistemas de portadoras óticas, baseados em taxas de 10Gbps e 40Gbps, a PMD, tornou-se a maior fonte de preocupação, pois a grande maioria das fibras até então instaladas, não foram construídas para compensar o efeito degenerativo da PMD e, portanto, este efeito limitaria a capacidade de expansão da velocidade de propagação dos pulsos em longas distâncias. Devido ao fato da PMD não ter sido discutida até o início dos anos noventa, aproximadamente 30% das fibras monomodo fabricadas e instaladas até 1995 teriam características construtivas que as tornariam problemáticas em taxas de transmissão acima de 10Gbps, e evidenciariam um forte efeito decorrente da PMD. Como conseqüência, seria inviável tecnicamente a expansão destes sistemas de transmissão para as taxas atualmente suportadas, a menos que fossem introduzidos equipamentos de compensação dinâmica da PMD, ou que as fibras fossem substituídas.

PMD – CONCEITUAÇÃO TEÓRICA

A PMD causa a dispersão dos pulsos ópticos enviados pela fibra, de forma crescente e aleatória com a distância. Portanto, a dispersão dos sinais óticos causa o incremento a níveis inaceitáveis da taxa de bits errados transmitidos e recebidos pelo enlace óptico, limitando a largura de banda de transmissão, com conseqüente limitação da taxa máxima de pulsos óticos conduzidos, comprometendo o comportamento linear do pulso propagado no meio fibra ótica.

Podemos definir a dispersão de sinais ópticos conduzidos em fibras óticas como o efeito de espalhamento do sinal no tempo, ocasionando a sobreposição dos pulsos adjacentes, nos casos de grandes taxas de pulsos e largo espectro de freqüências, quando a PMD de segunda ordem torna-se mais aparente. Em decorrência da dispersão dos pulsos e da sobreposição, os pulsos perdendo o seu formato característico, torna-se difícil detectar o código da informação binária pelos receptores na extremidade final da fibra.

O efeito da PMD nos pulsos ópticos transmitidos nas fibras é normalmente definido e medido através do Atraso de Grupo Diferencial – DGD (Differential Group Delay), que descreve a diferença no tempo de chegada das duas componentes ortogonais que formam o pulso. Desta forma, o sinal composto conduzido nos duas componentes com planos polarizados de forma ortogonal se "separarão" pelo efeito das diferentes velocidades de Grupo em cada plano de polarização. O sinal sofrerá então um espalhamento pela defasagem em tempo que cada componente de polarização terá em relação ao outro, formando o DGD. Como as fibras ópticas são anisotrópicas, possuindo diferentes valores para as constantes de propagação em cada direção, as duas componentes ortogonais da onda que sofreu birrefringência terão diferentes índice de refração entre si e, passarão a ter diferentes velocidades de propagação em cada direção. Como conseqüência, ocorre a dispersão por polarização, que é agravada pelo acoplamento do modo de polarização resultante de pequenas variações randômicas na birrefringência ao longo da extensão da fibra [4]. Desta forma, para extensões superiores a 100 metros de fibra, torna-se difícil prever o comportamento da polarização resultante. Portanto, o modelo de propagação linearmente polarizada com duas ondas ortogonais aplica-se para pequenos comprimentos de fibra. Para contornar esta dificuldade, usa-se o modelo no qual diversos pequenos pedaços de fibras birrefringentes são concatenados, formando uma longa fibra, cujos efeitos individuais de cada pedaço são sobrepostos, representando o efeito total. A aplicação desse modelo mostrou-se inviável experimentalmente para enlaces de fibras maiores do que 1 Km. [2]

O modelo no qual foi baseado esse trabalho, supõe a consideração de duas componentes inicialmente ortogonais (os principais estados de polarização – PSP), propagando-se com a mesma velocidade; mas, devido à birrefringência randômica ao longo da fibra, as componentes ortogonais do sinal passam a ter diferentes velocidades de propagação nas diferentes direções em que podem seguir, causando a separação no tempo (Δt) das duas componentes ortogonais, após algumas dezenas de quilômetros, o que é caracterizado como o "Atraso Diferencial". Na Figura 1 são ilustradas as duas componentes simuladas do sinal óptico numa fibra birrefringente.

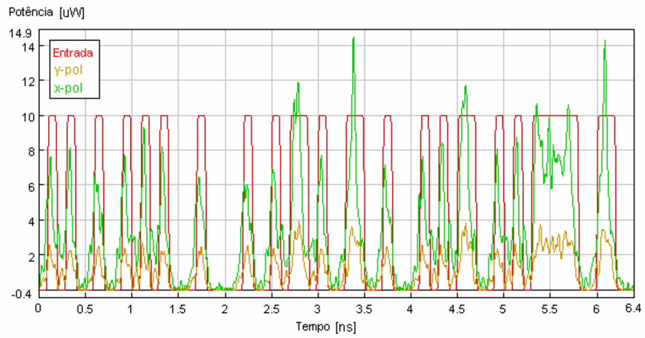

FIGURE. 1
SIMULAÇÃO DAS COMPONENTES DO SINAL ÓPTICO NUMA FIBRA BIRREFRINGENTE, USANDO O SOFTWARE VPI DA PHOTONICS.

No limite do modo de acoplamento extensível, os principais estados de polarização e o tempo de atraso diferencial na fibra não são fortemente correlacionados com as propriedades locais da fibra, desde que eles dependam dos efeitos resultantes de todos os efeitos locais ou pontuais, do modo de acoplamento randômico, por todo o caminho de propagação. Então, espera-se que os PSP e o tempo de atraso diferencial irão variar aleatoriamente de fibra para fibra, com o Atraso Diferencial de Grupo exibindo um comportamento que pode ser aproximado por uma distribuição de probabilidades de Maxwell [5].

Desta forma, o Atraso Diferencial entre as componentes ortogonais, passa a ser tratado como um valor médio para uma família de fibras ópticas com as mesmas características estatísticas. Para a realização de medições práticas, assume o valor do DGD médio em pico segundo (ps). Sabendo-se que este cresce com o quadrado da distância percorrida na fibra entre a entrada e a saída do sinal [4], pode ser calculado o valor do parâmetro PMD para a família de fibras ópticas em questão pelo uso da equação (1):

$$PMD = \frac{\langle \Delta\tau \rangle}{\sqrt{L}} \quad (1)$$

A solução proposta na referência [6] é do uso de um modelo de simulação de Monte Carlo para atingir a solução calculada e comprovar que o a função densidade de probabilidade (PDF) se aproxima a uma distribuição de probabilidade de Maxwell.

Uma vez conhecido o comportamento estatístico aproximado de um fenômeno, sua descrição prática pode ser feita, de modo aproximado, mas satisfatório, segundo a função distribuição de probabilidades.

Então, podemos caracterizar a PMD de uma família de fibras ópticas, estatisticamente equivalentes, pelo conhecimento do valor médio e dispersão em torno deste valor.

MÉTODO DE DESENVOLVIMENTO

Diversos processos são atualmente utilizados para a medição do DGD e da PMD em laboratório, ou em campo. Para a realização deste trabalho utilizamos o software de simulação VPI da Photonics Inc. Este software é disponível no Laboratório de Telecomunicações e Computação do Programa de Pós Graduação em Engenharia Elétrica da Universidade Presbiteriana Mackenzie. O mesmo permite a simulação de sinais ópticos, se propagando em enlaces de fibras ópticas, bem como a simulação de sistemas de comunicação e a medição simulada dos efeitos da PMD.

Utilizando as simulações disponíveis no software VPI, podem ser realizadas medições simuladas do DGD médio de uma família de fibras simuladas, estatisticamente equivalentes, de modo a comparar os resultados experimentais, com os resultados de cálculos teóricos solucionados com simulação por Monte Carlo.

O desenvolvimento teórico para a simulação de Monte Carlo toma como base o desenvolvimento expresso a partir da equação que descreve a birrefringência intrínseca ao meio, fibra óptica e pela variação vetorial do sinal acoplado com esse meio em polarização [6].

É significativo o resultado positivo, no campo de ensino de Engenharia, resultante deste procedimento. Não só a compreensão dos processos fica facilitada, como são ampliadas, em muito, as possibilidades de pesquisa na área. Nesse contexto, a utilização das tecnologias de informática com finalidade educacional, oferece suporte pedagógico às atividades do processo de ensino-aprendizagem, objetivando a qualidade, a flexibilidade e a real experimentação na educação. [8]

METODOLOGIA

Inicialmente estudamos a Dispersão Modal por Polarização (PMD) de primeira ordem em fibras ópticas monomodo, enfocando o modelo dos Principais Estados de Polarização (PSP), introduzido por Poole e Wagner na referência [2], acompanhando, em seguida, a evolução do modelo proposto, nos demais trabalhos das referências [3], [4], [5] e [6]. A revisão bibliográfica foi complementada pelo cálculo de sistemas matemáticos complexos e pelas medições simuladas em computador de enlaces de fibras com manifestação da PMD.

A seguir, estabelecem-se processos para solucionar sistemas de equações probabilísticas dinâmicas, por simulação do tipo Monte Carlo, comparando então os resultados com medições simuladas dos efeitos do PMD de uma família de fibras monomodo estatisticamente compatíveis, através do software de simulação Photonics-VPI. Este procedimento permitiu obter resultados equivalentes às medições realizadas em campo, em enlaces de fibras ópticas de muitas dezenas de quilômetros e com instrumentos de medição sofisticados.

Os resultados obtidos com estas medições simuladas e com os processos de resolução de sistemas de equações por método de simulação, permitiram a incorporação do conhecimento adquirido ao conjunto de técnicas ministradas aos alunos do Programa de Pós-Graduação em Engenharia Elétrica da Universidade Presbiteriana Mackenzie, na forma de aulas de laboratório que dão suporte às disciplinas teóricas do Programa.

Aos alunos são oferecidas possibilidades de realizar diversas medições e previsões teóricas de sistemas práticos, através de processos simulados, permitindo projetar enlaces e analisar problemas de situações reais encontradas em campo.

Do ponto de vista das teorias da aprendizagem, a compreensão, por parte do aluno, daquilo que lhe é apresentado, é condição essencial para sua aprendizagem. Num curso de Pós-Graduação em Engenharia Elétrica, a possibilidade de trabalhar com simuladores, além das evidentes vantagens científicas, as questões motivacionais, contributivas para a efetivação do processo de ensino-aprendizagem, não podem ser menosprezadas.

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OBTENÇÃO DE IMPLICANTES PRIMOS PARA FUNÇÕES BOOLEANAS ATRAVÉS DA OPERAÇÃO DE CONSENSO

Alexandre César Rodrigues da Silva[1]*, Ivanil Sebastião Bonatti*[2] *e Cláudio Kitano*[3]

Resumo *— No desenvolvimento de projetos de sistemas digitais envolvendo FPGA, necessita-se de eficientes algoritmos computacionais para a minimização das funções booleanas contendo um grande número de variáveis. Neste trabalho apresenta-se o algoritmo GeraPlex, que obtém todos os implicantes primos de uma função booleana através de sucessivas aplicações da operação de consenso aos ramos de uma árvore de decisão binária, onde cada caminho (nó até folha) representa um mintermo ou irrelevante da função. Da aplicação do consenso são definidas as operações de fusão, deslocamento e expansão, que diminui, mantém e aumenta, respectivamente, os caminhos da árvore. No final do processo os caminhos que permanecem na árvore representam os implicantes primos da função. Dezenas de funções foram minimizadas e os resultados obtidos comparados com o tradicional método tabular para a geração de implicantes primos. Em todos os casos o GeraPlex obteve os mesmos implicantes primos e apresentou desempenho superior em tempo e memória.*

Palavras Chave — Consenso iterativo, Minimização de funções Booleanas, Otimização, Síntese lógica .

INTRODUÇÃO

Na simplificação de funções booleanas de médio porte (tipicamente de 10 a 30 variáveis) o número de implicantes primos gerados pode crescer exponencialmente. Portanto a obtenção de todos os implicantes primos requer grande quantidade de memória e tempo de execução. Alguns autores trataram o problema de forma algébrica [1], [2], enquanto outros utilizaram-se de tabelas e árvores de decisão binária [3], [4], [5] e [6].

Quine [6] e Tison [7] utilizaram-se do consenso iterativo para obter todos os implicantes primos de uma dada função booleana. Neste trabalho, apresenta-se o algoritmo denominado GeraPlex, que obtém todos os implicantes primos de uma função booleana através de sucessivas aplicações da operação de consenso aos ramos de uma árvore de decisão binária que representa a tabela verdade da função a ser minimizada. Nesta árvore cada caminho, que vai da raiz à folha, representa um mintermo ou irrelevante da função.

No algoritmo proposto da aplicação do consenso aos ramos da árvore são definidas três operações: fusão, expansão e deslocamento que diminui, aumenta e mantém o número de caminhos da árvore, respectivamente.

Resultados experimentais indicam que o método proposto é uma eficiente alternativa para a resolução do problema considerado, pois é de fácil implementação e muito adequado para representar circuitos lógicos combinacionais.

O CONSENSO DE UMA FUNÇÃO

O Consenso de $f(x_1, x_2, \ldots, x_i, \ldots, x_n)$ com relação à variável x_i é definida como $C_{xi}(f) = f_{xi} \cdot f_{xi'}$ [9]. Dessa forma, pode-se afirmar que o consenso de uma função booleana com relação a uma variável representa o componente que é independente dessa variável. O consenso pode ser estendido para conjuntos de variáveis como uma aplicação iterativa da operação de consenso sobre as variáveis do conjunto. Por exemplo, o consenso entre os termos produtos A´.B´.D.E e A.B´.C.D é o termo produto B´.C.D.E. Não existe o consenso entre os termos produtos A´.B´ e A.B.C, pois deve haver uma única variável que ocorre negada em um dos termos e não negada no outro.

Método do Consenso para Obter Implicantes Primos

O método do consenso iterativo [10] para a obtenção dos implicantes primos de uma função booleana consiste na aplicação das operações de eliminação e consenso, até que estas operações não sejam mais aplicáveis. Na operação de eliminação elimina-se quaisquer termos produto que cobre algum outro termo produto e na operação de consenso acrescenta-se como termos produto o consenso de dois termos produtos, se este não for coberto por nenhum outro termo produto contido na soma de produto.

Como exemplo da aplicação do método do consenso considere a função $F_1(A,B,C,D) = \sum m(5,7,8,9,13)$. Esta função F_1(A.,B,C,D) pode ser representada através da soma de produto como A´.B.C´.D + A´.B.C.D + A.B´.C´.D´ + A.B´.C´.D + A.B.C´.D. O consenso entre A.B´.C´.D´ e A.B´.C´.D resulta no termo A.B´C´ que não é coberto por nenhum dos termos produtos, devendo então ser incluído na soma. Com a inclusão do termo consenso tem-se uma nova expressão soma de produto, ou seja, F_1(A.,B,C,D) = A´.B.C´.D + A´.B.C.D + A.B´.C´.D´ + A.B´.C´.D + A.B.C´.D + A.B´C´. Pode-se notar que o termo A.B´C´

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cobre os termos produtos A.B´.C´.D´ e A.B´.C´.D, podendo ambos serem eliminados. A nova expressão torna-se A´.B.C´.D + A´.B.C.D + A.B.C´.D + A.B´C´. As operações de consenso e eliminação são empregadas tanto quanto possível. Com a aplicação sistemática tem-se F_1(A.,B,C,D) = A.B´.C´ + A.C´.D + A´.B.D + B.C´.D, que representam os implicantes primos da função considerada. A Figura 1 apresenta no Mapa de Karnaugh os implicantes primos gerados.

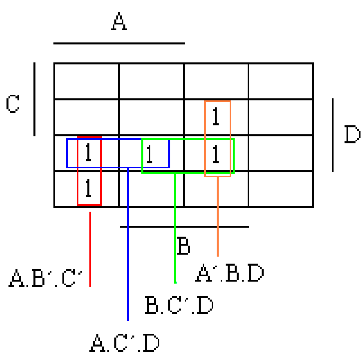

FIGURA. 1
MAPA DE KARNAUGH APRESENTANDO OS IMPLICANTES PRIMOS OBTIDOS PELA APLICAÇÃO DO CONSENSO INTERATIVO NA FUNÇÃO F_1(A,B,C,D).

ALGORITMO PROPOSTO PARA A GERAÇÃO DOS IMPLICANTES PRIMOS

O algoritmo proposto denominado GeraPlex obtém todos os implicantes primos, de uma dada função booleana, utilizando-se da operação de consenso aplicada aos ramos de uma árvore de decisão binária que representa a função a ser minimizada.

Uma árvore de decisão binária é uma forma equivalente à Tabela Verdade utilizada para representar funções booleanas. Nesta estrutura os mintermos são representados pelos ramos da árvore. A Figura 2 apresenta a árvore de decisão para a função F_2(A,B,C,D) = $\sum m(0,1,3,5,9,13,15)$.

Note que na Figura 2 a raiz da árvore (variável A) representa o bit mais significativo e que as folhas (variável D) representa o bit menos significativo. Um mintermo (linha da Tabela Verdade cuja função assume valor lógico 1) é representado por um caminho da árvore, que vai da raiz à folha. Dessa forma, o caminho 1001 representa o mintermo 9.

Esta forma para representar funções booleanas é bastante conveniente para implementações computacionais, pois um mesmo ramo da árvore pode ser utilizado por mais de um mintermo, o que significa menos utilização de memória.

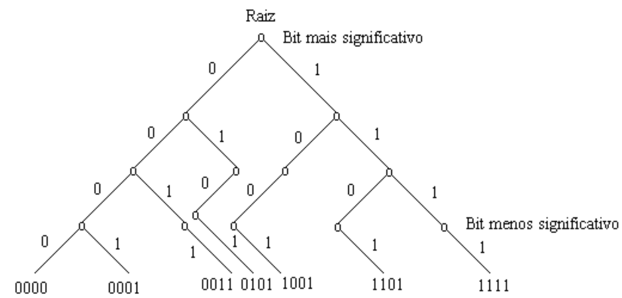

FIGURA. 2
ÁRVORE DE DECISÃO BINÁRIA PARA A FUNÇÃO F_2(A,B,C,D).

No algoritmo GeraPlex, a geração dos implicantes primos tem início analisando-se a possibilidade de se aplicar o consenso aos ramos da árvore pertencentes aos nós do nível mais distante da raiz. Após aplicar o consenso aos ramos dos nós de um nível, avança-se para o próximo nível, no sentido da raiz. Desse modo, quando analisa-se um nó, todas as sub - árvores abaixo desse nó já devem ter sido analisadas. Da aplicação do consenso aos ramos da árvore são definidas três operações:

- **Fusão:** A operação de fusão ocorre quando dois ramos de um nó geram um terceiro ramo. O ramo gerado cobre os outros dois ramos do nó. Neste caso os ramos cobertos são eliminados. Esta operação diminui a quantidade de caminhos da árvore;
- **Deslocamento:** A operação de deslocamento ocorre quando dois ramos de um nó geram um terceiro ramo, porém o ramo gerado cobre apenas um dos dois outros ramos. Neste caso, o ramo coberto é eliminado. Esta operação mantém a quantidade de caminhos da árvore;
- **Expansão:** A operação de expansão ocorre quando dois ramos de um nó geram um terceiro ramo, porém o ramo gerado não cobre nenhum dos outros dois ramos.

Descrição Resumida do Algoritmo GeraPlex

O algoritmo GeraPlex obtém os implicantes primos de uma função booleana, e além disso, determina os implicantes primos essenciais, com vistas à formulação do problema de cobertura como um problema de programação matemática. Os seguintes passos compõe o algoritmo:

- **Montagem das árvores**: Monta-se duas árvores com a mesma estrutura; uma contendo somente os mintermos da função (árvore dos mintermos) e a outra contendo os mintermos e os irrelevantes (árvore dos implicantes). A árvore dos mintermos é utilizada no final do algoritmo para se determinar quais dos implicantes primos gerados são essenciais. Na árvore de implicantes são gerados os implicantes primos da função através das operações de fusão, deslocamento e expansão. Na lista ligada, em estrutura de árvore, cada registro tem três apontadores rotulados por "zero", "um" e "dc";

- **Geração dos implicantes primos**: Os implicantes primos da função são gerados na árvore de implicantes através de sucessivas aplicações do Método do Consenso aos ramos da árvore. Para evitar a geração de implicantes não primos deve-se inicialmente aplicar, para cada nó no mesmo nível da árvore, o consenso a ramos que produzem a fusão para depois aplicar o consenso a ramos que produzem o deslocamento ou a expansão. Para cada nível analisado deve-se eliminar os implicantes não primos. Após analisar o nó da raiz, a árvore de implicantes só contém caminhos que representam os implicantes primos da função;
- **Determinação dos implicantes primos essenciais**: Esse passo consiste em determinar os caminhos que representam os implicantes primos essenciais da função que devem ser eliminados da formulação do problema de cobertura objetivando a sua simplificação. No final desse procedimento a árvore de implicantes contém somente implicantes primos que não são essenciais. Isto corresponde, no Mapa de Karnaugh, a um caso cíclico, podendo ser formulado como um problema de programação linear inteira 0 e 1.
  - Seleciona-se um mintermo (caminho) da árvore de mintermos;
  - Verifica-se na árvore de implicantes quantos implicantes cobrem o mintermo selecionado;
  - Se existir apenas um implicante que cobre o mintermo selecionado, este é considerado essencial sendo removido da árvore de implicantes. Elimina-se também, da árvore de mintermos, todos os mintermos cobertos pelo implicante eliminado da árvore de implicantes;
  - Retorna-se ao início desse passo até que todos os mintermos tenham sido analisados.

Como exemplo de aplicação do algoritmo GeraPlex considere a função $F_3(A,B,C) = \sum m(0,1,5) + d(2,7)$, cujo Mapa de Karnaugh está apresentado na Figura 3.

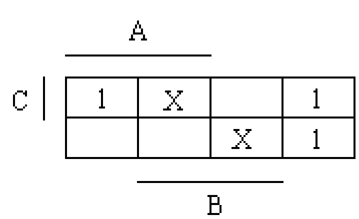

FIGURA. 3
MAPA DE KARNAUGH DA FUNÇÃO F_3(A,B,C).

A árvore inicial dos implicantes primos é mostrada na Figura 4. A geração dos implicantes primos inicia-se pela aplicação do consenso aos ramos dos nós do nível 0, ou seja, os mais distantes da raiz. A árvore apresentada na Figura 5 é o resultado da aplicação do consenso aos caminhos 000 e 001 que resulta no caminho 00X. Note que essa operação corresponde à fusão, pois o caminho gerado cobre os outros dois.

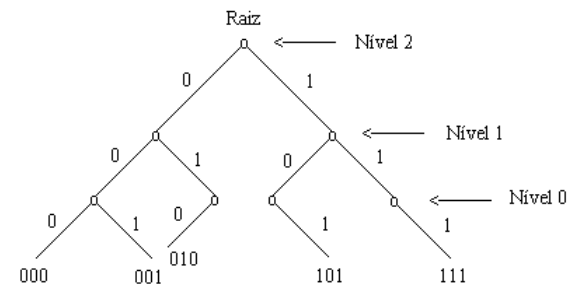

FIGURA. 4
ÁRVORE DE IMPLICANTES PRIMOS PARA A FUNÇÃO F_3(A,B,C).

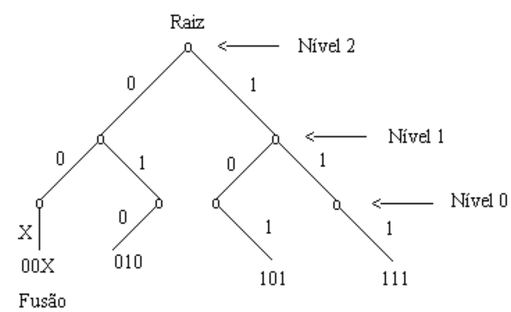

FIGURA. 5
ÁRVORE DE IMPLICANTES PRIMOS APÓS A APLICAÇÃO DO CONSENSO AOS NÓS DO NÍVEL 0.

Após a aplicar o consenso aos ramos de um nível da árvore, avança-se para os nós do próximo nível no sentido da raiz. A árvore apresentada na Figura 6 é o resultado da aplicação do consenso aos ramos dos nós de nível 1. O consenso entre os caminhos 101 e 111 gera o caminho 1X1, que cobre ou outros dois caminhos. Observe que o consenso entre os caminhos 00X e 010 gera o caminho 0X0, que cobre somente o caminho 010. Esta operação é definida como deslocamento.

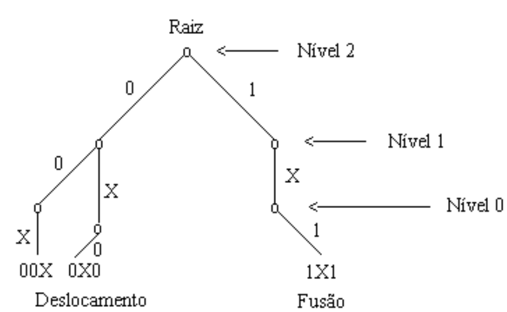

FIGURA. 6
ÁRVORE DE IMPLICANTES PRIMOS APÓS A APLICAÇÃO DO CONSENSO AOS NÓS DO NÍVEL 1.

Para o nó de nível 2 (raiz), da árvore apresentada na Figura 6, o consenso aplicado aos caminhos 00X e 1X1 gera o caminho X01. O caminho gerado não cobre nenhum dos outros dois caminhos. Essa operação é chamada de expansão, pois aumenta o quantidade de caminhos na árvore, como pode ser observado na Figura 7.

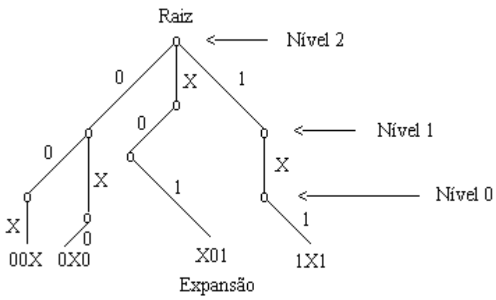

FIGURA. 7
ÁRVORE DE IMPLICANTES PRIMOS APÓS A APLICAÇÃO DO CONSENSO AO NÓ DO NÍVEL 2.

Observe que na árvore apresentada na Figura 7 não se pode mais aplicar o consenso. Todos os caminhos da árvore representam implicantes primos da função como mostra o Mapa de Karnaugh apresentado na Figura 8.

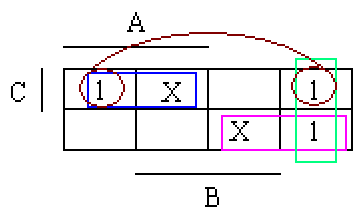

FIGURA. 8
MAPA DE KARNAUGH COM OS IMPLICANTES PRIMOS GERADOS PELO PROGRAMA GERAPLEX PARA A FUNÇÃO F3.

Com os implicantes primos obtidos, o problema de cobertura de funções booleanas pode ser formulado como um problema de programação linear inteira 0 e 1. Para a função F_3 tem-se a seguinte formulação do problema de cobertura:

$$\text{Min } F_3 = 3.1X1 + 3.0X0 + 3.00X + 3.X01$$
s.a.
$$0X0 + 00X \geq 1$$
$$00X + X01 \geq 1$$
$$1X1 + X01 \geq 1$$
$$1X1,\ 0X0,\ 00X \text{ e } X01 \in \{0, 1\}$$

Pode-se notar que o problema de cobertura passou a ser tratado como um problema de programação matemática, podendo-se, dessa forma, utilizar-se de todos os avanços dessa área de pesquisa.

Para as dezenas de casos estudados, o programa GeraPlex obteve os mesmos implicantes primos obtidos pelo método tabular de Quine-McCluskey. Foram também estudadas funções denominadas Tudo Um, isto é, funções contendo todos os mintermos possíveis. Trata-se de uma função sem uso prático, entretanto, consiste em um bom teste para avaliar o desempenho de algoritmos, pois exige grande quantidade de memória e consome muito tempo de computação.

No início do desenvolvimento desta pesquisa, pretendia-se comparar a eficiência do algoritmo desenvolvido com outros algoritmos implementados em pesquisas anteriores. Estas comparações foram realizadas, entretanto, foram logo desconsideradas, pois entendeu-se serem comparações desleais. Dois foram os motivos. Primeiro, as estruturas de dados utilizadas no programa GeraPlex são muito diferentes das estruturas empregadas no Quine-McCluskey e nos outros algoritmos, e com toda certeza essa foi a principal vantagem do GeraPlex sobre os outros algoritmos avaliados. Segundo, as linguagens de programação utilizadas foram diferentes, o que torna sem sentido qualquer tipo de comparação em termos de tempo de execução e uso de memória dos algoritmos.

O programa GeraPlex estará sendo comparado com um outro programa para a geração de implicantes primos que implementa o Método de Expansão de Shannon. Este outro programa, denominado Expander também utiliza-se de estrutura em diagrama de decisão binária e está programado na linguagem de programação C, da mesma forma que o GeraPlex.

Este é o motivo pelo qual não apresentou-se os dados comparativos entre o algoritmo implementado e alguns outros método clássicos. Entretanto, pode-se afirmar com muita segurança que a abordagem dada neste trabalho consiste em uma forma bastante eficiente para a geração de implicantes primos e formulação do problema de cobertura de funções booleanas como um problema de programação matemática.

CONCLUSÃO

Este trabalho apresentou uma alternativa eficiente para a geração de todos os implicantes primos de uma função booleana, a partir dos quais o problema de cobertura pode ser formulado como um problema de programação linear inteira 0 e 1.

Os implicantes primos da função foram gerados aplicando-se a operação de consenso aos ramos de uma árvore de decisão binária cujos caminhos (raiz até folha) representam os mintermos e irrelevantes da função. Da aplicação do consenso aos ramos da árvore são definidas as operações de fusão, deslocamento e expansão, que diminui, mantém e aumenta, respectivamente, os caminhos da árvore. No final do processo os caminhos que permanecem na árvore representam os implicantes primos da função, que no

Método de Quine-McCluskey (tradicional método tabular) corresponde a um Mapa Cíclico.

Dezenas de funções booleanas foram minimizadas e os resultados comparados com tradicionais métodos de geração de implicantes primos. Em todos os casos o GeraPlex obteve os mesmos implicantes primos e apresentou desempenho superior em tempo e memória.

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PROGRAMAÇÃO MATEMÁTICA APLICADA NO PROBLEMA DE COBERTURA DE FUNÇÕES BOOLEANAS COM MÚLTIPLAS SAÍDAS

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Resumo — *A complexidade dos sistemas digitais exige circuitos contendo várias saídas, ao invés de apenas uma. Essas funções de saídas podem ser implementadas independentemente, porém uma considerável economia ocorrerá se forem implementadas como um todo. Essa economia decorre do uso de um mesmo termo produto por duas ou mais funções, que é implementado uma única vez e compartilhado pelas funções. Apresenta-se neste trabalho o algoritmo MultPlex, que minimiza funções booleanas com múltiplas saída. Para a fase de geração de implicantes primos, utilizou-se um tradicional método tabular, que foi estendido para considerar as múltiplas funções. As Coberturas das funções são resultado de dois problemas de programação matemática, aqui denominados de problema de cobertura múltipla e problema de cobertura singular. Os testes realizados mostram que este tipo de enfoque resolve o problema de minimização de funções com múltiplas saídas de maneira eficiente e representa um avanço considerável para esta classe de problema.*

Palavras chave — Minimização de funções Booleanas, Otimização, Programação matemática, Síntese lógica .

INTRODUÇÃO

O problema de simplificar funções booleanas que representam circuitos digitais com um grande número de variáveis e com múltiplas saídas, onde as saídas dependem das mesmas variáveis de entrada, ainda continua sem uma solução satisfatória. Seguramente as funções para as múltiplas saídas podem ser minimizadas separadamente, contudo esse procedimento não leva a uma solução de menor custo.

Tanto o Mapa de Karnaugh quanto o Método de Quine-McCluskey [1] podem ser estendidos para simplificar várias funções simultaneamente, através do compartilhamento dos termos comuns. Tal procedimento torna-se impraticável se o número de variáveis ou o número de funções forem grandes.

Uma grande quantidade de algoritmos como, por exemplo, os descritos em [2] - [3] - [4] - [5] - [6] e [7] foram desenvolvidos na tentativa de solucionar esse problema. Um algoritmo denominado McBoole [8] obtém uma cobertura mínima para funções booleanas com múltiplas saídas expressa como uma lista de cubos. Baseando-se na manipulação eficiente de grafos e em técnicas de partição, o McBoole encontra, quase sempre, uma cobertura mínima global. Trata-se de um algoritmo atrativo para funções com até 20 variáveis de entrada e até 20 funções de saída.

Neste trabalho formulou-se o problema de minimização de funções booleanas com múltiplas saídas como um problema de programação linear inteira 0 e 1 e apresenta-se um algoritmo denominado MultPlex, que obtém a cobertura mínima, resolvendo os problemas matemáticos formulados. O critério de custo adotado é o número de portas ANDs na realização das funções.

Para a geração dos implicantes primos, utilizou-se um método tabular, adaptado para considerar funções com múltiplas saídas.

As coberturas das funções de saídas são soluções de dois problemas de programação matemática. No primeiro problema, denominado de cobertura múltipla, formulou-se o problema de cobertura como um problema de programação matemática cujas variáveis são os implicantes primos singulares (pertencentes a uma única função) e os implicantes primos múltiplos (pertencentes a uma ou mais funções) das funções de saída. No problema matemático gera-se uma restrição de cobertura para cada mintermo de todas as funções de saídas.

No segundo problema, denominado de cobertura singular, tem-se como variáveis os termos solução do problema de cobertura múltipla. Desse modo, tem-se tantos problemas singulares quanto forem o número de saídas da função sob estudo.

Na função objetivo de cada problema considera-se somente os implicantes primos solução da cobertura múltipla que cobre a função em questão. Nas restrições de cobertura, considera-se somente os mintermos da função.

GERAÇÃO DE IMPLICANTES PRIMOS PARA FUNÇÕES COM MÚLTIPLAS SAÍDAS

Para a cobertura de funções booleanas com múltiplas saídas considera-se, além dos implicantes primos singulares (que cobrem mintermos pertencentes a apenas uma das funções), os implicantes primos múltiplos (que cobrem mintermos originados do produto lógico de duas ou mais funções de saída).

Na geração dos implicantes primos utilizou-se o tradicional Método Tabular de Quine-McCluskey [1] que foi

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estendido para considerar funções com múltiplas saídas. Para esse tipo de funções os mintermos e os irrelevantes devem conter, além do identificador (representação binária de um mintermo ou irrelevante), uma outra seqüência de bits, denominada de rótulo, que assinala quais funções de saída incluem o termo produto (mintermo ou irrelevante). Desse modo, a notação 0100 11 significa que o mintermo 4 que é representado por $(0100)_2$ pertence as funções F_a e F_b representadas pela notação 11. Da mesma forma, a notação 11X0 01 significa que o implicante 11X0 cobre somente o mintermo pertencente à função F_b, pois tem-se 0 no identificador da função F_a.

Para a geração dos implicantes primos singulares e implicantes primos múltiplos, os mintermos e os irrelevantes são combinados da mesma forma que no tradicional Método de Quine-McCluskey, contudo algumas observações tornam-se necessárias:

- Só podem ser combinados mintermos ou irrelevantes comuns (assinalados para as mesmas funções de saída);
- Quando dois mintermos ou irrelevantes combinarem-se, os bits do rótulo do implicante resultante terá o dígito 1, somente nas posições onde ambos os rótulos dos mintermos ou irrelevantes combinados têm 1, ou seja, aplica-se a operação AND entre os bits dos rótulos. Por exemplo, a combinação do mintermo 0110 10 com o mintermo 1110 11 gera o implicante X110 10, que pertence somente à função f_a.
- Marcar um implicante como tendo sido combinado, somente se seu rótulo está contido no rótulo do implicante resultante da combinação.

Para exemplificar o emprego do método tabular para a geração de implicantes primos para múltiplas funções considere as funções $F_1(A,B,C) = \Sigma m(0,1,3,5)$, $F_2(A,B,C) = \Sigma m(2,3,5,6)$ e $F_3(A,B,C) = \Sigma m(0,1,6)$. A Figura 1 apresenta a tabela para a geração dos implicantes primos.

	A B C	f_1 f_2 f_3	
0	0 0 0	1 0 1	*
1	0 0 1	1 0 1	*
2	0 1 0	0 1 0	*
3	0 1 1	1 1 0	
5	1 0 1	1 1 0	
6	1 1 0	0 1 1	
0-1	0 0 X	1 0 1	
1-3	0 X 1	1 0 0	
1-5	X 0 1	1 0 0	
2-3	0 1 X	0 1 0	
2-6	X 1 0	0 1 0	

↑ Identificador ↑ Rótulo

FIGURA. 1
TABELA DE GERAÇÃO DE IMPLICANTES PRIMOS PARA AS FUNÇÕES F_1, F_2 , F_3.

O procedimento para a seleção dos implicantes primos, que corresponde à uma cobertura mínima para as funções em análise, pode ser o mesmo utilizado para a cobertura de uma única função. Entretanto, este método, que já é bastante complexo para tratar de uma única função, torna-se extremamente penoso e ineficiente para trabalhar com múltiplas funções.

Abordagem dada neste trabalho foi a formulação do problema de cobertura múltiplas funções de saída como um problema de programação linear inteira 0 e 1.

COBERTURA DE FUNÇÕES BOOLEANAS COM MÚLTIPLAS SAÍDAS SOB A ÓPTICA DA PROGRAMAÇÃO MATEMÁTICA

O problema de cobertura de funções booleanas com múltiplas saídas pode ser formulado como um problema de programação matemática.

Adotou-se como critério de custo a quantidade de portas ANDs necessárias para a implementação das múltiplas funções. Dessa forma, o problema de cobertura das múltiplas funções de saída torna-se bastante similar ao problema de cobertura para uma única função de saída. A diferença é que, no caso de funções com múltiplas saídas, a cobertura é efetuada em duas etapas.

Na primeira etapa, denominada de cobertura múltipla, as variáveis do problema matemático, são os implicantes primos singulares e os implicantes primos múltiplos, obtidos pelo método de geração de implicantes primos. As restrições de cobertura são tantas quanto forem os mintermos de todas as funções de saída. Se um mintermo está incluído em duas funções, tem-se duas restrições para esse mintermo. Apresenta-se a seguir a formulação do problema de cobertura múltipla para as funções F_1, F_2 e F_3.

$$\text{Min } F = 3.(00X+0X1+X01+01X+X10) + 4.(011+101+110)$$

s.a

$$00X \geq 1$$
$$00X + 0X1 + X01 \geq 1$$
$$011 + 0X1 \geq 1$$
$$101 + X01 \geq 1$$
$$01X + X10 \geq 1$$
$$011 + 01X \geq 1$$
$$101 \geq 1$$
$$110 + X10 \geq 1$$
$$00X \geq 1$$
$$00X \geq 1$$
$$110 \geq 1$$
$$00X, 0X1, X01, 01X, X10, 011, 101, 110 \in \{0, 1\}$$

Pode-se notar que o critério de custo é dado pela soma ponderada dos implicantes primos múltiplos e dos implicantes primos singulares e que há uma restrição para cada mintermo de todas as funções de saída. Desse modo, as quatro primeiras restrições referem-se, respectivamente, à cobertura dos mintermos 0, 1, 3 e 5 de F_1. As próximas quatro restrições se referem aos mintermos 2, 3, 5 e 6 de F_2 e as três últimas restrições referem-se aos mintermos 0, 1 e 6 de F_3. As restrições redundantes podem ser eliminadas.

A solução da cobertura múltipla é obtida utilizando-se algum método matemático de resolução de programação matemática como, por exemplo, o Método Simplex e o Plano de Corte de Gomory [9]. A solução para o problema em questão, apresentado como exemplo, é dada pelos implicantes 101 110, 110 011, 00X 101, 0X1 100 e 01X 010.

Obtida a solução da cobertura múltipla, inicia-se a segunda etapa da cobertura. Na segunda etapa, denominada de cobertura singular, tem-se um problema de programação matemática para cada uma das funções de saída, sendo que as variáveis do problema são os implicantes primos, solução da primeira etapa, que cobrem as funções em questão. As coberturas singulares para as funções F_1, F_2 e F_3 são de solução trivial. A função F_1 é coberta pelos implicantes 101, 00X e 01X, cujo custo dos ANDs é igual a 7. A função F_2 é coberta pelos implicantes primos 101, 110 e 01X, cujo custo é igual a 8, e a função F_3 é coberta pelos implicantes primos 110 e 00X, cujo custo é igual a 5.

O custo total dos ANDs, para realizar as funções F_1, F_2 e F_3, como uma função de múltiplas saídas é igual a 12, pois os mintermos 101 e 110 e o implicante primo 00X aparecem duas vezes na função. O custo do circuito, ANDs e OR, é igual a 12 + 3 + 3 + 2 = 20. As três funções quando implementadas independentemente têm um custo total igual a 26. Nota-se, portanto, uma economia de 6 unidades de custo, quando funções booleanas são tratadas como funções de múltiplas saídas.

O Algoritmo MultPlex

O algoritmo MultPlex, que obtém uma cobertura de custo mínimo para uma função booleana de múltiplas saídas, consiste nos seguintes passos:

1. Geração dos implicantes primos pelo método tabular;
2. Montagem do Tableau;
3. Obtenção de uma base inicial, relaxando-se as restrições de integralidade;
4. Verificação da factibilidade da solução básica inicial obtida;
5. Obtenção de uma base inicial factível , se a base obtida não o for;
6. Minimização da função objetivo;
7. Reconsiderando-se a integralidade das variáveis, faz-se a verificação da factibilidade da solução ótima obtida;
8. Obtenção de uma solução inteira, através do Plano de Corte de Gomory, se a solução obtida não o for;
9. Geração da cobertura singular, para cada uma das funções de saída;
10. Executar os passos de 2 até 8 para cada uma das formulações de cobertura singular geradas no passo anterior.

Como exemplo de aplicação do algoritmo descrito, considere as funções booleanas $F_4(A,B,C,D) = \Sigma m(2,3,6,10) + d(8)$, $F_5(A,B,C,D) = \Sigma m(2,10,12,14) + d(6,8)$ e $F_6(A,B,C,D) = \Sigma m(2,8,10,12) + d(0,14)$.

A primeira fase do método gera os seguintes implicantes primos: 0X10 110, 001X 100, X010 111, 10X0 111, X0X0 001, XX10 010 E 1XX0 011.

A formulação para a cobertura múltipla é dada por:

$$\text{Min } F = 3.(X0X0+XX10+1XX0) + 4.(0X10+001X+X010+10X0)$$

s.a

$$0X10 + 001X + X010 \geq 1$$
$$001X \geq 1$$
$$0X10 \geq 1$$
$$X010 + 10X0 \geq 1$$
$$0X10 + X010 + XX10 \geq 1$$
$$X010 + 10X0 + XX10 + 1XX0 \geq 1$$
$$1XX0 \geq 1$$
$$XX10 + 1XX0 \geq 1$$
$$X010 + X0X0 \geq 1$$
$$10X0 + X0X0 + 1XX0 \geq 1$$
$$X010 + 10X0 + X0X0 \geq 1$$
$$1XX0 \geq 1$$
$$X0X0, XX10, 1XX0, 0X10, 001X, X010, 10X0 \in \{0, 1\}$$

A solução ótima, para esse problema de programação linear, é dada por: 0X10 110, 001X 100, 1XX0 011 e X010 111. As coberturas das funções para a solução obtida são apresentadas no Mapa de Karnaugh da Figura 2.

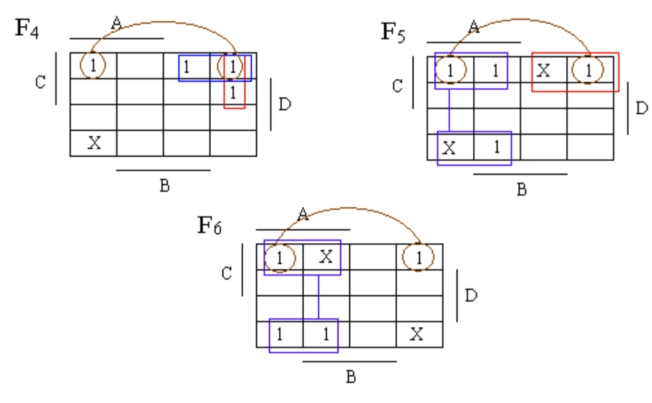

FIGURA. 2

COBERTURAS PARA AS FUNÇÕES BOOLEANAS F_4, F_5 E F_6 APRESENTADAS NO MAPA DE KARNAUGH.

Pode-se notar, pelo Mapa de Karnaugh da função F_5 que o implicante primo 0X10 é redundante, pois cobre mintermos já coberto por outro implicante primo. Portanto, após obter a solução para a cobertura múltipla, deve-se fazer uma cobertura singular, uma para cada função de saída, cujas variáveis são os implicantes primos obtidos como solução da cobertura múltipla.

A cobertura singular para a função F_4 é dada por:

$$\text{Min } F_4 = 4.(0X10 + 001X + X010)$$

s.a

$$0X10 + 001X + X010 \geq 1$$
$$001X \geq 1$$
$$0X10 \geq 1$$
$$X010 + 10X0 \geq 1$$
$$0X10, 001X \text{ e } X010 \in \{0, 1\}$$

A solução para este problema é dada por: 001X, 0X10 e X010.

A cobertura singular para a função F_5 é dada por:

$$\text{Min } F_5 = 3.\ 1XX0 + 4.(0X10 + X010)$$

s.a

$$0X10 + X010 \geq 1$$
$$1XX0 + X010 \geq 1$$
$$1XX0 \geq 1$$
$$1XX0, 0X10, X010 \in \{0, 1\}$$

A solução para este problema é dada por: 1XX0 e X010.

Note que o implicante primo 0X10, pertencente a solução da cobertura múltipla, foi eliminado da cobertura da função F_5, pois esse implicante é essencial somente para a cobertura da função F_4.

A cobertura singular para a função F_6 é dada por:

$$\text{Min } F_6 = 3.\ 1XX0 + 4.\ X010$$

s.a

$$X010 \geq 1$$
$$1XX0 \geq 1$$
$$1XX0 + X010 \geq 1$$
$$1XX0 \text{ e } X010 \in \{0, 1\}$$

A solução para este problema é dada por: 1XX0 e X010.

O custo para a realização das ANDs das três funções, como uma função de múltiplas saídas, corresponde a 11, enquanto o custo das ANDs para a realização das três funções, como funções independentes, corresponde a 17.

Muitas outras funções de uso prático como, por exemplo, o código de linha HDB-3 [10], foram implementadas utilizando-se o algoritmo desenvolvido neste trabalho. O problema de cobertura para o HDB-3, considerado de grande porte, gerou um problema matemático contendo 87 variáveis e 215 restrições. Vale mencionar que o MultPlex obteve os mesmos resultados gerados pelo programa Espresso [8].

Conclusão

Esta pesquisa tratou da minimização de funções booleanas que implementam circuitos digitais com múltiplas saídas, evidenciando a necessidade de se considerar esse tipo de implementação em projetos de sistemas digitais.

O algoritmo MultPlex foi apresentado através de alguns exemplos. Para a fase de geração dos implicantes primos utilizou-se um método tabular, modificado para considerar funções booleanas com múltiplas saídas. Obtido os implicantes primos das funções o problema de cobertura é formulado como um problema de programação matemática.

A fase de cobertura é efetuada em duas etapas, denominadas de cobertura múltipla e cobertura singular.

Na cobertura múltipla considera-se as funções de saída como um todo e formula-se um problema de programação linear inteira com os implicantes primos múltiplos (implicantes pertencentes a uma ou mais funções) e os implicantes primos singulares (pertencente a apenas uma das funções). Com o resultado da cobertura múltipla formulam-se as coberturas singulares, onde as funções de saída são consideradas isoladamente.

O algoritmo MultPlex representa uma contribuição definitiva na simplificação de funções booleanas de múltiplas saídas, pois define o problema de simplificação como um problema de programação matemática. Dessa forma, métodos computacionais eficazes podem ser empregados com o objetivo de solucioná-lo.

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COM2AHDL: FERRAMENTA CAD DESENVOLVIDA PARA O ENSINO DE CIRCUITOS DIGITAIS

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Resumo — *A rápida evolução dos sistemas eletrônicos tem motivado o uso, cada vez mais, de ferramentas CAD no ensino de disciplinas envolvendo laboratórios. Na prototipagem rápida, empregando FPGA, torna-se imprescindível o uso de ferramentas de síntese. Muitas linguagens de descrição de hardware compõem os ambientes de projeto disponibilizados para as Universidades através de Programas Universitários. O objetivo deste trabalho foi habilitar estudantes da disciplina Circuitos Digitais I, ministrada na Faculdade de Engenharia de Ilha Solteira, a projetar e desenvolver ferramentas computacionais que pudessem ser utilizadas em conjunto com os ambientes de projeto comerciais. Uma das ferramentas desenvolvidas, denominada COM2AHDL, gera um modelo AHDL para circuitos combinacionais, cuja descrição inicial é feita através da Tabela Verdade que descreve o comportamento do circuito. Esta iniciativa, além de permitir a sinergia entre disciplinas, possibilitou que alunos desenvolvessem suas próprias ferramentas para gerar modelos em alto nível de abstração e com interface para ferramentas comerciais.*

Palavras chave — Ferramentas CAD, Linguagens de Descrição de Hardware, AHDL, Síntese lógica .

INTRODUÇÃO

A rápida evolução da indústria de microeletrônica tem desafiado os atuais currículos acadêmicos em manterem-se adequados de modo a fornecer os conhecimentos necessários aos seus alunos. Os laboratórios tradicionais, dos cursos de graduação em circuitos digitais, têm utilizados software de simulações para o auxílio no projeto e modelagem de pequenos sistemas digitais clássicos. Esses modelos de sistemas têm sido utilizados para explanar ou reforçar muitos dos conceitos e idéias contidas em livros textos. Na descrição desses modelos empregava-se, até então, a captura de esquemático.

Atualmente, muitos desses cursos estão se alicerçando com base no uso da tecnologia de FPGA (Field Programmable Gate Array) e nos ambientes das avançadas ferramentas CAD (Computer Aided Design).

Estes sofisticados ambientes de síntese lógica estão sendo disponibilizados para as universidades através de programas universitários. Dessa forma, tem-se a oportunidade de introduzir os estudantes no uso de HDLs (linguagens de descrição de hardware) e na metodologia de projetos hierárquico (top-down e button-up).

Neste artigo descreve-se a experiência desenvolvida no Curso de Circuitos Digitais I ministrado na Faculdade de Engenharia de Ilha Solteira – UNESP, onde os alunos foram motivados a desenvolverem suas próprias ferramentas para serem utilizadas em conjunto com os sofisticados ambientes comerciais.

Uma dessas ferramentas, denominada COM2AHDL (Combinacional para AHDL), traduz a especificação contida na tabela verdade, descrevendo o comportamento de um circuito combinacional, para um modelo na linguagem de descrição AHDL (Altera Hardware Description Language). Essa iniciativa, além de permitir a sinergia entre disciplinas, possibilitou que alunos desenvolvessem suas próprias ferramentas computacionais para gerarem modelos em alto nível de abstração integráveis com o ambiente comercial Max+Plus II da Altera.

Através do arquivo "report file", gerado no processo de compilação do modelo, os estudantes podem extrair informações relevantes para o entendimento da teoria de circuitos digitais.

METODOLOGIA DE PROJETO

A metodologia de projeto utilizada consiste, basicamente, em 4 passos, sendo que utilizou-se dois conjuntos de ferramentas, a COM2AHDL e a TAB2VHDL [1] em conjunto com o ambiente Max+Plus II. Os passos são os seguintes:

- **Descrição**: Faz-se uma especificação abrangente de como o sistema projetado deve funcionar. Essa descrição deve ser feita, tanto quanto possível, através de linguagens de descrição de hardware. Neste estágio de projeto já é possível efetuar simulações com o objetivo de detectar, antecipadamente, erros de projetos ou má interpretação da especificação inicial. O trabalho humano torna-se mais racional quando emprega-se o diagrama de transição de estados (circuitos seqüenciais) ou a tabela verdade (circuitos combinacionais);
- **Implementação**: O objetivo é decidir sobre a estrutura da implementação e quais blocos funcionais serão utilizados. Isto requer a partição do projeto em blocos menores cujo comportamento pode ser descrito em

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de blocos: os blocos disponíveis em dispositivos físicos e os blocos que o próprio projetista necessita descrever. Quando o projeto é implementado, novamente utiliza-se a simulação para verificar se erros não foram introduzidos nesse processo;

termos de hardware. Esta ação resulta em duas espécies

- **Síntese**: A síntese do sistema projetado é feita através de um programa que lê a especificação, descrita em alguma linguagem de descrição ou através de esquemático, e produz um *netlist* otimizado e mapeado dentro da tecnologia destino. As ferramentas de síntese, em geral, fornecem arquivos de relatório contendo parâmetros como tempo de compilação, quantidade de células utilizadas, tempo de atrasos, funções booleanas sintetizadas, e muitas outras informações;
- **Layout**: O layout é também conhecido por *Place* e *Route*. Este passo produz uma descrição exata do dispositivo físico final. A descrição do layout diz exatamente como as partes do dispositivo são usadas e como os fios são conectados dentro do dispositivo.

A ferramenta apresentada nesse trabalho insere-se na fase de descrição do projeto onde, a partir da tabela verdade que descreve o comportamento do circuito combinacional, gera-se um modelo AHDL, a partir do qual o projeto pode ser sintetizado por ferramentas de síntese comercial.

A ferramenta COM2AHDL gera, automaticamente, uma descrição AHDL que seria cansativo quando escrita a mão pelo projetista. Além disso, o arquivo de entrada serve como documentação do projeto. A Figura 1 apresenta a tela inicial do programa COM2AHDL.

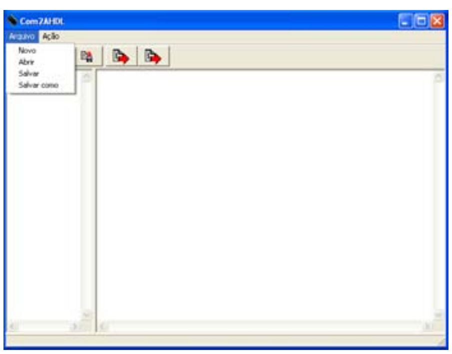

FIGURA. 1
TELA INCIAL DO PROGRAMA COM2AHDL.

O COM2AHDL foi inicialmente programado na linguagem C e posteriormente transcrito em C^{++} Builder oferecendo, dessa forma, uma interface mais amigável com o estudante.

FERRAMENTA COM2AHDL

Um simples exemplo de um circuito codificador BCD8421 para 7 segmentos é utilizado para ilustrar o emprego da ferramenta desenvolvida. O circuito contém um barramento de entrada denominado BCD8421 de dimensão 4, ou seja, pode-se representar essa entrada na forma de vetor como BCD8421[3..0], onde o bit de posição 0 representa o menos significativo e o de posição 3 o mais significativo. Do mesmo modo, o circuito tem um barramento de saída, denominado SEGMENTO que na forma de vetor é represento por SEGMENTO[6..0], ou seja, consiste em um barramento de dimensão 7. A Figura 2 apresenta o esquemático que representa o circuito codificador.

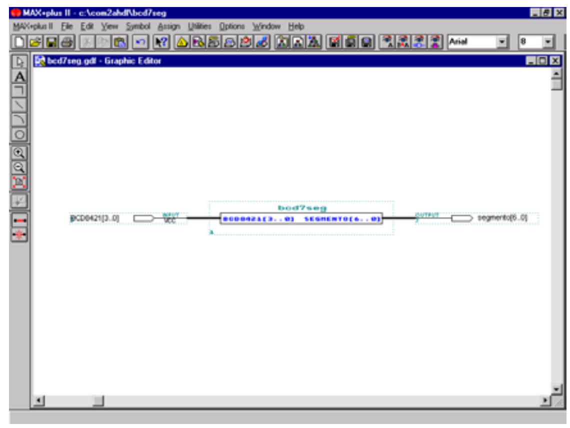

FIGURA. 2
ESQUEMÁTICO DO CODIFICADOR BCD8421 PARA 7 SEGMENTOS.

No programa COM2AHDL transcreve-se, na janela da esquerda, a tabela verdade que descreve o funcionamento do circuito a ser projetado e, após selecionar a opção adequada, é gerado, na janela da direita, uma descrição em AHDL que está pronta para ser sintetizada no ambiente Max + Plus II. A Figura 3 apresenta a descrição do codificador BCD8421 para 7 segmentos e o modelo AHDL gerado.

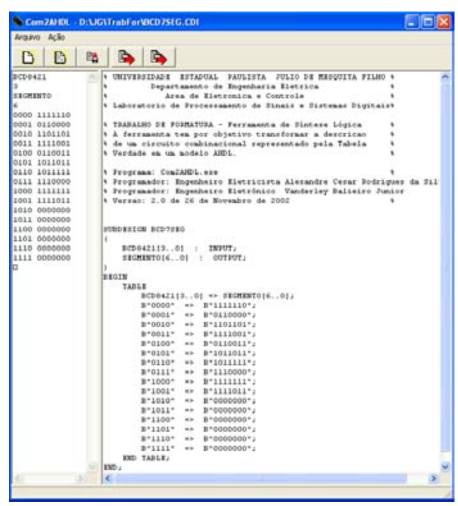

FIGURA. 3
TABELA VERDADE DO BCD8421 PARA 7 SEGMENTOS E O MODELO AHDL.

Com o modelo AHDL gerado a ferramenta de síntese automaticamente executa a minimização das funções lógicas e a síntese lógica a nível de porta lógicas. Em geral, muitas das portas de nível intermediárias são compartilhadas entre as várias saídas do sistema. Pode-se notar que no modelo descrito na linguagem de descrição AHDL não se utilizou equações lógicas, apenas descreveu-se o comportamento que se espera do circuito.

O estudante pode também simular o modelo e analisar o resultado da síntese lógica. A Figura 4 apresenta o modelo em estudo como entrada do ambiente de projeto Max + Plus II.

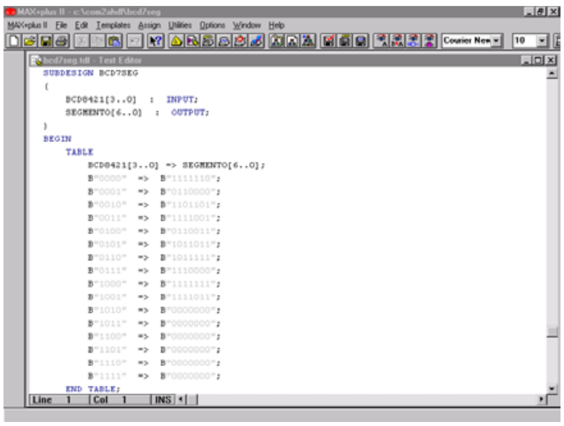

FIGURA. 4
MODELO AHDL DO BCD8421 PARA 7 SEGMENTOS NO MAX+PLUS II.

Para se verificar o perfeito funcionamento do modelo, este pode ser simulado. A Figura 5 apresenta o resultado da simulação.

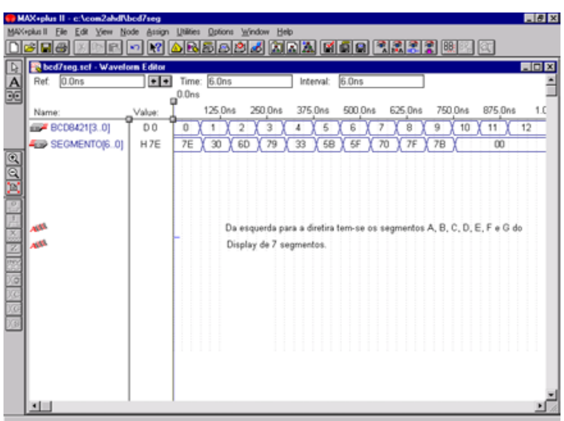

FIGURA. 5
RESULTADO DA SIMULAÇÃO DO CODIFICADOR BCD8421 PARA 7 SEGMENTOS NO AMBIENTE MAX+PLUS II.

Pode-se notar, pelo resultado da simulação apresentado na Figura 5, que o modelo funcionou como o previsto. No barramento de saída, representado na notação hexadecimal, foram acionados os segmentos correspondentes aos números BCD8421 tidos no barramento de entrada em cada instante de tempo.

Da análise do arquivo "report file", gerado pelo ambiente de síntese, o aluno pode extrair as funções combinacionais de cada função de saída. Essas funções, por terem sido otimizadas por algoritmos de minimização, são apresentadas na sua forma mínima. A Figura 6 apresenta parte do arquivo de relatório onde pode-se notar que a função que representa o SEGMENTO1 é dada por:

SEGMENTO1 = LCELL(_EQ002 $!BCD84211);
_EQ002 = !BCD84210 & BCD84211 & BCD84212 & !BCD84213 # BCD84210 & !BCD84211 & !BCD84212 & !BCD84213 # !BCD84211 & BCD84212 & BCD84213;

Nesta representação o símbolo & representa a operação AND, o símbolo # representa a operação OR e o símbolo ! representa a operação NOT. Note que BCD8421n, com n variando entre 0 e 3, representam as variáveis do sistema, ou seja, os sinais de entrada.

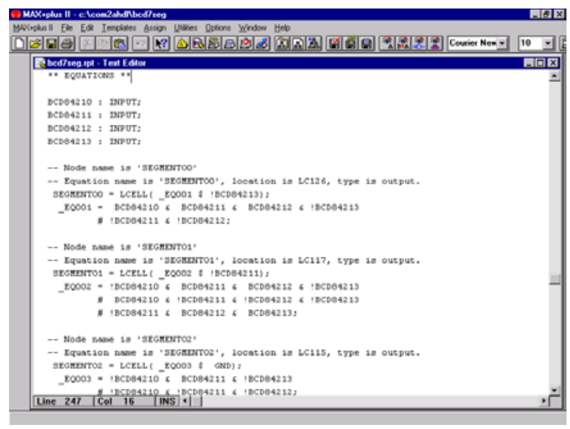

FIGURA. 6
ARQUIVO DE RELATÓRIO APRESENTANDO AS FUNÇÕES COMBINACIONAIS DAS FUNÇÕES DE SAÍDAS.

A LINGUAGEM DE DESCRIÇÃO AHDL

A AHDL (Altera Hardware Description Language) é uma linguagem modular de alto nível empregada para se modelar lógica combinacional complexa, operações em grupos, máquinas de estados e tabelas verdades. A especificação é feita através de uma entrada textual que, posteriormente, é compilada e simulada, podendo então ser utilizada para programar componentes FPGA da Altera. Esta linguagem permite que os projetistas criem projetos hierárquicos que podem incorporar outros arquivos de projeto. A representação simbólica de um projeto AHDL é criado automaticamente no processo de compilação e síntese que pode ser incorporado dentro de uma descrição gráfica (captura de esquemático).

Um modelo AHDL contém partes denominadas de “Sections” e “Statements”. Todo modelo deve conter uma *Design Section* ou uma *Subdesign Section* combinada com uma *Logic Section*. Algumas *Sections* e *Statements* são opcionais. Descreve-se a seguir as seções e declarações aceitas no AHLD:

- **Title Statements** (opcional): gera comentários para o arquivo de relatório (report file) gerado pelo compilador;
- **Constant Statements** (opcional): especifica um nome simbólico que pode ser substituído por uma constante;
- **Function Prototype Statements** (opcional): declara os portos de uma macrofunção ou primitiva e a ordem em que estes portos devem ser declarados na linha de referência;
- **Define Statements** (opcional): define uma função matemática que retorna um valor que está baseado em um argumento;
- **Parameters Statements** (opcional): declara um ou mais parâmetros que controlam a implementação de uma função parametrizável. Um valor default pode ser especificado para cada parâmetro;
- **Design Sections** (necessário): especifica pinos, células lógicas, opções lógicas e atribuição de dispositivos. Também especifica quais os pinos estão ligados juntos na placa. Esta seção é necessária se for a única seção do modelo;
- **Assert Statements** (opcional): permite que o projetista teste condições de uma expressão qualquer e relate o resultado;
- **Subdesign Sections** (necessário): declara os portos de entradas, de saídas e os bidirecionais de um modelo AHDL. Essa seção é necessária a não ser que o modelo consista somente da seção Design;
- **Variable Sections** (opcional): declara uma variável que representa uma informação interna;
- **Logic Section** (necessário): define as operações lógicas do modelo. Essa seção é necessária, a menos que o modelo consista somente da seção Design.

Considere como exemplo o circuito lógico apresentado na Figura 7 na forma de esquemático. O modelo AHDL para o circuito pode ser descrito como:

```
SUBDESIGN  FUNÇÃO
(
   A0, A1, B        :  INPUT;
   Out1, Out2       :  OUTPUT;
)
BEGIN
  Out1  =  A1 & !A0;
  Out2  =  Out1 # B;
END;
```

A seção *Subdesign* descreve os portos de entradas e de saídas e especifica os seus nomes que podem ser referenciados. O *Subdesign* também tem um nome que deve ser o mesmo nome do arquivo contendo o modelo AHDL.

A seção *Logic*, que descreve as operações lógicas do circuito utiliza declarações de atribuições e expressões relacionais.

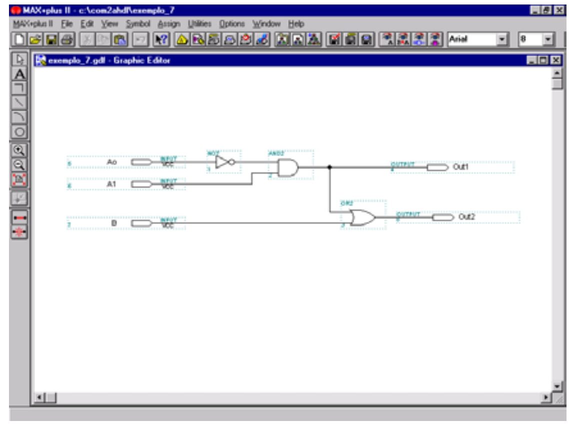

FIGURA. 7
CIRCUITO LÓGICO REPRESENTANDO UMA FUNÇÃO BOOLEANA.

A linguagem também disponibiliza a lógica condicional, onde é possível escolher diferentes comportamentos dependendo do valor de uma entrada lógica. Essa lógica condicional é implementada através das declarações IF e CASE.

A AHDL oferece uma grande facilidade em converter padrões de entradas em valores de saídas. Isto é feito pelo mapeamento das entradas em padrões de saídas através do uso da tabela verdade.

A declaração *Truth Table* contém um cabeçalho que descreve quais entradas são mapeadas para quais saídas e em que ordem. No exemplo apresentado a seguir o padrão de saída para todos os possíveis padrões da entrada, denominada IN[1..0], é descrito através de declaração *Truth Table*.

```
SUBDESIGN  DECODER
(
   IN[1..0]         :  INPUT;
   A, B, C, D       :  OUTPUT;
)
BEGIN
  TABLE
     IN[1..0]  =>  A,  B,  C,  D;
        H ”0”  =>  1,  0,  0,  0;
        H ”1”  =>  0,  1,  0,  0;
        H ”2”  =>  0,  0,  1,  0;
        H ”3”  =>  0,  0,  0,  1
  END TABLE;
END;
```

Utilizou-se da declaração *Truth Table* nos modelos gerados pelo programa COM2AHDL.

Dezenas de projetos de circuitos combinacionais, que são deixados como atividade para os alunos, foram implementados em FPGA utilizando-se a ferramenta desenvolvida. Em todos os projetos constatou-se o perfeito funcionamento, tanto através da simulação quanto em teste de bancada.

EXEMPLO DE PROJETO

Projeto 1: Um técnico de laboratório possui 4 produtos químicos (A, B, C e D) e 2 recipientes para guardá-los. É conveniente remover os produtos químicos de um recipiente para outro de tempos em tempos. É perigoso manter B e C juntos a menos que A também esteja presente. C e D não podem estar juntos com A. O projeto consiste em gerar um circuito lógico para indicar as situações perigosas de armazenamento dos produtos químicos [2].

A Figura 8 apresenta a descrição do projeto como entrada para a COM2AHDL e o modelo AHDL gerado. A simulação do modelo comprovou o seu perfeito funcionamento.

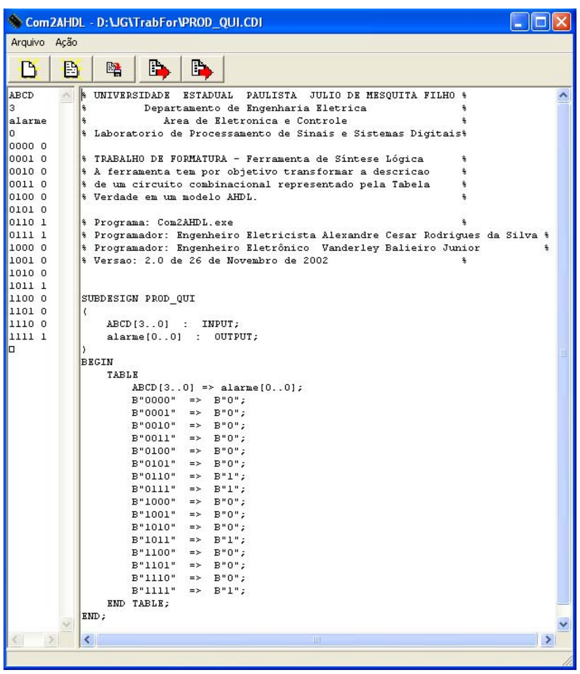

FIGURA. 8
TABELA VERDADE E O MODELO AHDL GERADO PELA FERRAMENTA COM2AHDL.

Uma outra ferramenta, que se utiliza dos mesmos passos de projeto apresentado neste trabalho, está sendo testada para gerar o modelo VHDL para um circuito combinacional.

CONCLUSÃO

Este trabalho apresentou uma ferramenta que, em conjunto com as disponíveis comercialmente, permite que o projeto de um circuito combinacional seja implementado em FPGA a partir da descrição da tabela verdade que descreve o funcionamento do mesmo.

A iniciativa do desenvolvimento desse trabalho surgiu da necessidade de alunos do curso de Circuitos Digitais I, ministrado na Faculdade de Engenharia de Ilha Solteira, criarem as suas próprias ferramentas para o auxílio ao desenvolvimento de projeto de circuito digitais.

A ferramenta desenvolvida permitiu a automatização do projeto de circuitos digitais e se tornou extremamente conveniente, pois retirou do projetista a tarefa da descrição do modelo. Dessa forma, cabe aos alunos apenas a análise crítica das soluções, deixando para a máquina as cansativas tarefas sujeito a erros.

AGRADECIMENTOS

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ENSINO SOBRE ALOCAÇÃO DE ESTADOS EM FSM COM O EMPREGO DA AHDL

Marcos Ikeguchi Ohira[1], Fábio Pieroni Zanella[2] e Alexandre César Rodrigues da Silva[3]

Resumo *— Com o rápido aumento da complexidade dos circuitos e da densidade de integração dos CIs, as ferramentas automáticas de síntese tornaram-se necessárias para o projeto de circuitos digitais. Circuitos seqüenciais são modelados por máquinas de estados finitos (FSM) onde os estados são caracterizados somente por nomes simbólicos. Alocação de estado é o mapeamento do conjunto de estados (nomes simbólicos) de uma FSM para um conjunto de códigos binários com o objetivo de minimizar a área do circuito combinacional necessário para realizar a FSM. Comparou-se alguns algoritmos de alocação de estados utilizados no ambiente de projeto Max+ Plus II da Altera. Vários códigos de linhas foram modelados na linguagem de descrição de hardware AHDL e implementados em FPGA. Este trabalho está sendo desenvolvido junto ao curso de graduação do DEE-FEIS-UNESP na linha de pesquisa de sistemas digitais, com o objetivo de inicializar o aluno no uso de ferramentas de síntese digitais.*

Palavras-Chave — Máquinas de estados finitos, alocação de estado, circuitos combinacionais, AHDL, FPGA e ferramentas de síntese digitais.

INTRODUÇÃO

As máquinas de estados, também chamadas de máquinas seqüenciais, são sistemas que respondem em estados diferentes de acordo com um dado de entrada. Caso o sistema esteja em determinado estado, ele ficará no mesmo estado a não ser que o sinal de entrada, denominado de relógio, se altere [1].

Com relação às dependências de entrada, saída, estado atual e próximo estado, as máquinas podem ser classificadas em dois modelos: Mealy e Moore.

Uma máquina seqüencial é denominada máquina de Moore, se suas saídas forem dependentes apenas dos estados e não da entrada. Uma máquina seqüencial é denominada máquina de Mealy, se suas saídas forem dependentes tanto do estado atual como da entrada. Para ambos os modelos de máquinas, o próximo estado é dependente do estado atual e da entrada.

Uma outra característica muito importante das máquinas seqüenciais é a dependência de um clock. Em geral, uma referência de tempo é muito utilizada em sistemas digitais. Quanto à dependência de um clock, as máquinas seqüenciais podem ser classificadas como: síncronas e assíncronas.

As máquinas síncronas são máquinas cuja mudança de estado acontece de acordo com um clock.

Máquinas assíncronas mudam de estado independente de um clock de referência.

Além das diferenças citadas entre máquinas síncronas e assíncronas, na questão de implementação das duas máquinas, as síncronas são muito mais fáceis em relação às assíncronas.

Conhecidas as propriedades das máquinas de estados, um bom exemplo de máquina de estado é o flip-flop, este tem dois estados para uma entrada, em suma, é um sistema (ou máquina de estado) muito simples. Com uma combinação de flip-flops, pode-se obter sistemas extremamente complexos.

Alocação de Estados

As alocações de estados são métodos para dispor estados de máquina, dependendo da sua aplicação, em combinações diferentes.

Para cada tipo de aplicação existe uma alocação ótima e um tipo de preocupação diferente como, por exemplo, custo lógico do circuito e o comportamento do circuito para cada tipo de elementos de memória. Portanto, a escolha do tipo de alocação é muito importante e isso se dá somente sob tentativa dentre todos os algoritmos de alocação.

Antes de se escolher o tipo de alocação a ser utilizada deve-se, inicialmente, conhecer a quantidade de estados e quantidade de flip-flops necessários para o circuito.

Para uma máquina com n flip-flops a quantidade total de estados para essa máquina é representada pela equação 2^n, e o número mínimo de flip-flops necessários para representar os s estados da máquina é representado pela equação $\log_2 s$.

Tomar conhecimento das quantidades de estados e quantidade de flip-flops são informações iniciais para se determinar o algoritmo de alocação ótimo, porém, como já mencionado, para se determinar o melhor algoritmo de alocação deve-se utilizar todos os algoritmos e verificar o melhor. Como isso é um trabalho muito exaustivo, tem-se algumas considerações a serem feitas para se atingir o tipo de algoritmo com um tempo razoavelmente menor, como, por exemplo, determinar uma condição inicial para a máquina (preset ou reset), fazer as minimizações de estados, etc [2]-[3]-[6].

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Tipos de Algoritmos de Alocação de Estados

- **Simplest:** É o algoritmo de alocação mais simples, pois ele utiliza a quantidade de flip-flop mínima que é obtido da equação $\log_2 s$, sendo s o menor número inteiro obtido. Esse tipo de alocação é muito simples para ser utilizado, porém não é muito usual, pois o custo no circuito, principalmente em relação ao circuito de controle, fica muito alto.
- **Decomposed:** É um algoritmo mais apurado em relação ao Simplest, pois este tem o estado inicial em reset e cada um de seus bits pode representar uma operação da máquina. O bit mais significativo (MSB), após a máquina sair da condição de reset, é sempre "1", pois indica que a máquina está em operação, e os outros bits indicam os estados da máquina.
- **One-Hot:** O mais utilizado algoritmo de alocação. Este utiliza apenas um bit por estado de máquina, isso garante que o circuito de controle da máquina se torne muito mais simples, com isso diminui o custo do circuito. Utilizando o algoritmo One-Hot não é necessário um circuito de controle na sua saída [1]. A desvantagem que esse tipo de alocação apresenta ocorre quando se tem uma máquina com muitos estados, pois o circuito da máquina irá utilizar uma quantidade grande de flip-flops aumentando assim o custo do circuito. Este algoritmo também é usado pelo AHDL, que será apresentado a seguir.
- **Almost One-Hot:** Assim como o nome já diz, esse algoritmo de alocação é uma variação do One-Hot, pois ao contrário do One-Hot, o estado inicial do Almost One-Hot é o reset, isso apresenta duas vantagens, pois diminui um flip-flop no circuito, fazendo com que o custo do circuito diminua e facilite a inicialização do circuito, pois é mais simples iniciar uma máquina à partir do reset [3].

Altera Hardware Description Language (AHDL)

A AHDL é uma linguagem muito potente, versátil e de fácil utilização, pois permite descrever um projeto de várias formas, como, por exemplo, na forma hierárquica com compartilhamento entre arquivos.

Como se trata de uma linguagem, todo o circuito, ou projeto, são feitos de forma descritiva que pode ser feita no próprio editor de texto do software MAX+plus II [4], ou em qualquer outro editor de texto, desde que utilize o código ASCII. Contudo, para que se possa simular o circuito descrito, deve-se compilar o arquivo texto, para isso utiliza-se o compilador do software MAX+plus II. Em face disso, a utilização do editor de texto existente no próprio software é muito vantajosa, pois no mesmo software é possível escrever o circuito, compilar e fazer as simulações.

Além de todas essas vantagens, um circuito implementado em AHDL, pode ser transformado em um símbolo para ser utilizado na forma esquemática (.gdf) [4].

Implementação de Máquinas de Estado em AHDL

Uma máquina de estados pode ser facilmente implementada utilizando a AHDL, pois pode utilizar equações Booleanas ou tabelas verdade para fazer a implementação, sendo que as alocações podem ser feitas tanto pelo próprio usuário quanto pelo software.

Para se implementar uma máquina de estados deve-se seguir os seguintes passos:

- Construir uma tabela de próximo estado;
- Declarar a máquina de estados (na estrutura Variable Section);
- Adicionar a tabela verdade (ou de próximo estado), ou se for o caso, as equações booleanas (estrutura Logic Section).

Esses passos são seguidos para que o software faça as alocações. Se o usuário for fazê-las, a única diferença é que se deve declarar os estados e suas alocações.

As máquinas de estados utilizam flip-flops como elemento de memória e para serem implementadas em AHDL é necessário que o clock, reset e enable sejam devidamente designados, visto que o flip-flop depende desses parâmetros para funcionamento, ou seja, a entrada de clock, enable e reset devem ser devidamente declaradas quando necessário, caso contrário, a máquina não funcionará de maneira correta.

Como já mencionado, a implementação de uma máquina de estado pode ser feita de duas formas: alocação direta, na qual o próprio usuário faz as alocações, e a indireta, na qual o software faz as alocações.

Nas alocações indiretas o software faz todas as minimizações de estados necessárias e implementa um tipo de alocação de estado que são basicamente dois tipos, o Simplest e o One-Hot. A escolha do algoritmo utilizado é ditada pela família de FPGA (*Field Programable Gate Array*) utilizado. Para FPGA's da família MAX, o software, por definição, faz a alocação do tipo Simplest e, também, tem-se a possibilidade da utilização do algoritmo One-Hot, através da seleção da opção One-Hot State Machine Encoding. Para os FPGA's da família FLEX a alocação utilizada é o One-Hot, independentemente da opção One-Hot State Machine Encoding [5].

Quanto ao tipo de máquina a ser implementada (Mealy ou Moore) as mudanças são muito pequenas, devido à versatilidade da linguagem [4].

METODOLOGIA

Neste trabalho estudou-se métodos de alocação de estados e a linguagem de descrição de hardware (AHDL), que junto ao docente da área de sistemas digitais do DEE-FEIS-UNESP, está sendo disseminada nas disciplinas de Circuitos Digitais e Projetos de Sistemas Digitais.

Essas duas teorias (alocação e AHDL) estão sendo ensinadas aos alunos de graduação com o intuito de motivar o aprendizado, pois, mostra de uma maneira prática, que um mesmo circuito digital, mais precisamente máquinas de estados finitas síncronas, podem ter variados comportamentos, dependendo de sua alocação de estados, e com a linguagem AHDL os alunos aprendem que um circuito digital pode, também, ser implementado em uma linguagem de alto nível.

Como estudo inicial utilizou-se diferentes técnicas de alocação de estado (Simplest, One-Hot e Almost-One-Hot), cujos códigos foram implementados na linguagem de descrição AHDL.

Escolheu-se para o estudo das alocações de estados os códigos de linha AMI (Alternated Mark Inversion), o código HDB1 (High-Density Bipolar First-Order Coding) e o código HDB3 (High-Density Bipolar Third-Order Coding) devido a sua importância em transmissão de dados em banda base através de um par de fios (par telefônico) que é a maneira mais simples, prática e econômica de comunicação de dados em perímetros urbanos ou distâncias de alguns quilômetros.

Estes códigos foram todos simulados no ambiente Max + Plus II e para o mesmo código foram utilizadas as alocações citadas.

RESULTADOS

Embora cada alocação de estado não altere o funcionamento de cada código de linha utilizado, os resultados obtidos no report file, gerado pelo MAX+plus II, têm diferenças entre si, pois o tipo de alocação altera os custos das funções lógicas, definidos como o número de portos de entradas das portas lógicas em seu formato primitivo, o número de células utilizadas (para uma implementação em FPGA), a quantidade de memória e tempo de síntese. Tais parâmetros foram utilizados para comparação entre as implementações.

Todos os códigos foram implementados no componente programável FPGA MAX7000E, Device: EPM 7128ELC84-7, e as simulações comprovam seu perfeito funcionamento.

As simulações referentes a cada código estão apresentadas na Figura 1.

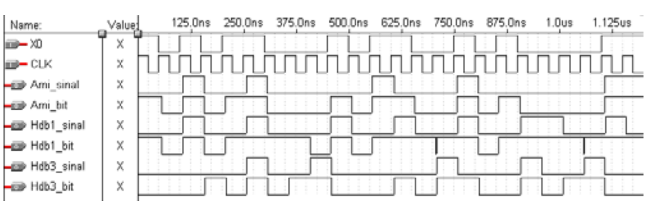

FIGURA 1.
SIMULAÇÃO DOS CÓDIGOS IMPLEMENTADOS.

A partir do Report File gerado pelo software Max+Plus II e das alocações, foram obtidos os custos totais para cada código, cujos resultados estão apresentados na Tabela I.

TABELA I.
CUSTOS OBTIDOS PARA CADA CÓDIGO VARIANDO-SE O TIPO DE ALOCAÇÃO.

Código	Alocação	Custo Lógico	Células Utilizadas	Memória Utilizada	Tempo de Compilação
AMI	Simplest	012	03	3,622 K	00:00:07
	One-Hot	012	04	3,670 K	00:00:03
	Almost One-Hot	012	03	3,499 K	00:00:04
HDB1	Simplest	028	04	3,688 K	00:00:04
	One-Hot	057	06	3,786 K	00:00:04
	Almost One_hot	058	06	6,197 K	00:00:02
HDB3	Simplest	340	14	3,687 K	00:00:09
	One-Hot	268	34	5,598 K	00:00:10
	Almost One-Hot	159	34	3,888 K	00:00:06

CONCLUSÃO

Com esse projeto concluiu-se que determinados tipos de alocações utilizados apresentaram vantagens em diferentes aspectos, por exemplo, para a alocação do tipo Almost One-Hot foi obtido, em geral, a menor tempo de compilação em relação a todas as implementações realizadas. Na alocação Simplest obteve-se a menor quantidade de células utilizadas.

Os resultados apresentados na Tabela I mostram que não existe um método de alocação ideal para otimizar um circuito, pois notou-se que para cada situação e condição (por exemplo células de FPGA utilizadas) há uma alocação específica que torna o circuito otimizado.

O ensino da linguagem AHDL no curso de graduação proporciona ao discente um conhecimento diferenciado, pois através da AHDL, o aluno pode descrever um circuito digital de forma alternativa e muito versátil, unido à facilidade de aprendizado.

Pode-se salientar que para o ambiente utilizado (MAX+plus II) a linguagem AHDL é uma linguagem de alto nível muito poderosa, visto que é uma linguagem desenvolvida pela ALTERA, fabricante do próprio MAX+plus II.

AGRADECIMENTOS

Os autores agradecem à CAPES e à PI Componentes por todo o suporte oferecido durante a realização do projeto, e também aos docentes da área de sistemas digitais do DEE-FEIS-UNESP.

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E2HDL: UMA NOVA FERRAMENTA DE SÍNTESE PARA IMPLEMENTAR EQUAÇÕES ALGÉBRICAS EM FPGA

Adriano dos Santos Cardoso[1], Alexandre César Rodrigues da Silva[2] e Aparecido Augusto de Carvalho[3]

Resumo *— O desenvolvimento de ferramentas de síntese automática permite que projetistas gerem uma descrição de Hardware sem a necessidade do conhecimento profundo da tecnologia em que o sistema será implementado. Este artigo apresenta uma ferramenta de síntese para projetos de sistemas digitais denominada E2HDL (Equação para Linguagem de Descrição de Hardware). Com a especificação dos parâmetros da equação, a ferramenta desenvolvida gera um modelo em linguagem de descrição de hardware, podendo ser a AHDL ou a VHDL, que implementa a equação desejada. Esta ferramenta em conjunto de ambientes de síntese comerciais possibilita a configuração, em FPGA, de uma grande quantidade de formas de ondas, utilizando somente recursos digitais. Para avaliar a sua eficiência implementou-se em FPGA uma grande variedade de formas de ondas como, por exemplo, seno, sigmoide, gaussiana e muitas outras. Diferentes especificações puderam ser avaliadas. A ferramenta, apresentou-se como uma poderosa contribuição para a criação automatizada de circuitos digitais.*

Palavras Chave — Ferramenta de Síntese, FES, FPGA, VHDL.

INTRODUÇÃO

Com a evolução dos processos de produção tecnológicos, os sistemas de integração de circuitos se tornaram mais complexos. O mercado demanda por circuitos mais eficientes e pela redução nos prazos de desenvolvimento. Esses fatores, justificam a utilização cada vez mais freqüente da automação dos processos de desenvolvimento dos projetos.

Circuitos com centenas de elementos apresentam uma dificuldade enorme de serem implementados com ferramentas CAD (*Compiter Aid Design*), baseadas em captura de esquemático. Atualmente, os projetos vêm sendo desenvolvidos com ferramentas com níveis mais altos de abstração, usando HDLs (*Hardware Descripton Language*) e métodos de detalhamento e refinamento automático.

Os sistemas e processos digitais podem ser representados em função de um domínio e, em cada domínio por um nível de abstração.

A representação de um modelo que contém os níveis de abstração e os domínos de descrição de um sistema digital foi proposta pela primeira vez por Gajski e Kuhn [1], o chamado Diagrama Y, apresentado na Figura 1.

FIGURA 1.
ELEMENTOS PRIMITIVOS DE CADA NÍVEL DE ABSTRAÇÃO NO DIAGRAMA DE GAJSKI E KUHN (DIAGRAMA Y).

Neste diagrama, os níveis de abstração (Nível de Dispositivo, Nível Lógico, Nível RTL, Nível de Arquitetura) são identificados pelas suas distâncias do centro do diagrama, enquanto os segmentos de reta radiais correspondem a domínios de descrição. Por exemplo, um diagrama de esquemáticos de portas lógicas TTL é uma descrição estrutural lógica, estando, portanto, localizado na intersecção do eixo rotulado Domínio Estrutural com o nível lógico de abstração.

A Figura 2 representa o diagrama de Gajski da ferramenta desenvolvida. A E2HDL leva do nível de abstração de Equações Algébricas para o nível de Equações

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Booleanas. O ambiente de projeto MAX + Plus II leva o nível de portas lógicas (Compilador) e, finalmente, para o nível de Planta Baixa (Configurador de FPGA).

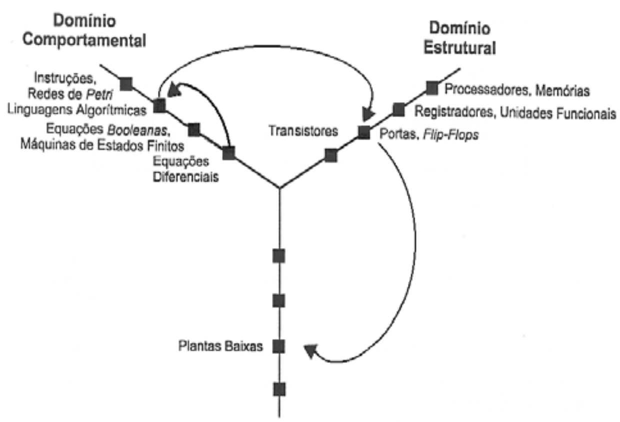

FIGURA 2.
REPRESENTAÇÃO DAS TRANSIÇÕES OCORRIDAS COM A E2HDL.

Uso de Lógica Programável

O uso de Lógica Programável (LP) está ligada intrinsecamente com o uso de tecnologias digitais, ou seja, criar um projeto com tecnologia FPGA (que é a LP escolhida), é criar um projeto digital. Projetos digitais podem-se utilizar de equipamentos variados como microprocessadores, tecnologia discreta e tecnologia de lógica programável, entre outros. A utilização do FPGA é decorrente de algumas vantagens tais como:

- Arquitetura em Hierarquia de Projeto;
- Paralelismo, o que leva a vários processos ou projetos simultâneos;
- Relógio (Clock) Elevado;
- Reutilização de Programas;
- Grande número de E/S (*I/O*);
- Fácil Roteamento;
- Possibilidade de Sistemas-on-Chip;
- Ferramentas de projeto;
- Utilização de funções parametrizáveis;
- Grande número de Células Programáveis.

CRIAÇÃO DE DECOFICADORES DIGITAIS UTILIZANDO FERRAMENTAS DE SÍNTESE AUTOMÁTICA

SISTEMAS DIGITAIS

Um sistema digital é um sistema discreto, isto é, transforma valores discretos de entrada em valores discretos de saída. Ele trabalha aplicando operações ou transformações nos valores de entrada. Os resultados dessas operações são passados a outras operações e, finalmente, para o valores de saída.

A descrição através de uma interpretação funcional do sistema é chamado de Descrição Comportamental. Em linguagem de descrição de hardware, a descrição comportamental é diretamente integrada na linguagem. Assim, pode-se trabalhar em uma descrição com um nível mais alto de abstração.

As ferramentas de síntese, trabalham em torno de modelos funcionais que representam algum conjunto de funções.

Um dos modelos que se pode trabalhar nessas ferramentas são os decodificadores. Estes, representam funções booleanas. Assim, cada um dos pinos de saída é uma função de todas as entradas.

Um decodificador de 7 segmentos representa bem esta ideia, ele possui 4 entradas (A, B, C, D) e 7 saídas (a, b, c, d, e, f, g) e a saída "a", pode ser transcrita como:

$$a = F(A,B,C,D) = \\ = \Sigma(0,2,3,5,6,7,8,10,12,14,15) \quad (1)$$

Extrapolando para as outras saídas, determina-se as funções b, c, d, e, f, g e aplica-se os processos de minimização (fornecidas pelo ambiente de projeto Max + Plus II da Altera).

IMPLEMENTAÇÃO DE FORMAS DE ONDA ANALÓGICAS

O intervalo de valores possíveis de um contador, depende da quantidade de flip-flops que se está trabalhando, ou de outra forma, do número de bits. Assim, um contador de n = 8 bits, por exemplo, apresenta em função da contagem, valores em sua saída entre 0 e 255, ou seja, $2^n - 1$, onde n é o número de bits. Desta forma, a cada pulso de relógio a contagem aumenta em uma unidade percorrendo todos os valores de forma crescente. Acoplando-se a saída do contador a um decodificador com o mesmo número de bits, a cada valor de contagem, tem-se no barramento de saída do decodificador valores em função da contagem atual do contador. A freqüência de saída do sistema, depende do número de bits e do relógio conforme (2). A Figura 3, representa o sistema que gera uma onda analógica partindo de recursos digitais.

$$fsinal = \frac{fclock}{2^n} \quad (2)$$

Onde:
n = número de bits do contador;
fclock = freqüência do relógio (entrada);

$fsinal$ = freqüência do sinal (saída).

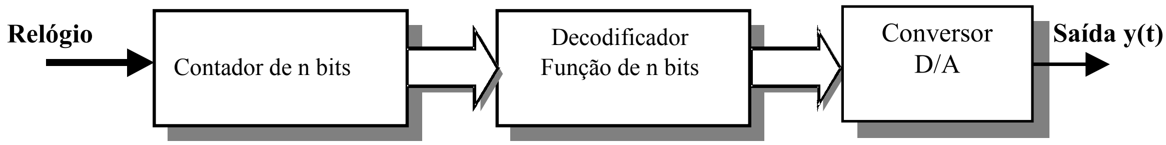

FIGURA 3.
GERAÇÃO DE SINAL ANALÓGICO UTILIZANDO DECODIFICADOR

FERRAMENTAS DE PROJETO BASEADAS EM SÍNTESE AUTOMÁTICA

Métodos de síntese automatizada ótima para equações Booleanas datam das décadas de 50 e 60 e não tinham a capacidade de resolver sistemas muito complexos. A necessidade de manipular quantidades crescentes de informações durante o projeto de sistemas digitais exigia a consideração constante de novas ferramentas. Estas deveriam transcender as atividades de facilitar a captura e de exercitar descrições, passando a ser capazes de gerar novas descrições de forma automatizada e corretas por construção, baseadas nos mesmos requisitos manipulados pelos projetistas. O estilo de projeto estabelecido por estas novas ferramentas baseia-se no uso de ferramentas computacionais e guia o processo de projeto. A ferramenta central possui embutido um conjunto de modelos de síntese, e é capaz de gerar uma descrição correta por construção, bem como uma avaliação do desempenho desta descrição. O laço de realimentação é fechado pelo projetista, que julga os resultados da síntese e aceita a descrição, ou a rejeita e escolhe um novo modelo de síntese para ser usado. Essa escolha pode ser feita com o auxílio de outras ferramentas distintas e apropriadas no processo de validação.

As ferramentas de simulação podem, ainda, ser empregadas, visando fornecer mais detalhes sobre a implementação. Freqüentemente, o sintetizador gera uma descrição a partir dos requisitos, e refina esta descrição através de técnicas de otimização. Somente a descrição resultante deste processo é fornecida ao projetista.

ESTIMULAÇÃO ELÉTRICA FUNCIONAL E FORMAS DE ONDA

A estimulação elétrica funcional (FES) vem sendo aplicada para restaurar e manter a atividade muscular de pacientes paralisados que sofreram lesão medular. Várias formas de onda de corrente e tensão vêm sendo aplicadas com sucesso na recuperação destes pacientes. Equipamentos desenvolvidos comercialmente, entretanto, apresentam de forma geral, serias restrições quanto à variação dos parâmetros do sinal aplicado (freqüência, forma de onda, amplitude, número de pulsos em modulação tipo Burst, tempo de repouso, etc.) o que abre a possibilidade do desenvolvimento de equipamentos mais completos e versáteis.

Uma grande variedade de aparelhos está comercialmente disponível para aplicações eletroterapêuticas. A instrumentação na eletroterapia está se proliferando rapidamente com aos avanços da engenharia, dos desenvolvimentos na pesquisa de eletroterapia e do alcance ampliado dos problemas tratados pela eletroterapia.

Muitos aparelhos projetados antes do início dos anos 80 incluíam geradores de forma de onda capazes de produzir somente um tipo de forma de onda a partir de um único aparelho.

Hoje, contudo, muitos estimuladores disponíveis comercialmente são capazes de produzir várias formas de onda distintas, mas, muitos dos parâmetros de controles não estão disponíveis. Esta dificuldade, abre a possibilidade do uso de novas tecnologias e da introdução de equipamentos com mais recursos, possibilitando uma geração de pulsos mais adequada do ponto de vista fisiológico ao paciente e, também, mais confortável.

Este trabalho apresenta o desenvolvimento de uma ferramenta de síntese automática para a geração de circuitos digitais com o uso de tecnologia de lógica programável. Os circuitos gerados, representam formas de onda de diferentes tipos de especificações e utilizam somente componentes digitais. A ferramenta tem como entrada os principais parâmetros de uma equação.

MATERIAIS E MÉTODOS

A ferramenta foi desenvolvida em linguagem C, e trabalha com funções analógicas para serem implementadas em hardware. A ferramenta gera um arquivo de HDL e para gerar um arquivo bastante pequeno, optou-se pela AHDL (*Altera Hardware Description Language*) da empresa Altera.

As formas de onda são parametrizadas com diferentes especificações, a ferramenta possui parâmetros de entrada para definir a quantidade de bits que o sinal digital deverá possuir e, também, a quantidade de pulsos necessários para percorrer-se um ciclo do sinal. Assim, se uma forma de onda tiver 8 bits de entrada e 12 bits de saída, tem-se uma forma de onda que necessita de um conversor D/A de 12 bits e 256 pulsos de relógio para completar um ciclo.

A ferramenta de síntese E2HDL gera o arquivo texto HDL.

O ambiente de programação MAX + Plus II da Altera simula e compila os arquivos HDLs e gera vários arquivos de reportagem e de interface com outros ambientes de programação.

O aplicativo TBL2M, foi desenvolvido para interpretar dados do arquivo .TBL (arquivo de simulação) e converte-los em um arquivo gráfico do MatLab.

E, de forma geral, podemos descrever os passos para a geração de formas de onda como:

- Descrição da forma de onda (análise espectral);
- Utilização de uma das ferramentas de síntese para gerar o arquivo HDL (AHDL ou VHDL);
- Compilação, Simulação;
- Criação do Arquivo de Simulação TBL;
- Execução do Programa TBL2M;
- Visualização da forma de onda proposta no MatLab;
- Validação do Circuito;

RESULTADOS

A forma de onda escolhida para implementação em FPGA foi a onda denominada farádica. Esta onda tem como característica um pulso de breve duração seguido de um período de decaimento exponencial. A equação farádica, foi modelada de acordo com as especificações da literatura de eletroterapia [7]. A Figura 4, apresenta a onda farádica simulada com 8 bits de entrada e 8 bits de resolução. Na figura, além da forma de onda, são mostrados os valores dos contadores em função do tempo.

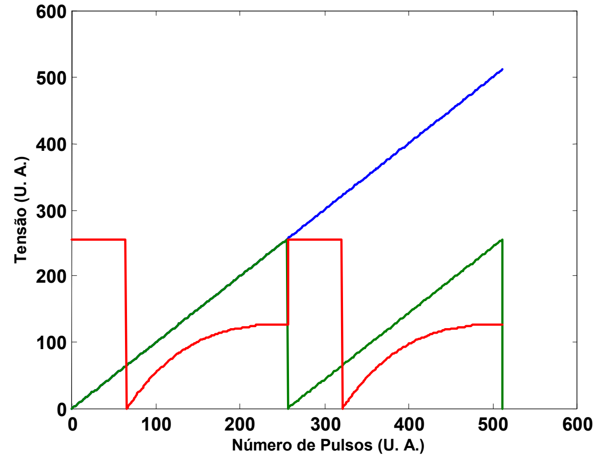

FIGURA 4.
FORMA DE ONDA IMPLEMENTADA EM FPGA

A Figura 5, apresenta a mesma forma de onda plotada com 5 períodos.

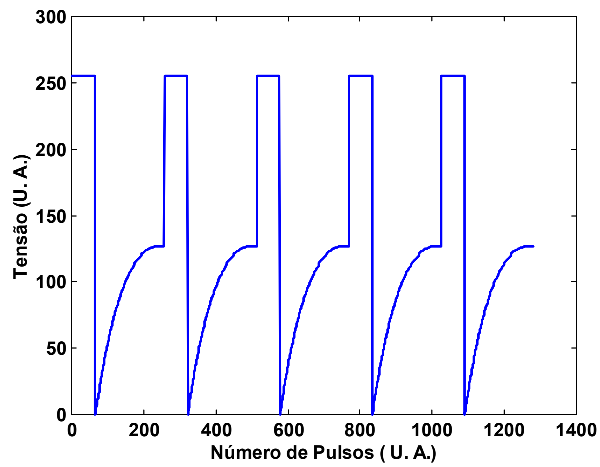

FIGURA 5.
FORMA DE ONDA IMPLEMENTADA EM FPGA

CONCLUSÕES

As ferramentas de síntese automática apresentaram-se como poderosas ferramentas para a geração de circuitos digitais.

A estrutura em hierarquia de projeto permite que, uma vez necessária a modificação da forma de onda previamente descrita, a fácil substituição desta por uma outra mais adequada dentro do projeto.

As freqüências de trabalho realizadas nas medições e simulações, permitem a implementação física das formas de onda, já que o objetivo é a aplicação em sistemas de Estimuladores Neuromusculares onde a freqüência de trabalho é quase sempre menor que 10 KHz.

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DA ANÁLISE EM SÉRIE DE FOURIER AO FPGA

Adriano dos Santos Cardoso[1], Alexandre César Rodrigues da Silva[2] e Aparecido Augusto de Carvalho[3]

Resumo *— Sinais analógicos ou digitais são descritos por funções. Dessa forma, a expansão em séries são métodos válidos para a descrição desses tipos de sinais. A expansão em série de Fourier é, provavelmente, a mais utilizada dentre todas as formas de expansões em séries ortogonais. Atualmente, os recursos disponibilizados nos osciloscópios digitais têm permitido a análise espectral de sinais analógicos, gerando, assim, os coeficientes da Série de Fourier. Os coeficientes da Série de Fourier descrevem a forma de onda sob análise. Neste trabalho, desenvolveu-se uma ferramenta de síntese denominada F2HDL (Fourier para HDL), onde os coeficientes da Série de Fourier, obtidos de um sinal analógico, a partir de uma análise espectral, pode ser implementado em FPGA. Estudos realizados com diferentes tipos de sinais comprovaram que a ferramenta desenvolvida possibilita a geração de formas de onda digitais em uma faixa muito grande de freqüência, podendo atingir dezenas de MHz.*

Palavras Chave — Análise Espectral, Ferramentas de Síntese, FPGA, HDL, VHDL.

INTRODUÇÃO

O PROCESSO DE SISTEMAS DIGITAIS

Em [2], o processo de projeto foi definido de forma simples como a especificação e a descrição final. A diferença fundamental entre a descrição inicial e a descrição final está no fato desta última conter todas as informações necessárias à fabricação do sistema, ao contrário da primeira. O processo de projeto pode ser dividido em duas etapas distintas: a de síntese, onde se agrega algum tipo de informação `a descrição, e, assim, desenvolve-se uma descrição mais próxima da descrição final, e a validação, também chamada de análise, onde é verificado os acertos das tomadas de decisões durante as etapas de síntese.

Durante o processo de projeto, dois conceitos devem ser atendidos: Correção e Otimização. Um projeto é correto se e somente se atende todos os requisitos da descrição inicial e é factível. E, ainda, a descrição de um projeto é ótima se é correta e ainda possui menor custo e melhor desempenho dentre todas as soluções.

Em resumo, pode-se dividir os critérios em:

- Espaço – O sistema deve ter o menor tamanho possível;
- Tempo – O sistema deve apresentar o menor tempo de resposta possível;
- Consumo de energia – O sistema deve apresentar o menor consumo possível.

Para se escolher uma dentre as soluções ótimas, deve-se adequar critérios de acordo com o tipo de aplicação do sistema.

A partir de uma descrição abstrata o projetista deve ser capaz de uma descrição detalhada de forma tal que o projeto seja, então, ótimo e mantenha a funcionalidade e desempenho a um custo mínimo.

UM MODELO PARA O PROCESSO DE PROJETO: O DIAGRAMA Y

Em termos de hierarquia, um projeto digital pode ser dividido em quatro níveis ascendentes de abstração:

- nível elétrico – É o mais baixo nível, nele estão contidas informações da teoria de circuitos e da física dos semicondutores, ou ainda, de diagramas elétricos com resistores capacitores, transistores etc;
- nível lógico – Contém informações onde se agrega conceitos da teoria de circuitos digitais tais como equações booleanas, teoria de grafos, tabelas de transição de diagramas de máquinas de estados, etc;
- nível microarquitetura – Carrega informações sobre macroblocos, transferência entre registradores, planta baixa com a localização dos módulos, ULAs, grafos de fluxo de dados, etc;
- nível sistêmico – São descritos algoritmos, fluxogramas, memórias, processadores, etc.

Pode-se decompor as informações de um sistema digital em três diferentes categorias:

- físico - contém informação geométrica sobre os componentes, módulos e sobre a disposição espacial destes no sistema a ser fabricado;
- estrutural - contém informação sobre como interconectar blocos de base de comportamento;

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- comportamental - carrega informação sobre o comportamento do sistema, sem se envolver em como tal comportamento pode ser obtido, seja do ponto de vista físico, seja do ponto de vista estrutural.

A representação de um modelo que contém os níveis de abstração e os domínos de descrição de um sistema digital foi proposta pela primeira vez por Gajski e Kuhn [1], o chamado Diagrama Y, apresentado na Figura 1.

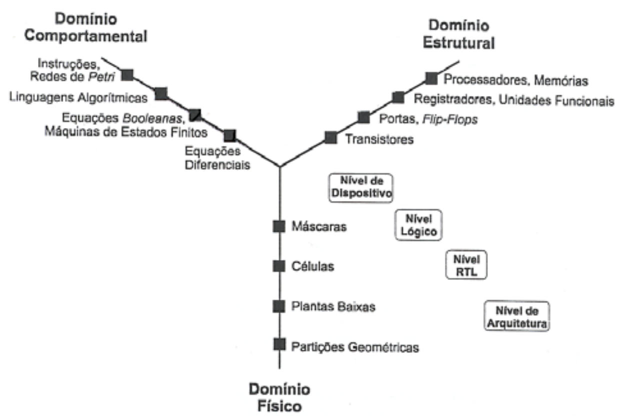

FIGURA 1.
ELEMENTOS PRIMITIVOS DE CADA NÍVEL DE ABSTRAÇÃO NO DIAGRAMA DE GAJSKI E KUHN (DIAGRAMA Y).

Neste diagrama, os níveis de abstração (Nível de Dispositivo, Nível Lógico, Nível RTL, Nível de Arquitetura) são identificados pelas suas distâncias do centro do diagrama, enquanto os segmentos de reta radiais correspondem a domínios de descrição. Por exemplo, um diagrama de esquemáticos de portas lógicas TTL é uma descrição estrutural lógica, estando portanto localizado na intersecção do eixo rotulado Domínio Estrutural com o nível lógico de abstração.

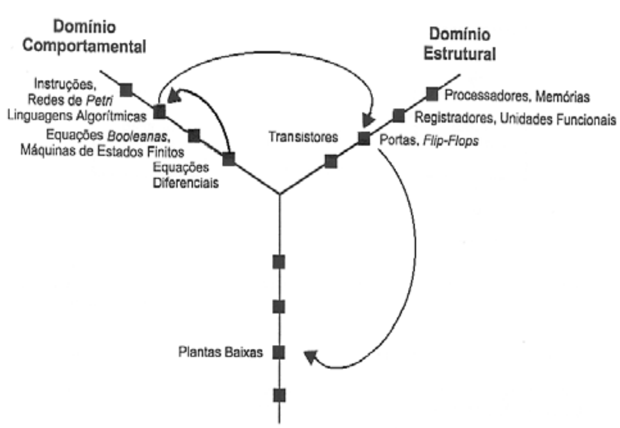

FIGURA 2.
REPRESENTAÇÃO DAS TRANSIÇÕES OCORRIDAS COM A F2HDL.

A Figura 2 representa o diagrama de Gajski da ferramenta desenvolvida. A F2HDL leva do nível de abstração de Equações Algébricas para o nível de Equações Booleanas. O ambiente de projeto MAX + Plus II leva para o nível de portas lógicas (Compilador) e finalmente, para o nível de Planta Baixa (Configurador de FPGA).

FERRAMENTAS DE PROJETO BASEADAS EM SÍNTESE AUTOMÁTICA

Métodos de síntese automatizada ótima para equações Booleanas datam das décadas de 50 e 60 e não tinham a capacidade de resolver sistemas muito complexos. A necessidade de manipular quantidades crescentes de informações durante o projeto de sistemas digitais exigia a consideração constante de novas ferramentas. Estas deveriam transcender as atividades de facilitar a captura e de exercitar descrições, passando a ser capazes de gerar novas descrições de forma automatizada e corretas por construção, baseados nos mesmos requisitos manipulados pelos projetistas. O estilo de projeto estabelecido por estas novas ferramentas baseia-se no uso de ferramentas computacionais e guia o processo de projeto. A ferramenta central possui embutido um conjunto de modelos de síntese e é capaz de gerar uma descrição correta por construção, bem como uma avaliação do desempenho desta descrição. O laço de realimentação é fechado pelo projetista, que julga os resultados da síntese e aceita descrição, ou a rejeita e escolhe um novo modelo de síntese para ser usado. Essa escolha pode ser feita com o auxílio de outras ferramentas distintas e apropriadas no processo de validação.

As ferramentas de simulação podem ainda ser empregadas visando fornecer mais detalhes sobre a implementação. Freqüentemente, o sintetizador gera uma descrição a partir dos requisitos, e refina esta descrição através de técnicas de otimização. Somente a descrição resultante deste processo é fornecida ao projetista.

CRIAÇÃO DE DECOFICADORES DIGITAIS UTILIZANDO FERRAMENTAS DE SÍNTESE AUTOMÁTICA

SISTEMAS DIGITAIS

Um sistema digital é um sistema discreto, isto é, transforma valores discretos de entrada em valores discretos de saída. Ele trabalha aplicando operações ou transformações nos valores de entrada. Os resultados dessas operações são passados a outras operações e finalmente para o valores de saída.

A descrição através de uma interpretação funcional do sistema é chamado de Descrição Comportamental. Em linguagem de descrição de hardware, a descrição comportamental é diretamente integrada na linguagem. Assim, pode-se trabalhar em uma descrição com um nível mais alto de abstração.

As ferramentas de síntese, trabalham em torno de modelos funcionais que representam algum conjunto de funções.

Um dos modelos que se pode trabalhar nessas ferramentas são os decodificadores. Estes representam funções booleanas. Assim, cada um dos pinos de saída é uma função de todas as entradas.

Um decodificador de 7 segmentos representa bem esta idéia, ele possui 4 entradas (A, B, C, D) e 7 saídas (a, b, c, d, e, f, g) e a saída “a”, por exemplo, pode ser transcrita como:

$$a = F(A,B,C,D) = \\ = \Sigma(0,2,3,5,6,7,8,10,12,14,15) \tag{1}$$

Extrapolando para as outras saídas, determina-se as funções b, c, d, e, f, g e aplica-se os processos de minimização (fornecidas pelo ambiente de projeto Max + Plus II da Altera).

Em termos de linguagem de descrição de hardware (HDL), utilizou-se como base o uso de tabelas, assim, descreve-se o comportamento de uma função em todos os valores (passos) possíveis conforme o exemplo da Figura 3.

IMPLEMENTAÇÃO DE FORMAS DE ONDA ANALÓGICAS

O intervalo de valores possíveis de um contador, depende da quantidade de flip-flops que se esta trabalhando, ou de outra forma, do número de bits. Assim, um contador de n = 8 bits, por exemplo, apresenta em função da contagem, valores em sua saída entre 0 e 255 ou seja $2^n - 1$, onde n é o número de bits. Desta forma, a cada pulso de relógio a contagem aumenta em uma unidade percorrendo todos os valores de forma crescente. Acoplando-se a saída do contador a um decodificador com o mesmo número de bits, a cada valor de contagem, tem-se no barramento de saída do decodificador valores em função da contagem atual do contador. A frequência de saída do sistema, depende do número de bits e do relógio conforme descrito em (2). A Figura 4, representa o sistema que gera uma onda analógica partindo de recursos digitais.

$$fsinal = \frac{fclock}{2^n} \tag{2}$$

Onde:
n = número de bits do contador;
fclock = freqüência do relógio (entrada);
fsinal = freqüência do sinal (saída);

```
SUBDESIGN 7segment
(
        i[3..0]                 : INPUT;
        a,b,c,d,e,f,g           : OUTPUT;
)
BEGIN
    TABLE
            i[3..0]     =>      a,b,c,d,e,f,g;
            H"0"        =>      1,1,1,1,1,1,0;
            H"1"        =>      0,1,1,0,0,0,0;
            H"2"        =>      1,1,0,1,1,0,1;
            H"3"        =>      1,1,1,1,0,0,1;
            H"4"        =>      0,1,1,0,0,1,1;
            H"5"        =>      1,0,1,1,0,1,1;
            H"6"        =>      1,0,1,1,1,1,1;
            H"7"        =>      1,1,1,0,0,0,0;
            H"8"        =>      1,1,1,1,1,1,1;
            H"9"        =>      1,1,1,1,0,1,1;
            H"A"        =>      1,1,1,0,1,1,1;
            H"B"        =>      0,0,1,1,1,1,1;
            H"C"        =>      1,0,0,1,1,1,0;
            H"D"        =>      0,1,1,1,1,0,1;
            H"E"        =>      1,0,0,1,1,1,1;
            H"F"        =>      1,0,0,0,1,1,1;
    END TABLE;
END;
```

FIGURA 3.
DESCRIÇÃO EM AHDL DO DECODIFICADOR DE 7 SEGMENTOS

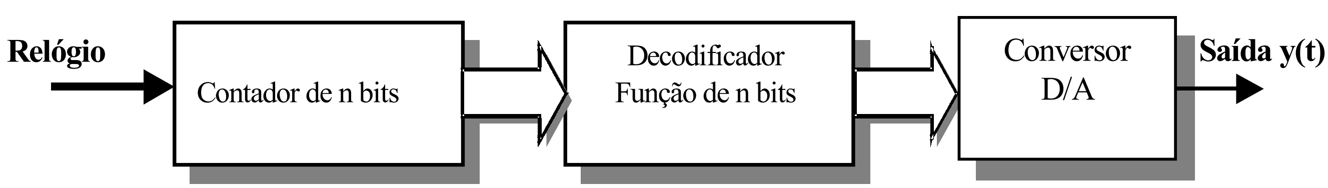

FIGURA 4.
GERAÇÃO DE SINAL ANALÓGICO UTILIZANDO DECODIFICADOR

ENGENHARIA REVERSA

A utilização da tecnologia FPGA para a geração e implementação de formas de onda foi descrita em [3]-[4].

Algumas formas de onda podem ser facilmente descritas por meio de equações e, de modo particular, com os coeficientes de um polinômio. Outras, porém, podem apresentar uma forma um tanto complexa para esse tipo de modelagem, ou ainda, pode-se ter apenas a forma visual (ou capturada por Osciloscópio Digital) para a possível reprodução. Deste problema, surgiu a necessidade de se gerar formas de onda, partindo da análise espectral que é facilmente gerada pelos softwares que fazem análises de formas de ondas capturadas por osciloscópios digitais. Uma vez capturada a forma de onda que se quer reproduzir, pode-se efetuar a análise espectral e os resultados serão a entrada para uma Ferramenta de Síntese. Através da superposição dos coeficientes e os respectivos pesos multiplicados por funções senos e cosenos, pode-se reproduzir a forma desejada. Conforme a necessidade, pode-se, ainda, acrescentar ou diminuir a quantidade de bits da forma de onda ou, também, alterar a quantidade de dados da análise espectral fornecida à ferramenta F2HDL.

MATERIAIS E MÉTODOS

Para a geração de formas de onda usando somente recursos digitais, desenvolveu-se uma ferramenta de síntese automática onde a partir da descrição da forma de onda pode-se gerar a descrição em termos de elementos digitais.

A ferramenta de síntese F2HDL gera o arquivo texto de HDL.

O ambiente de programação MAX + Plus II da Altera, simula e compila e gera vários arquivos de reportagem e de interface com outros ambientes de programação.

O aplicativo TBL2M, foi desenvolvido para interpretar dados do arquivo .TBL (arquivo de simulação) e converte-los em um arquivo gráfico do MatLab.

A Figura 5, apresenta o fluxo do processo de geração de arquivos utilizado para implementação e validação das formas de onda. E, de forma geral, podemos descrever os passos para a geração de formas de onda como:

1. Descrição da forma de onda (análise espectral);
2. Utilização de uma das ferramentas de síntese para gerar o arquivo HDL (AHDL ou VHDL);
3. Compilação, Simulação ;
4. Criação do Arquivo de Simulação TBL;
5. Execução do Programa TBL2M;
6. Visualização da forma de onda proposta no MatLab;
7. Validação ou correção do Circuito;

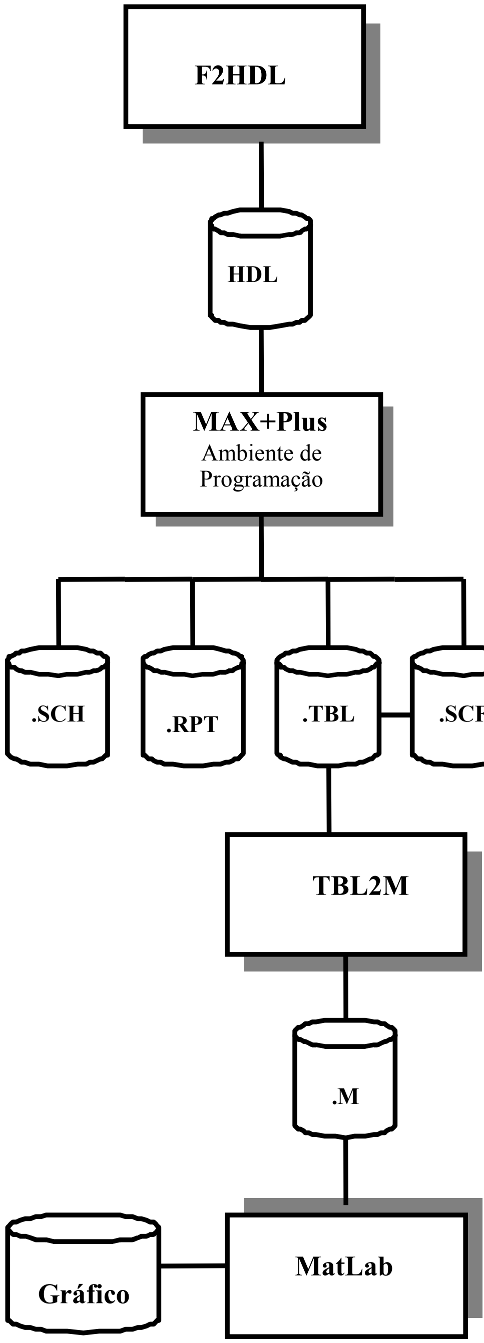

FIGURA 5.
ESQUEMA DE PROCESSO DE GERAÇÃO DE FORMAS DE ONDA EM FPGA

RESULTADOS

A Figura 6, apresenta o resultado de um processo de geração de forma de onda com os dados de entrada apresentado na Tabela I. Na figura 6, a rampa representa a contagem do contador. Quando esta atinge o valor máximo, automaticamente é zerado dando início a um novo ciclo. A forma de onda apresentada é a composição espectral, considerando-se os ângulos de fase, e as respectivas amplitudes de cada harmônica.

TABELA I
Valores de Entrada

N. da Harmônica	Amplitude (p.u)	Defasagem (rad)
1	1	0
2	1	0.7

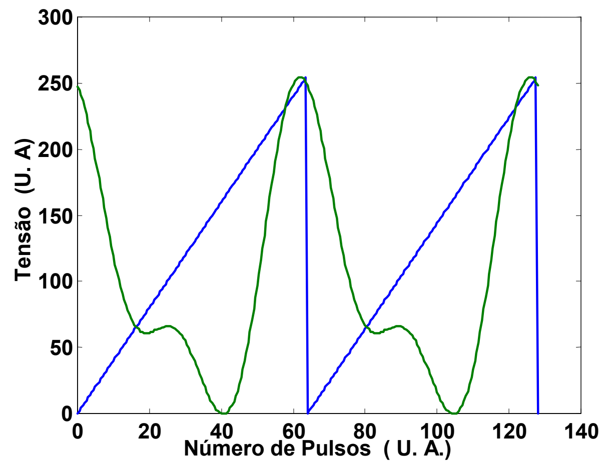

FIGURA 6.
FORMA DE ONDA IMPLEMENTADA EM FPGA

CONCLUSÕES

As ferramentas de síntese automática, desenvolvidas nesse trabalho, apresentaram-se como poderosas ferramentas para a geração de circuitos digitais.

A ferramenta F2HDL apresenta uma nova maneira de se obter uma forma de onda. Através da engenharia reversa pode-se capturar um sinal periódico qualquer, fazer a análise espectral e a partir daí gerar o circuito digital em FPGA correspondente.

A estrutura em hierarquia de projeto permite que uma vez necessária a modificação da forma de onda previamente descrita, é fácil a substituição desta por uma outra mais adequada dentro do projeto.

As freqüências de trabalho realizadas nas medições e simulações permitem a implementação física das formas de onda, uma vez que o objetivo é a aplicação em sistemas de Estimuladores Neuromusculares onde a freqüência de trabalho é quase sempre menor que 10 KHz.

AGRADECIMENTOS

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SENSOR DE TEMPERATURA MICROCONTROLADO USANDO O MC68HC11

Rodrigo Martins Costa[1], Marcos Ikeguchi Ohira[2] e Alexandre César Rodrigues da Silva[3]

Resumo *— Foi desenvolvido um sistema microcontrolado, baseado no MC68HC11 da Motorola, para medir temperaturas ambientes e apresentar a medida na tela de um microcomputador, em intervalos de 30 segundos por um período de 5 minutos. A faixa de temperatura é de 0º a 100ºC. O trabalho foi dividido em três etapas: na primeira etapa efetuou-se pesquisa de informações relevantes e da funcionalidade do ambiente de desenvolvimento; na segunda etapa desenvolveu-se a interface analógica; na terceira desenvolveu-se o programa do microcontrolador. A interface analógica foi desenvolvida utilizando-se como elemento sensor o transistor 2N2219. O sensor foi calibrado obtendo-se uma resposta linear da tensão em função da temperatura. O programa do microcontrolador foi desenvolvido em sua linguagem Assembler e os valores de temperatura medidos são mostrados na tela do microcomputador. O sistema apresentou boa resposta sendo a margem de erro inferior a 1ºC.*

Palavras chave — Microcontrolador, sensor, temperatura, transistor, interface.

INTRODUÇÃO

Sensores sempre foram muito utilizados em vários segmentos produtivos como, por exemplo, na indústria automotiva, na biomedicina, na automação industrial em geral, nos controles de processos e mais recentemente no monitoramento de condições ambientais onde se exige a análise de diversos pontos do sistema. Em escala global o monitoramento ambiental é feito através de instrumentos baseados em satélites. Esse tipo de monitoramento é denominado de sensoriamento remoto.

Com o advento da microeletrônica e conseqüentemente da tecnologia dos microcontroladores, os sensores têm adquirido muito mais funcionalidades. Pode-se dizer que os sensores adquiriram inteligência (Smart Sensors) e capacidade de comunicação digital.

O rápido desenvolvimento e o emergente emprego dos sensores inteligentes aliados ao campo da tecnologia de rede de computadores têm feito a rede de transdutores (sensores e atuadores) inteligentes uma atrativa e promissora solução para o monitoramento de medidas distribuídas e aplicações de controle [5].

Este trabalho de pesquisa tem como objetivo principal iniciar estudos em sistema de medida de temperatura usando um microcontrolador. Na Figura 1 é apresentado um diagrama de bloco do sistema proposto para estudo.

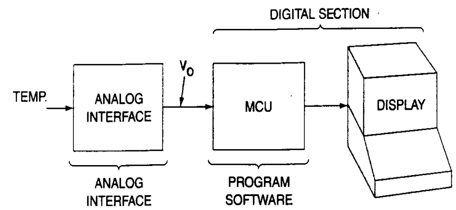

FIGURA 1
SISTEMA PARA MEDIR TEMPERATURA EMPREGANDO UM MICROCONTROLADOR.

Pode-se notar claramente que o sistema de medida é composto por uma interface analógica que converte a variável física (temperatura), em um sinal elétrico (tensão) adequado para o conversor A/D (analógico – digital) do microcontrolador.

Escolheu-se a medição de temperatura por ser um dos problemas mais antigos do homem, pois ela afeta diretamente o meio ambiente e todas as reações físico-químicas da natureza. Certamente os transdutores de temperatura são os mais diversos possíveis. Qualquer componente eletrônico varia suas características com a temperatura. Dessa forma, enquanto alguns componentes são projetados para medir a temperatura, outros o são para serem estáveis com a temperatura [4]. Para se medir a temperatura são necessários dois tipos de componentes: os estáveis, para os circuitos de controle, interface, etc., e o variável que representa o transdutor.

Com essa proposta de trabalho deu-se os primeiros passos no sentido de adquirir o conhecimento necessário para que num futuro próximo possa-se estar trabalhando com o sensor em redes, pois como pode ser notado nos artigos que tratam do assunto, um dos componentes chaves do projeto 1451 são os TEDs (Transducer Electronic Data Sheet) que estão baseados em microprocessador.

OBJETIVOS

Desenvolver um sistema microcontrolado para medir temperaturas ambientes e apresentar as medidas na tela de um microcomputador em intervalos de 30 segundos por um período de 5 minutos. A faixa de temperatura é de 0º a 100

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ºC. Estas especificações tiveram como objetivo adquirir capacitação para um melhor controle sobre microcontrolador, pois, dessa forma, necessita-se medir a temperatura através da contagem do número de ciclos de relógio (clock) de um oscilador durante o período especificado.

O sistema foi capaz de efetuar leituras de temperaturas com diferentes tipos de elementos sensores (sensores de platina, bimetálicos, etc). Um equipamento desse tipo para ser considerado de boa qualidade e confiabilidade em termos de precisão, deve permitir leituras com erros inferiores a 1ºC.

DESENVOLVIMENTO

Metodologia

Uma primeira etapa do projeto foi a pesquisa de informações relevantes (transdutores de temperatura, faixas de medição, interface serial, dispositivos, componentes, etc.) e da funcionalidade do ambiente de desenvolvimento, a placa MC68HC11EVBU da Motorola.

Após explorar o ambiente de desenvolvimento, o sistema e os componentes primitivos (dispositivos) a interface analógica foi considerada.

Após a interface analógica ter sido desenvolvida (projetada), desenvolveu-se o programa do microcontrolador funcionando em conjunto com o programa para o microcomputador.

O SENSOR DE TEMPERATURA

Junção Semicondutora

Uma opção de termômetro de baixo custo, apresentado na Figura 2, utiliza o transistor 2N2222 como elemento sensor. A não-linearidade de V_{be} com a temperatura é mínima na faixa de –5ºC a 125ºC, o que significa uma imprecisão de apenas ± 1ºC. O diodo Zener regula a tensão de entrada a 1,2V através de R2 para fixar a corrente de operação do sensor. O resistor R4 polariza o amplificador para uma saída zero quando a temperatura for 0ºC. O resistor de realimentação R5 é finalmente ajustado para um coeficiente de temperatura do sistema de 100mV/ºC. Tanto os resistores, como o Zener, quanto o amplificador operacional devem ser estabilizados ou devem variar muito pouco suas características com variações de temperatura ambiente.

Os sensores de temperatura de silício da série MTS 102, 103 e 105 da Motorola são transistores comuns, mas com uma tensão base-emissor otimizada que varia linearmente com a temperatura. Esse circuito é mostrado na Figura 3. Este dispositivo tem uma resposta linear a partir de –40ºC até 150ºC.

Para utilizar este sensor de temperatura, basta polarizar o transistor e medir sua tensão base-emissor com o coletor ligado na base. O circuito da Figura 3 mostra uma aplicação deste dispositivo. O 7812 é utilizado aqui não somente para polarizar o transistor através do resistor de 110kΩ, agindo como fonte de corrente, como também para alimentar os dois amplificadores operacionais. O primeiro deles serve como buffer e o segundo amplifica o sinal para se obter na saída 10 mV/ºC. O resistor R(cal) subtrai 273,16ºC equivalentes à transformação de kelvin para graus centígrados.

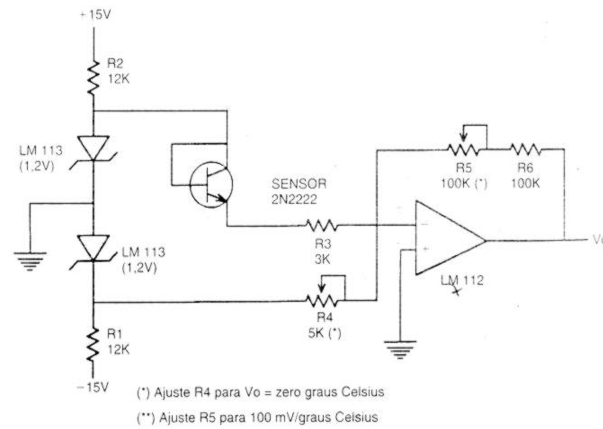

FIGURA 2
UM SISTEMA DE MEDIDA DE TEMPERATURA DE BAIXO CUSTO COM PRECISÃO DE ±1ºC.

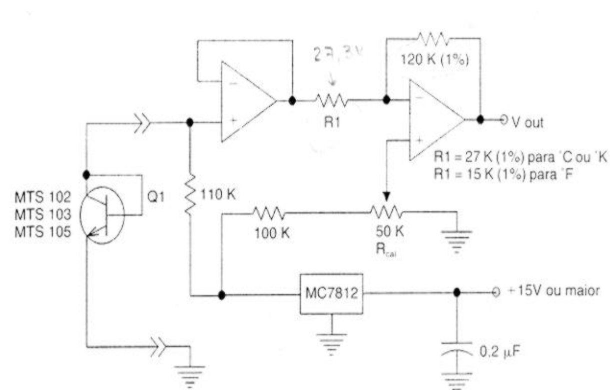

FIGURA 3
APLICAÇÃO PRÁTICA DO MTS 102

RESULTADOS

Dentre as opções de medida apresentadas adotou-se os sensores 2N2219 (semelhante ao 2N2222) e o AD590 por serem comercialmente mais facilmente encontrados e por serem relativamente baratos, tanto os elementos sensores quanto os componentes para o condicionamento do sinal.

Após alguns testes com os circuitos apresentados, considerou-se uma boa resposta com o circuito mostrado na Figura 3, porém utilizando o transistor 2N2219A.

A resposta do circuito apresentado foi de, aproximadamente 100mV/ºC, conforme descrito. O circuito foi implementado em laboratório, e está mostrado na Figura 4.

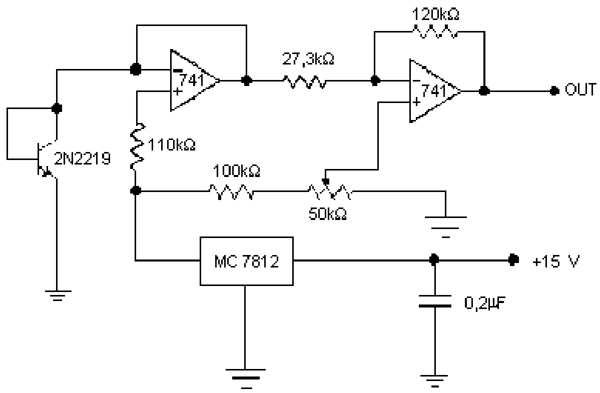

FIGURA 4
CIRCUITO SENSOR DE TEMPERATURA IMPLEMENTADO EM LABORATÓRIO

Realizou-se a calibração desse circuito utilizando-se água com gelo, para se obter uma temperatura de zero grau, e água quente. O procedimento adotado foi o de iniciar com a água fervendo (aproximadamente 100ºC) e esfriar a água misturando-se água fria, diminuindo, assim, a temperatura.

Com esses dados, de tensão de saída em função da temperatura, obteve-se o gráfico apresentado na Figura 5.

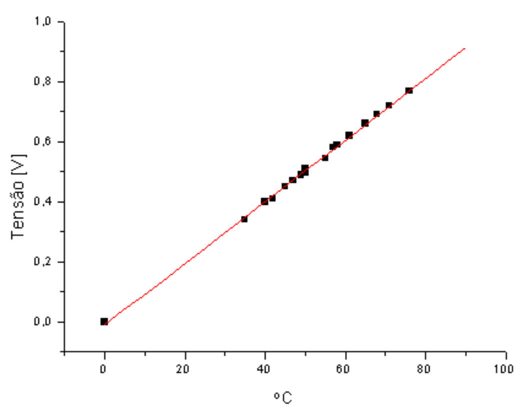

FIGURA 5
GRÁFICO DA TENSÃO DE SAÍDA EM FUNÇÃO DA TEMPERATURA USANDO O 2N2219

Pode-se verificar que a resposta do sensor é linear e é de 100mV/ºC, aproximadamente. Utilizando o software Microcal Origin 4.0, traçou-se este gráfico e obteve-se a equação da tensão em função da temperatura:

$$V = 0{,}01025.T - 0.00992 \qquad (1)$$

A expressão (1) pode ser aproximada para

$$V = 0{,}01.T \qquad (2)$$

Foram realizadas outras calibrações utilizando tensões de alimentação diferentes para verificar sua influência na resposta do circuito. Utilizando uma alimentação de ± 9V, realizou-se mais 4 medições, elevando a temperatura e diminuindo, para verificar também se o dispositivo apresentaria histerese. A Tabela I mostra os dados obtidos e com os quais traçou-se as curvas mostradas no gráfico da Figura 6.

TABELA I
DADOS OBTIDOS DE TENSÃO EM FUNÇÃO DA TEMPERATURA

ºC	25	30	35	40	45	50	55	60
V1	0,243	0,293	0,344	0,408	0,444	0,506	0,590	0,637
V2		0,386	0,400	0,485	0,541	0,586	0,634	0,681
V3		0,307	0,356	0,412	0,455	0,523	0,578	0,631
V4				0,426	0,487	0,526		0,637

TABELA I
(CONTINUAÇÃO)

ºC	65	70	75	80	85	90	95	99
V1	0,693	0,738	0,802	0,853	0,903	0,974	1,036	1,087
V2	0,740	0,785	0,841	0,894	0,943	0,990	1,050	
V3	0,686	0,727	0,786	0,841	0,893	0,966	1,018	1,042
V4	0,676	0,725		0,851				

[1] 2ª Calibração – aquecimento
[2] 2ª Calibração – resfriamento
[3] 3ª Calibração – aquecimento
[4] 3ª Calibração – resfriamento

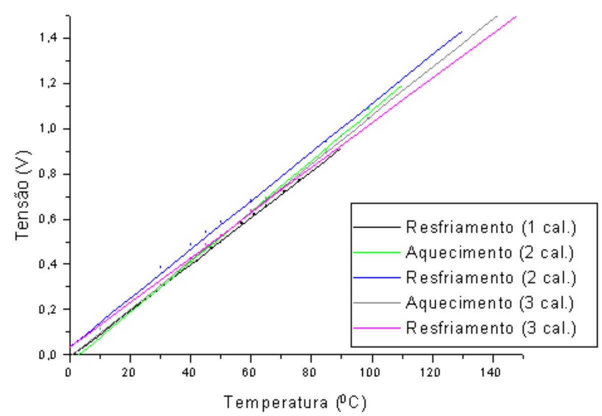

FIGURA 6
CURVAS OBTIDAS NAS CALIBRAÇÕES REALIZADAS

Essas novas medidas, utilizando 9V como alimentação, mostrou resultados lineares da tensão em função da

VOCÊ É O LÍDER DA SALA

Cacilda Andrade[1] e Marcos Bonavita[2]

Abstract *– Abordagem da aplicação dos princípios Dale Carnegie relativos ao comportamento e ao relacionamento humano para melhoria da comunicação entre aluno-professor, dentro da sala de aula. Uma rápida visão sobre o cenário atual de algumas faculdades brasileiras e o comportamento dos alunos que as freqüentam, visando a discussão destes princípios com conseqüentes resultados práticos na vivência professor-aluno. Enfatiza a questão do professor como o líder na sala de aula e o aluno como agente multiplicador.*

Index Terms – Didática de ensino, Princípios Dale Carnegie, Relacionamento e Liderança professor-aluno, Comunicação eficaz na sala de aula.

Atualmente vivemos numa sociedade dinâmica, cujo cenário é influenciado pela tecnologia e pelo crescente acesso à informação, principalmente através da Internet, Jornais, Revistas, Noticiários, etc., quase de forma "on line" com os fatos e acontecimentos. Diante disto, podemos fazer uma análise mais profunda do perfil atual das Escolas Brasileiras, na preparação dos seus alunos, focando-se no nível universitário privado, com alunos freqüentadores de cursos noturnos, que enfrentam o cenário acima citado.

Do ponto de vista das escolas, instituições de ensino, o aluno é visto como um cliente, receptor de material didático em tempo e quantidade pré-definidas. As escolas investem pesadamente em recursos materiais e humanos. O MEC exige e monitora os cursos e professores, até Mestrados e Doutorados. Isto é fato, mas a questão é como propiciar o "adequado" interesse e dedicação do aluno pelo tema oferecido.

Do nosso ponto de vista, algumas escolas tendem a manter seus processos de informações de ensino e administrativos com uma dose de fluxos burocratizados, com aulas mais teóricas do que participativas. Este assunto também é citado no artigo do Jornal Administrador, "o que falta para as escolas serem competitivas" [4]. Observam-se escolas com muitos recursos, porém muitas vezes não disponíveis, ou seja, recursos de qualidade e em quantidade, porém mais parados do que utilizados, por não existir o devido planejamento operacional com suas composições e flexibilidades administrativas. Isto vem da cultura Brasileira de não possuir o hábito do "plano de longo prazo". Como exemplo, no caso do professor necessitar algum recurso, é orientado para fazê-lo com muitos dias de antecedência. Daí se constrói um fluxo de ocupação dos recursos na prática, em vez de planejarem o uso de todos os recursos existentes ao longo do período (semestral ou anual), com isso distribuindo esses recursos/disponibilidade entre as matérias/aulas de maior necessidade, ampliando a eficácia do uso e aumentando a abrangência a cada novo recurso adquirido. Outro exemplo pode ser o não uso de ferramentas para modelagem de fluxos de processos, que quando feito manualmente, acaba levando mais de 50 minutos da aula, sendo que com o uso do microcomputador e recursos de softwares específicos ou até mesmo um simples *power point*, poder-se-ia gastar uns 5 minutos em vez dos 50. E os alunos desenvolveriam não só o "layout" (desenho do fluxo), mas também o funcionamento em detalhes, podendo até propor melhorias para esse fluxo, ou ainda simular processos alternativos, desenvolvendo a sua criatividade, aprendendo a analisar preventivamente os desvios e variação de custos, etc. Diante disto, a questão é como estimularmos o interesse do aluno pela matéria/aula.

Já do ponto de vista dos alunos, verifica-se uma postura deles muito cômoda, influenciada pela relação custo x benefício dos cursos, até influenciando a qualidade e o reconhecimento do nível da instituição, popularmente falando. Isto é, pelo fato de estarem pagando a escola, julgam não ser preciso usar de seus próprios esforços para escrever, exercitar-se, pensar e formar seu raciocínio, concluindo o aprendizado. Por essa falta de "vontade aparente" gera uma falta de respeito com os colegas interessados em aprender e com os professores, ávidos a repassar seus conhecimentos. Atribui-se a isso, o fato de, por serem de curso noturno, virem já cansados física e mentalmente para as aulas, alguns com muito fraca formação escolar básica anterior e a acomodação dada pelo uso não adequado da tecnologia. Por exemplo, atender várias vezes o celular em aula, mesmo saindo da sala, não querendo escrever, onde recorrem a cópias reprográficas ou "copy and paste" nos trabalhos, não querendo calcular mentalmente, não sendo pontuais com os horários, não tornando eficaz o seu próprio aprendizado. Externam, com isso, uma falta de compromisso para consigo mesmo, com a sua carreira e sua formação acadêmica, conseqüentemente, correndo o grande risco de não ficarem preparados adequadamente para sua auto-sustentação, para serem grandes empreendedores e líderes no mercado de trabalho, uma selva de pedra, cada vez mais competitiva e selvagem, tornando frágil não só a ele, mas toda uma comunidade, até o País.

Mediante estes cenários, a Escola, Professores e Alunos, todos com grande responsabilidade social, devem comprometer-se em aprender, a praticar, testar, demonstrar e ensinar aos demais a comprarem as "idéias/assuntos" abordados em aula. Citamos abaixo alguns objetivos, que se

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deve sempre ter em mente, com isso criando seus próprios pilares de uma sólida base:

1) Ser e ter condições de auto-sustentação, de sobrevivência própria e de seus dependentes;
2) Serem multiplicadores, aprendendo e ensinando a gerar riquezas, não sendo somente consumidores;
3) Saber conviver bem com as pessoas, se relacionar formalmente (em termos de postura, diálogo, apresentação e conteúdo), com isso sendo pessoas mais solicitadas e realizadas;
4) Saber ouvir, selecionar e dar a devida interpretação, sabendo dosar o seu discurso;
5) Possuírem um diploma que seja mais que um "canudo" ou "quadro exposto", mas que seja realmente uma "Certificação da Competência", algo que o capacite como um profissional, permita agir por completo, seja um referencial com potencial de crescimento e desenvolvimento próprio.

Assim, sensibilizados com este cenário em que estamos em constante contato, vendo diariamente acontecer na nossa vida de profissionais com uma vasta e variada experiência no mercado industrial Brasileiro e Internacional, também em serviços de informática e consultoria de negócios, sendo orientadores e formadores de pessoas, juntamos forças, reflexões e energia para estarmos encontrando meios de enriquecer as nossas aulas e relacionamentos acadêmicos para servir de base para o futuro desses nossos alunos.

Procurando por melhores formas de comunicação e interação, com conseqüente repassagem dessas informações, fomos buscar uma referência internacional com 90 anos de tradição. Fizemos um auto-investimento em curso, no Instituto Dale Carnegie, especializado em treinamento comportamental e de relacionamento humano, onde aprendemos as técnicas, fomos treinados e colocamos em prática alguns dos princípios ensinados pelo fundador do Instituto, sua forma de aplicação e conseqüentes resultados práticos que vivenciamos com nossos alunos. Aprendemos técnicas para lidar com as pessoas, maneiras de fazer com que gostem uns dos outros, como conquistar estas pessoas a pensarem do seu modo e como ser um líder.

Achamos de extrema importância estarmos repassando esse conhecimento e experiência adquirida, testando o resultado de cada aula, onde adicionamos nossa vivência e o convívio com nossos alunos, cujos princípios já fazem parte de nossas vidas e da didática de ensino. A aplicação dos princípios de Dale Carnegie é constante, diária, e que funciona a partir do momento que os aplicamos e verificamos o retorno em nós mesmos e em quem nos cerca. Ficamos mais entusiasmados, felizes dentro e fora da sala de aula, podendo ser aplicado nas mais diferentes ocasiões e momentos de nossa vida.

A forma de externar sentimentos, sentir emoções, se explicitar, isto é a comunicação de quem fala para quem ouve, podendo ser do aluno ao professor e vice-versa. Mas é de extrema importância que o aluno conviva com esses princípios aplicados pelo professor, pois aí se cria indiretamente o interesse pela matéria, pelo professor, pela sua própria carreira e em si mesmo, para tornar-se um ser humano mais feliz. Isto reforça que a forma de aprendizado vai alem da base técnica. Precisamos estar o tempo todo atento, para o nosso inter-relacionamento e desenvolvimento pessoal, que certamente reflete positivamente em nosso estado de espírito e em nosso dedicado trabalho.

Saber lidar com as pessoas, saber relacionar-se, saber tratá-las devidamente com conseqüência obtenção do apoio do grupo envolvido, isso é a função de um líder. E qual é a função de um líder? Liderar para alcançar a melhoria contínua do trabalho e da convivência humana. A visão que temos é que o professor deva ser o líder dos seus alunos, o exemplo, um amigo, um mestre de referência, respeitar e ser respeitado, pois usando algumas posturas citadas abaixo, estaremos abordando e praticando sobre os princípios do Dale Carnegie, com isso alcançando nosso objetivo de fazer crescer o interesse do aluno pelo conteúdo aprofundado em aula:

- Devemos nos tornar pessoas mais amigáveis;
- Devemos conquistar os alunos, para o nosso modo de pensar;
- Elogiemos os alunos, de forma honesta e sincera;
- Corrijamos suas posturas e trabalhos evitando críticas e condenações;
- Nos mostremos interessados no trabalho e progresso deles;
- Sejamos bons ouvintes: parando, olhando e escutando;
- Respeitemos a opinião expressa pelo aluno, analisando tanto pelo seu ângulo, como também pelo nosso ângulo de professor;
- Orientemos objetivamente ao ponto correto, fazendo com que ele conclua a seu próprio favor, usando analogias e fatos de forma indireta.

Mas uma grande questão é como conseguir que esses temas se tornem metas e até objetivos comuns entre os professores e alunos. Com alguns exemplos desta visão inovadora e prática é que pretendemos divulgar e demonstrar a importância e a possibilidade da melhoria em nossos relacionamentos, que só agrega mais valor à nossa experiência profissional e de vida. Nossa intenção é ir além da exposição da matéria/disciplina, é com isso sensibilizar e realmente acreditando na poderosa frase "querer é poder", transformar o inimigo em amigo, a dificuldade em facilidade, o insucesso em caso de sucesso. A idéia não é mudar as pessoas, mas sim criar um ambiente para que o aluno possa entrar, absorver e começar, ele próprio acreditando em você, no que você pensa, com isso ele mesmo se transforma. Acredite, você consegue melhorar muito o clima se você quiser e tiver as ferramentas apropriadas.

A Escola é voltada para criar conhecimento. A educação vem preparada do lar, para o bom relacionamento, para a vida, mas existem ferramentas que o Líder precisa utilizar, independentemente do seu tempo, da sua época, cujas principais podemos apontar:

- A *força da palavra* é o poder de comunicação, de convencimento, de atenção, de influência, de entendimento do ouvinte. Isto através do seu discurso enfático, dramático, imobilizador e convincente. Por exemplo, o discurso proferido por um General Romano, um Ditador, o Político, o Pastor religioso, um Pai ou o Professor;
- A *expressão corporal* é a maneira e o meio que reforça o entendimento da força da palavra, é a comunicação não verbal. Por exemplo, a postura, a vestimenta, o enfardamento, os gestos e os movimentos físicos realizados para atrair a atenção do ouvinte;
- O *entusiasmo* dentro de si, que é a energia interna contaminando aos ouvintes com alto poder de convencimento. É o próprio querer algo. Usar a força da palavra e da expressão corporal para externar um sentimento em que você primeiramente acredita e com isso poder convencer aos demais. Por exemplo, um discurso seu, normal, mas que ao final as pessoas pedem mais, que continue como no fim de uma excelente apresentação de um show ou de uma peça teatral;
- O *conhecimento da matéria* é o explicar com o naturalismo de quem conhece o assunto, tornando realmente fácil o entendimento. Usando de analogias sobre fatos "comuns e conhecidos". Por exemplo, uma aula de algum assunto difícil, chato, que o professor use de "artifícios ou analogias diretas e indiretas", com exemplos da realidade popular para fixar e absorver o conhecimento.

Todas essas competências reunidas em uma só pessoa nos levam ao professor ideal, um líder. E o que é ser um Líder ou um Facilitador? Melhor ainda, que tal ser um "Líder facilitador"? Já que ser um Líder é saber relacionar-se com outras pessoas, fazendo com que elas lhe sigam e realizem os seus desejos, ser um Facilitador é proporcionar os meios para a solução ou que o aprendizado de um determinado assunto seja alcançado, então ser um Líder facilitador é ter atitudes, comportamentos e comunicação que estimule ao aluno, e com isso consiga um ótimo relacionamento, promovendo a inspiração para que ele alcance sua meta e você o seu objetivo como Líder. Neste caso, é fazer com que os outros saibam fazer, saibam multiplicar e com isto estejam se tornando pessoas melhores, para si próprios e para a sociedade, comprovando a eficácia do aprendizado em sua escola.

Para transformarmos a categoria de professor comum, para um professor líder-facilitador, mostramos abaixo os princípios Dale Carnegie e situações em que mais utilizamos no nosso ambiente acadêmico [1], [2] e [3]:

1) Ao chegar nas salas de aulas, entre sorrindo sempre...comece de maneira amistosa, com empatia, e de forma sincera, refaça sempre um novo contato com os alunos. Por exemplo, ao entrar de cara fechada ou de mau humor, os alunos percebem e até perguntam se houve alguma coisa, já ficam de "pé atrás", o que provoca o atraso do início do interesse pela aula.

Princípio Dale Carnegie: "Sorria".

2) Elimine a crítica ao falar, com isso a pessoa ficará menos ressentida, menos acuada com algum comentário, pois o que ao aluno soa negativo, o faz perder pelo interesse pela aula. Por exemplo, "o aluno diz: Não acho nada na Internet", ao invés de dizer que ele está fazendo algo de errado, inverta e enfatize o positivo. Diga: "Troque de ferramenta de busca, seja persistente, procure por outras palavras chaves, filtros auxiliares, etc".

Princípio Dale Carnegie: "CCQ = Não critique, não condene, não se queixe".

3)Aprecie honesta e sinceramente, fazendo o aluno sentir-se importante, elevando sua auto-estima, pois quando ela se expõe ao comentar ou apresentar algo, se sentirá mais seguro de si. Mesmo que o trabalho não tenha sido do agrado do professor, mantenha o elogio e cite os pontos a melhorar. Elogie verdadeiramente os menores progressos, as respostas e a participação voluntária.

Princípio Dale Carnegie: "Aprecie honesta e sinceramente".

4)Crie o desejo na outra pessoa em querer concluir ou participar, mas sem obrigá-la. Pois o desejo em querer fazer/participar, são sentimentos que estão ocultos dentro dela.

Princípio Dale Carnegie: "Desperte veementemente o desejo nos demais".

5)Seja um bom ouvinte. Ao ouvirmos "algo inadequado", de pronto tendemos a corrigir, sem esperar e entender aonde o aluno quer chegar. Queremos que a nossa visão "correta" seja entendida, aceita e que a outra pessoa concorde de pronto. Mas, precisamos parar, ouvir mais e entender pelo outro lado, tenha paciência, com isso podemos mudar nossa opinião quando o aluno concluir seu pensamento.

Princípio Dale Carnegie: "Seja um bom ouvinte", "Pare, Olhe, Escute".

6)Use exemplos do dia-a-dia e casos práticos, analogias de temas vividos ou em evidência no momento, para que se correlacione com o tema em questão e desperte a curiosidade dos alunos.

Princípio Dale Carnegie: "Fale de coisas que interessem à outra pessoa".

7)Nunca diga ou corrija o aluno, dizendo “você está enganado” ou “você está errado”, respeite a opinião dos outros. Esclareça, dando exemplos de forma indireta, mostrando ao aluno a forma correta que deveria ter utilizado. E se estiver o professor enganado, reconheça o seu erro imediatamente.

Princípio Dale Carnegie: “Se está enganado, reconheça o seu erro rápida e energicamente”.

8)Somente o comprometimento real pode promover o entendimento, portando crie uma situação positiva questionando-o indiretamente, de forma que o aluno responda “sim” ao quanto for solicitado ou referenciado pelo professor. Use analogias e exemplos simples de forma a obter esse sim.

Princípio Dale Carnegie: “Consiga que a outra pessoa diga sim, sim, imediatamente”.

9)Ao explicar algum tema, use da técnica de dramatização para aumentar a aderência do tema na mente dos alunos. Crie situações de analogia ou cenários extremamente opostos à situação normal, exagere muitas vezes. Por exemplo, ao explicar uma situação de pouco interesse coletivo, subi em cima da cadeira, e com isso trouxe os desinteressados a ouvir o que eu dizia, prestando mais atenção.

Princípio Dale Carnegie: “Dramatize as suas idéias”.

10)Testar-se ou mostrar-se competente perante os demais cria um clima de competição e de desafio, que o ser humano adora. Portanto faça desafios possíveis e mensuráveis ao provocar os alunos, e que permita a participação de todos.

Princípio Dale Carnegie: “Lance um desafio”.

11)Quando quiser que os alunos obedeçam, evite dar ordens diretas, faça perguntas que os envolvam na direção do assunto que deseja explicar, com isso a atenção do aluno questionado e dos outros ao redor se prendem na resposta a ser dada, criando a expectativa quanto à resposta e ao próximo questionamento, tornando a classe mais atenta.

Princípio Dale Carnegie: “Faça perguntas em vez de dar ordens diretas”.

BIOGRAFIA

Carnegie, Dale (1888 - 1955) Escritor, orador; nascido em Maryville, Mo. direcionado à arte de falar em público desde os dez anos. Carnegie ao sair da faculdade, trabalhou como vendedor para a "Armorur and company" por dois anos e meio. Mudou-se para Nova Iorque em 1911 a fim de estudar na Academia Americana de Artes Dramáticas. Após ter representado alguns papéis, teve o bom senso de abandonar a carreira de ator e decidiu que daria aulas de oratória em escolas noturnas. Assim, Carnegie teria os dias livres para ler livros, preparar palestras, escrever romances e contos já que seu desejo era "de viver para escrever e escrever para viver". Sua primeira palestra foi na Young Men´s Crhistian Associations (ACM) no dia 22 de outubro de 1912. Num curto período de tempo Carnegie já estava desenvolvendo o seu próprio curso, e escrevendo panfletos que seriam publicados como livros, pois não havia na época materiais didáticos já publicados. Depois de ter servido no exército na Primeira Guerra Mundial, ele conduziu o "tour" das palestras de Lowell Thomas. Em seguida, conduziu o seu próprio "tour" a fim de promover suas idéias acerca do sucesso através da oratória. No início dos anos 30, era conhecido por seus livros e por um programa de rádio, quando publicou o Como Fazer Amigos e Influenciar Pessoas (1930), ganhando sucesso imediato e tornando-se dos maiores best-sellers de todos os tempos. Esse fato foi o suficiente para ele se tornar um orador e um escritor: começou a ter colunas em jornais. Criou o Instituto Dale Carnegie® em 1912, com o objetivo de preparar as pessoas para falar em público, caracterizando respeito, confiabilidade, comunicação e organização que transcenderam no tempo, línguas e culturas dos países. É destinado a desenvolver a Comunicação Eficaz e Relações Humanas, com filiais em todo o mundo; viveu para ver o dia em que o seu nome se tornaria virtualmente sinônimo de tudo o que ele promoveu. Atualmente são mais de 4 milhões de pessoas graduadas pelo treinamento e milhões de livros de cada título seu já lido [1].

CONCLUSÃO

Existe uma lei, fundamental para o relacionamento humano. E, se você respeitar esta lei, conquistará muitos amigos e felicidade. Procure sempre fazer as outras pessoas se sentirem importantes - seja sincero. “Ser importante é o desejo mais profundo do ser humano. É o que nos torna diferentes dos outros animais. Sorria, seja um bom ouvinte e encoraje as pessoas a falarem sobre si mesmas.” Dale Carnegie

Um general, chefe, pai, professor, aluno ou simples ouvinte será que devem somente dar ou cumprir ordens? Ensinar cegamente a fazer! Quantos Pais e Mestres já não falaram que aprenderam com seus erros ou com seus filhos e alunos. Portanto tudo isso tem relação com a participação do aluno nas aulas, com sua transparência e honestidade na troca de experiências, que certamente o professor deveria propiciar ao aluno, facilitando e abrindo sua mente. Portanto, tudo isto tem relação com a participação, transparência e honestidade que devem ter professores líderes de sucesso e com isso teremos bons alunos, seres humanos melhores, verdadeiros multiplicadores, isto é, excelentes futuros professores.

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USANDO A LINGUAGEM VRML NO ENSINO DE HISTÓRIA DA CIÊNCIA E DA TECNOLOGIA DA ENGENHARIA ELÉTRICA

Antonio Lopes de Souza[1], José Carlos de Oliveira[2] e Marcelo Paulino de Lima Santos[3]

Resumo *— Este trabalho divide-se em duas partes: a primeira apresenta uma argumentação teórica sobre o uso da linguagem VRML (uma sigla para "Virtual Reality Modeling Language") no ensino da História da Ciência. A segunda parte apresenta a implementação em realidade virtual de um Museu-Laboratório Virtual voltado para ensino de História da Ciência e da Tecnologia da Engenharia Elétrica. Esse museu tem como entrada a replicagem em realidade virtual do ambiente de trabalho de Michael Faraday na Royal Institution de Londres. Essa replicagem foi feita tomando-se como base gravuras da época (século XIX) e é a partir da mesma que todo o projeto do museu se desenvolve. O acervo do museu-laboratório é formado por replicagens em realidade virtual de máquinas, dispositivos e experiências que marcaram o desenvolvimento da ciência da eletricidade e do magnetismo. O projeto vem sendo desenvolvido com foco em dois objetivos principais: o conhecimento histórico em si e o aprendizado de conceitos fundamentais ao estudo da moderna engenharia elétrica através do domínio do conhecimento histórico.*

Palavras-chave — Ensino de Engenharia Elétrica, História da Ciência, Realidade Virtual, VRML.

INTRODUÇÃO

A industrialização cada vez mais presente em todo tipo produção e a crescente preocupação com a:

- melhoria da qualidade dos produtos – como resposta às demandas de um mercado mais exigente;
- qualidade de vida – ampliando desta feita a relação do produto com todos os aspectos da vida e da sociedade;
- busca por inclusão de contingentes maiores de pessoas ao mercado de trabalho – buscando com isso diminuir a miséria e aumentar a eficiência na produção de bens e serviços;

têm exigido dos engenheiros tratar a ciência e a técnica (ou tecnologias) não apenas nos seus meandros intrínsecos, mas sim, como bens culturais. Não são somente os conhecimentos técnicos e científicos que devem ser objetos de apurados, intensos e sólidos estudos – sobre isto não há dúvida nenhuma – mas se impõe cada vez mais que o engenheiro se enverede no conhecimento dos meios e ambientes onde irá depositar o resultado de seu trabalho. Assim o engenheiro atual deverá ter conhecimento eco-social, ou seja, um conhecimento mais globalizado, tanto do meio físico/natural quanto do ambiente humano. Ele deve ser capaz de produzir as tecnologias necessárias a solução dos problemas postos e prever o impacto delas sobre o todo físico e social. Nesse sentido o seu trabalho torna-se cada vez mais de equipe – constituídas de pessoas que detém o conhecimento das mais variadas facetas da sociedade - concitando o engenheiro a ter preocupações com a psicologia, com o relacionamento entre pessoas, com a interlocução e entendimento entre elas, em síntese, o futuro engenheiro deverá ter maior grau tanto de comunicação quanto de sociabilidade. Por esses predicados pode-se dizer que o engenheiro é um poderoso e essencial agente do desenvolvimento econômico e social de uma nação. Nesse sentido o seu treinamento deverá ter como tônica o estabelecimento de ambiente que estimule a criatividade e que desenvolva aptidões para modelar sistemas cada vez mais amplos e complexos.

REALIDADE VIRTUAL e HISTÓRIA da CIÊNCIA

Os treinos estritos em ciência e técnica vem sendo desenvolvidos pelo ensino de engenharia desde as suas origens. No entanto, as habilidades em relacionar os conhecimentos técnicos com as demais órbitas da sociedade, na intensidade hoje requerida, são preocupações que ganharam corpo, só recentemente, no seio das universidades brasileiras. Uma forma de sistematizar essas novas exigências no aprendizado do engenheiro é dinamizar os cursos de história da ciência e da técnica. Ao travar relações dentro da história com os contextos do descobrimento, da invenção, da evolução e desenvolvimento de bens científicos e técnicos, juntamente com um conhecimento dos seus conteúdos habilitar-se-á o aluno com a necessária visão holística do processo de criação do engenheiro. Uma história da ciência e da técnica que busque o entendimento de correlações e interações de conhecimentos pretéritos com o contexto sócio econômico, de então, treina o aluno para sentir-se mais seguro ao tomar decisões na atualidade, ai já

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como engenheiro, com respeito a introdução de novas tecnologias nos novos ambientes sociais complexos.

A idéia aqui desenvolvida é de fornecer um ensino de história da ciência e da técnica, em especial da engenharia elétrica, que leve em conta os atributos apontados acima; que se aproveite das potencialidades das novas tecnologias da informação e que contemple o ensinamento dos aspectos genuinamente técnicos e científicos, sobretudo em suas fundamentações.

A estratégia do ensino é pesquisar na história eventos e experimentos cruciais que fundamentaram um ramo do saber ou então causaram rupturas ou desenvolvimento significativo das teorias existentes. O segundo passo é replicar as condições, os ambientes, as máquinas ou dispositivos inventados que esclareçam ou ilustrem aspectos fundamentais do saber constituído. Essas replicagens seriam objeto de manipulações, por ações no computador, através do "mouse" ou teclado visando modificar a posição dos objetos replicados em 3D, aproximando ou distanciando-se dos objetos criados, acionando chaves e botões que alteram intensidades de variáveis que atuam na RV criada, girando manivelas virtuais, baixando alavancas virtuais, acrescentando objetos, volumes, "pesos", temperatura, correntes etc. Ou seja, criando um ambiente de interatividade onde a meta é se aproximar o mais possível da situação real onde cientistas e técnicos conseguiram estabelecer leis, e fenômenos relevantes para o entendimento do comportamento da natureza no aspecto observado. Essas ações objetivam fazer com que o aluno compreenda o "fenômeno", de forma não apenas escrita, mas através de ações que imitem as atuações de cientistas e técnicos que no passado agiram para determinar leis da natureza. Além de que se pode reproduzir e discutir as condições da formulação das leis e princípios, resgatando a atuação das personalidades científicas, os materiais existentes, as dificuldades, os limites, a interação entre os cientistas. Tudo em bloco, em forma de hipertexto, conjugando RV, animações, visualizações onde a beleza visual/gráfica entra como elemento adicional para motivar e incentivar ainda mais o assunto tratado. Ao trabalhar com a realidade virtual nos moldes postos o aluno estará apto a realizar aplicações também virtuais, dentro dos limites impostos por programação. Treinará então a análise dos resultados obtidos virtualmente, em um contexto já ocorrido.

A história da ciência pode ser considerada um poderoso auxiliar à educação técnica para evitar que o intelectual, que trabalha com a ciência e/ou a técnica, não fique restrito somente aos percalços internos da disciplina em que trabalha. Ela é uma porta que se abre para mostrar ao homem o senso prático das suas pesquisas, dar um sentido que visa não apenas o acúmulo de conhecimentos técnicos e científicos, mas também um engrandecimento cultural e humano. As biografias de muitos cientistas mostram que suas preocupações transcendiam a mera atividade imediata, para atingir questões filosóficas, sociais e humanas. A História da Ciência traz para dentro dos conhecimentos estritamente técnicos a cultura viva dos mais diferentes povos. Mesmo que, nos dias atuais, os conhecimentos científicos de ponta estejam se tornando mercadorias, ela pode mostrar caminhos para superar esses entraves, recuperando sentidos já percebidos por muitos de que a ciência pode ser útil para a paz e para resolver os problemas da miséria material e espiritual da sociedade.

As novas diretrizes curriculares para o curso de engenharia têm chamado a atenção que o profissional de engenharia deve ter além de uma sólida formação técnica e científica capacidade para a "... resolução de problemas considerando os aspectos políticos, econômicos, sociais, ambientais e culturais, com visão ética e humanística, em atendimento às demandas da sociedade" [1]. Certamente para isso ele deve ser capaz de avaliar o impacto das atividades da engenharia no contexto social e ambiental, demonstrando preocupação com a valorização do ser humano e a preservação do meio ambiente. O ensino da História da Ciência e da Técnica em muito contribui para a obtenção de engenheiros com essas características.

A TECNOLOGIA DA REALIDADE VIRTUAL

A Tecnologia da realidade virtual aplica-se ao desenvolvimento, via computador, de ambientes artificiais que conjugam três características: imersão, interatividade e navegabilidade. Atualmente as duas formas mais comuns de implementação da tecnologia da realidade virtual são:

- Realidade virtual imersiva, que faz uso de uma série de dispositivos periféricos para produzir a sensação de realismo tais como capacetes, luvas e sensores especiais.
- A realidade virtual via Internet (também chamada de realidade virtual desktop) que pode ser visualizada em navegadores da web através do uso de plug-ins específicos.

A realidade virtual via Internet pode ser desenvolvida através do uso da linguagem VRML (uma sigla para Virtual Reality Modeling Language). A VRML é uma linguagem independente de plataforma e empregada na descrição de cenas tridimensionais, que podem ser visualizadas e manipuladas tanto através da Internet como a partir de arquivos residentes no computador do usuário. Ela suporta animações em 3D e interações em tempo real com a linguagem Java. Essas características tornam a realidade virtual via *Internet* um recurso potencialmente importante para o processo de ensino aprendizado. Uma parcela considerável de arquivos em VRML disponíveis atualmente na Internet são direcionados para as atividades de ensino e aprendizado.

REALIDADE VIRTUAL NO ENSINO de ENGENHARIA

Em 1948 um grupo de educadores propôs o desenvolvimento de um sistema de classificação de metas e objetivos educacionais dividido três domínios: o cognitivo, o afetivo e o psicomotor. O estudo para o domínio cognitivo (relacionado aos conhecimentos e habilidades intelectuais) foi desenvolvido por Benjamin Bloom et al. e concluído em 1956. Nesse estudo foi feita uma classificação dos objetivos educacionais cognitivos numa hierarquia de seis níveis, do mais simples ao mais complexo, que ficou conhecida como a Taxonomia de Bloom [2].

Os seis níveis são:

1. Conhecimento: recordar informações.
2. Compreensão: compreender a informação memorizada.
3. Aplicação: usar um conceito geral para resolver um problema particular.
4. Análise: dividir um problema em suas partes fundamentais.
5. Síntese: criar algo novo a partir da combinação de diferentes idéias.
6. Avaliação: juntar elementos para criar uma unidade específica, estabelecer um padrão ou definir uma nova abordagem.

Os três primeiros níveis, Conhecimento, Compreensão e Análise se aplicam a aulas puramente expositivas enquanto que os três últimos aparecem em processos onde os alunos tem uma participação mais ativa na construção de seu aprendizado.

Felder e Silverman [3] classificaram cinco dimensões para o processo de aprendizagem: percepção (sensorial ou intuitiva), entrada (visual ou aural) organização (indutiva ou dedutiva), processamento (ativo ou reflexivo) e compreensão (seqüencial ou global). Posteriormente, Felder introduziu algumas mudanças nessa classificação, eliminando a dimensão indutiva/dedutiva e substituindo a categoria visual/aural por visual/verbal. A cada dimensão de estilo de aprendizagem corresponderia um estilo de ensino. Desse modo existiriam, também, cinco dimensões para os estilos de ensino [3]: conteúdo (concreto ou abstrato), apresentação (visual ou verbal), organização (indutiva ou dedutiva), participação do aluno (ativa ou passiva) e perspectiva (seqüencial ou global). A classificação dos domínios de ensino/aprendizagem de Felder e Silverman tem referências na "Teoria dos Tipos Psicológicos" de C. G. Jung [4]. De acordo com a classificação de Felder e Silverman estudantes cujo estilo de aprendizagem é preferencialmente visual teriam melhor desempenho em um estilo de ensino que privilegiasse o uso de imagens, diagramas, mapas, gráficos e demonstrações experimentais. Por outro lado, dados disponibilizados por diferentes educadores [6]-[8] sugerem que o estilo de aprendizado dos estudantes de engenharia é predominantemente visual. Baseado na correção desses dados é possível concluir que o uso de recursos de visualização, modelagem e simulação seriam especialmente úteis no ensino de engenharia. A prática profissional nos mostra que essa assertiva é particularmente verdadeira no caso da Engenharia Elétrica. Os estudantes dessa área da engenharia defrontam-se freqüentemente com conceitos abstratos tais como: campos elétricos, campos magnéticos, funções potenciais, fluxos, correntes, etc. A maioria dessas e outras funções elétricas são comumente visualizadas de modo indireto, pela observação das conseqüências de sua presença. O elevado grau de abstração nos conceitos fundamentais da Engenharia Elétrica força os profissionais na área de formação de engenheiros eletricistas a recorrer, freqüentemente, a técnicas de representação visual. Devido a isso, ganham importância as atividades didáticas voltadas para a modelagem, visualização, simulação e experimentação. Dentro desse contexto, e possível afirmar que a realidade virtual é uma ferramenta potencialmente útil na formação de engenheiros eletricistas. Suas características essencialmente gráficas, aliadas ao uso do som e da a possibilidade de navegação interativa se casam com o estilo de aprendizagem visual da maioria dos estudantes de engenharia, podendo a mesma se transformar ser um instrumento de enriquecimento do processo de ensino/aprendizado. De acordo com Bell e Fogler [9] o uso da realidade virtual no processo educacional beneficia especialmente aqueles estudantes que conjuguem características de aprendizes ativos e visuais onde aprendizes ativos são aqueles que aprendem fazendo, interagindo e participando. Ainda de acordo com os mesmo autores, o uso adequado de recursos educacionais em realidade virtual pode oferecer aos alunos um ambiente educacional rico no qual possam exercer dos níveis mais elevados da taxonomia de Bloom.

UMA VISITA VIRTUAL AO LABORATÓRIO DE MICHAEL FARADAY

A tecnologia da realidade virtual tem sido utilizada em um projeto em desenvolvimento no Departamento de Eletroténica da Universidade Federal do Rio de Janeiro (UFRJ) objetivando a produção de recursos instrucionais para o ensino/aprendizado de engenharia elétrica [10]. Parte dos recursos desse projeto – projeto LANTEG, uma sigla para Laboratório de Novas Tecnologias para o Ensino da Engenharia – estão sendo implementados através do uso da linguagem VRML e várias razões determinaram essa escolha. Uma delas é o custo, ainda muito elevado, da montagem de um ambiente de visualização e interação para realidade virtual imersiva. Esse ambiente precisa ser fixo o que obrigaria o deslocamento do professor e dos alunos até o local onde foi instalado sempre que o seu uso fosse necessário. No caso da linguagem VRML, os arquivos podem ser visualizados em um computador de uso pessoal, facilmente transportável para sala da aula. Além disso, arquivos em VRML podem ser disponibilizados via Internet, o que permite expandir (democratizar) o uso dos recursos em desenvolvimento para um número maior de usuários.

A estrutura do Projeto LANTEG é formada pela união de um conjunto de sub-projetos direcionados para temas distintos (mas complementares) dentro da área da Engenharia Elétrica tais como: Teoria Eletromagnética, Máquinas Elétricas, Eletrônica Analógica e Digital, Eletricidade Aplicada e História da Ciência e da Técnica. O sub-projeto para História da Ciência e da Técnica está associado a uma disciplina de graduação no mesmo tema [11]. Algumas questões surgiram quando do planejamento desse curso. Uma delas foi como estruturar um curso de História da Ciência que se casasse mais proximamente com o estilo de aprendizado predominantemente visual dos alunos de engenharia? O curso deveria discutir a evolução da ciência e da tecnologia do eletromagnetismo e a primeira idéia foi o uso de recursos visuais bidimensionais. Os autores têm catalogado um extenso banco de imagens de máquinas eletrodinâmicas clássicas, relacionadas à evolução da tecnologia do eletromagnetismo, e esse material poderia ser organizado, via um sistema de apresentação, em várias seqüências de slides. No entanto, descrever uma máquina eletrodinâmica clássica, geralmente com estrutura bastante complexa, através de uma imagem bidimensional nem sempre é uma atividade fácil. Havia a dúvida se conceitos fundamentais definidos pelos primeiros cientistas poderiam ser enfatizados, ressaltados, a partir de uma imagem bidimensional (sem com isso cair numa descrição essencialmente verbal). A primeira solução pensada foi concentrar o trabalho nas máquinas cujo desenvolvimento originaram saltos tecnológicos importantes e tentar apresenta-las presencialmente aos alunos. Algumas dessas máquinas ainda podem ser encontradas em museus de ciência de modo que a idéia tinha alguma possibilidade de ser implementada. No entanto havia também uma série de restrições à sua realização: as máquinas em questão são peças raras restando poucos exemplares em Museus de História da Ciência e Tecnologia. Nesses museus o contato é predominantemente contemplativo, não se permitindo o manuseio das peças por razões, óbvias, de segurança. Havia, ainda, outra restrição, de caracter geográfico, associada ao fato de que a maioria dessas peças estarem em museus de ciência localizados fora do Brasil. Desse modo o contato com a informação técnica e histórica transportada pelas máquinas antigas acabaria por se resumir a uma experiência contemplativa, um processo não interativo e menos enriquecedor. Surgiu, então a idéia do uso da realidade virtual nesse processo. Com a replicagem das máquinas através do uso da tecnologia da realidade virtual permitir-se-ia ao aluno o acesso a modelos tridimensionais interativos. Ele poderia manipular os objetos, escolher aqueles com os quais gostaria de interagir, observa-los de diferentes ângulos, decompô-los em suas partes constitutivas, acioná-los com segurança (mais precisamente, simular o acionamento) e entender os princípios de seu funcionamento. Como conseqüência da idéia de replicagem das máquinas eletrodinâmicas, surgiram duas novas questões. A primeira delas relacionava-se o fato de que as máquinas eletrodinâmicas focalizadas faziam parte de um contexto experimental e que, em função disso, seria interessante replicar não apenas as máquinas mas as próprias experiências nas quais foram usadas, ou para as quais foram criadas. A outra questão, uma conseqüência da argumentação do parágrafo anterior, lembrava que o material desenvolvido fazia parte de um contexto mais amplo, ainda, que envolvia o próprio homem, na figura do cientista, que desenvolveu a técnica estudada. Essa última questão direcionou o projeto para a replicagem em realidade virtual do próprio ambiente de trabalho dos cientistas. Desse modo o aluno teria a possibilidade de visualizar, explorar e interagir com uma réplica do local de trabalho do cientista foco de seu estudo. Teria, também, concentrada (organizada) em um único ambiente, uma visão global da produção do pesquisador estudado. Foi feita, então, uma relação inicial de cientistas cujos trabalhos produziram marcos na ciência da Engenharia Elétrica. Dessa lista inicial fazem parte: Michael Faraday, Charles Coulomb, Hans Christian Oersted, André Marie Ampère, e Alessandro Volta. Para cada cientista foi previsto um Laboratório-Museu virtual cujas portas de entrada seriam as replicagens dos seus ambientes de trabalho. A partir desses laboratórios virtuais o aluno encontraria informações sobre o cientista, o contexto histórico de seu trabalho, suas experiências fundamentais e os equipamentos desenvolvidos, tudo apresentado de forma predominantemente visual e interativa. Esse artigo apresenta o estágio atual de desenvolvimento do Laboratório-Museu Virtual de Michael Faraday.

O LABORATÓRIO-MUSEU de MICHAEL FARADAY

A informação visual sobre o laboratório de Michael Faraday foi obtida a partir de uma imagem, largamente difundida na Internet, que mostra o cientista trabalhando em seu laboratório, localizado em um porão do prédio da Royal Institution de Londres. De acordo com informações adicionais, colhidas também na Internet, essa imagem é uma reprodução em preto e branco de uma aquarela feita pela artista Harriet Jane Moore (1801-1884) em meados do século dezenove. Harriet Moore produziu uma série de trabalhos sobre o interior do prédio da Royal Institution usando a técnica da aquarela. A imagem citada acima é reproduzida em escala na Figura 1 para efeito de comparação. Tomando-se como base a pintura de Harriet Moore o interior do laboratório de Faraday foi replicado. A Figura 2 mostra o ambiente do laboratório vazio, apenas com os móveis, sem a inclusão dos instrumentos e material de trabalho. A Figura 3 apresenta uma vista do laboratório replicado tomada de um ângulo ligeiramente diferente da pintura original. Nessa imagem o laboratório já aparece com os instrumentos e material de trabalho. A Figura 4 mostra detalhes da bancada de trabalho e recipientes de vidro nas prateleiras ao fundo. A Figura 5 mostra um conjunto de objetos replicados para compor a cena da aquarela de Harriet Moore. Nesse conjunto podem ser identificados uma peça semelhante a um alambique que é localizada em primeiro plano, no canto inferior direito da aquarela. Há também outra peça, também localizada em primeiro plano, sobre a mesa, no lado direito da aquarela. É uma espécie de garrafa metálica da qual sai um tubo que termina em uma espécie de tigela metálica. Não conseguimos, ainda, identificar a finalidade dessas peças. As Figuras 6 e 7 são imagens tomadas de duas replicagens em VRML para a reconstrução duas experiências clássicas realizadas por Faraday: os "Copos de Faraday" e o "Disco Gerador de Faraday", respectivamente. A experiência dos Copos de Faraday foi uma das primeiras demonstrações da relação entre fluxo de corrente, campo magnético e força magnética. O Disco de Faraday permite demonstrar os princípios de funcionamento de um gerador elementar: um disco metálico condutor gira dentro de um campo magnético uniforme e o resultado é o surgimento de uma força eletromotriz induzida radialmente no disco.

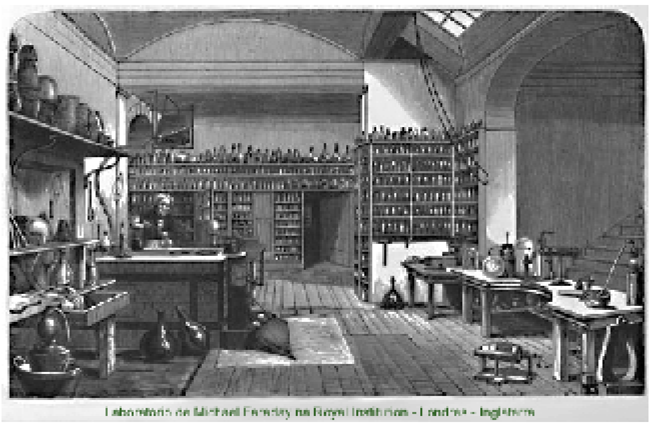

FIGURA. 1
REPRODUÇÃO DE UMA AQUARELA DA ARTISTA HARRIET MOORE, TOMADA COMO BASE PARA A REPLICAGEM EM VRML DO LABORATÓRIO DE FARADAY

FIGURA. 2
LABORATÓRIO DE FARADAY: REPLICAGEM EM VRML SEM A INCLUSÃO DE OBJETOS

FIGURA. 3
LABORATÓRIO DE FARADAY: REPLICAGEM COM A INCLUSÃO DE OBJETOS.

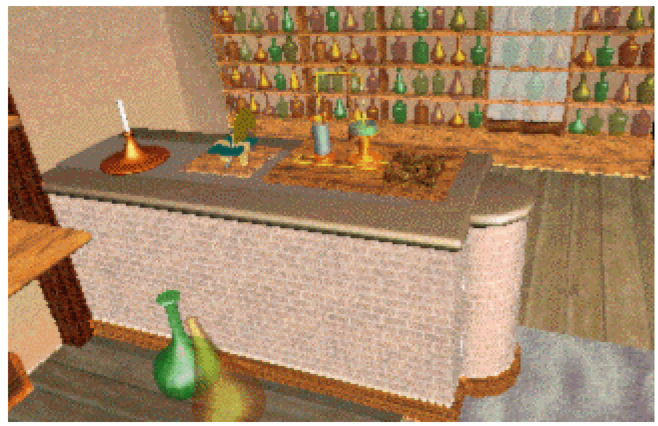

FIGURA. 4
LABORATÓRIO DE FARADAY: DETALHE DA BANCADA DE TRABALHO .

FIGURA. 5
LABORATÓRIO DE FARADAY: ALGUNS OBJETOS REPLICADOS PARA COMPOR A CENA DA AQUARELA DE HARRIET MOORE.

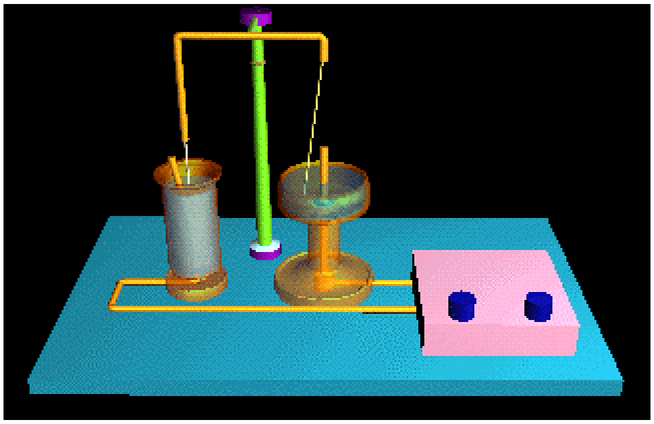

FIGURA. 6
LABORATÓRIO DE FARADAY: REPLICAGEM EM VRML PARA A EXPERIÊNCIA DOS COPOS DE FARADAY.

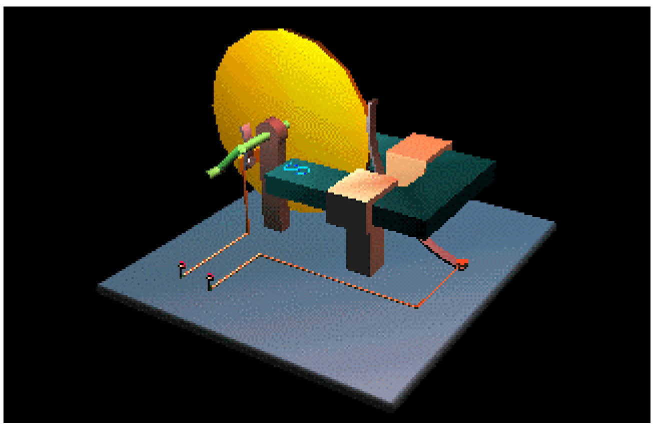

FIGURA. 7
LABORATÓRIO DE FARADAY: REPLICAGEM EM VRML PARA A EXPERIÊNCIA DO DISCO GERADOR DE FARADAY.

O desenvolvimento do Laboratório Museu Virtual de Michael Faraday não está ainda completo. Inúmeros problemas precisam ser resolvidos, principalmente no que diz respeito ao tamanho dos arquivos. É necessário um trabalho consistente de otimização para que os tamanhos exagerados dos arquivos (da ordem de 50Mb) possam ser reduzidos a dimensões passíveis de serem processados e transmitidos via Internet. Várias técnicas para otimização de arquivos de computação gráfica estão sendo testadas eficientemente e os resultados desse trabalho serão brevemente anunciados em outra publicação dos autores.

CONCLUSÃO

O uso adequado de recursos disponibilizados pela tecnologia da realidade virtual pode proporcionar ao aluno de engenharia estímulos complementares importantes para a construção de seu conhecimento. O presente trabalho apresentou alguns produtos do uso da tecnologia da realidade virtual no desenvolvimento de material educacional para um curso de História da Ciência e da Técnica. Uma breve análise sobre a importância do conhecimento da História da Ciência na formação de engenheiro foi desenvolvida. Discorreu-se também sobre o uso de ferramentas da computação gráfica, mais especificamente da realidade virtual, no desenvolvimento de recursos educacionais objetivando adequá-los ao estilo de aprendizado visual, predominante entre os estudantes da área da engenharia. O conceito de Laboratório-Museu Virtual analisado e os uma implementação de mesmo, através da reconstrução do ambiente de trabalho de Michael Faraday foi elaborado. O trabalho realizado ressalta a importância dos recursos da computação (Internet, realidade virtual e animações interativas) como ferramenta de visualização e modelagem no ensino/aprendizado da engenharia elétrica, uma das mais abstratas das engenharias. O uso adequado e planejado desses recursos educacionais pode contribuir para a disseminação do saber e democratização do acesso ao conhecimento.

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A GRUPOTERAPIA NA FORMAÇÃO CONTINUADA DE PROFESSORES DO ENSINO SUPERIOR

Karina Perez Mokarzel Carneiro[1]

Resumo — *A proposta deste trabalho é analisar a ação preventiva das grupoterapias com professores de ensino superior e de pós-graduação. Durante muitos séculos, o ensino baseou-se num paradigma: o professor é detentor dos conhecimentos e os transmite a um grupo de estudantes, que depois devolvem o que aprenderam por intermédio de provas. O estudante é assim considerado, não sendo observadas as diferenças existenciais entre crianças, adolescentes e adultos em salas de aula. A maioria dos professores em atividade hoje não teve no seu currículo profissional capacitação para exercer esse papel de formador. Muitos estão desgastados, lutando contra muitas dificuldades. A própria forma de ser da Educação entrou em crise. Aponta-se como uma das saídas para esses problemas a implantação de programas de formação continuada de professores, sob orientação psicopedagógica, com o objetivo de criar uma cultura de formação, melhorando, assim, a qualidade no ensino.*

Palavras chaves — Ensino superior, formação continuada, grupoterapia preventiva, professor.

INTRODUÇÃO

A orientação educacional surgiu para atender àqueles que apresentavam problemas e dificuldades escolares, principalmente nas escolas de primeiro e segundo graus, pois, nesta faixa etária as estruturas cognitivas e a personalidade da criança ainda estão sendo formadas. Pensava-se que atuando neste nível de aprendizagem evitavam-se dificuldades futuras. Acreditava-se que alunos de cursos superiores eram adultos e responsáveis pelos seus atos e que eram capazes de conduzir sua própria formação. Porém, a realidade mostra que existem universitários e pós-graduandos que também apresentam dificuldades de aprendizagem, sejam em aspectos cognitivos, afetivos e/ou sociais.

A grupoterapia tem auxiliado na prevenção e solução de tais dificuldades, atuando junto aos alunos, professores, funcionários, dirigentes e familiares. Assim, cada escola deve ter o seu próprio serviço de orientação, viabilizando o atendimento a todos de modo efetivo e permanente.

As razões do fracasso escolar são inúmeras e estão relacionadas com todos os envolvidos com a aprendizagem. Não se deve cometer a injustiça de se culpar apenas o aluno, em quaisquer casos de insucesso escolar, deixando de analisar cada situação de maneira mais crítica e abrangente, considerando-se a dimensão política e filosófica da educação, a situação da escola e as responsabilidades dos professores.

A intenção de um programa de formação continuada de professores, através de um processo grupal, é desencadear perturbações no professor que o levem a refletir sobre sua prática e incentivar o desenvolvimento de instrumentos didático-pedagógicos que possam restabelecer a motivação e a criatividade nas escolas. Estas reflexões devem ser proporcionadas pela escola, juntamente com um psicopedagogo, visando melhorar a qualidade no ensino.

CONTEXTUALIZAÇÃO

As dificuldades na aprendizagem surgem a partir de vários fatores: neurológicos, psicológicos, familiares, sociais, uso de drogas, relacionamento com o professor, etc. As discussões em torno das dificuldades que acometem o ensino superior nos congressos nacionais e internacionais, revelam a imensidão e a complexidade do problema. Porém, as providências tomadas pelas instituições de ensino e políticas, tais como: mudanças na grade curricular, diminuição da carga de aulas expositivas, melhoria dos laboratórios e o incentivo aos cursos de mestrado e doutorado apenas em áreas técnicas, não são suficientes para reverter o quadro. Para que haja mudança efetiva na situação em que se encontra o ensino no Brasil, é imprescindível a orientação educacional constante e periódica do corpo discente e docente.

O educador, por estar em contato direto com o educando e ser o principal responsável pela construção do conhecimento, pode tanto promover a aprendizagem como também dificultá-la. Muitas das dificuldades dos alunos estão relacionadas com a antipatia que estes nutrem pelo professor, com a relação professor-aluno, com o autoritarismo desmedido, com as metodologias inadequadas de ensino, com frustrações e fantasmas dos ensinantes e com a desmotivação. Na maioria das vezes os professores desconhecem os efeitos malignos de sua atuação ineficiente e acham que a culpa é sempre do aluno.

Existem fatores intervenientes nos resultados acadêmicos, entre os quais, a maioria nada tem a ver com o processo específico da aprendizagem. Por isso, a prevenção efetuada através da orientação de professores e de apoio continuado aos alunos, oferece a possibilidade de um desenvolvimento adequado e crescente na educação.

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O trabalho preventivo de orientação de professores nas instituições de ensino superior é feito individualmente ou em grupos, sob a forma de grupoterapias, palestras, assessorias, treinamentos, intervenções periódicas, congressos, mini cursos, mesas redondas, etc.

A orientação individual acontece por solicitação do próprio professor que deseja melhorar a eficiência de seu trabalho ou dos alunos que se sentem prejudicados com a atuação do docente. O docente é orientado quanto às metodologias de ensino e de avaliação da(s) disciplina(s) por ele ministrada(s), quanto as bibliografias de áreas diversas que o ajude no aprimoramento de seu trabalho, quanto ao relacionamento com seus alunos, ao processo de transferência e contratransferência, ao controle de frustrações, etc.

Os trabalhos em grupo devem ser programados de maneira que não atrapalhe os professores, afastando-os por muito tempo de suas atividades. É essencial o caráter interdisciplinar no preparo de tais atividades, contando com a ajuda de profissionais como médicos, neurologistas, fonoaudiólogos, neurolingüistas, pedagogos e psicólogos. A participação do orientador é importante no incentivo a participação de todos nas atividades propostas.

Um dos desafios da orientação educacional é a quebra da resistência à mudanças por parte dos professores na transposição das metodologias de ensino tradicionais para metodologias mais modernas, dinâmicas e motivadoras.

O PROFESSOR DO ENSINO SUPERIOR

Nos cursos superiores brasileiros são considerados habilitados a seguir a carreira docente, aqueles que possuem um título superior, qualquer que seja ele. Assim, para ser professor de medicina, basta ser médico; para ser professor de história, basta ser historiador; para lecionar na área de engenharia, basta ser engenheiro. Tal procedimento deve ter origem no entendimento de que o domínio dos saberes técnicos da profissão é suficiente para transformar um indivíduo legalmente diplomado num professor.

Como resultado disso, os professores aprendem a ser docentes, quando isso acontece de fato, pela própria experiência, o que em geral se dá como um esforço solitário.

O modelo de ensino onde o professor é o detentor do saber e o elemento ativo do processo ensino-aprendizagem, e o aluno é totalmente passivo, aceita o conhecimento como uma verdade não contestável, é desmotivador. Não basta que o professor aprimore o seu conhecimento técnico, é preciso ser mestre. Ser um mestre é mais que repassar conhecimentos, é promover situações desafiadoras para o aluno, que o transporte para um nível de conhecimento superior ao já existente. Portanto, além da capacitação técnica é indispensável ao professor o conhecimento de técnicas de ensino e de relacionamento humano.

Na reflexão de Bazzo [1], “A competição da escola com os meios modernos de divulgação de informações nos coloca uma séria questão com relação à motivação dos estudantes: as aulas tradicionais deixam definitivamente de ser atraentes, quando confrontadas com a televisão com seus múltiplos canais e seus programas cada vez mais bem produzidos, com a ‘navegação’ via Internet, com os programas multimídia, com a realidade virtual. As avaliações, nos moldes ainda atualmente empregados, tornam-se mais que ultrapassadas, são inócuas ou mesmo um obstáculo para a aprendizagem. Como resultado, colhem-se cada vez mais a desilusões, desistências e inconformismos com o sistema de ensino”.

A relação que o professor estabelece com o aluno é uma das características fundamentais para a permanência e o aproveitamento do indivíduo nas atividades propostas pelo docente. Muitas das dificuldades apresentadas pelos alunos estão relacionadas com a antipatia pelo professor.

Tanto o professor quanto os alunos trazem consigo experiências anteriores ao encontro na sala de aula. A relação professor-aluno vai depender principalmente da maturidade afetiva do professor. A orientação educacional grupal contribui para esta maturidade, porém, se o professor não conseguir lidar com seus fantasmas e frustrações, deve procurar a orientação individual do psicopedagogo.

As atividades propostas pelo grupoterapeuta devem contribuir para a diminuição, ou até eliminação, de características antipáticas dos professores como: autoritarismo, insegurança, frieza, desprezo, desinteresse, agressividade e ironia, e passem a ter atitudes que os tornem mais simpáticos. Os alunos apreciam professores calmos, pacientes, alegres, atenciosos, pontuais, que gostam do que fazem e que se preocupam com o aprendizado. A autoridade e a disciplina para o professor simpático surgem naturalmente.

As aulas puramente expositivas, onde o professor é quem estabelece o ritmo e a seqüência, não são atrativas e contribuem com a não permanência do aluno na escola. Há que se mudar a estratégia hoje utilizada para trabalhos mais dinâmicos, atrativos, que desenvolva além do conhecimento puramente intelectual, outras qualidades como liderança, trabalho em grupo, criatividade, perseverança, percepção, etc. Apesar de existirem inúmeras metodologias de ensino, será sempre necessária a criação de outras, mais atrativas e adequadas ao estágio de desenvolvimento histórico e à realidade imediata dos alunos.

Os alunos se sentem motivados pelos professores que se interessam pelo aprendizado. A utilização de estratégias de ensino criativas, dinâmicas e que incentivem a participação ativa dos alunos torna os trabalhos escolares mais atraentes e competitivos quando comparados à TV, à Internet e a outras atividades.

Devido às constantes mudanças sociais ocorridas no mundo, o ensino altamente baseado na memorização e na reprodução de tarefas repetitivas, não é mais apropriado ao perfil do atual profissional. Portanto, as avaliações individuais centradas na memorização, na repetição de métodos, na reprodução precisa e detalhada das explicações do professor e na punição do erro, se tornaram inadequadas para os dias atuais.

Um dos principais aspectos debatidos nas instituições de ensino são as formas de avaliação e as maneiras de quantificar o aproveitamento escolar. Por ser uma das maiores causas da desmotivação, da repetência e da evasão escolar, o sistema de avaliação deve ser repensado e arduamente discutido. Porém, isto não deve implicar em um relaxamento dos níveis de exigência, mas em se adotar uma forma mais eficaz de valorizar a aquisição do conhecimento, observando as capacidades adquiridas pelo indivíduo quanto a generalizações, comparações, análises, sínteses, críticas, discriminações, organizações, estruturas lógicas, etc.

Não existe uma maneira única de se avaliar um grupo de alunos, pois há diferenças entre disciplinas, escolas, número de alunos e abordagem. Cabe ao professor analisar qual o melhor sistema de avaliação a ser adotado na sua disciplina. O orientador educacional deve incentivar os docentes a experimentarem novos métodos de avaliação e aperfeiçoar os já existentes.

Toda experiência deve ser relatada aos outros docentes da instituição, colocando os pontos positivos e negativos, as dificuldades encontradas na execução de tal trabalho e os resultados obtidos. Ao expor e ouvir experiências diversas e ao debater sobre o assunto, o professor aumenta seu senso crítico podendo, assim, reavaliar sua metodologia de avaliação, identificar falhas e saná-las.

Alguns professores gostam de ser detentores do saber. Submetem seus alunos a massacres psicológicos e se vangloriam por serem os responsáveis pelos mais altos índices de reprovação da escola. Suas avaliações não valorizam a construção do conhecimento, conseguem, apenas, qualificar informações retidas naquele momento.

Outros professores, com medo de críticas e de perderem a posição que ocupam, aplicam provas fáceis para que a maioria dos alunos obtenha a aprovação, o que não avalia a construção do aprendizado.

Os professores extremistas normalmente apresentam forte resistência a mudanças. Com o trabalho do grupoterapeuta há que se instalar na instituição a cultura de que as metodologias de avaliação devem realmente quantificar e qualificar a construção do conhecimento.

Outro ponto de igual importância a ser tratado é o significado do erro nas avaliações. O grupoterapeuta deverá desenvolver nos educadores a capacidade crítica de analisar se o erro é proveniente de problemas relacionados ao aluno, ao próprio professor, à escola ou à sociedade. Os erros dos alunos devem fornecer elementos para o professor refletir sobre sua prática e modificar sua estratégia de ensino.

As escolas e seus educadores tendem a se preocupar mais com a quantificação do acerto e a punição do erro do que com o raciocínio do aluno, desconsiderando totalmente a construção do conhecimento.

CONCEITUAÇÃO DE GRUPO

Todo indivíduo deve ser estudado dentro do contexto social, pois em toda a sua existência, convive com outros indivíduos, partilhando o mesmo espaço e os mesmos desejos, interesses e ambições.

Pichon-Rivière [2] relata que "Todo conjunto de pessoas ligadas entre si por constantes de tempo e espaço, e articuladas por sua mútua representação interna (dimensão ecológica), configura uma situação grupal. Tal situação está sustentada por uma rede de motivações e nela interagem entre si, por meio de um complexo mecanismo de assunção e adjudicação de papéis. É nesse processo que deverá surgir o reconhecimento de si e do outro no diálogo e no intercâmbio permanente. Essa situação grupal constitui o instrumento mais adequado para essa aprendizagem de papéis (aprendizagem social), em que consiste a internalização operativa da realidade".

Nas palavras de Zimerman [3], "O ser humano é gregário, e ele só existe, ou subsiste, em função de seus inter-relacionamentos grupais. Sempre, desde o nascimento, ele participa de diferentes grupos, numa constante dialética entre a busca de sua identidade individual e a necessidade de uma identidade grupal e social".

Segundo o Novo Dicionário Aurélio, "grupo é uma pequena associação ou reunião de pessoas ligadas para um fim comum". Para alguns autores, o conjunto de duas pessoas (por exemplo, um casal) já configura um grupo. Pode-se conceituar também através do grupo familiar, escolar, terapêutico, profissional, esportivo, religioso, etc. Estes grupos estão constantemente sendo renovados e ampliados no decorrer da vida do indivíduo.

As pessoas levam seu universo pessoal ao grupo, composto pelas suas características de personalidade, vivências pessoais e experiência profissional. Por isso, o resultado de um grupo como um todo é diferente do somatório de suas partes.

Inseridos numa situação grupal, os indivíduos reagirão diferentemente em função destas características, focados num processo de interação, no qual as ações e reações individuais influirão e serão influenciadas pelo grupo.

Ao trabalhar com um grupo, um coordenador deve levar em consideração as características pessoais dos membros do grupo, sejam elas características de personalidade, físicas, econômico-sociais ou profissionais.

OBJETIVOS DO GRUPO

A existência de um grupo ou uma equipe deve ser fundamentada numa razão de ser que justifique sua própria existência. Esta razão de ser chama-se objetivos. A definição clara dos objetivos de um grupo por si só não garante o sucesso do mesmo. Ao se trabalhar com grupos, deve-se ter o entendimento aprofundado de como os objetivos grupais estão em interação com os objetivos individuais dos membros do grupo. Os objetivos individuais e grupais podem sofrer alterações ao longo do processo do grupo; assim, faz-se necessário a revisão constante destes objetivos.

Os objetivos do grupo especificam e definem os seus fins; identificam os alvos para os quais as atividades do grupo estão apontadas. Quando eficazmente desenvolvidos, diminuem as angústias dos integrantes do grupo, ampliam a base dos interesses comuns, sentimentos de identificação, motivações, padrões do grupo, participações úteis e satisfação dos membros do grupo.

A maioria dos grupos tem dificuldade em fazer com que os membros participem ativa e objetivamente. Este problema está relacionado com a falta de conhecimento claro dos objetivos, com a concordância sobre os propósitos do grupo ou da impossibilidade de perceber como as atividades se congregam para a consecução dos objetivos fixados.

Vivemos numa sociedade que está rapidamente se modificando. Os interesses e necessidades dos membros do grupo mudam com rapidez, aconselhando revisões e discussões sobre seus fins e objetivos. Tais revisões podem conduzir à mudança de objetivos, à fixação de outros, à reorientação das prioridades e, mesmo, ao reconhecimento da necessidade de se dissolver o grupo.

Às vezes, a complexidade da organização, o excesso de formalidade e a execução de um só tipo de trabalho impedem que o grupo procure os objetivos realmente importantes. Isto pode acontecer com qualquer grupo. A relação entre os objetivos definidos e as atividades estabelecidas formalmente permite superar tais dificuldades.

O propósito do grupo pode ser modificar o grupo e seus membros, ou, no caso do grupo de ação, decidir e executar programas específicos. Na designação dos objetivos deve-se indicar as modificações ou o tipo de ação que se espera do grupo e de seus membros.

Ao chegarem novos membros, é importante que os objetivos lhes sejam apresentados. O grau de satisfação e de participação dos membros antigos influencia os novos a aceitarem os objetivos e trabalharem a favor do grupo.

Uma vez determinados os objetivos, as futuras experiências e atividades do grupo tendem a ser moldadas e avaliadas segundo os seus termos. O grau com que os objetivos dos membros do grupo estão incorporados aos objetivos grupais influencia diretamente a fidelidade e a participação dos membros nas atividades organizadas.

CLASSIFICAÇÃO DOS GRUPOS

A classificação aqui utilizada se baseia no critério das finalidades a que se propõe o grupo. Será dividido em dois grandes ramos genéricos: Operativos e Terapêuticos. Na prática essas ramificações se completam. Cada um destes ramos, por sua vez, se subdivide em outras ramificações, conforme o esquema abaixo.

- **Grupos operativos**:
  (1) Ensino-aprendizagem (através da técnica de "Grupos de Reflexão").
  (2) Institucionais (empresas, escolas, igreja, exército, associações, etc.).
  (3) Comunitários (programas de saúde mental).
- **Grupos terapêuticos**:
  (1) De auto-ajuda – na área médica em geral (diabéticos, reumáticos, idosos, etc.); na área psiquiátrica (alcoolistas anônimos, pacientes, etc.).
  (2) Psicoterápicos (base psicanalítica, psicodrama, teoria sistêmica, cognitivo-comportamental, abordagem múltipla).

GRUPOS OPERATIVOS

Na ação preventiva da grupoterapia junto aos docentes, a modalidade de grupo utilizada é a de grupos operativos.

A conceituação e a aplicação dos grupos operativos, devem ao psicanalista argentino Pichon-Rivière [2]. Este autor enfoca que "A técnica de grupos por nós criada, chamada de grupos operativos, caracteriza-se por estar centrada, de forma explícita, em uma tarefa que pode ser a aprendizagem, a cura (abrange os grupos terapêuticos), o diagnóstico das dificuldades de uma organização profissional, etc. Sob esta tarefa subjaz outra, implícita, que aponta para a ruptura, através do esclarecimento das pautas estereotipadas que dificultam a aprendizagem e a comunicação, significando um obstáculo frente a toda situação de progresso ou mudança".

Zimerman [3] observa que o termo "grupo operativo" é muito genérico, sendo que, em essência, designa mais propriamente uma ideologia do que uma técnica específica. Essa ideologia, visa sempre um aprendizado conectado com uma mudança psicológica (atitudes), especialmente a de aprender a aprender.

CONCLUSÕES

A preocupação das escolas superiores sempre foi de formar profissionais com o perfil estipulado pelo mercado de trabalho. Devido às grandes mudanças pelas quais o país vem passando, a educação brasileira precisa ser revisada e reestruturada.

O processo de reavaliação do ensino não é tarefa fácil, pois além da imensidão territorial, é totalmente dependente dos interesses político e da boa vontade das instituições. Um ensino de qualidade, motivador, criativo e dinâmico, requer dedicação de todas as partes envolvidas no processo de ensino-aprendizagem.

O professor é a figura mais próxima do aluno, portanto pode atuar tanto como gerador de dificuldades ou como promotor da aprendizagem, dependendo do seu equilíbrio emocional e psíquico. Controlar suas frustrações ajuda a amenizar a resistência à mudanças abrindo espaço para a orientação educacional. Não basta que o docente domine o conhecimento técnico, é preciso conhecer metodologias de ensino dinâmicas, estimulantes e desafiadoras.

Neste sentido, pode-se compreender a importância da orientação educacional preventiva no âmbito escolar. Acredita-se que uma das saídas para o caos em que se encontra a educação no Brasil é a formação continuada dos docentes, através de grupoterapias. Nas atividades em grupo, os docentes poderão discutir, analisar e refletir sobre seu trabalho e, assim, adquirir formação didática e humanística, tão necessária para a construção do conhecimento do aluno.

É fundamental que o grupoterapeuta goste e acredite na modalidade de trabalho escolhida, pois só assim, resultados realmente satisfatórios serão conseguidos.

O que se espera é uma educação tão prazerosa quanto a internet, a TV a cabo e os bailes, onde os professores possam ensinar aprendendo e, acima de tudo, despertar e exteriorizar o aprendizado do aluno.

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A GRUPOTERAPIA NA FORMAÇÃO CONTINUADA DE PROFESSORES DO ENSINO SUPERIOR

Karina Perez Mokarzel Carneiro[1]

Resumo *— A proposta deste trabalho é analisar a ação preventiva das grupoterapias com professores de ensino superior e de pós-graduação. Durante muitos séculos, o ensino baseou-se num paradigma: o professor é detentor dos conhecimentos e os transmite a um grupo de estudantes, que depois devolvem o que aprenderam por intermédio de provas. O estudante é assim considerado, não sendo observadas as diferenças existenciais entre crianças, adolescentes e adultos em salas de aula. A maioria dos professores em atividade hoje não teve no seu currículo profissional capacitação para exercer esse papel de formador. Muitos estão desgastados, lutando contra muitas dificuldades. A própria forma de ser da Educação entrou em crise. Aponta-se como uma das saídas para esses problemas a implantação de programas de formação continuada de professores, sob orientação psicopedagógica, com o objetivo de criar uma cultura de formação, melhorando, assim, a qualidade no ensino.*

Palavras chaves — Ensino superior, formação continuada, grupoterapia preventiva, professor.

INTRODUÇÃO

A orientação educacional surgiu para atender àqueles que apresentavam problemas e dificuldades escolares, principalmente nas escolas de primeiro e segundo graus, pois, nesta faixa etária as estruturas cognitivas e a personalidade da criança ainda estão sendo formadas. Pensava-se que atuando neste nível de aprendizagem evitavam-se dificuldades futuras. Acreditava-se que alunos de cursos superiores eram adultos e responsáveis pelos seus atos e que eram capazes de conduzir sua própria formação. Porém, a realidade mostra que existem universitários e pós-graduandos que também apresentam dificuldades de aprendizagem, sejam em aspectos cognitivos, afetivos e/ou sociais.

A grupoterapia tem auxiliado na prevenção e solução de tais dificuldades, atuando junto aos alunos, professores, funcionários, dirigentes e familiares. Assim, cada escola deve ter o seu próprio serviço de orientação, viabilizando o atendimento a todos de modo efetivo e permanente.

As razões do fracasso escolar são inúmeras e estão relacionadas com todos os envolvidos com a aprendizagem. Não se deve cometer a injustiça de se culpar apenas o aluno, em quaisquer casos de insucesso escolar, deixando de analisar cada situação de maneira mais crítica e abrangente, considerando-se a dimensão política e filosófica da educação, a situação da escola e as responsabilidades dos professores.

A intenção de um programa de formação continuada de professores, através de um processo grupal, é desencadear perturbações no professor que o levem a refletir sobre sua prática e incentivar o desenvolvimento de instrumentos didático-pedagógicos que possam restabelecer a motivação e a criatividade nas escolas. Estas reflexões devem ser proporcionadas pela escola, juntamente com um psicopedagogo, visando melhorar a qualidade no ensino.

CONTEXTUALIZAÇÃO

As dificuldades na aprendizagem surgem a partir de vários fatores: neurológicos, psicológicos, familiares, sociais, uso de drogas, relacionamento com o professor, etc. As discussões em torno das dificuldades que acometem o ensino superior nos congressos nacionais e internacionais, revelam a imensidão e a complexidade do problema. Porém, as providências tomadas pelas instituições de ensino e políticas, tais como: mudanças na grade curricular, diminuição da carga de aulas expositivas, melhoria dos laboratórios e o incentivo aos cursos de mestrado e doutorado apenas em áreas técnicas, não são suficientes para reverter o quadro. Para que haja mudança efetiva na situação em que se encontra o ensino no Brasil, é imprescindível a orientação educacional constante e periódica do corpo discente e docente.

O educador, por estar em contato direto com o educando e ser o principal responsável pela construção do conhecimento, pode tanto promover a aprendizagem como também dificultá-la. Muitas das dificuldades dos alunos estão relacionadas com a antipatia que estes nutrem pelo professor, com a relação professor-aluno, com o autoritarismo desmedido, com as metodologias inadequadas de ensino, com frustrações e fantasmas dos ensinantes e com a desmotivação. Na maioria das vezes os professores desconhecem os efeitos malignos de sua atuação ineficiente e acham que a culpa é sempre do aluno.

Existem fatores intervenientes nos resultados acadêmicos, entre os quais, a maioria nada tem a ver com o processo específico da aprendizagem. Por isso, a prevenção efetuada através da orientação de professores e de apoio continuado aos alunos, oferece a possibilidade de um desenvolvimento adequado e crescente na educação.

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O trabalho preventivo de orientação de professores nas instituições de ensino superior é feito individualmente ou em grupos, sob a forma de grupoterapias, palestras, assessorias, treinamentos, intervenções periódicas, congressos, mini cursos, mesas redondas, etc.

A orientação individual acontece por solicitação do próprio professor que deseja melhorar a eficiência de seu trabalho ou dos alunos que se sentem prejudicados com a atuação do docente. O docente é orientado quanto às metodologias de ensino e de avaliação da(s) disciplina(s) por ele ministrada(s), quanto as bibliografias de áreas diversas que o ajude no aprimoramento de seu trabalho, quanto ao relacionamento com seus alunos, ao processo de transferência e contratransferência, ao controle de frustrações, etc.

Os trabalhos em grupo devem ser programados de maneira que não atrapalhe os professores, afastando-os por muito tempo de suas atividades. É essencial o caráter interdisciplinar no preparo de tais atividades, contando com a ajuda de profissionais como médicos, neurologistas, fonoaudiólogos, neurolingüistas, pedagogos e psicólogos. A participação do orientador é importante no incentivo a participação de todos nas atividades propostas.

Um dos desafios da orientação educacional é a quebra da resistência à mudanças por parte dos professores na transposição das metodologias de ensino tradicionais para metodologias mais modernas, dinâmicas e motivadoras.

O Professor do Ensino Superior

Nos cursos superiores brasileiros são considerados habilitados a seguir a carreira docente, aqueles que possuem um título superior, qualquer que seja ele. Assim, para ser professor de medicina, basta ser médico; para ser professor de história, basta ser historiador; para lecionar na área de engenharia, basta ser engenheiro. Tal procedimento deve ter origem no entendimento de que o domínio dos saberes técnicos da profissão é suficiente para transformar um indivíduo legalmente diplomado num professor.

Como resultado disso, os professores aprendem a ser docentes, quando isso acontece de fato, pela própria experiência, o que em geral se dá como um esforço solitário.

O modelo de ensino onde o professor é o detentor do saber e o elemento ativo do processo ensino-aprendizagem, e o aluno é totalmente passivo, aceita o conhecimento como uma verdade não contestável, é desmotivador. Não basta que o professor aprimore o seu conhecimento técnico, é preciso ser mestre. Ser um mestre é mais que repassar conhecimentos, é promover situações desafiadoras para o aluno, que o transporte para um nível de conhecimento superior ao já existente. Portanto, além da capacitação técnica é indispensável ao professor o conhecimento de técnicas de ensino e de relacionamento humano.

Na reflexão de Bazzo [1], "A competição da escola com os meios modernos de divulgação de informações nos coloca uma séria questão com relação à motivação dos estudantes: as aulas tradicionais deixam definitivamente de ser atraentes, quando confrontadas com a televisão com seus múltiplos canais e seus programas cada vez mais bem produzidos, com a 'navegação' via Internet, com os programas multimídia, com a realidade virtual. As avaliações, nos moldes ainda atualmente empregados, tornam-se mais que ultrapassadas, são inócuas ou mesmo um obstáculo para a aprendizagem. Como resultado, colhem-se cada vez mais a desilusões, desistências e inconformismos com o sistema de ensino".

A relação que o professor estabelece com o aluno é uma das características fundamentais para a permanência e o aproveitamento do indivíduo nas atividades propostas pelo docente. Muitas das dificuldades apresentadas pelos alunos estão relacionadas com a antipatia pelo professor.

Tanto o professor quanto os alunos trazem consigo experiências anteriores ao encontro na sala de aula. A relação professor-aluno vai depender principalmente da maturidade afetiva do professor. A orientação educacional grupal contribui para esta maturidade, porém, se o professor não conseguir lidar com seus fantasmas e frustrações, deve procurar a orientação individual do psicopedagogo.

As atividades propostas pelo grupoterapeuta devem contribuir para a diminuição, ou até eliminação, de características antipáticas dos professores como: autoritarismo, insegurança, frieza, desprezo, desinteresse, agressividade e ironia, e passem a ter atitudes que os tornem mais simpáticos. Os alunos apreciam professores calmos, pacientes, alegres, atenciosos, pontuais, que gostam do que fazem e que se preocupam com o aprendizado. A autoridade e a disciplina para o professor simpático surgem naturalmente.

As aulas puramente expositivas, onde o professor é quem estabelece o ritmo e a seqüência, não são atrativas e contribuem com a não permanência do aluno na escola. Há que se mudar a estratégia hoje utilizada para trabalhos mais dinâmicos, atrativos, que desenvolva além do conhecimento puramente intelectual, outras qualidades como liderança, trabalho em grupo, criatividade, perseverança, percepção, etc. Apesar de existirem inúmeras metodologias de ensino, será sempre necessária a criação de outras, mais atrativas e adequadas ao estágio de desenvolvimento histórico e à realidade imediata dos alunos.

Os alunos se sentem motivados pelos professores que se interessam pelo aprendizado. A utilização de estratégias de ensino criativas, dinâmicas e que incentivem a participação ativa dos alunos torna os trabalhos escolares mais atraentes e competitivos quando comparados à TV, à Internet e a outras atividades.

Devido às constantes mudanças sociais ocorridas no mundo, o ensino altamente baseado na memorização e na reprodução de tarefas repetitivas, não é mais apropriado ao perfil do atual profissional. Portanto, as avaliações individuais centradas na memorização, na repetição de métodos, na reprodução precisa e detalhada das explicações do professor e na punição do erro, se tornaram inadequadas para os dias atuais.

Um dos principais aspectos debatidos nas instituições de ensino são as formas de avaliação e as maneiras de quantificar o aproveitamento escolar. Por ser uma das maiores causas da desmotivação, da repetência e da evasão escolar, o sistema de avaliação deve ser repensado e arduamente discutido. Porém, isto não deve implicar em um relaxamento dos níveis de exigência, mas em se adotar uma forma mais eficaz de valorizar a aquisição do conhecimento, observando as capacidades adquiridas pelo indivíduo quanto a generalizações, comparações, análises, sínteses, críticas, discriminações, organizações, estruturas lógicas, etc.

Não existe uma maneira única de se avaliar um grupo de alunos, pois há diferenças entre disciplinas, escolas, número de alunos e abordagem. Cabe ao professor analisar qual o melhor sistema de avaliação a ser adotado na sua disciplina. O orientador educacional deve incentivar os docentes a experimentarem novos métodos de avaliação e aperfeiçoar os já existentes.

Toda experiência deve ser relatada aos outros docentes da instituição, colocando os pontos positivos e negativos, as dificuldades encontradas na execução de tal trabalho e os resultados obtidos. Ao expor e ouvir experiências diversas e ao debater sobre o assunto, o professor aumenta seu senso crítico podendo, assim, reavaliar sua metodologia de avaliação, identificar falhas e saná-las.

Alguns professores gostam de ser detentores do saber. Submetem seus alunos a massacres psicológicos e se vangloriam por serem os responsáveis pelos mais altos índices de reprovação da escola. Suas avaliações não valorizam a construção do conhecimento, conseguem, apenas, qualificar informações retidas naquele momento.

Outros professores, com medo de críticas e de perderem a posição que ocupam, aplicam provas fáceis para que a maioria dos alunos obtenha a aprovação, o que não avalia a construção do aprendizado.

Os professores extremistas normalmente apresentam forte resistência a mudanças. Com o trabalho do grupoterapeuta há que se instalar na instituição a cultura de que as metodologias de avaliação devem realmente quantificar e qualificar a construção do conhecimento.

Outro ponto de igual importância a ser tratado é o significado do erro nas avaliações. O grupoterapeuta deverá desenvolver nos educadores a capacidade crítica de analisar se o erro é proveniente de problemas relacionados ao aluno, ao próprio professor, à escola ou à sociedade. Os erros dos alunos devem fornecer elementos para o professor refletir sobre sua prática e modificar sua estratégia de ensino.

As escolas e seus educadores tendem a se preocupar mais com a quantificação do acerto e a punição do erro do que com o raciocínio do aluno, desconsiderando totalmente a construção do conhecimento.

CONCEITUAÇÃO DE GRUPO

Todo indivíduo deve ser estudado dentro do contexto social, pois em toda a sua existência, convive com outros indivíduos, partilhando o mesmo espaço e os mesmos desejos, interesses e ambições.

Pichon-Rivière [2] relata que "Todo conjunto de pessoas ligadas entre si por constantes de tempo e espaço, e articuladas por sua mútua representação interna (dimensão ecológica), configura uma situação grupal. Tal situação está sustentada por uma rede de motivações e nela interagem entre si, por meio de um complexo mecanismo de assunção e adjudicação de papéis. É nesse processo que deverá surgir o reconhecimento de si e do outro no diálogo e no intercâmbio permanente. Essa situação grupal constitui o instrumento mais adequado para essa aprendizagem de papéis (aprendizagem social), em que consiste a internalização operativa da realidade".

Nas palavras de Zimerman [3], "O ser humano é gregário, e ele só existe, ou subsiste, em função de seus inter-relacionamentos grupais. Sempre, desde o nascimento, ele participa de diferentes grupos, numa constante dialética entre a busca de sua identidade individual e a necessidade de uma identidade grupal e social".

Segundo o Novo Dicionário Aurélio, "grupo é uma pequena associação ou reunião de pessoas ligadas para um fim comum". Para alguns autores, o conjunto de duas pessoas (por exemplo, um casal) já configura um grupo. Pode-se conceituar também através do grupo familiar, escolar, terapêutico, profissional, esportivo, religioso, etc. Estes grupos estão constantemente sendo renovados e ampliados no decorrer da vida do indivíduo.

As pessoas levam seu universo pessoal ao grupo, composto pelas suas características de personalidade, vivências pessoais e experiência profissional. Por isso, o resultado de um grupo como um todo é diferente do somatório de suas partes.

Inseridos numa situação grupal, os indivíduos reagirão diferentemente em função destas características, focados num processo de interação, no qual as ações e reações individuais influirão e serão influenciadas pelo grupo.

Ao trabalhar com um grupo, um coordenador deve levar em consideração as características pessoais dos membros do grupo, sejam elas características de personalidade, físicas, econômico-sociais ou profissionais.

OBJETIVOS DO GRUPO

A existência de um grupo ou uma equipe deve ser fundamentada numa razão de ser que justifique sua própria existência. Esta razão de ser chama-se objetivos. A definição clara dos objetivos de um grupo por si só não garante o sucesso do mesmo. Ao se trabalhar com grupos, deve-se ter o entendimento aprofundado de como os objetivos grupais estão em interação com os objetivos individuais dos membros do grupo. Os objetivos individuais e grupais podem sofrer alterações ao longo do processo do grupo; assim, faz-se necessário a revisão constante destes objetivos.

Os objetivos do grupo especificam e definem os seus fins; identificam os alvos para os quais as atividades do grupo estão apontadas. Quando eficazmente desenvolvidos, diminuem as angústias dos integrantes do grupo, ampliam a base dos interesses comuns, sentimentos de identificação, motivações, padrões do grupo, participações úteis e satisfação dos membros do grupo.

A maioria dos grupos tem dificuldade em fazer com que os membros participem ativa e objetivamente. Este problema está relacionado com a falta de conhecimento claro dos objetivos, com a concordância sobre os propósitos do grupo ou da impossibilidade de perceber como as atividades se congregam para a consecução dos objetivos fixados.

Vivemos numa sociedade que está rapidamente se modificando. Os interesses e necessidades dos membros do grupo mudam com rapidez, aconselhando revisões e discussões sobre seus fins e objetivos. Tais revisões podem conduzir à mudança de objetivos, à fixação de outros, à reorientação das prioridades e, mesmo, ao reconhecimento da necessidade de se dissolver o grupo.

Às vezes, a complexidade da organização, o excesso de formalidade e a execução de um só tipo de trabalho impedem que o grupo procure os objetivos realmente importantes. Isto pode acontecer com qualquer grupo. A relação entre os objetivos definidos e as atividades estabelecidas formalmente permite superar tais dificuldades.

O propósito do grupo pode ser modificar o grupo e seus membros, ou, no caso do grupo de ação, decidir e executar programas específicos. Na designação dos objetivos deve-se indicar as modificações ou o tipo de ação que se espera do grupo e de seus membros.

Ao chegarem novos membros, é importante que os objetivos lhes sejam apresentados. O grau de satisfação e de participação dos membros antigos influencia os novos a aceitarem os objetivos e trabalharem a favor do grupo.

Uma vez determinados os objetivos, as futuras experiências e atividades do grupo tendem a ser moldadas e avaliadas segundo os seus termos. O grau com que os objetivos dos membros do grupo estão incorporados aos objetivos grupais influencia diretamente a fidelidade e a participação dos membros nas atividades organizadas.

CLASSIFICAÇÃO DOS GRUPOS

A classificação aqui utilizada se baseia no critério das finalidades a que se propõe o grupo. Será dividido em dois grandes ramos genéricos: Operativos e Terapêuticos. Na prática essas ramificações se completam. Cada um destes ramos, por sua vez, se subdivide em outras ramificações, conforme o esquema abaixo.

- **Grupos operativos**:
  (1) Ensino-aprendizagem (através da técnica de "Grupos de Reflexão").
  (2) Institucionais (empresas, escolas, igreja, exército, associações, etc.).
  (3) Comunitários (programas de saúde mental).
- **Grupos terapêuticos**:
  (1) De auto-ajuda – na área médica em geral (diabéticos, reumáticos, idosos, etc.); na área psiquiátrica (alcoolistas anônimos, pacientes, etc.).
  (2) Psicoterápicos (base psicanalítica, psicodrama, teoria sistêmica, cognitivo-comportamental, abordagem múltipla).

GRUPOS OPERATIVOS

Na ação preventiva da grupoterapia junto aos docentes, a modalidade de grupo utilizada é a de grupos operativos.

A conceituação e a aplicação dos grupos operativos, devem ao psicanalista argentino Pichon-Rivière [2]. Este autor enfoca que "A técnica de grupos por nós criada, chamada de grupos operativos, caracteriza-se por estar centrada, de forma explícita, em uma tarefa que pode ser a aprendizagem, a cura (abrange os grupos terapêuticos), o diagnóstico das dificuldades de uma organização profissional, etc. Sob esta tarefa subjaz outra, implícita, que aponta para a ruptura, através do esclarecimento das pautas estereotipadas que dificultam a aprendizagem e a comunicação, significando um obstáculo frente a toda situação de progresso ou mudança".

Zimerman [3] observa que o termo "grupo operativo" é muito genérico, sendo que, em essência, designa mais propriamente uma ideologia do que uma técnica específica. Essa ideologia, visa sempre um aprendizado conectado com uma mudança psicológica (atitudes), especialmente a de aprender a aprender.

CONCLUSÕES

A preocupação das escolas superiores sempre foi de formar profissionais com o perfil estipulado pelo mercado de trabalho. Devido às grandes mudanças pelas quais o país vem passando, a educação brasileira precisa ser revisada e reestruturada.

O processo de reavaliação do ensino não é tarefa fácil, pois além da imensidão territorial, é totalmente dependente dos interesses político e da boa vontade das instituições. Um ensino de qualidade, motivador, criativo e dinâmico, requer dedicação de todas as partes envolvidas no processo de ensino-aprendizagem.

O professor é a figura mais próxima do aluno, portanto pode atuar tanto como gerador de dificuldades ou como promotor da aprendizagem, dependendo do seu equilíbrio emocional e psíquico. Controlar suas frustrações ajuda a amenizar a resistência à mudanças abrindo espaço para a orientação educacional. Não basta que o docente domine o conhecimento técnico, é preciso conhecer metodologias de ensino dinâmicas, estimulantes e desafiadoras.

Neste sentido, pode-se compreender a importância da orientação educacional preventiva no âmbito escolar. Acredita-se que uma das saídas para o caos em que se encontra a educação no Brasil é a formação continuada dos docentes, através de grupoterapias. Nas atividades em grupo, os docentes poderão discutir, analisar e refletir sobre seu trabalho e, assim, adquirir formação didática e humanística, tão necessária para a construção do conhecimento do aluno.

É fundamental que o grupoterapeuta goste e acredite na modalidade de trabalho escolhida, pois só assim, resultados realmente satisfatórios serão conseguidos.

O que se espera é uma educação tão prazerosa quanto a internet, a TV a cabo e os bailes, onde os professores possam ensinar aprendendo e, acima de tudo, despertar e exteriorizar o aprendizado do aluno.

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PROPOSTAS PARA A MELHORIA DOS CURSOS DE ENGENHARIA DEPOIS DE UM PROCESSO DE AVALIÇÃO. ESTUDO DE CASO: MACKENZIE

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Resumo: —*Esse trabalho apresenta uma síntese dos resultados obtidos a partir da iniciativa da realização de um processo de avaliação, feito através de levantamentos de dados junto a alunos ingressantes, alunos veteranos, alunos egressos e professores dos cursos de Engenharia da Universidade Presbiteriana Mackenzie durante o ano de 2001. Serão apresentados os cruzamentos e análises dos resultados obtidos que direcionaram discussões entre docentes, chefes de departamentos, diretores e reitoria. O processo de avaliação e suas conseqüências visaram a melhoria das relações professor - instituição, professor – aluno, conteúdo – aprendizado, assim como, reformulações nos procedimentos didáticos-pedagógicos. A análise dos resultados do levantamento realizado junto aos alunos egressos teve como objetivo verificar se esses profissionais estavam colocados no mercado de trabalho e se atendiam ás necessidades da sociedade atual. Essas informações foram úteis nas reformulações dos perfis dos profissionais que se espera formar. A pesquisa junto aos alunos ingressantes permitiu formar nova imagem do perfil sócio – econômico – cultural desse grupo. Foi também realizada um avaliação docente junto a todos os alunos da Escola de Engenharia. Cada aluno respondeu um questionário sobre quatro de seus professores , de tal forma que todos os docentes foram avaliados. Os professores, por sua vez, responderam, de forma anônima, a um documento que apresentava somente duas questões: quais os pontos positivos e os negativos dos cursos aonde atuavam.*

PRINCIPAL CONTRIBUIÇÃO: O objetivo principal desse trabalho é propor discussões que possam culminar em mudanças necessárias nas abordagens didático – pedagógicas, em metodologias motivadoras que envolvam o aluno e na própria revisão dos projetos pedagógicos dos cursos em questão.

1-INTRODUÇÃO

O objetivo deste trabalho é relatar e interpretar os procedimentos avaliativos realizados durante os anos 2001-2002 nos cursos de Engenharia da Universidade Presbiteriana Mackenzie (UPM).

Observamos que sempre que tratamos de avaliação institucional de cursos, é comum encontrar uma reação negativa ao processo, uma vez que a ele se associa uma característica de punição, de perseguição ou de valorização apenas dos aspectos negativos daquele curso. Justamente por isso, inicialmente nos preocupamos por esclarecer junto ao Diretor e Chefes de Departamento da Faculdade de Engenharia da UPM, bem como aos professores e alunos qual o sentido que estávamos dando ao processo avaliativo, o qual explicamos a seguir.

2- CONCEITO DE AVALIAÇÃO E SEUS PRINCÍPIOS FUNDAMENTAIS.

Entendemos por Avaliação um processo voltado para o desenvolvimento e evolução de uma situação qualquer. Tratando-se da avaliação de um curso de graduação, ela deverá sempre estar voltada para a melhoria da qualidade deste curso.

O processo de avaliação possui duas dimensões: a primeira é de diagnóstico de uma situação, que se realiza através de levantamento de informações que nos permitam conhecê-la melhor. A segunda é prospectiva, quer dizer, um olhar para frente, enquanto tomam-se decisões para fortalecer os pontos fortes e adequar melhor ou corrigir aqueles que, por ventura estejam deixando a desejar, sempre visando para o desenvolvimento da situação avaliada.

Um processo de avaliação assim considerado, para ser eficaz, exige que os participantes daquela realidade que se pretende avaliar assumam um compromisso tanto com o diagnóstico como com as propostas alavancadoras de evolução.

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A partir dessa concepção de avaliação, fundamentamo-nos em alguns princípios orientadores para realizarmos a avaliação dos Cursos de Engenharia da UPM, que passamos a enumerar:

1. Avaliação como processo crítico – transformador, e não como tarefa tecno-burocrática.

2. Avaliação como processo democrático, contando com o envolvimento e participação de todos os integrantes do curso: alunos, professores, chefias de departamento e diretor.

3. Avaliação como uma proposta pedagógica e formativa para os participantes do processo

4. Avaliação como recurso para encontrar formas alternativas de revitalização e de perspectivas interdisciplinares que signifiquem evolução do curso.

5. Na avaliação de um curso, os procedimentos avaliativos deverão se dirigir não unicamente para as pessoas, com o fim de responsabilizá-las ou culpá-las pelo que se observa ou pelos dados colhidos, mas a avaliação deverá orientar-se para a organização, como um todo, seus objetivos, os processos que nela têm curso, as atividades através dos quais os processos são conduzidos, o exercício das diferentes e complementares funções administrativas e pedagógicas, a participação e o envolvimento dos diferentes participantes, suas atividades, os "produtos" ou "resultados" que são ou deixam de ser obtidos, os padrões de desempenho e de qualidade com que tudo isso se processa em relação às necessidades ou expectativas.

3—ETAPAS DO PROCESSO DE AVALIAÇÃO DOS CURSOS DE ENGENHARIA DA UPM.

A realização do processo de avaliação dos cursos de Engenharia da UPM constou de várias etapas:

1. Levantamento da documentação já existente e elaboração do histórico das iniciativas já tomadas na Escola de Engenharia, em relação a avaliação institucional, desde 1991.

2. Consultas com especialistas externos:

Reunião com o assessor da Pró-Reitoria de Graduação da USP (Universidade de São Paulo) para apresentação e discussão de procedimentos de avaliação realizados na USP.

Visita à Comissão de Avaliação Institucional da PUC- RIO, já estabelecida há alguns anos, para obtenção de informações de atividades lá realizadas, além de auxílio nos processos operacionais.

Reuniões com o Diretor e Chefes de Departamentos da Faculdade de Engenharia para:

esclarecimentos e discussão sobre possíveis iniciativas isoladas de avaliação, já realizadas ou a realizar;identificar situações e acontecimentos que possam ter influenciado o andamento dos cursos oferecidos pela Unidade, como aumento significativo de vagas, critérios para contratação de docentes, condições de trabalho oferecidas pela instituição, etc.

3. De posse desses dados, demos início às atividades do processo avaliativo, apresentando aos alunos ingressantes nos cursos de Engenharia/2002 um questionário a ser preenchido, buscando identificar o perfil dos jovens que se matriculavam nesses cursos na UPM. Conhecer as características do público com o qual trabalhamos, através de um instrumento científico, e não apenas através de nossas impressões, permite um diagnóstico mais seguro das necessidades e possibilidades de atuação dos alunos, e, como decorrência, o professor e coordenação podem planejar melhores as atividades a serem desenvolvidas no decorrer do curso.

4- OUVINDO OS PROFESSORES

O passo seguinte foi a elaboração de um levantamento diagnóstico que seria feito junto aos professores dos cursos de engenharia e a realização de reuniões de sensibilização, inicialmente com o Diretor e Chefes de Departamento, e em seguida com todos os professores da Faculdade.

O objetivo das reuniões foi alertar Chefias e Professores para o significado daquele processo de avaliação: sua concepção, a proposta que apresentávamos, a necessidade da participação, do envolvimento e do compromisso de todos na direção de se obter melhorias detectáveis na qualidade dos cursos de engenharia.

A proposta apresentada consistia em que os professores respondessem voluntária e anonimamente, a duas questões em aberto (anexo 2) visando levantar os pontos positivos (fortes) e negativos (fracos) de cada curso, além de medidas, a curto,médio e longo prazo, que poderiam resolver problemas identificados pelos docentes.

5- OUVINDO OS ALUNOS

Os alunos de todas as turmas dos cursos de Engenharia responderam, em outubro de 2001, a um questionário que procurou avaliar as condições de oferta das disciplinas do curso, o trabalho docente , o envolvimento dos alunos e sua participação, e as condições de entorno do desenvolvimento das disciplinas.

Foi desenvolvido um sistema onde cada aluno respondeu um questionário sobre quatro professores de disciplinas que ele estava cursando na época, dando para cada questão de 1- muito ruim a 5- muito bom .

O aluno recebeu em classe, através da Comissão Permanente de Avaliação, um documento contendo as disciplinas sobre as quais ele deveria responder, disciplinas essas escolhidas de forma aleatória. O aluno, depois de destacar seu nome (e responder de forma anônima) devolveu para a Comissão, o questionário.

O departamento de Sistemas, depois da leitura óptica, calculou as médias por questão e a média geral de cada

professor . Também foi calculada a média por questão de cada Curso.
Cada professor recebeu, em envelope fechado, seu próprio resultado. No documento encaminhado a cada professor também foi informada a média docente em cada modalidade.
As respostas foram analisadas e os resultados disponibilizados também na intranet com acesso restrito às Chefias.

6- CRUZAMENTO DE DADOS OFERECIDOS POR PROFESSORES E ALUNOS DO MESMO CURSO, ANÁLISE DOS MESMOS E PROPOSTAS

De posse dos dados e informações dos alunos e dos professores, procuramos verificar a freqüência dos aspectos indicados como fortes ou fracos, a convergência ou não de pontos avaliados e sua respectiva pontuação e os tipos de medidas oferecidas para a solução dos problemas indicados.
Este material foi muito significativo. Fizemos uma análise sobre ele e preparamos um novo documento que foi discutido pelos professores em um Encontro de Avaliação realizado em uma manhã. Nessa reunião foi elaborado um plano de prioridades de ações a serem desenvolvidas visando a melhoria das condições de ensino.
Dados que foram alvo do estudo deste encontro:

As repostas obtidas pelos alunos dos curso foram
Os professores dominam o conteúdo ensinado.
Há respeito, por parte dos alunos, ao professor e seu trabalho.
Os alunos se consideram pontuais, assíduos e que têm comportamento adequado nas aulas,
Os alunos consideram as disciplinas cursadas importantes para a sua formação.
Os professores usualmente preparam suas aulas.
Os professores são pontuais.
Os professores são assíduos.
Os professores têm disponibilidade para responder perguntas e respeitam as dificuldades dos alunos.
Há continuidade lógica dos conteúdos ministrados.
Há uso adequado do horário atribuído às aulas.
Há coerência entre conteúdo ministrado e exigido nas avaliações.

No entanto os alunos acham que:
As condições de sala de aula podem melhorar.
O resultado das avaliações nem sempre reflete o real aprendizado do aluno.
A Biblioteca poderia ser melhor com atendimento mais eficiente

Professores: As repostas dadas pelos professores dos curso foram:
Os professores responderam um questionário com apenas duas questões abertas: Pontos positivos e negativos da Escola.
Foram levantados vários problemas e suas consequências na qualidade do ensino. Muitos professores contribuíram com sugestões possíveis de e de implantação imediata.

6.1-Análise e cruzamento

A avaliação do Curso de Engenharia realizada pelos docentes e alunos aponta para alguns pontos positivos: Os professores de Engenharia Civil avaliam o curso como essencialmente prático e abrangente, e com um currículo organizado de acordo com a prática profissional, buscando aperfeiçoar as visitas técnicas e incentivando a apresentação de projetos em várias disciplinas (Engenharia Mecânica). Isto certamente colabora para que os alunos tenham descoberto a importância das disciplinas. .
Os professores de Engenharia Mecânica afirmam que é alta a qualificação do seu corpo docente, o que vem de encontro às afirmações dos alunos de que o professor domina o conteúdo, prepara as aulas, que eles respeitam o trabalho do professor, reconhecem a pontualidade e assiduidade do mesmo, vêm uma qualidade importante no docente que é sua disponibilidade em responder perguntas, e que os professores têm respeito aos alunos e às suas dificuldades.
Os professores da Engenharia Civil julgam boa a distribuição da carga horária e usam recursos computacionais, que em parte é confirmado pelos alunos quando estes avaliam que há um uso adequado do horário atribuído às aulas e há continuidade lógica nos conteúdos ministrados. Os professores de Engenharia Mecânica chamam a atenção para a divisão das turmas para aulas práticas como um fator muito importante para o trabalho deles, assim como o processo de melhoria da biblioteca e de laboratórios indicados pelos docentes da Engenharia Civil.
Os professores levantam alguns aspectos que podem ser melhorados com providências simples:dificuldade para realizar visitas técnicas, laboratórios deficientes em número e equipamentos, falta de disciplinas optativas e de outras condições como espaço para atendimento de alunos, ou convivência dos professores e falta de apoio para participação em congressos e seminários.
Já os alunos, juntamente com os professores, identificam que as condições das salas de aula podem melhorar e que o número de alunos, as vezes, é grande, que a bibliografia indicada nem sempre facilita a compreensão dos conteúdos. A forma de ensinar nem sempre motiva muito os alunos e não há incentivo suficiente às atividades acadêmicas fora de aula. São unânimes também os alunos não têm disponibilidade para estudo fora do horário das aulas.
Frente a esses dados, algumas perguntas aparecem de imediato:
Se os alunos não consultam a bibliografia como afirmar que ela não é apta para facilitar a compreensão dos conteúdos?

Como afirmar que a biblioteca não atende às necessidades da disciplina?
De um lado os professores são elogiados por dominarem os conteúdos, prepararem as aulas, terem disponibilidade para responder as perguntas, usarem bem o horário das aulas e por outro a forma de ensinar não é motivadora. O que estaria faltando?

Ainda: como poderiam os professores ajudar a desenvolver o espírito crítico ao ensinar suas matérias? O que significa "desenvolver o espírito crítico"?

Os alunos dizem não ter disponibilidade para estudar fora do período de aula; por que? Porque trabalham? Porque não foram motivados para tal? Será que é possível se fazer seriamente um curso universitário sem estudar?
Porque não há uma boa orientação para as atividades extra classe? Porque não se programam adequadamente outras atividades para além das aulas?
Estas são algumas perguntas que poderíamos fazer a partir dos dados obtidos de professores e alunos, quando analisados conjuntamente. Certamente, outras poderão ser interessantes também. para um planejamento de trabalho entre os professores. Nesse sentido apresentamos algumas sugestões que nos pareceram válidas e que encaminharemos às Chefias e Professores dos cursos de Engenharia**:**
Que sejam realizadas reuniões com os diretores de cada unidade e com suas chefias departamentais. Posteriormente sugerimos a organização de mais seminários, a exemplo do primeiro, com os professores de cada Engenharia permitindo que todos possam participar da análise dos dados obtidos e a partir desta análise oferecer subsídios para definição de prioridades da unidade e um planejamento de ações que permitam um desenvolvimento dos próprios cursos. Um processo avaliativo só tem significado se permitir a realização de um plano de ações que permitam corrigir os pontos falhos e melhorar os pontos positivos. Simultaneamente propomos reuniões com os alunos para apresentação e discussão das informações obtidas, e as sugestões que direção e professores estão fazendo para o desenvolvimento daquela unidade, visando envolver a todos os participantes do curso no processo de melhoria.

7. PESQUISA COM OS ALUNOS EGRESSOS

Para fecharmos o círculo de buscas de informações sobre os cursos de Engenharia da UPM, entendemos que é necessário conhecer o que pensam nossos ex-alunos sobre o exercício de sua profissão e a contribuição dos cursos para o exercício competente, atualizado e social de sua profissão. Por essa razão, iniciamos em 2002 um contato com os alunos egressos da Engenharia Mackenzie, através de um questionário (anexo 4) .

Até agora já obtivemos cerca de 70 .alunos egressos respondentes ao questionário. A tabulação e análise destes primeiros dados parecem corroborar as informações que obtivemos a respeito dos mesmos cursos por parte dos alunos atuais. Esse fato aponta para a objetividade das informações que nossos alunos atuais nos querem passar e como, de fato, precisam ser levadas em conta nas medidas a serem tomadas para a efetiva melhoria dos cursos de graduação de Engenharia da UPM.

8-CONSIDERAÇÕES FINAIS

Processos de avaliação passam a ser de suma importância para a melhoria dos cursos de Engenharia. Através das informações obtidas nesse levantamentos as decisões tomadas serão para possíveis modificações de grades, currículos, conteúdos e até professores terão suporte mais adequado e mais chances de acerto, contribuindo para um projeto pedagógico próximo da realidade.
Algumas decisões já foram tomadas levando em conta os resultados obtidos pelo processo:

- O Currículo e a grade de horário foi reformulada de tal forma a envolver mais o aluno nas atividades
- O número de alunos em sala já foi reduzido para cinqüenta
- As bibliotecas estão cada vez mais ágeis para atender os discentes
- A direção vem incentivando a participação docente em congressos
- Foi criada a Coordenadoria de Iniciação Científica visando estimular a participação discente em projetos de pesquisa.
- As visitas técnicas vem sendo mais organizadas e incentivadas.

Depois da discussão dos resultados desta avaliação no I Encontro de Avaliação dos Professores da Escola de Engenharia elaborou-se um documento com algumas propostas para melhorias imediatas e outras para melhorias a longo prazo.

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ELABORAÇÃO DE PROJETO DIDÁTICO-PEDAGÓGICO CONTEMPLANDO AS PROPOSTAS DO EXAME NACIONAL DE CURSOS

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Resumo:*A elaboração de um projeto Didático-Pedagógico de um curso, atendendo a Lei de Diretrizes e Bases nº 9394 de 20 de dezembro de 1996 deverá envolver todos os segmentos acadêmicos, levando em conta os objetivos gerais da Universidade, os objetivos específicos do curso, procurando formar "cidadãos conscientes, capazes de exercer a liderança nos grupos sociais nos quais irão atuar", com* capacidade científica *adquiridos por meio do desenvolvimento de conceitos sólidos e eficazes técnicas didático-pedagógicas possibilitando que as fronteiras tecnológicas sejam facilmente assimiladas facilitando o ensino continuado, com elevados códigos éticos e morais, resultando na solução de problemas de forma moderna, criativa, competitiva, com uma preocupação com a Qualidade Total em todos os segmentos, para que o compromisso com a comunidade seja honrado, orientando ações sociais, buscando a consciência crítica e a participação.*

O projeto pedagógico deverá contemplar as atividades complementares, com ênfase no processo participativo, levando o acadêmico a se tornar um elemento ativo no processo ensino-aprendizagem, com uma programação de estudos coerentemente integrados, explicitando competências e habilidades a serem adquiridas.

Como o projeto deverá ser real, inovador e um agente facilitador do ensino-aprendizagem, o perfil do aluno deverá ser traçado, para que a abordagem seja centrada no próprio aluno e a partir daí, a avaliação seja baseada na aferição das competências e habilidades, com um currículo baseado em competências, pois o futuro profissional deverá possuir características de tomar decisões, trabalhar em equipe e principalmente enfrentar desafios de várias origens, começando pelo Exame Nacional de Cursos ("Provão"), que deverá ser encarado não como uma finalidade em si, mas sim como mais um passo a ser dado e com sucesso, num processo continuado de aprendizagem.

Dessa forma, o Projeto Didático Pedagógico de um Curso, deverá contemplar também uma estrutura curricular que possua a identidade da Instituição e do Curso para o desenvolvimento de um conjunto de capacidades referenciais e metodológicas, com um diferencial que serão as habilidades adquiridas pelos acadêmicos, capacitados e competentes.

Palavras-Chaves: *projeto didático-pedagógico, provão, habilidades, competências.*

INTRODUÇÃO

A palavra ***projeto*** etimologicamente, deriva do latim ***projetus*** e significa algo como um jato lançado para frente. Com relação ao prefixo, a palavra **projeto** é articulada com os significados de problema e programa e com relação à raiz partilha de uma ambigüidade fecunda com palavras como sujeito, objeto, trajeto.

Projeto designa igualmente tanto aquilo que é proposto realizar quanto o que será feito para atingir tal meta. Os indivíduos não sobrevivem sem os seus projetos pessoais, mas também não vivem só para eles, pois é inerente do ser humano a busca de metas e objetivos mais amplos, pois existe uma necessidade maior que é o da participação com o coletivo[1].

No século XVII o ***projeto*** foi encarado simplesmente como uma idéia de ação; no decurso do século XVIII, a palavra assumiu o sentido de plano que visa realizar essa idéia"[2]. Atualmente, tal definição do ponto de vista pedagógico pode e deve ser ainda mais abrangente, assumindo um caráter de um ***Projeto Didático-Pedagógico,*** deixando de ser apenas uma idéia de ação, mas também uma responsabilidade da realização de um ideal que deverá ser proposto, envolvendo um universo de seres humanos, que acreditam nas propostas e nas expectativas de que um futuro bem sucedido venha a se tornar realidade, ao final do curso escolhido.

PROJETO DIDÁTICO-PEDAGÓGICO

De um modo geral, a importância especial do projeto, deve ser associada à singular mediação realizada entre a criação individual, a intenção de reprodução, a habilidade de criação e o desenvolvimento, levando a uma realização pessoal abrangente, entre as expectativas do novo e a consolidação de padrões no imaginário coletivo, numa busca contínua pela excelência da qualidade, o que deve se tornar um padrão da Instituição de Ensino.

Um bom projeto, desenvolvido de forma correta, com adequação à realidade e às peculiaridades da Instituição de Ensino, resultará certamente na satisfação dos envolvidos no processo [3].

O projeto didático-pedagógico é uma proposta coletiva de trabalho que descreve um conjunto de capacidades, referenciais adotados e metodologias a serem utilizadas, por meio de um levantamento da situação atual, seguido da elaboração do diagnóstico e de uma programação, culminado com uma avaliação de qualidade.

A elaboração de um projeto didático-pedagógico deve ser norteada pelos seguintes itens:

- Objetivos Gerais da Universidade;
- Objetivos Gerais do Curso;
- Objetivos Específicos do Curso;
- Competências;
- Habilidades;
- Diferencial do Curso;
- Interdisciplinaridade;
- Fronteiras Tecnológicas;
- Solução de Problemas;
- Avaliação.

O projeto didático pedagógico ainda deve contemplar as exigências do Exame Nacional de Cursos, que é uma conseqüência de um programa de qualidade e um instrumento de avaliação, pois as Instituições foram motivadas a iniciar uma corrida direcionada à formação de um profissional com melhor nível, que é um objetivo só realizável por meio de investimentos na qualidade do corpo docente, na atualização curricular, na modernização dos laboratórios e no acervo das bibliotecas e na avaliação do valor agregado durante o curso.

Portanto o projeto didático-pedagógico atualmente se reveste da maior importância, pois além da competência, o profissional a ser formado, deve ter uma consciência ética e moral dentro de sua área de atuação.

Paralelamente, se as novas diretrizes curriculares flexibilizam os projetos pedagógicos respeitando a comunidade onde a IES está inserida, o provão funciona como elemento contrário a esta abertura, de certa forma engessando conteúdos e esquecendo peculiaridades.

Assim o projeto pedagógico deverá deixar claro quais são os objetivos e de que forma poderão ser alcançados, explicitando processos de avaliação que deverão verificar a eficácia ou não de suas estratégias pedagógicas e administrativas, sem deixar de contemplar as funções básicas da Universidade, que são o Ensino, a Pesquisa e a Extensão.

O Ensino, que recebe a maior parte das energias e recursos do sistema universitário, nutre-se principalmente de conhecimentos de países mais adiantados que em geral, têm uma restrita relação com os problemas da comunidade em que se insere. A Pesquisa estuda problemas que muitas vezes não oferecem a oportunidade de uma participação significativa dos acadêmicos. A Extensão Universitária recebe uma atenção marginal do sistema, levando à comunidade, de forma paternalista e unilateral, os resíduos mais frívolos das preocupações universitárias.

Nota-se que existe um paralelismo e um isolamento entre as três funções, de tal modo que a pesquisa não alimenta o ensino, nem a extensão tem uma interação significativa com ambos[4]. A problemática está em elaborar um plano, com um ensino de excelência inserido na comunidade, com uma educação continuada por meio dos Cursos de Extensão Universitária atrativa e inserida no contexto do curso, que consiga direcionar e despertar o aluno para uma pesquisa de ponta.

Para que tais objetivos sejam alcançados, a interdisciplinaridade e a flexibilidade que devem nortear um Projeto Pedagógico de um curso de Engenharia deve levar em conta o ensino centrado no aluno, ou por competências, que é direcionado para que todos os alunos possam atingir o domínio total dos objetivos específicos mínimos de um assunto (disciplina ou curso), consistindo num esforço para evitar a mediocridade ou a superficialidade da aprendizagem, assegurando aos alunos que possam realizar as atividades propostas da melhor maneira possível, o que pode ser traduzido por modalidades estruturais da inteligência, das ações e das operações.

Portanto, a educação centrada no aluno promove a criação de ambientes inovadores auxiliando na ligação da nova informação à anterior, pesquisando sobre a informação relevante e pensando acerca do seu próprio pensamento, evidenciando a necessidade de se proceder ao desenvolvimento do projeto educacional num sentido integrador do aluno, das tecnologias de informação e dos contextos de construção e produção da própria aprendizagem.

Entretanto, antes de se definir o currículo por competências, deve-se repensar nas competências do currículo. A razão dessa exigência é a freqüente comprovação que tradicionalmente os objetivos mais amplos de ensino não são capazes de assegurar um bom desempenho profissional futuro.

Os princípios que norteiam para a competência são:

- Informar ao aluno o que dele se espera (objetivos específicos acessíveis);
- Respeitar as individualidades dos alunos (tempo e velocidade de aprendizagem);
- Verificar a aprendizagem em quantidade e qualidade e utilizar mecanismos de correção e superação das dificuldades.

A diferença entre o ensino tradicional e o ensino por competências é formar um profissional com as características:

- Ensino centrado no aluno;
- Maior responsabilidade atribuída ao aluno para a superação das dificuldades;
- Enfrentar desafios;
- Maior atenção aos pré-requisitos;
- Maior flexibilidade;
- Incentivar a criatividade;
- Maior aptidão para resolver problemas; tomar decisões; trabalhar em grupo e de comunicação.

O ensino por competências exige não só um planejamento mais detalhado de ensino, mas também maior cuidado na verificação da aprendizagem, com uma avaliação muita bem elaborada, que forneça ao aluno condições de encarar com tranqüilidade todos os desafios futuros, tais como a prova de final de curso, o aprimoramento intelectual e pessoal, o mercado de trabalho, a aprendizagem continuada, a pesquisa, entre outros.

Além disso, o Projeto pedagógico também deve incluir as habilidades que se espera dos alunos. As habilidades podem ser definidas grosseiramente, como a capacidade de realizar determinadas tarefas com absoluto êxito. Entretanto a capacidade de realizar determinadas tarefas passa necessariamente por uma gama de etapas, onde nenhuma delas pode ser suprimida e todas precisam ser atrativas, o que não é uma tarefa fácil em se tratando de ciências exatas.O futuro não é uma mera continuação do passado, mas dele conserva muitos conceitos, que servem tanto para o desenvolvimento das fronteiras tecnológicas, como para uma absoluta inaptidão tecnológica [5].

Um homem universal é aquele que possui uma instrução completa que lhe possibilita aprender a aprender e ao mesmo tempo, se adaptar, criar ou mudar as condições de trabalho quando possível, ou seja, ser flexível. De acordo com as abordagens sócio-construtivistas da educação, a aprendizagem é um fator primordial, sendo um processo ativo e participativo, por meio do qual a formação do conhecimento é uma atividade construtiva de experiências e significados socialmente negociados e partilhados.

Nesta perspectiva, a aprendizagem é um processo de construção da representação interna do conhecimento, uma interpretação pessoal da experiência. A construção do conhecimento resulta num modelo conceitual do mundo realizado a partir da experiência do indivíduo sobre este.

No campo das instituições e sistemas organizacionais, a flexibilidade aparece como uma meta a ser alcançada, ou seja, como um valor a ser agregado no campo da formação profissional, que é uma adaptação dos sistemas produtivos às situações inesperadas, uma nova relação entre competitividade e educação, em que se destaca a necessidade de saber fazer, ser, pensar e agir.

Assim sendo, os planos pedagógicos devem contemplar as novas tecnologias educacionais que complementam o ensino teórico e as práticas em laboratórios com as tecnologias modernas utilizando equipamentos atualizados com a realidade atual do mercado de atuação futura dos alunos. Tais ações irão proporcionar um salto na melhoria da qualidade dos resultados obtidos, para que as competências sejam adquiridas em um espaço de tempo reduzido.

Desta forma pode-se delinear as diretrizes gerais para o desenvolvimento de um Projeto Pedagógico do Curso de Engenharia.

CONCLUSÃO

Para a elaboração de um projeto didático-pedagógico eficiente, devem ser definidos objetivos gerais e específicos, bem como o perfil do profissional a ser formado, enfatizando o tipo de especialização, ou seja, a vocação do curso, as ações necessárias para cumprir esses objetivos e o suporte operacional para implementar e acompanhar as ações necessárias à consecução dos objetivos além de uma avaliação de qualidade.

Para a consecução dos objetivos estabelecidos e a formação de profissionais com o perfil adequado, ações devem ser definidas. Esta etapa corresponde à determinação de **o que fazer** e **como fazer** para implantar o Projeto Pedagógico. Os meios que se dispõe para isso são o rol de disciplinas, a metodologia de ensino e as atividades de formação complementar.

Para a realização das ações com a finalidade de alcançar os objetivos do Projeto Pedagógico proposto, deve-se criar um suporte operacional que permita realizar essas ações e avaliar seus resultados, visando corrigir possíveis desvios observados durante a implementação deste currículo em relação às propostas iniciais e aquelas realmente alcançadas. Compõem este suporte operacional, a **organização do curso**, a **implantação das medidas** necessárias e o **acompanhamento** das ações desenvolvidas, não se esquecendo do perfil pretendido.

Para que se consiga uma inevitável associação entre a pesquisa científica e tecnológica e a engenharia de produtos e de processos intensificada[6], um projeto didático pedagógico, deve contemplar uma a estrutura curricular com disponibilidade para atividades complementares, como parte da integralização curricular; o estimulo a iniciação científica por meio de projetos inovadores e multidisciplinares, possuindo ainda uma identidade com Instituição de Ensino e com o Curso de Engenharia, para o desenvolvimento de um conjunto de capacidades referenciais e metodológicas, com um diferencial que serão as habilidades adquiridas pelos acadêmicos, capacitados e competentes.

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CURRICULUM MÍNIMO: UM RETROCESSO OU UM AVANÇO?

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RESUMO - *Atualmente, os cursos de Engenharia, nas suas diversas modalidades, teoricamente não necessitam obedecer a qualquer tipo de currículo mínimo, pois de acordo com a Lei de Diretrizes e Bases de 11/03/2002, onde somente é elencado uma série de matérias, não é mais necessário que se obedeça à Resolução 48/76 do CFE.*

Entretanto os cursos das áreas de ciências exatas necessitam invariavelmente, de sólida formação básica e, nos cursos de Engenharia, as disciplinas responsáveis pela formação básica: Matemática, Física, Química, Informática, Desenho, Eletricidade, Resistência dos Materiais e Fenômenos de Transporte são aquelas que irão possibilitar o desenvolvimento e o avanço necessários às rápidas transformações do cenário científico-tecnológico, capacitando os acadêmicos à aquisição de competências e habilidades dentro de sua área respectiva.

Como os sólidos conceitos básicos fundamentais independem da nacionalidade, da regionalidade, da política sócio-econômica vigente, entre outros, e os meios escolhidos para o seu desenvolvimento podem levar a modificações dos objetivos, deve haver uma quantificação e qualificação desses conceitos, com uma abrangência capaz de suprir as suas necessidades, criando por fim um modelo de interação científica, que deve ser objeto permanente de discussões, debates e reflexões, garantindo a identidade, mas proporcionando uma competitividade sadia entre as diferentes Instituições (Públicas e Privadas), desde que a qualidade mínima e necessária esteja garantida por um currículo básico e uniforme, para cada uma das áreas, que deve ser aferida periodicamente, como atualmente, por meio dos Exames Nacionais de Cursos, ou, preferencialmente pelas instituições dos Exames de Ordem.

Assim, o aspecto criativo, regional, e os diferenciais serão responsáveis pelo modelo interativo entre a Ciência e a Sociedade, criando condições para o exercício da cidadania, propiciando a liberdade e o direito à tomada de decisões, partindo de uma sólida estrutura criada pela Instituição para, a partir daí, desenvolver a continuidade do currículo com as especificidades exigidas pela área, atendendo aos objetivos gerais da Universidade e aos objetivos específicos do Curso.

A finalidade é formar "cidadãos conscientes, capazes de exercer a liderança nos grupos sociais nos quais irão atuar", com capacidade científica adquirida por meio do desenvolvimento de conceitos básicos sólidos e eficazes, e de um projeto didático-pedagógico que deve contemplar também uma estrutura curricular que possua a identidade da Instituição e do Curso para o desenvolvimento de um conjunto de capacidades referenciais e metodológicas, com um diferencial que são as habilidades adquiridas pelos acadêmicos, capacitados e competentes.

Portanto o elenco das disciplinas do ***currículo mínimo*** *e o seu conteúdo é um dos elementos agregadores da mesma área que vai possibilitar o afloramento das diferenças individuais, tanto das Escolas, quanto dos alunos, quando das Avaliações, tanto as internas, quanto às externas, inclusive, para obter-se um padrão mínimo de exigências no Exame de Avaliação Nacional dos Cursos Superiores, o " Provão".*

Palavras-Chaves: *cursos de engenharia, currículo mínimo, habilidades, competências.*

INTRODUÇÃO

A Legislação Brasileira estabeleceu pela primeira vez em 1961 na Lei de Diretrizes e Bases (LDB), alguns requisitos mínimos e a duração de cursos superiores, aplicáveis ao ensino e ao exercício profissional da Engenharia.

Em 1962, o Conselho Federal de Educação (CFE) fixou os currículos mínimos dos cursos de Engenharia Civil, Mecânica, Elétrica (especialização em Eletrônica e Eletrotécnica), de Minas, Metalúrgica, Química e Naval. Outros currículos mínimos de Engenharia foram estabelecidos no campo das Ciências Agrárias e também visando a formação Engenheiros de Operação, voltados para atividades do setor industrial, uma carreira que posteriormente foi extinta.

Em 1968 o assunto foi novamente analisado, e o capítulo da LDB referente ao ensino superior foi substituído pela Lei n^{o} 5540. Em meados da década de 1970, as habilitações da Engenharia já tinham funcionamento regular e em 1973, após dez anos da implementação dos primeiros currículos mínimos, o Ministério da Educação e Cultura (MEC) julgou conveniente uma revisão do assunto, encarregando uma Comissão de Especialistas de Ensino de Engenharia (CEEEng) a fazer os estudos necessários e formular uma nova proposta de currículo mínimo, a qual foi encaminhada em 1974 ao Conselho Federal de Educação (CFE), ocasião em que, além das modalidades tradicionais da Engenharia, ainda foi fixado o currículo mínimo de Engenharia de Produção.

Tais estudos e análises originaram a Resolução n° 48/76 – CFE, ficando estabelecido que a estrutura de currículo mínimo definida pela referida Resolução seria a única a vigorar no País a partir de 1982[1].

Do ponto de vista educacional, existem outras razões que também justificam a existência do **currículo mínimo**, como a necessidade de se garantir uma qualidade mínima na formação do engenheiro e uma homogeneidade mínima entre os cursos equivalentes.

Em outubro de 1997, as Instituições CEEEng, ABENGE e CONFEA, participaram de discussões no Congresso Anual da ABENGE, realizado em 1997, em Salvador-Bahia, sobre a resolução 48/76, cujas conclusões claramente configuravam duas tendências[2].

Na primeira, preconizava-se a manutenção da estrutura da Resolução 48/76, aumentando-se o número de áreas para atender às necessidades já apontadas pela sociedade.

A segunda tendência, que defendia a redução do número de áreas, evoluiu para uma proposta de eliminação das áreas definidas pela Resolução, e pelo estabelecimento de um **núcleo único tecnológico** que caracterizasse o curso de Engenharia. Foi discutida a forma como essa mesma proposta estava sendo executada nos Estados Unidos da América pelas Escolas de Engenharia pertencentes à *Coalitions Foundation,* um dos oito projetos que serviram de inspiração para o Projeto de Reengenharia no Brasil (REENGE), apoiados pela *National Science Foundation*[1].

Os resultados das análises realizadas no Congresso da ABENGE sobre as perspectivas para o estabelecimento de diretrizes curriculares para as habilitações do curso de engenharia, foram discutidas por meio de um levantamento feito na ocasião, que contabilizou um número provável muito elevado para as Áreas preconizadas na estrutura da Resolução 48/76 modificada, caso fosse adotada a tendência favorável à manutenção do conceito de Áreas e ao seu aumento em função da demanda qualificada.

Atualmente, como resultado de novas análises sobre o assunto, foram geradas novas interpretações da Lei de Diretrizes e Bases que foram revisadas e aprovadas pelo Conselho Nacional de Educação (CNE), e pela resolução CNE/CES n^{o} 11/2002, onde os cursos de Engenharia, nas suas diversas modalidades, teoricamente não necessitam obedecer a qualquer tipo de currículo mínimo [3].

Na realidade, a nova LDB gerou novas diretrizes curriculares para todos os Cursos, porém sem contradizer a resolução 48/76, confirmando o seu teor mas possibilitando uma flexibilização na aplicação dos conceitos ali contidos, necessária para que os currículos possam acompanhar a velocidade com que as transformações ocorrem na sociedade.

ANÁLISE DA SITUAÇÃO

A rapidez com que a ciência e a tecnologia são transformadas e transformam o mundo atual, bem como o cenário político, econômico e social, envolvidos nesta dinâmica, apresentam desafios constantes para as Instituições que trabalham com o ensino de engenharia, dada as dimensões deste cenário e a sua relação com um projeto social, do qual o currículo se constitui numa de suas principais peças.

De acordo com a Lei de Diretrizes e Bases de 11/03/2002, são salientadas as competências e habilidades desejadas, tais como aplicar conhecimentos matemáticos, científicos, tecnológicos e instrumentais à engenharia; projetar e conduzir experimentos e interpretar resultados; identificar, formular e resolver problemas de engenharia; comunicar-se eficientemente nas formas escrita, oral e gráfica; atuar em equipes multidisciplinares; avaliar o impacto dessa atividade de engenharia no contexto social e ambiental [4].

A LDB modificada, se insere num cenário internacional e relaciona uma série de matérias que orientam os currículos dos cursos indicando as percentagens de áreas de conhecimento relativas à formação básica e à formação profissionalizante a serem mantidas, que, entretanto, já constavam na resolução 48/76.

Observa-se que estas exigências são precárias, pois currículos com conteúdos e estruturas deficientes em determinados campos, tanto da formação básica quanto da profissional, não conduzem efetivamente a uma mudança plena sobre a visão da Ciência e da Tecnologia e as suas interações com a Sociedade. Assim, o papel da formação é fundamental e deve ser constantemente analisado[5], pois a importância do conhecimento para o desenvolvimento não é uma novidade na história da humanidade e se constitui numa variável de destaque para o desenvolvimento econômico e tecnológico, resultante de um esforço contínuo de educação com elevados padrões de excelência[6].

Não se pode esperar que novos conceitos sejam absorvidos completamente apenas por efeito do discurso lógico-formal. Ao contrário, há todo um percurso a ser realizado, de forma a dotar e embasar de algum sentido o novo conceito, relacionando-o gradativamente com aqueles já sedimentados. Este percurso começa pela imitação, passa pelo uso, para só então alcançar a compreensão e depois a criação [7].

Essa compreensão será modificada ao longo da vida do acadêmico, passando por diferentes teorias e por níveis mais abstratos de explicação. A passagem de um nível de abstração a outro pode ser facilitada pela discussão do processo de aprendizado em si, colocando em questão o sujeito, o que Piaget chama de "abstração reflexionante" [8].

A publicação da nova Lei de Diretrizes e Bases da Educação e das peças jurídicas suplementares gerou grandes expectativas em toda a comunidade educacional do país. Algumas boas, pelas oportunidades de abertura e flexibilidade prenunciadas, mas outras inquietantes, motivada pela preocupação com a completa eliminação de um balizamento mínimo, visto por muitos como desejável e mesmo necessário, especialmente em cursos técnicos e científicos comprometidos com a responsabilidade civil e social, como nos cursos de Engenharia[1, 9].

Várias opiniões desencontradas têm sido emitidas com relação à substituição do conceito antigo dos **currículos mínimos** pelo conceito mais moderno das **diretrizes curriculares**. Têm sido ouvidas afirmações que vão desde um extremo: "... superação da camisa de força imposta pelos currículos mínimos...” até o extremo oposto: “...diretrizes curriculares são currículo mínimo e mais alguma coisa”.

Desde o início de suas atividades, a Comissão de Especialistas de Ensino de Engenharia–CEEng, da Secretaria da Educação Superior (SESu/MEC), tem exposto a sua interpretação sobre a questão, a respeito dos cursos de Engenharia. Entende que desde a publicação da Resolução n° 48/76–CFE, as estruturas curriculares das habilitações do curso de engenharia já estão sendo normalizadas por um sistema de diretrizes curriculares, que só precisa de aprimoramento e atualização. Na verdade as diretrizes curriculares deveriam nortear os cursos, balizando as condições mínimas necessárias a sua área de atuação.

De acordo com o parecer emitido pela CEEEng sobre o Processo 23000.000078/96-36, encaminhado ao Conselho Nacional de Educação, essa tarefa, embora muito delicada, será grandemente facilitada pela existência da Resolução n° 48/76, do antigo CFE, reconhecida por muitos como um passo importante já em 1976, para a substituição das estruturas curriculares rígidas, por um sistema de diretrizes flexível, versátil e descentralizado. Entretanto, é consenso um outro nível de preocupações, quanto ao caráter conceitual fundamental relativo aos atributos esperados do futuro engenheiro, que também deve ser levado em consideração.

O emprego morre, mas o trabalho não. Este precisa e vai continuar, só que de forma diferente da anterior. Deverá ser realizado por meio de projetos que têm princípio, meio e fim. Ao fim de cada projeto, novos projetos terão de ser concebidos e executados. Nessa ciranda do trabalho, as pessoas deverão ser cada vez mais polivalentes e competentes. Muito mais competentes que seus pares e seus concorrentes.

Para que este diferencial seja alcançado será necessário que a base científica, que é imprescindível, seja disponibilizada para todos os cursos de engenharia, de forma a proporcionar uma formação tecnológica sem traumas, para que o aluno não seja desmotivado e adquira confiança em si mesmo e na sua capacitação. Desta forma, o desenvolvimento e a criação de um **currículo mínimo, principalmente nas disciplinas envolvidas no ciclo básico** se faz necessária, para suprir as necessidades impostas pelas disciplinas de formação tecnológica.

Para o profissional deste milênio, não haverá trabalho para a mão-de-obra não qualificada e muito menos para a mão-de-obra apenas adestrada em determinada profissão, não capacitada para atuar em projetos complexos.

Essas considerações conduzem o curso para uma linha de formação polivalente, num ensino por competências, porém com **sólida formação básica**, com um conhecimento tecnológico adaptável às rápidas transformações impostas pelas fronteiras tecnológicas onde não são admitidos enganos. Tais fronteiras necessitam de soluções corretas, rápidas, seguras, criativas e economicamente viáveis. As soluções passam necessariamente pela descrição matemática precisa do problema, por sua análise físico-química e pela criação de modelos, resultado das habilidades adquiridas pelos alunos, principalmente nas **disciplinas básicas**, que serão aplicadas nas suas diferentes peculiaridades, resultando em criatividade, no aumento de produtividade, na melhoria na qualidade dos produtos, na redução dos custos, na eliminação de desperdícios, de modo a torná-los agentes modificadores não só do mercado como da sociedade.

Paralelamente, já ocorre uma demanda de profissionais preparados para planejar, desenvolver e supervisionar a execução de quaisquer projetos de engenharia interfaciados por computadores e por sistemas de computação, além de instalar e operar equipamentos, respondendo pela manutenção deles e dos sistemas.

O acadêmico ingressante numa Universidade espera e deve receber uma formação profissional que lhe assegure condições de competir pelas reais oportunidades oferecidas no mercado de trabalho vigente.

É importante destacar que, por melhor que seja a preparação universitária proporcionada aos alunos, ela não será suficiente para acompanhar o avanço tecnológico. Estes deverão ser continuamente reciclados, por meio de cursos de atualização profissional, exigindo constantes esforços dirigidos a um contínuo aprendizado. Somente a adoção, por parte do aluno, de uma filosofia de educação permanente assegurará a existência de profissionais polivalentes, multifuncionais, com capacidade de domínio das inovações, tão exigidos pelo mercado de trabalho, voltando-se novamente à questão da **sólida formação básica**.

O ensino direcionado para a interdisciplinariedade possibilita uma melhor estruturação dos conceitos e, somente os programas definidos com metodologias compartilhadas por várias disciplinas facilitam o desenvolvimento das habilidades, atitudes e valores que ajudarão o aluno a incorporar-se efetivamente à sociedade em geral e ao mundo do trabalho em especial. Se essa interdisciplinaridade consegue se firmar logo nas **etapas iniciais do curso**, a aprendizagem fluirá naturalmente.

A interdisciplinaridade é vista no Curso de Engenharia fundamentalmente como um **processo** e uma **filosofia** de trabalho, que entra em ação na hora de se enfrentar os problemas e questões que se avolumam em cada campo de conhecimento. Este processo e esta filosofia devem ser aplicadas desde as etapas iniciais do curso[9].

Os cursos de Engenharia podem evitar a excessiva compartimentação dos conhecimentos, o que prejudica seu caráter polivalente, optando pela filosofia da interdisciplinaridade como uma linha mestra da implementação curricular.

A construção de um **currículo mínimo,** com disciplinas de introdução à Engenharia, facilitaria o direcionamento das aplicações específicas em cada uma das habilitações, despertando a motivação do aluno na sua área de interesse.

CONCLUSÃO

A conceituação básica necessária ao exercício de uma profissão é imutável, mas a forma como as competências e habilidades são desenvolvidas e definidas dentro do contexto institucional podem e devem se alterar em função das necessidades técnicas e sociais. O currículo não pode ser uma mera seqüência de disciplinas, mas um poderoso instrumento institucional, que possa direcionar o acadêmico para o binômio **saber** – **fazer**, baseando-se nos princípios definidos e fundamentados na Lei de Diretrizes e Bases.

O que se busca, portanto, com referência a um **perfil básico**, é sinalizar as características importantes para que o profissional possa se inserir no mundo produtivo, mantendo-se atualizado e contribuindo, efetivamente, para o desenvolvimento da tecnologia e o exercício da técnica. A rapidez da evolução tecnológica fornece um caráter de rápida obsolescência às informações técnicas.

Ao contrário, as competências representam um instrumento perene e capacitam o formando a atuar diante de "situações novas", libertando-o de condicionamentos e facilitando-lhe o exercício do aprendizado autônomo e continuado, uma vez que sua **sólida formação fundamental** o permite.

A elaboração do currículo de um curso deve apresentar as características formais da estrutura curricular das habilitações do curso de Engenharia, de caráter conceitual, quanto aos atributos esperados do futuro engenheiro, que deve ser levado em consideração.

Se o aluno consegue adquirir uma sólida formação básica, os núcleos de formação profissional geral e de formação específicas do Curso serão beneficiados, pois as barreiras impostas pelas disciplinas de ciências exatas, tais como física, matemática e química, serão eliminadas ou minimizadas e as disciplinas profissionalizantes, contando com o atrativo da sua vocação, se tornarão os meios para alcançar os objetivos finais do Curso, na habilidade escolhida, motivando o aluno a se aprofundar nos domínios tecnológicos, tornando o Engenheiro do Século XXI, um profissional competente e eficaz, capacitado a vencer os desafios profissionais e incentivando-o a uma busca de maiores conhecimentos e técnicas por meio do ensino continuado, obtendo uma plena satisfação dos seus ideais.

Assim sendo, a manutenção dos currículos mínimos para as disciplinas de formação básica nos Cursos de Engenharia, continua a se constituir num **avanço** educacional, desde que sejam ministradas com tecnologia educacional atualizada e atraente, com as justificativas da sua existência, concebida como um degrau facilitador ao entendimento das ciências da engenharia, com aplicações direcionadas nas suas especificidades.

Além disso, torna-se incompatível uma avaliação dos egressos dos Cursos de Engenharia, como o Exame Nacional de Cursos, sem um referencial que é fornecido pelo currículo mínimo, pois toda avaliação está balizada por um objetivo, que é norteado pelas competências requeridas para cada uma das habilitações dos Cursos de Engenharia.

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TRATAMENTO DO GÁS DIÓXIDO DE ENXOFRE EM UM REATOR DE LEITO GOTEJANTE DE CARVÃO ATIVADO: COMPARAÇÃO DOS MODOS CONTÍNUO E PERIÓDICO DE OPERAÇÃO

Sandro Megale Pizzo[1] e Deovaldo de Moraes Jr.[2]

Resumo — *Num leito de 77,92 (di) × 80,00mm de carvão ativado realizou-se a depuração de uma mistura de SO_2 em ar, comparando-se o desempenho dos modos contínuo e periódico de operação. Foram analisadas a concentração inicial de SO_2 (500, 1.000 e 1.500ppm em ar), a velocidade superficial da fase gasosa (20, 40 e 60mm/s) e da fase líquida (2mm/s), o período (10 e 20 minutos) e a fração de descarga (0,1, 0,2 e 0,3). A eficiência de remoção da operação periódica variou de 40 a 100% e sofreu maior influência da variação da velocidade superficial de gás e de sua concentração inicial. Foram obtidas eficiências de remoção de 100% nos casos da operação contínua. A taxa de produção de ácido sulfúrico variou entre $0,6\times10^{-8}$ e $2,5\times10^{-7}$mol/g.s. A operação periódica possibilitou obter maiores taxas de produção de ácido sulfúrico e menores perdas de carga que a operação em estado estacionário.*

Palavras chave — *carvão ativado, dióxido de enxofre, leito fixo, operação periódica.*

INTRODUÇÃO

Depois do CO_2, o SO_2 é o poluente com maior volume de emissões na atmosfera. O dióxido de enxofre é um gás incolor, corrosivo, de forte odor irritante, eliminado como subproduto da queima de combustíveis fósseis, carvão e em fundições de minérios. Sua distribuição na atmosfera se dá de forma heterogênea e na presença de luz solar e de material particulado suspenso, origina os sulfatos que reagem com vapor d'água precipitando-se como chuva ácida. A acidificação de solos e das águas causa danos ao aos ecossistemas ao solubilizar os metais pesados tóxicos as todas as formas de vida e lixiviar micronutrientes importantes ao desenvolvimento dos vegetais. A inalação do SO_2 pelos animais e pelos seres humanos pode causar problemas crônicos no aparelho cardio-respiratório e, nos casos de exposição severa, pode matar por asfixia [1].

Visando a atender a legislação ambiental cada vez mais restritiva, na sociedade industrializada contemporânea buscam-se formas limpas de geração de energia através de combustíveis tratados antes da queima, para a eliminação do enxofre. Nos casos em que a geração do poluente é inevitável, devem ser adotados procedimentos que minimizem sua emissão nas chaminés.

O tratamento do gás, normalmente, utiliza-se dos lavadores contendo recheios aleatórios ou estruturados, nos quais o SO_2 é absorvido em uma solução de cal ou cal hidratada [2]. Essas mesmas substâncias podem ser empregadas nos reatores de leito fluidificado, nos quais se produz gesso a partir de uma reação gás-sólido em altas temperaturas [3].

Um processo regenerativo que apresenta a possibilidade de produzir soluções ácidas é a oxidação e hidratação do SO_2 em reatores de leito fixo gotejante, constituído de carvão ativado. Nessa via de tratamento, o SO_2 adsorvido é oxidado cataliticamente pelo oxigênio nas partículas porosas de carvão produzindo trióxido de enxofre. O SO_3 não dessorve espontaneamente e o leito é regenerado mediante a lavagem contínua com água, obtendo-se soluções diluídas de ácido sulfúrico na temperatura ambiente [4].

Contudo, a presença da fase líquida em escoamento contínuo dificulta a difusão dos reagentes gasosos até os sítios ativos do catalisador pois são formados filmes de água ao redor das partículas do leito. A fase líquida não pode ser suprimida porque isso implicaria na saturação do leito, tornando-o incapaz de adsorver o SO_2.

Uma alternativa para superar esse obstáculo é a lavagem periódica do leito [5]. Nesse caso, o escoamento da fase líquida é intermitente, o que permite a drenagem do leito e a exposição da superfície das partículas de carvão à mistura gasosa reacional, graças à evaporação dos filmes de líquido. As descargas de água acontecem a intervalos regulares de tempo e têm uma duração preestabelecida. Denomina-se período (τ) o intervalo de tempo decorrido entre as etapas de lavagem e fração de descarga (σ) a relação entre a duração dessas etapas e o período.

Dessa forma, é possível tratar o gás e produzir soluções mais concentradas variando-se a duração e a freqüência da lavagem [5]. Porém, o escoamento da fase

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líquida só pode ser minimizado desde que se proporcione a regeneração suficiente do catalisador e a relação do desempenho do processo com os parâmetros característicos da operação periódica deve ser determinada [6]. Uma outra vantagem da operação periódica é a menor perda de carga através do leito [7].

O objetivo desse trabalho foi comparar o desempenho dos modos periódico e contínuo de operação de um reator de leito fixo de carvão ativado no tratamento de uma mistura de SO_2 e ar, em termos da eficiência de remoção e da taxa de produção de ácido sulfúrico.

MATERIAIS E MÉTODOS

O reator de leito gotejante para o tratamento do gás contendo SO_2 é representado na Figura 1. Uma coluna de aço inox acondicionava um leito fixo de 77,92(d.i.)×80,00mm. Ele era constituído de partículas porosas de carvão de casca de coco, ativado em corrente de vapor d'água a alta temperatura, de 2,00-2,36mm de diâmetro, área superficial específica de aproximadamente $700m^2/g$ e poros com diâmetro médio de 10Å.

A corrente gasosa de entrada era formada a partir da mistura de SO_2, proveniente de um cilindro, e ar da linha de ar comprimido. O líquido de lavagem era água na temperatura ambiente, bombeada a partir de um reservatório. O escoamento das fases gasosa e líquida era concorrente descendente. As medidas de vazão dos gases e da água eram feitas em rotâmetros. Uma válvula de solenóide acionada por um temporizador controlava a lavagem intermitente do leito no caso da operação periódica. Na operação contínua, essa válvula permanecia sempre aberta.

O gás podia ser coletado na entrada e na saída do reator para análise de concentração do SO_2 em analisador de gases Horiba PG-250, conectado a um microcomputador para aquisição de dados. A partir das concentrações de entrada e de saída do gás eram calculadas as eficiências médias de remoção de SO_2. A solução líquida resultante da lavagem ao final dos experimentos era analisada através de titulações para se determinar a concentração dos ácidos produzidos. A concentração de ácido sulfuroso era medida utilizando-se solução de iodo e amido como indicador. A titulação dos ácidos totais empregava solução de hidróxido de sódio e fenolftaleína. A concentração de ácido sulfúrico era calculada, então, pela diferença entre os resultados das titulações [4].

Na parede da coluna de aço, próximo ao topo e à base do leito, foram instalados dois termopares para se observar a variação da temperatura e duas tomadas de pressão, para as medidas de perda de carga.

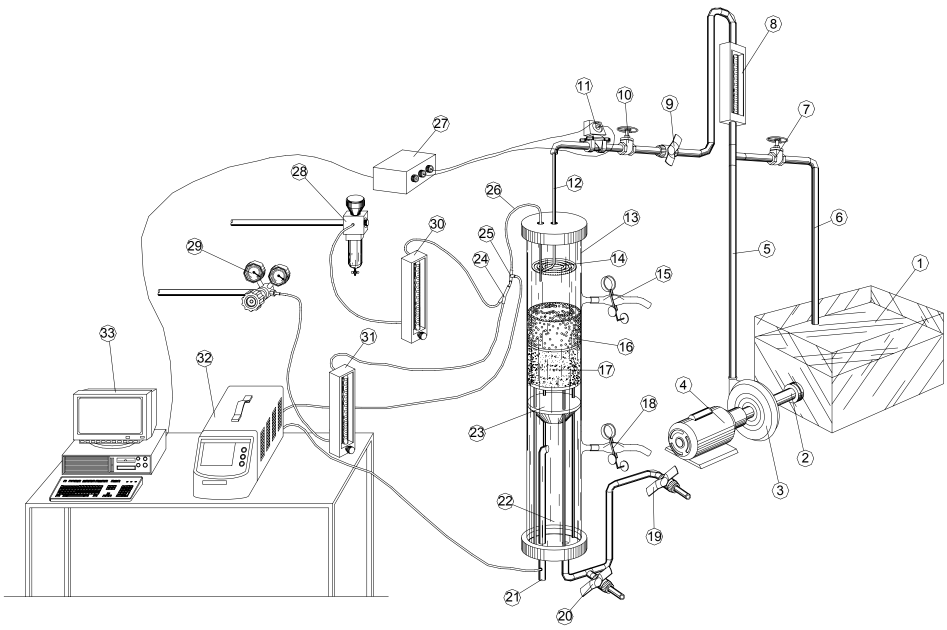

FIGURA 1
REATOR DE LEITO GOTEJANTE PARA TRATAMENTO DO GÁS CONTENDO SO_2.

Na análise de desempenho do reator de leito gotejante foram consideradas a concentração inicial (500, 1.000 e 1.500ppm de SO_2) e a velocidade superficial do gás (20, 40 e 60mm/s). A velocidade superficial de líquido foi mantida constante em 2mm/s. Os experimentos de operação periódica foram realizados com períodos de 10 e 20 minutos e frações de descarga de 0,1, 0,2 e 0,3. Foram realizadas réplicas de alguns dos experimentos de operação contínua e de operação periódica.

RESULTADOS E DISCUSSÃO

As eficiências médias de remoção de SO_2 foram calculadas a partir das concentrações médias de saída e de entrada e variaram de 40 a 100% nos experimentos de operação periódica. Em todos os experimentos de operação contínua a concentração média de saída foi praticamente nula e a eficiência de remoção aproximou-se de 100%. Na Figura 2 são mostrados os resultados da eficiência média de remoção em função da velocidade superficial de gás para experimentos com concentração inicial de 1.500ppm.

O escoamento ininterrupto de água nos casos da operação contínua proporcionou a absorção de grandes quantidades de SO_2. Notou-se que a eficiência de remoção aumentava na medida em que se diminuía o período e se aumentava a fração de descarga, situação em que o modo periódico se aproximava da operação contínua. Porém, as variáveis que mais afetaram a eficiência de tratamento do gás na operação periódica foram a concentração inicial e a velocidade superficial do gás. Quando se aumentou a velocidade superficial do gás ou a sua concentração inicial, a eficiência média de remoção diminuiu.

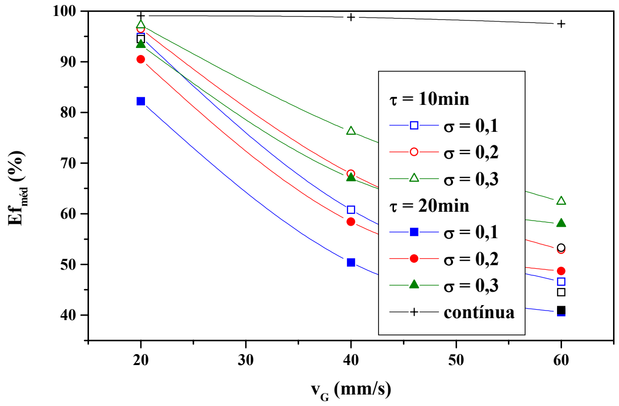

FIGURA 2
EFICIÊNCIA MÉDIA DE REMOÇÃO DE SO_2 NOS EXPERIMENTOS COM CONCENTRAÇÃO INICIAL DE 1.500PPM.

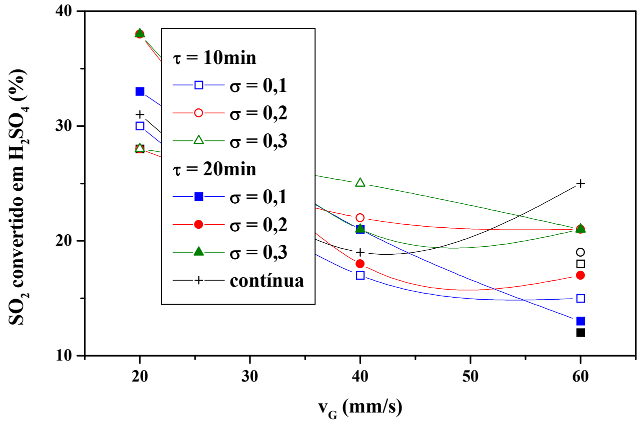

FIGURA 3
CONVERSÃO DE SO_2 A H_2SO_4 NOS EXPERIMENTOS COM CONCENTRAÇÃO INICIAL DE 1.500PPM.

Embora tenha apresentado altos níveis de remoção do SO_2, a operação contínua não foi capaz de efetivamente produzir ácido sulfúrico em comparação com algumas situações da operação periódica. Um exemplo disso é dado na Figura 3, que traz as porcentagens de SO_2 convertido em H_2SO_4 correspondentes aos resultados anteriores. Esses resultados confirmam a idéia de que a lavagem intermitente do leito facilitaria a adsorção e a oxidação do SO_2.

As concentrações de ácido sulfúrico em solução variaram entre 0,14 e 0,50milimol/L. As taxas de produção resultantes situaram-se entre $0{,}6\times10^{-8}$ e $2{,}5\times10^{-7}$mol/g.s. Ainda com relação aos experimentos realizados com 1.500ppm de SO_2, a Figura 4 apresenta as taxas de produção de H_2SO_4.

As taxas de produção de ácido sulfúrico obtidas foram aproximadamente dez vezes menores que aquelas relatadas em trabalhos utilizando concentrações iniciais de SO_2 uma ordem de grandeza superiores na operação periódica [5]. De todo modo, não houve uma tendência definida da variação da taxa de produção de H_2SO_4 com respeito aos períodos e frações de descarga analisadas neste trabalho.

Por fim, na Figura 5 estão representadas as perdas de carga médias observadas nos experimentos de operação contínua e periódica.

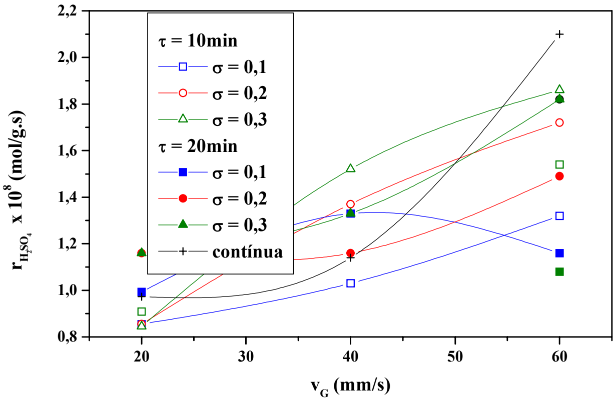

FIGURA 4
TAXA DE PRODUÇÃO DE ÁCIDO SULFÚRICO PRODUZIDO NOS EXPERIMENTOS COM 1.500PPM DE SO_2.

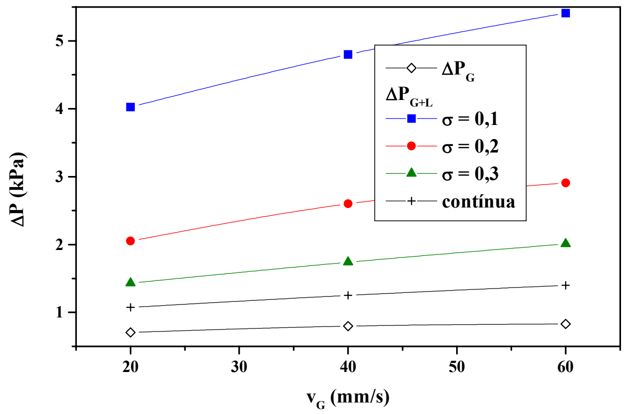

FIGURA 5
PERDAS DE CARGA ATRAVÉS DO LEITO PARA OS EXPERIMENTOS DE OPERAÇÃO CONTÍNUA E PERIÓDICA.

Apesar das medidas terem sido imprecisas e os valores terem sido muito baixos, vê-se que nos experimentos de operação periódica a perda de carga no leito é inferior, na maior parte do período, àquela apresentada pela operação contínua [7].

CONCLUSÃO

Em algumas situações, a lavagem periódica de um leito gotejante de carvão ativado empregado no tratamento de uma mistura gasosa contendo SO_2 permitiu obter soluções aquosas de ácido sulfúrico diluídas, com maior concentração que aquelas da operação contínua.

Comumente, as soluções mais concentradas foram produzidas na maior velocidade superficial do gás e concentração inicial do SO_2. A obtenção de soluções mais concentradas é possível, também, ao se diminuir a fração de descarga em um período fixo ou ao se aumentar o período para uma dada fração de descarga, desde que o catalisador seja suficientemente regenerado [6]. Entretanto, nessas condições operacionais, a eficiência de remoção do gás pode ser baixa, do ponto de vista do controle ambiental. Uma alternativa viável consistiria em utilizar as próprias soluções diluídas para se efetuar a lavagem do leito [7], desde que a concentração de H_2SO_4 não inibisse a solubilização do SO_2 [4].

Outras formas de se conseguir bons níveis de remoção do gás e a produção de soluções mais concentradas consistem em alterações das características físicas e químicas do material adsorvente. No caso do SO_2, a capacidade de adsorção pelo carvão ativado não se relaciona exclusivamente com a área superficial específica, mas também com a distribuição adequada de tamanho de poros [8].

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COMPARAÇÃO DO PERFIL DE ALUNOS DO CURSO DE ENGENHARIA QUÍMICA DOS PERÍODOS DIURNO E NOTURNO DE UMA ESCOLA PARTICULAR

Sonia Braunstein Faldini[1], *Raquel Cymrot*[2], *Maria Olívia Argüeso Mengod*[3], *Maria Elizabeth Brotto*[4] *e Luiz Henrique Schiavon*[5].

Resumo — *Foram comparados os perfis de estudantes, dos períodos diurno e noturno, de Engenharia Química da Escola Superior de Química "Oswaldo Cruz", uma faculdade particular, localizada na cidade de São Paulo; quanto à idade, ao sexo, ao número de disciplinas cursadas, ao tempo de estudo, a percentagem de aprovação, ao exercício de atividades profissionais e ao tempo despendido com a condução. Os dados avaliados foram obtidos mediante aplicação de questionários que foram respondidos por alunos do primeiro, segundo e terceiro anos, perfazendo um total de duzentos alunos do período noturno e cinqüenta alunos do período diurno. Verificou-se que: os alunos do diurno em sua maioria são egressos de escolas de ensino médio particular diurna, enquanto os alunos do noturno são egressos de escolas noturnas e os alunos do diurno apesar de cursarem um maior número de disciplinas tem maior percentagem de aprovação do que os alunos do noturno. Em relação ao tempo de estudo, os alunos do período diurno estudam com maior freqüência, dedicando mais horas por disciplina, mesmo cursando mais disciplinas; quando comparados aos do noturno, que se dedicam ao estudo preponderantemente no período de provas. As turmas do diurno são mais heterogêneas do que as do noturno, observando-se um grupo de alunos que realmente estuda e um outro que estuda o mínimo necessário para a aprovação. Os alunos do noturno têm mais atividades profissionais e também despendem mais tempo em condução do que os do diurno.*

Índice de termos — engenharia química, ensino particular, períodos diurno e noturno, testes de comparação.

Introdução

Pesquisas indicam que as universidades em geral, têm pouco conhecimento sobre as características de seus alunos [1].

Repensar a universidade implica em repensar os diferentes graus de ensino e a diferenciação entre a escola diurna e a noturna [2].

No Brasil existem 2,5 milhões de alunos matriculados no ensino superior [3], 55% estudam no período noturno; e em São Paulo, 86% do alunado do noturno está na rede particular [2].

Os estudantes entram na vida universitária com uma visão utilitarista e imediatista sobre o ensino superior, reconhecendo nela uma instituição social que presta serviços à sociedade e deve oferecer a melhor qualidade possível [4]. Por outro lado, os resultados obtidos no provão e devido as mudanças curriculares dos cursos de engenharia, torna-se necessária a comparação dos perfis dos estudantes dos períodos diurno e noturno destes cursos [5].

Os alunos do ensino superior diurno são normalmente vistos pelos professores com as seguintes características: experiências escolares eficientes antes do ingresso no ensino superior; não ingressaram ainda no mercado de trabalho, ou estagiam; como não trabalham dispensam maior tempo para o estudo. A rotina deste estudante é regulada pelo tempo disponível para: o período de aulas, o tempo para o descanso e o sono, o horário para as refeições e tempo despendido da residência para a universidade e vice-versa.

Os alunos do ensino superior noturno, em geral, trabalhadores estudantes, por sua vez: apresentam experiências escolares deficientes antes do ingresso no ensino superior; ingressaram precocemente no mercado de trabalho; necessitam trabalhar oito ou mais horas por dia, e portanto, dispõem de pouco tempo para o estudo. A rotina deste estudante é regulada pelo tempo disponível para as atividades do aluno do diurno, acrescida de: jornada de trabalho e tempo despendido da residência para o trabalho, do trabalho para a universidade e da universidade para a residência [2].

A formação de um bom profissional necessita de ensino de boa qualidade que resulte em aprendizagem. O curso noturno de Engenharia Química das Faculdades Oswaldo Cruz foi aberto na década de sessenta, e o diurno na década de noventa. Os registros acadêmicos mostram que estes alunos em sua maioria são técnicos químicos formados e trabalhadores de indústrias químicas, nas quais ocupam posições de destaque [5].

Baseando-se na importância do tempo de estudo na aprendizagem, foram aplicados questionários aos alunos do período diurno e noturno visando conhecer a parcela de tempo dedicada ao estudo, em período de provas e fora dele, o número de disciplinas cursadas e aprovadas, o sexo, a idade, a porcentagem de aprovação, o tempo despendido com condução, a escola de origem no ensino médio e o exercício de atividades extracurriculares. A amostra consistiu de 250 alunos, sendo 200 do período noturno e 50 do diurno, do primeiro, segundo e terceiro anos, do curso de Engenharia Química. Convém lembrar que em ambos

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períodos o curso é oferecido apenas até o terceiro ano, a partir do quarto ano só há o período noturno.

Metodologia

Os alunos pesquisados foram os alunos matriculados no ano de 2001, que cursaram disciplinas no ano de 2000 na Instituição. A pesquisa foi aplicada em sala de aula entre os dias oito e treze de março de 2001.

Foi realizada uma análise descritiva das variáveis aleatórias estudadas com cálculo para as variáveis quantitativas da média, moda, mediana, variância, desvio padrão, coeficiente de variação e intervalo com confiança de 95% para a média.

Para compararmos os perfis dos alunos do período diurno com os perfis dos alunos do período noturno foram realizados testes de diferença de média ou diferença de proporção.

Os testes para diferença de média foram precedidos de teste para diferença de variâncias, uma vez que o teste para diferença de médias depende das suposições quanto à igualdade ou não das variâncias nos dois grupos.

A fim de testarmos se existe independência entre as variáveis período e origem do ensino médio, utilizou-se o teste Quiquadrado com 3 graus de liberdade

Nível de significância do teste é a probabilidade de rejeitarmos a hipótese testada, quando tal hipótese é verdadeira. Para todos os testes realizados utilizamos um nível de significância de 5%.

Denotamos por "p" o nível descritivo do teste, isto é, a probabilidade de rejeitarmos a hipótese testada se encontrarmos um valor igual ou mais extremo que o encontrado na amostra. Toda vez que $p > 0,05$ não rejeitamos a hipótese testada. Quando há rejeição da hipótese de independência, analisamos os valores observados e esperados para confirmar as prováveis causas da dependência.

A validação da amostra também foi feita através de teste de independência entre as variáveis pertencerem ou não à amostra e a variável conhecida na população (sexo, faixa etária e nº de disciplinas cursadas).

Foram utilizados os programas de computação EXCEL e SPSS.

Resultados

A. Análise descritiva das variáveis consideradas:

1. Quanto ao sexo: A porcentagem de mulheres no curso no período diurno é de 52,17% e no período noturno de 40%.
2. Quanto a idade: A idade média dos alunos do período diurno é 21,52 anos, com intervalo de confiança [20,46; 22,58], e no período noturno é de 22,57 anos, com intervalo de confiança [22,05; 23,10].
3. Quanto a série: Com relação ao período diurno, o número de alunos na primeira série é praticamente o dobro dos alunos da Segunda e terceira séries, ao que se atribui em parte a entrada do aluno no mercado de trabalho no período diurno, e a transferência do aluno para o período noturno a fim de conciliar ambas atividades.
4. Quanto ao número de disciplinas cursadas: Praticamente, 92% dos alunos cursam de seis a oito disciplinas no período diurno. O número médio de disciplinas cursadas é de 6,75, com intervalo de confiança [6,45;7,05]. No período noturno, a porcentagem é de 60% para os alunos que cursam de seis a oito disciplinas. O número médio de disciplinas cursadas é de 5,83, com intervalo de confiança [5,67; 5,98].
5. Quanto a porcentagem de aprovação: Obteve-se esta porcentagem relacionando-se o número de disciplinas aprovadas e o número de disciplinas cursadas.

Os resultados são mostrados nas tabela I e II, para os períodos diurno e noturno, respectivamente.

TABELA I
Porcentagem de aprovação em função do número de questionários respondidos – Período diurno.

% de aprovação	Freqüência	%
0← 60	0	0,00
60 ← 80	1	2,13
80 ←100	3	6,38
100	43	91,49
Total	47*	100,00

* Excetuando-se a variável tempo de estudo, as outras variáveis podem não ter sido respondidas por todos os alunos que participaram da pesquisa.

Para os alunos do período diurno encontrou-se: média = 98,38; moda = 100,00; mediana = 100,00; variança = 31,58; desvio padrão = 5,62; coeficiente de variação = 0,06 e intervalo de confiança [96,77; 99,98].

TABELA II
Porcentagem de aprovação em função do número de questionários respondidos – Período noturno.

% de aprovação	Freqüência	%
0← 60	9	4,64
60 ← 80	7	3,61
80 ←100	21	10,82
100	157	83,93
Total	194*	100,00

* Excetuando-se a variável tempo de estudo, as outras variáveis podem não ter sido respondidas por todos os alunos que participaram da pesquisa.

Para os alunos do período noturno encontrou-se: média = 93,99; moda = 100,00; mediana = 100,00; variança =

230,05; desvio padrão = 15,17; coeficiente de variação = 0,16 e intervalo de confiança [91,85; 96,12].

6. Quanto ao tempo de estudo: Os períodos considerados foram: de segunda a sexta feira sem provas, de segunda a sexta feira com provas, final de semana sem provas, final de semana com provas, semanal sem provas e semanal com provas. O termo semanal é relativo ao período de segunda a domingo. Realizou-se também um levantamento do número de horas de estudo por disciplina, sem provas e com provas, e a % de horas estudados na época de provas.

Considerando-se o tempo de estudo de segunda a sexta feira sem provas, no período diurno, o valor médio é de 6,05h, com intervalo de confiança [4,04; 8,06], e com provas 11,77h, com intervalo de confiança [8,68; 14,86]. No período noturno, o valor médio do tempo de estudo de segunda a sexta feira sem provas é 1,92h, com intervalo de confiança [1,60; 2,24], e com provas 5,15h, com intervalo de confiança [4,48; 5,82].

O valor médio do tempo de estudo no final de semana sem provas no período diurno é 2,39h, com intervalo de confiança [1,61; 3,17], e com provas 6,14h, com intervalo de confiança [4,82; 7,46].

No período noturno, o tempo de estudo médio no final de semana sem provas é 1,61h, com intervalo de confiança [1,33; 1,88], e com provas 5,25h, com intervalo de confiança [4,69; 5,81].

Considerando-se o período correspondente a uma semana, de segunda a domingo, o valor médio do tempo de estudo sem provas no período diurno é 8,44h, com intervalo de confiança [5,87; 11,01], e com provas 17,91h, com intervalo de confiança [13,85; 21,97]. No período noturno o valor médio sem provas é 3,53h, com intervalo de confiança [3,05;4,00], e com provas é 10,40h, com intervalo de confiança [9,36; 11,44].

A porcentagem do número de horas de estudo com provas, em relação ao número de horas total (sem e com provas), resulta em um valor médio de 71,09% h/h, com intervalo de confiança [66,85; 75,34] para o período diurno, e 76,37% h/h, com intervalo de confiança [74,20; 78,54] para o período noturno.

7. Quanto a escola de origem do ensino médio e o período: A escola cursada no ensino médio pode ter sido pública ou particular, e o período diurno ou noturno. Dos estudantes do período diurno, 76% freqüentaram escolas particulares diurnas, 12% freqüentaram escolas públicas diurnas e 12% freqüentaram escolas noturnas. Dos estudantes do período noturno, 31% freqüentaram escolas particulares diurnas, 15% freqüentaram escolas públicas diurnas e 54% freqüentaram escolas noturnas.

8. Quanto a atividade profissional: Esta pode ser estágio ou trabalho, na área do curso ou não. No período diurno 27,08% dos alunos estagiam e 64,58% dos alunos trabalham. 78% exercem alguma atividade profissional, sendo que destes 63,89% atuam na área de Engenharia Química. No período noturno 31,09% dos alunos estagiam e 69,43% dos alunos trabalham. 95,70% exercem alguma atividade profissional, sendo que destes 79,67% atuam na área de Engenharia Química.

9. Quanto ao tempo gasto diariamente com a atividade profissional, com a condução e com a atividade profissional e a condução. Período diurno. Na atividade profissional considerando-se todos os alunos pesquisados, inclusive os que não têm atividade, o valor médio é de 5,22h, com intervalo de confiança [4,26; 6,17], e entre aqueles que tem atividade profissional o valor médio é 6,77h, com intervalo de confiança [6,12; 7,42]. Na condução trajeto: casa, trabalho, faculdade e casa) o valor médio é 2,18h, com intervalo de confiança [1,87; 2,49]. Praticamente, 52% dos alunos despendem de duas a quatro horas diárias com condução. No total, atividade profissional e condução, o valor médio é 7,45h, com intervalo de confiança [6,34; 8,55].

Período noturno. Na atividade profissional considerando-se todos os alunos pesquisados, inclusive os que não têm atividade, o valor médio é de 7,85h, com intervalo de confiança [7,52; 8,19], e entre aqueles que tem atividade profissional o valor médio é de 8,44h, com intervalo de confiança [8,28; 8,61]. Na condução (trajeto: casa, trabalho, faculdade e casa) o valor médio é 2,80h, com intervalo de confiança [2,62; 2,97]. Praticamente, 54% dos alunos despendem de duas a quatro horas diárias com a condução. No total, atividade profissional e condução, o valor médio é 10,65h, com intervalo de confiança [10,22; 11,08].

B. Discussão dos testes para diferença de médias, proporções e de independência

As Tabelas III, IV e V ilustram os resultados dos testes realizados que serão discutidos a seguir.

A Tabela III contém testes de comparação de médias.

A Tabela IV contém um resumo dos testes de comparação de proporções.

TABELA III

Testes para diferenças de médias - Comparação diurno e noturno.

Variável	variância noturno	variância diurno	p	Conclusão	média noturno	média diurno	p	Conclusão
Idade	14,20	14,54	0,476	N/ Rej H_0	22,57	21,52	0,078	N/ Rej H_0
Nº de disciplinas	1,27	1,13	0,287	N/ Rej H_0	5,83	6,75	0,000	Rej H_0
% de aprovação	230,05	31,58	0,000	Rej H_0	93,99	98,38	0,001	Rej H_0
Horas de estudo de 2ª a 6ª sem provas	5,29	52,45	0,000	Rej H_0	1,92	6,05	0,000	Rej H_0
Horas de estudo de 2ª a 6ª com provas	23,15	123,89	0,000	Rej H_0	5,15	11,77	0,000	Rej H_0
% das horas de estudo de 2ª a 6ª em provas	279,51	240,25	0,236	N/ Rej H_0	75,48	69,08	0,015	Rej H_0
Horas de estudo de fim de semana sem provas	4,00	7,97	0,003	Rej H_0	1,61	2,39	0,065	N/ Rej H_0
Horas de estudo de fim de semana com provas	16,44	22,65	0,092	N/ Rej H_0	5,25	6,14	0,182	N/ Rej H_0
% horas de estudo de fim de semana em provas	332,53	399,06	0,229	N/ Rej H_0	80,18	77,66	0,396	N/ Rej H_0
Horas de estudo por disciplina sem provas	0,36	1,92	0,000	Rej H_0	0,585	1,243	0,001	Rej H_0
Horas de estudo por disciplina com provas	1,85	4,80	0,000	Rej H_0	1,77	2,60	0,010	Rej H_0
Horas de estudo total sem provas	11,58	85,71	0,000	Rej H_0	3,53	8,44	0,000	Rej H_0
Horas de estudo total com provas	56,27	214,30	0,000	Rej H_0	10,40	17,91	0,000	Rej H_0
% das horas de estudo totais em época de provas	237,52	234,04	0,456	N/ Rej H_0	76,37	71,09	0,031	Rej H_0
Horas de atividade profissional	5,95	11,39	0,004	Rej H_0	7,85	5,22	0,000	Rej H_0
Horas de atividade profiss. entre os que trabalham	1,39	4,08	0,000	Rej H_0	8,44	6,77	0,000	Rej H_0
Horas na condução	1,54	1,24	0,023	Rej H_0	2,80	2,18	0,000	Rej H_0

H_o: as variáveis estudadas nos dois períodos têm, respectivamente, a mesma variância e a mesma média.

TABELA IV

Testes de diferenças de proporções

Variável	Noturno	Diurno	p	Conclusão
Sexo	0,40	0,52	0,132	N/Rej Ho
Estágio	0,31	0,27	0,589	N/RejHo
Trabalho	0,69	0,65	0,518	N/Rej Ho
Ativ. Prof.	0,96	0,78	0,000	Rej Ho
Ativ. Prof. Área	0,80	0,64	0,040	Rej Ho

Ho: a proporção do período diurno e do noturno é a mesma para a variável estudada.

A Tabela V contém um teste de independência entre as variáveis ensino médio e período de estudo.

TABELA V

Testes de independência

Variáveis	p	Conclusão
Ensino médio X período	0,00	Rej Ho

Ho: as duas variáveis são independentes.

1. Sexo, idade e período: O período cursado não depende do sexo e da idade do estudante.
2. Número de disciplinas e período: Os alunos do diurno fazem mais disciplinas.
3. % aprovação e período: Os alunos do noturno aprovam menos e são mais heterogêneos. Há maior variabilidade no noturno, existem alunos com maior porcentagem de aprovação e outros com menor porcentagem de aprovação.
4. Tempo de estudo e período: de segunda a sexta feira, sem e com provas, os alunos do noturno estudam menos que os do diurno e são mais homogêneos, todos estudam pouco; já, entre os alunos do diurno alguns estudam muito. Em termos percentuais, alguns alunos no noturno estudam mais em época de provas do que os alunos do diurno. Quanto ao número total de horas estudadas, sem e com provas, os alunos do noturno estudam menos que os do diurno e entre os alunos do diurno alguns estudam muito, com maior variabilidade.
5. Horas de estudo de fim de semana e período: No fim de semana não houve diferença no tempo médio de estudo no diurno e no noturno.
6. Estudo por disciplina e período: A análise do tempo de estudo por disciplina, sem e com provas, mostra que os alguns alunos do noturno estudam menos horas por disciplina, e que alguns alunos do diurno estudam muito, com maior variabilidade.
7. % de horas de estudo totais e período: A porcentagem das horas de estudo totais em época de provas não diferiu nos dois períodos.
8. Horas de atividade e condução e período: A proporção de alunos com atividade profissional e com atividade profissional na área no noturno é maior que no diurno e tem menor variabilidade. Menos alunos trabalham no diurno, e entre os que trabalham os alunos do noturno exercem mais horas de atividade profissional. Os alunos do noturno despendem mais horas na condução do que os do diurno. Dessa forma os alunos do noturno

despendem mais horas em atividade profissional e condução do que os do diurno.

9. Horas de atividade profissional e período: Os alunos do noturno exercem mais atividade profissional e também mais atividade profissional na área do que os do diurno.
10. Ensino médio e período: Os estudantes que cursam o período diurno são provenientes de escolas de ensino médio particulares diurnas mais do que o esperado, já os estudantes do período noturno são provenientes de escolas de ensino médio noturnas acima do nível esperado.

Conclusão

As variáveis sexo e idade não apresentam diferenças significativas entre as populações do curso diurno e noturno. Não há predominância de sexo masculino no período noturno nem estudantes mais velhos.

O número de disciplinas cursadas pelo estudante do diurno é maior que do noturno.

A aprovação do estudante do período noturno é inferior a do período diurno.

Os alunos do diurno estudam mais que os do noturno. Existe uma variabilidade no tempo de estudo. As classes do diurno são mais heterogêneas quanto ao tempo de estudo, isto é, há alunos que estudam muito e alunos que estudam pouco. No período noturno, o tempo de estudo varia pouco com a população.

O aluno do noturno estuda pouco, isto é, menos horas que o aluno do diurno pois gasta mais tempo com atividades profissionais e condução. Em época de provas, entretanto, o tempo de estudo aumenta muito quando comparado com o do aluno diurno.

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TRABALHOS DE SÉRIE, O DESAFIO DE UMA EXPERIÊNCIA MULTIDISCIPLINAR

Amaury Pessoa Gebran

Resumo *- "Trabalhos de Série", relato da experiência realizada no Curso de Engenharia Elétrica da Universidade Tuiuti do Paraná, a partir da dissertação de Mestrado apresentada no Programa de Pós-Graduação em Tecnologia Educacional do CEFET-PR.*

O Trabalho de Série tem por objetivo integrar as disciplinas de cada série, e busca uma forma de como pode-se e deve-se adaptar o ensino de engenharia aos novos conceitos de Comportamento e Postura, tanto Técnica como Gerencial; dando a este problema, um tratamento multidisciplinar ou mesmo Interdisciplinar.

Procurou-se portanto criar uma sistematização de trabalhos que pudessem dar ao aluno uma experiência teórico / prática, buscando formar um engenheiro que seja reflexivo (Análise, Síntese e Resolução) e com capacidade de abstração.

Palavras-chave: Multidisciplinaridade, Formação, Ensino de Engenharia, Pesquisa.

1.) INTRODUÇÃO

Nosso ponto de partida é o trabalho industrial moderno, que nos últimos anos está passando pelas grandes modificações que a ciência e a tecnologia estão promovendo no modelo produtivo e na sociedade como um todo.

O processo de globalização da economia, o binômio produtividade/qualidade, as telecomunicações estendendo as fronteiras dos países, e o marketing multimídia são, entre outros indícios implacáveis de que os avanços científicos e tecnológicos estão preconizando o que poderíamos chamar de a terceira revolução, protagonizada pelos imensos avanços da cibernética, tendo como expoente maior a informática.

Os países em desenvolvimento, como o Brasil, sentiram fortemente o impacto desta mudança de base tecnológica, em virtude da sua frágil posição na divisão internacional do trabalho, imposta pelo novo "paradigma produtivo", tendo em vista a concentração de capitais e de novas tecnologias nos próprios países geradores de inovações.

Vários cursos de Engenharia, atualmente oferecidos em diversos países, espelham em muito a filosofia e o ideal da universidade da década de 50. Houve a reestruturação para um currículo abrangente com o foco em ciência da engenharia contra as necessidades das habilidades técnicas. Neste contexto, o objetivo era atender à dinâmica das mudanças da tecnologia com forte ênfase nas pesquisas, principalmente nas décadas de 60 e 70. Na década de 80, houve a expansão da matrícula com a população estudantil engajada na expectativa da expansão de empregos no setor produtivo das respectivas áreas de formação. No entanto, o setor produtivo passou a ter características muito diferentes das que eram tradicionalmente conhecidas. Grande número das empresas emergentes passaram a competir com as existentes, demandando por profissionais com habilidades multidisciplinares e capazes de dar respostas aos novos problemas, exigindo táticas flexíveis para resolvê-los.

Portanto, neste trabalho, tentamos iniciar uma reflexão, sobre como a ruptura deste novo "paradigma produtivo" poderá modificar o Ensino da Engenharia , uma vez que parece estar havendo um estreitamento na relação oferta e procura de profissionais da área, ou seja, de que forma podemos e devemos adaptar nosso ensino aos novos conceitos de Comportamento e Postura, tanto Técnica como Gerencial; e de que forma dar a este problema, um tratamento Interdisciplinar, definida por Landsheere(1992) como: caminhada no sentido da integração onde se opera a fusão unificante entre duas ou várias disciplinas, ou alguns temas problemáticos.

2.) PROPOSTA

Um dos mais significativos problemas que envolvem o processo de aprendizagem na área tecnológica, em particular, é a questão metodológica que permeia todo este processo.

Este tem sido dissecado década após década e novas teorias trazem uma melhor compreensão do processo de internalização do conhecimento. Saber como o ser humano aprende é, sem dúvida, um passo decisivo na busca do melhor método.

Estudos importantes tratam da capacidade de integração dos diversos conhecimentos. Por outro lado, incrementa-se a instrumentalização de apoio ao processo, como forma material e dinâmica de enriquecimento dos recursos colocados à disposição tanto dos docentes quanto dos discentes.

Com toda a riqueza de recursos teóricos e materiais existentes, ainda existem problemas inerentes à educação em geral, ao longo de toda a sua história.

Amaury Pessoa Gebran – Coordenador do Curso de Engenharia Elétrica da Universidade Tuiuti do Paraná, Mestre em Educação Tecnológica.

Trata-se de um problema de múltiplas variáveis, que não se limitam somente ao educando, ao educador, ao método ou ao material de apoio, dentre outras variáveis. Como possibilitar a integração intelectual das disciplinas ? Como garantir que os conhecimentos desenvolvidos pelos alunos venham a se transformar em habilidades e/ou competências ?

Evidentemente há muito o que se explorar mesmo baseando-se a discussão na força da experimentação. Processos didáticos que se comprovem como bem sucedidos e que se consagrem pelo poder da repetitividade, precisam ser aprimorados e difundidos para que, o saber científico desta área de investigação cresça em qualidade e contribua efetivamente para o progresso da educação.

Face ao exposto, procurou-se criar uma sistematização de trabalhos que pudessem dar ao aluno uma experiência teórico / prática, buscando formar um engenheiro que seja reflexivo (Análise, Síntese e Resolução), com capacidade de abstração que é qualidade extremamente importante, como cita Teilhard de Chardin (1989), "o desenvolvimento humano depende de nossa capacidade de reflexão, do aprimoramento da capacidade de pensar e saber, o que significa saber que se sabe".

Desta forma pesou-se na realização dos ***Trabalhos de Série***, onde a interdisciplinaridade será sempre privilegiada, e em alguns casos poderíamos arriscar dizer que estaríamos inclusive utilizando a transdisciplinaridade, uma vez que conhecimento extra Universidade adquiridos através de experiências profissionais, pessoais e sociais estariam sendo utilizados, desta forma além de incentivarmos o trabalho em grupo estaríamos dando a chance dos alunos solidificarem seus conhecimentos.

3.) OS TRABALHOS DE SÉRIE

Hoje há necessidade de utilização de uma nova prática dos currículos de engenharia, tornando-se necessário cultivar no educando de forma bastante incisiva, a liderança e a criatividade, além de logicamente, lutar para deixá-los profissional e mentalmente preparados, com as ferramentas tecnológicas que os cursos de engenharia tenham lhes passado. Desta forma, pode-se dizer, que o currículo deve preparar o indivíduo para criar sobre a aprendizagem, para desenvolver suas próprias idéias, para ter capacidade de analisar todas as coisas e, portanto para saber em que fontes buscar suas respostas, e principalmente para sintetizar todas estas idéias, evitando assim a frustração das imposições sociais.

Os currículos devem privilegiar a interdisciplinaridade. Se isto não ocorrer, a parte mais difícil ficará então com por conta do educando, montar toda a estrutura a partir de dados esparsos recebidos, como exemplo, pode-se pensar em trabalhar um assunto de diversas formas, talvez até a sua exaustão nas mais variadas formas e nos mais diversos conteúdos, ou seja, ter-se-ia um currículo não estático e que poderia ser adaptado de forma rápida em função das necessidades dos educandos.

Lembrando sempre que, o engenheiro na sua essência deve estar voltado não só para a técnica, a tecnologia, mas também para a sociedade, pois estas a alguém deverão servir, e na nova postura do engenheiro não se pode esquecer a ênfase humanística a ele delegada, pois caso contrário, a que causa estará ele servindo?

Tendo-se como base que os conteúdos de uma disciplina estejam em consonância com os de outra, até o desenvolvimento de características de trabalho em grupo, passando-se pela inserção do social, o incentivo da busca contínua de conhecimentos e ainda no sentido de motivar os alunos buscando incitar e incentivar a sua participação no curso, pensou-se em trabalhar com a realização de projetos para cada uma das séries do curso, conforme descrito a seguir.

Caracterização:

O Trabalho de Série, é um trabalho acadêmico anual, requisito parcial obrigatório, na complementação das notas bimestrais de todos os alunos do Curso de Engenharia Elétrica da Universidade Tuiuti do Paraná, envolvendo todas as disciplinas da série[1].

O aluno não deixará de cumprir, sob nenhuma hipótese , as demais obrigações acadêmicas exigidas pela instituição.

Objetivos:

O Trabalho de Série tem os seguintes objetivos:

I – **integrar** de forma multidisciplinar, as disciplinas de cada série;

II - **motivar** o aluno, a aperfeiçoar seu grau de sociabilidade(trabalhos em grupo);

(1) Na UTP o regime ensino é seriado anual

III - **aperfeiçoar** o grau de desenvolvimento técnico de cada aluno;

IV- **desenvolver** a criatividade de cada aluno;

V – **incentivar** o aluno a realização de pesquisa;

VI – **possibilitar** a realização de produção teórica e crítica desta atividade visando a vida profissional;

VII – **colaborar** com a comunidade acadêmica e a sociedade por meio de idéias e projetos inovadores voltados para a solução de seus problemas, melhor qualidade de vida do ser humano e menor impacto ambiental;

VIII – **possibilitar** a avaliação global da prática para que possa se integrar ao mercado de trabalho;

IX – **aproximar** o aluno ao meio produtivo, tanto a indústria de bens de consumo e de capital como de prestação de serviço;

Avaliação:

Os Trabalhos de Série serão avaliados através da

(1) Na UTP o regime de ensino é seriado anual

entrega pelas equipes de relatórios técnicos, monografia, maquete funcional e defesa perante banca.

As avaliações serão válidas para as provas de segunda chamada respeitando-se o bimestre a qual ela se refere.

No primeiro bimestre a entrega da proposta aos professores, eqüivalerá até 5% do valor da nota total do bimestre.

No segundo bimestre a entrega do primeiro relatório técnico aos professores, eqüivalerá até 10% do valor da nota total do bimestre**.** Este relatório será analisado em reunião de colegiado, que é realizada quinzenalmente.

No terceiro bimestre a entrega do relatório técnico final aos professores, eqüivalerá até 20% do valor da nota total do bimestre.

No quarto bimestre, serão avaliados a confecção da

maquete funcional e defesa perante banca da monografia; a realização completa desta etapa, eqüivalerá até 40% do valor da nota total do bimestre.

Desta forma, pelo menos um conteúdo de cada disciplina da série corrente deverá ser utilizado na realização do trabalho de série, e este deverá ser mostrado de forma separada durante a defesa perante banca.

4.) CONCLUSÃO

Em um primeiro momento a reação contrária dos alunos foi muito grande, pois além de sentirmos que para eles, estes trabalhos não tinham finalidade e era somente mais um trabalho, vimos que esta reação passava digamos pelo "medo" da realização de algo desconhecido, situação corriqueira no cotidiano da atividade produtiva, já ressaltamos que esta forma de trabalho era experimental, e como era a primeira vez que implementávamos este tipo de trabalho, houve uma certa ressalva por partes dos alunos, tanto que trabalhos não obedeceram exatamente a seqüência que havíamos proposto, portanto nem todos os bimestres as avaliações puderam ser realizadas exatamente desta forma, fato aliás, que chamou bastante atenção, a preocupação com a avaliação.

Cabe aqui ressaltar que houve também uma certa ressalva por parte dos professores, logicamente que um tipo de formulação desta envolve muito mais trabalho por parte dos professores, pois as orientações que estes precisavam dispor aos alunos custavam-lhes muito mais tempo e desta forma um envolvimento cada vez maior.

Podemos dizer que após os resultados alcançados na primeira edição que acabamos de relatar, houve toda uma motivação nova tanto entre os alunos, como entre os professores que após a participação nas bancas elogiaram não só a iniciativa mas também a forma com foi desenvolvido o trabalho.

Sentimos que as dificuldades que foram encontradas pelos alunos para a implementação das maquetes, trouxe um novo alento e questionamentos, que fizeram inclusive que houvesse uma mudança na postura dos mesmo na forma de encarar o curso.

Esta mudança de postura foi tão forte que tivemos que modificar a idéia deste trabalho pois pensávamos que teríamos que propor o problema a ser resolvido todos os anos, ao invés os alunos passaram a sugerir idéias, propor trabalhos, o que a nosso ver é uma postura muito melhor, desta forma os alunos acabam ficando, muito mais envolvidos e se responsabilizando pelas idéias, se tornado "pais" destes trabalhos.

Interessante notar que na visão desta nova forma de trabalho, alguns alunos deixam bem claro que os seus desenvolvimentos serão realizados no decorrer não só de uma determinada série mas também uma continuidade, quer dizer um produto está a caminho de ser desenvolvido, o espírito empreendedor está sendo de alguma forma induzido.

Portanto, um novo profissional pode estar sendo de alguma forma preparado, tornando-se aquele que constantemente está preocupado com três grandes qualidades:

- Excelência
- Inovação
- Agilidade

Excelência, pois não basta mais ser bom, tem que procurar ser o melhor, como profissional e ser humano;

Inovar, a cada dia, a contínua busca do novo, hoje fui melhor que ontem e sou pior que amanhã;

Agilidade, a garantia que estou fazendo antes dos outros, na busca pela sobrevivência.

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APLICABILIDADE DE UM AMBIENTE PRÓ-ATIVO PARA A EDUCAÇÃO A DISTÂNCIA EM UMA SITUAÇÃO REAL

Janaine Cristiane de Souza[1] e Sérgio Donizetti Zorzo[1]

Abstract *— Este artigo mostra a aplicabilidade de um ambiente pró-ativo, que consiste na expansão de um ambiente de Educação a Distância baseado na Web para desktops, em uma situação real. Essa expansão foi realizada para prover mecanismos de acesso ao ambiente através de dispositivos móveis, especificamente telefones celulares. O emprego de dispositivos celulares nesse novo ambiente, como uma forma de auxiliar o processo de ensino-aprendizagem, propõe uma inversão na interação aluno-ambiente. Na interação ambiente-aluno, o ambiente age pró-ativamente nesse processo através do envio de mensagens curtas aos alunos de um curso, com o propósito de motivar a sua participação e reforçar o conteúdo estudado. Os celulares utilizados no acesso ao ambiente ainda apresentam algumas limitações, que impossibilitam a utilização de alguns recursos didático-pedagógicos, mas, por outro lado, esses dispositivos têm a facilidade de atingir o aluno a qualquer momento e em qualquer lugar, devido principalmente à mobilidade oferecida pela Rede Celular.*

Index Terms *— Ambiente pró-ativo, apoio ao processo de ensino-aprendizagem, dispositivos móveis, educação a distância.*

INTRODUÇÃO

Nos últimos anos, a educação vem passando por um processo de desenvolvimento e modernização devido aos avanços tecnológicos. Com isso, meios mais desenvolvidos e modernos têm sido utilizados no processo de ensino-aprendizagem. A utilização de *desktops* combinada com o uso da Internet possibilita a oferta de cursos a distância, através de ambientes para a EAD (Educação a Distância). Nesses ambientes, o aluno é considerado um ser ativo, responsável pela iniciativa de acesso e uso, podendo utiliza-los pelo tempo que desejar, com periodicidade determinada apenas por ele próprio. Tais ambientes podem fazer o registro do acompanhamento e emitir relatórios gerenciais sobre as atividades dos alunos, mas não chegam a interferir no processo de interação aluno-ambiente, porque os *desktops* não propiciam mobilidade aos alunos [1].

Com o surgimento da Computação Móvel [2], os usuários ganharam acesso a informações e serviços, independentemente de localização física. Esse acesso é possível através da utilização de dispositivos móveis, tais como: laptops, palmtops, telefones celulares e diferentes tipos de PDAs (*Personal Digital Assistants*).

No Ambiente Pró-Ativo para a EAD apresentado neste trabalho, telefones celulares 2G (Segunda Geração) que operam com o WAP (*Wireless Application Protocol*) são empregados para apoio ao processo de ensino-aprendizagem. O emprego desses dispositivos propõe uma inversão na interação aluno-ambiente, na medida em que permite ao ambiente agir pró-ativamente nesse processo.

Os telefones celulares 2G ainda apresentam algumas limitações, que impossibilitam a utilização de alguns recursos didático-pedagógicos. Por outro lado, com o emprego desses dispositivos os alunos podem conciliar estudo e trabalho, mesmo estando em constante deslocamento, devido às vantagens oferecidas pela Rede Celular, que são: mobilidade, flexibilidade, portabilidade, disponibilidade, conforto e comunicação facilitada.

Com o propósito de mostrar a aplicabilidade do Ambiente Pró-Ativo para a EAD em uma situação real e o emprego de telefones celulares como apoio ao processo de ensino-aprendizagem, neste artigo são apresentados a descrição desse novo ambiente, a sua arquitetura, bem como um estudo de caso voltado para a classe de aplicação Treinamento em Vendas. Finalmente, discute algumas conclusões sobre este trabalho.

AMBIENTE PRÓ-ATIVO

O ambiente pró-ativo consiste na expansão de um ambiente de EAD baseado na Web para *desktops* [3], desenvolvido por pesquisadores do GSDR (Grupo de Sistemas Distribuídos e Redes) desta Universidade. Esse novo ambiente permite que os professores e os alunos realizem tarefas relacionadas com o processo de ensino-aprendizagem dentro de um determinado curso, utilizando *desktops* e telefones celulares.

O emprego de dispositivos celulares nesse ambiente, como uma forma de auxiliar o processo de ensino-aprendizagem, propõe uma inversão na interação aluno-ambiente, na medida em que permite ao ambiente agir pró-ativamente nesse processo [1]-[4]-[5].

Nesse novo ambiente, a pró-atividade é estimulada através do envio de mensagens curtas, referentes ao conteúdo das aulas, aos alunos de um curso, com o propósito de motivar a sua participação e reforçar o conteúdo já estudado. Por outro lado, outros tipos de mensagens curtas relacionados com o acompanhamento poderiam ser incorporados ao ambiente para explorar a pró-atividade, tais como: alerta, informativa e congratulação.

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As mensagens do tipo alerta seriam enviadas em duas situações: caso o aluno alcançasse uma porcentagem de acerto em um teste considerada inferior àquela determinada pelo professor ou um teste fosse realizado em um tempo superior ao que o professor estipulou. Já as mensagens do tipo informativa seriam enviadas assim que o aluno revolvesse todos os testes do curso, para informá-lo sobre a média final obtida. Por sua vez, as mensagens do tipo congratulação seriam enviadas quando o aluno realizasse um teste em um tempo inferior àquele estipulado pelo professor.

No processo de ensino-aprendizagem, o professor é responsável pela criação e edição de cursos, determinação da política de autorização de acesso e envio desses cursos para uma área temporária do Servidor Web utilizado pelo ambiente. Ele também pode enviar mensagens curtas a todos os alunos de um curso.

O aluno, por sua vez, deve efetuar seu cadastro no ambiente para poder realizar os cursos oferecidos. No decorrer de um curso, ele pode assistir às aulas, fazer as provas e os testes, receber as mensagens curtas e interagir com o professor e com os outros alunos, utilizando dois tipos de comunicação: unidirecional (*e-mail*) e bidirecional (*chat)*.

O ambiente ainda proporciona funcionalidades relativas ao cadastro e remoção de professores, à publicação, visualização e remoção de cursos, à remoção e visualização de informações sobre os alunos cadastrados, bem como à configuração do Servidor Web.

ARQUITETURA DO AMBIENTE PRÓ-ATIVO

Para realizar a expansão do ambiente de EAD baseado na Web para *desktops*, foi proposta uma extensão da sua arquitetura [6], como ilustra a Figura 1.

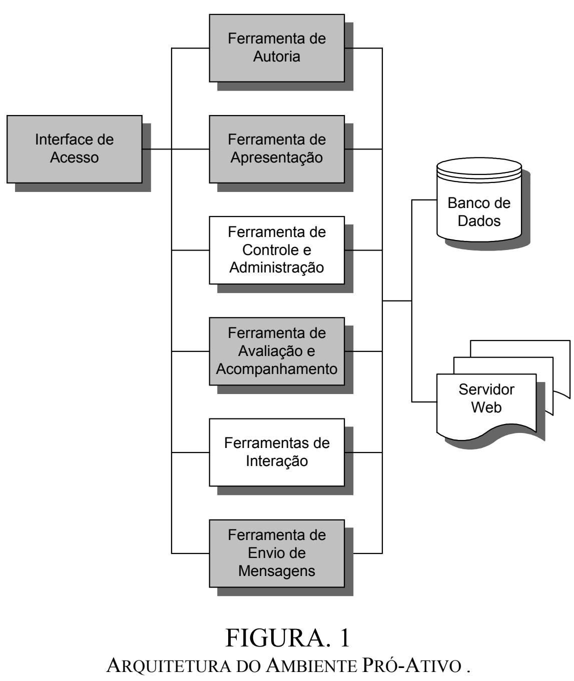

FIGURA. 1
ARQUITETURA DO AMBIENTE PRÓ-ATIVO .

A arquitetura, mostrada na Figura 1, é composta por sete módulos: Interface de Acesso, Ferramenta de Autoria, Ferramenta de Apresentação, Ferramenta de Controle e Administração, Ferramentas de Interação, Ferramenta de Envio de Mensagens e Ferramenta de Avaliação e Acompanhamento. Além desses módulos, essa arquitetura também possui um BD (Banco de Dados) e um Servidor Web. O BD é utilizado para o armazenamento dos dados dos alunos, dos professores e dos cursos, enquanto o Servidor Web contém os arquivos referentes aos cursos.

Os módulos em destaque na Figura 1, como a Interface de Acesso, a Ferramenta de Avaliação e Acompanhamento, a Ferramenta de Apresentação e a Ferramenta de Autoria foram novamente implementados e adequados ao novo ambiente. Por outro lado, a Ferramenta de Envio de Mensagens é um módulo novo acrescentado a essa arquitetura para dar suporte à interação ativa com os alunos. Segue abaixo uma breve descrição sobre cada módulo.

A Interface de Acesso permite o cadastro de novos alunos, a autenticação de alunos já cadastrados, a seleção de cursos e a navegação entre os outros módulos do ambiente. Sua funcionalidade no telefone celular consiste apenas na autenticação do aluno.

A Ferramenta de Autoria auxilia o professor na criação e edição de cursos (aulas e provas), na determinação da política de autorização de acesso e no envio desses cursos para uma área temporária do Servidor Web utilizado pelo ambiente. Com o emprego do telefone celular, algumas novas funcionalidades foram adicionadas: a criação e edição de testes e de mensagens curtas, o envio de mensagens curtas aos alunos de um curso.

A Ferramenta de Apresentação permite a exibição das páginas de aulas e provas que compõem um curso, de acordo com a seqüência e o critério de apresentação previamente determinados pelo professor com o auxílio da Ferramenta de Autoria, através de um *browser*. Por outro lado, no telefone celular os alunos podem, aleatoriamente, realizar os testes, obedecendo apenas o critério de apresentação que o professor definiu.

A Ferramenta de Controle e Administração, desenvolvida para *desktops*, auxilia o administrador na manutenção do ambiente. Para a manutenção, essa ferramenta disponibiliza as seguintes operações: cadastro e remoção de professores, publicação, visualização e remoção de cursos, remoção e visualização de informações sobre os alunos cadastrados e configuração do Servidor Web.

A Ferramenta de Avaliação e Acompanhamento permite a correção das provas feitas por um aluno, calculando a sua nota. Um histórico do aluno contendo dados relativos a sua participação e o seu desempenho no curso também é gerado por essa ferramenta. Já a sua correspondente para telefones celulares provê a correção dos testes realizados por um aluno, exibindo o número de acertos na tela do seu celular.

As Ferramentas de Interação, desenvolvidas para *desktops*, permitem duas formas de comunicação entre as pessoas envolvidas com os cursos: unidirecional através do *e-mail* e bidirecional pelo *chat*.

A Ferramenta de Envio de Mensagens para telefones celulares possibilita o envio de mensagens curtas referentes ao conteúdo das aulas, bem como daquelas do tipo lembrete, criadas pelo professor através da Ferramenta de Autoria, aos alunos de um curso.

ESTUDO DE CASO

Com o objetivo de mostrar a viabilidade da aplicação do Ambiente Pró-Ativo para a EAD em uma situação real e o emprego de telefones celulares nesse ambiente, como uma forma de auxiliar o processo de ensino-aprendizagem, um estudo de caso [6] voltado para a classe de aplicação Treinamento em Vendas é apresentado. Esta seção descreve a aplicação, mostra os processos de elaboração, criação e publicação do curso, além de algumas considerações sobre a interação aluno-ambiente e ambiente-aluno.

Descrição da Aplicação

Tendo como base a classe de aplicação Treinamento em Vendas, foi realizada a simulação da aplicabilidade do Ambiente Pró-Ativo para a EAD em uma distribuidora que comercializa papéis, suprimentos de informática e materiais para escritório, devido às questões práticas e também econômicas da empresa.

Nessa distribuidora, existem três tipos de funcionários: atendentes, entregadores e vendedores. Os atendentes são responsáveis por receber os pedidos dos clientes via telefone. Os entregadores estão encarregados de realizar as entregas dos produtos solicitados pelos clientes, com agilidade e rapidez. Os vendedores se deslocam pela região em que a empresa atua, buscando novos clientes e procurando manter um relacionamento com os clientes já existentes, dispondo de telefones celulares.

Como os vendedores não agendam visitas com os seus clientes, muitas vezes precisam aguardar para serem atendidos. Dessa maneira, o telefone celular pode ser empregado no tempo em que os vendedores ficam aguardando a disponibilidade do cliente. Neste estudo de caso, a aplicação está voltada para esses funcionários, que têm a oportunidade de se aperfeiçoar, mesmo estando em constante deslocamento, devido às vantagens oferecidas pelas Redes Celulares. Segundo Rosenberg [7], a EAD é perfeita para treinar vendedores, que costumam passar muito tempo na rua.

Elaboração, Criação e Publicação do Curso

Para a elaboração do curso, denominado HEV (Habilidades Específicas da Venda), o professor utilizou alguns materiais específicos da área de vendas, disponibilizados pelo SENAC (Serviço Nacional de Aprendizagem Comercial) [8].

Depois de elaborado, o curso HEV foi criado pelo professor com o auxílio da Ferramenta de Autoria, integrada ao ambiente proposto. A estrutura parcial desse curso pode ser visualizada na Figura 2.

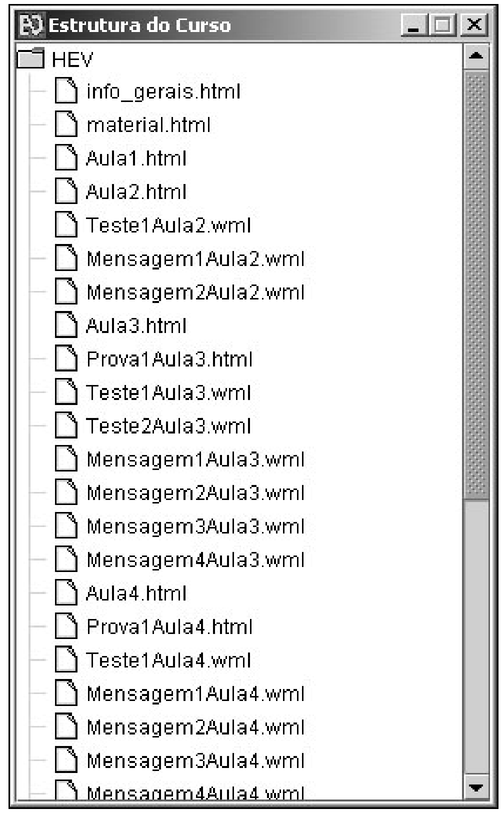

FIGURA. 2
ESTRUTURA PARCIAL DO CURSO.

A estrutura parcial do curso HEV, ilustrada na Figura 2, é composta por informações gerais, material, aulas, provas, testes e mensagens curtas. As informações gerais incluem o objetivo do curso e o seu conteúdo programático. O material contém as referências bibliográficas utilizadas para a sua elaboração. As provas e os testes permitem que os alunos avaliem seu desempenho, enquanto as mensagens curtas reforçam o conteúdo já estudado. As aulas abordam as etapas necessárias para o sucesso no processo de venda.

Para o curso HEV, o professor habilitou a ferramenta de interação *chat* na interface da Figura 3, permitindo uma comunicação bidirecional entre aluno-professor e aluno-aluno. Além disso, o professor também determinou uma política de autorização de acesso ao curso, dividida em três passos: Script de Aulas e Provas, Script de Testes e Script de Mensagens.

No Script de Aulas e Provas, mostrado na Figura 3, duas restrições foram estabelecidas: a aula 4 (Aula4.html) estaria acessível ao aluno se ele tivesse um aproveitamento de no mínimo 70% na prova referente à aula 3 (Prova1Aula3.html) e só assistiria à aula 5 (Aula 5.html) caso alcançasse 100% de acerto na prova da aula 4 (Prova1Aula4.html).

No Script de Testes, foi definido que o aluno realizaria os testes relativos a uma aula do curso somente após ter assistido a ela. Por exemplo: o aluno só poderia resolver o teste 1 (Teste1Aula2.wml) da aula 2 (Aula2.html) ao finalizar essa aula.

No Script de Mensagens, algumas restrições relacionadas com o envio das mensagens curtas aos alunos foram definidas. Assim como no Script de Testes, cada mensagem referente a uma determinada aula só seria enviada ao aluno quando ele terminasse de assistir a ela. Por exemplo: o aluno receberia as mensagens 1 (Mensagem1Aula2.wml) e 2 (Mensagem2Aula2.wml) da aula 2 (Aula2.html) depois de assistir a essa aula.

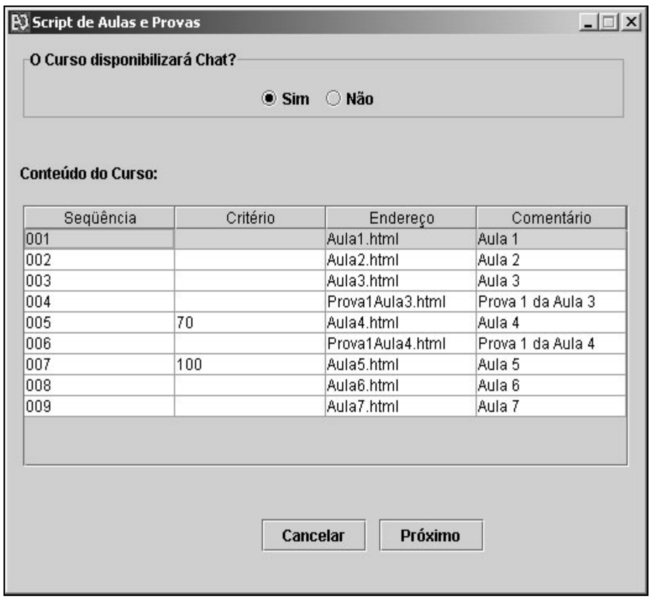

FIGURA. 3.
SCRIPT DE AULAS E PROVAS

Após a determinação da política descrita anteriormente, todos os arquivos gerados durante a criação do curso foram transferidos para uma área temporária do Servidor Web. Por fim, o administrador do ambiente efetuou o cadastro do professor responsável pelo curso e realizou a sua publicação. Nesse momento, o curso tornou-se acessível aos alunos cadastrados no ambiente.

Interação Aluno-Ambiente e Ambiente-Aluno

Na interação aluno-ambiente, o aluno é considerado um ser ativo, responsável pela iniciativa de acesso e uso do ambiente, podendo utilizá-lo pelo tempo que desejar com periodicidade determinada apenas por ele próprio. Inicialmente, os alunos acessaram o ambiente, especificando a URL (http://200.18.98.121/ead/index.html) da página principal (Figura 4) no *browser* de seus *desktops*. Através dessa página, os alunos efetuaram seu cadastro no ambiente, informando seus dados pessoais em um formulário acessível através do link Inscrição, como ilustrado na Figura 4.

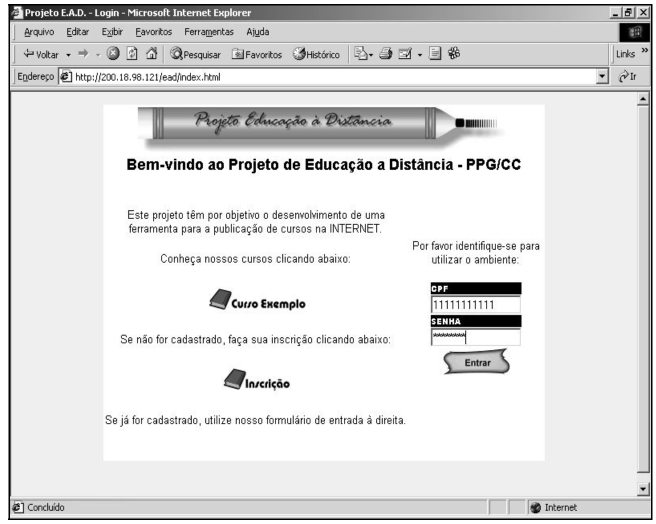

FIGURA. 4
INTERFACE PRINCIPAL DE ACESSO AO AMBIENTE PRÓ-ATIVO.

Em seguida, os alunos realizaram a sua matrícula no curso HEV oferecido pelo ambiente. A partir desse momento, ao informarem CPF (Cadastro de Pessoas Físicas) e senha no formulário de *login*, ilustrado na Figura 4, os alunos tornaram-se aptos a assistir às aulas, a fazer as provas em *desktops* e a realizar os testes nos telefones celulares. A Figura 5 mostra um teste apresentado aos alunos no decorrer do curso HEV.

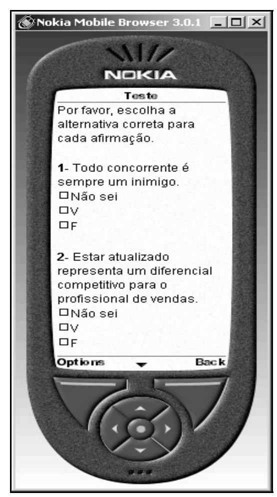

FIGURA. 5
TESTE APRESENTADO.

Enquanto os alunos estavam realizando o curso HEV, puderam se comunicar com o professor e entre si, bem como solucionar suas dúvidas, via *e-mail* e *chat*.

Na interação ambiente-aluno, o ambiente age pró-ativamente no processo de ensino-aprendizagem através do envio de mensagens curtas aos alunos de um curso, com o propósito de incentivar a sua participação e reforçar o conteúdo já estudado. A Figura 6 mostra uma mensagem enviada aos alunos.

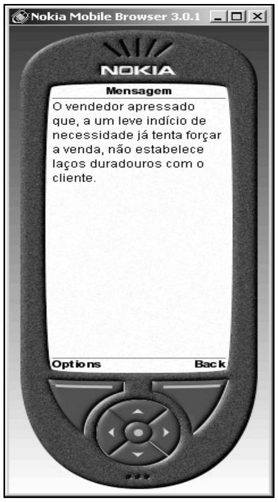

FIGURA. 6
MENSAGEM ENVIADA.

No decorrer do curso HEV, o ambiente realizou as correções das provas e dos testes realizados pelos alunos. Tais correções foram feitas a partir da comparação das respostas dos alunos com as dos arquivos de gabaritos armazenados no Servidor Web. O ambiente também gerou um histórico para cada aluno com dados relativos à sua participação e ao seu desempenho no curso. A Figura 7 apresenta o resultado da correção de um teste realizado por um aluno.

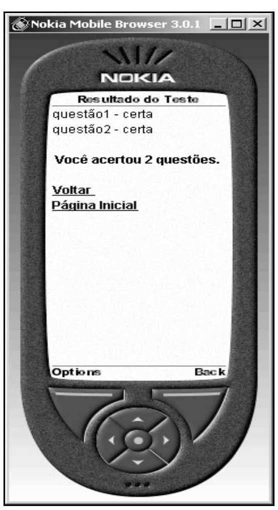

FIGURA. 7
RESULTADO DA CORREÇÃO DE UM TESTE.

CONCLUSÕES

Este artigo apresentou um estudo de caso voltado para a classe de aplicação Treinamento em Vendas, com o propósito de mostrar a viabilidade da aplicação do Ambiente Pró-Ativo para a EAD em uma situação real e o emprego de telefones celulares nesse ambiente como uma forma de auxiliar o processo de ensino-aprendizagem.

Para testar as funcionalidades do ambiente implementado, uma distribuidora que comercializa papéis, suprimentos de informática e materiais para escritório, foi escolhida a partir da classe de aplicação definida. Por questões práticas e também econômicas, decidiu-se simular a aplicabilidade desse ambiente nessa distribuidora. Embora uma simulação tenha sido realizada, o ambiente se comportou de forma esperada durante os testes de utilização das ferramentas que o compõem.

Pelos resultados obtidos na simulação, esse novo ambiente poderia ser facilmente aplicado em uma situação real. Apesar da classe de aplicação Treinamento em Vendas ter sido escolhida como objeto de estudo, outras classes de aplicação poderiam ser utilizadas para testar a aplicabilidade do ambiente, como Apresentações e Ensino de Idiomas.

O emprego de telefones celulares 2G WAP nesse novo ambiente, como uma forma de auxiliar o processo de ensino-aprendizagem, propõe uma inversão na interação aluno-ambiente. Na interação ambiente-aluno, o ambiente age pró-ativamente nesse processo através do envio de mensagens curtas aos alunos de um curso, com o propósito de motivar a sua participação e reforçar o conteúdo já estudado.

Embora telefones celulares ainda limitados tenham sido utilizados no acesso ao ambiente para esse estudo de caso, os alunos puderam conciliar estudo e trabalho, mesmo estando em constante deslocamento, devido principalmente à mobilidade oferecida pela Rede Celular. Segundo Souza e Zorzo [1], as tecnologias tradicionais usadas para oferecer cursos a distância não seriam adequadas para o treinamento de funcionários que se deslocam por uma região.

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APLICABILIDADE DE UM AMBIENTE PRÓ-ATIVO PARA A EDUCAÇÃO A DISTÂNCIA EM UMA SITUAÇÃO REAL

Janaine Cristiane de Souza[1] *e Sérgio Donizetti Zorzo*[1]

Abstract *— Este artigo mostra a aplicabilidade de um ambiente pró-ativo, que consiste na expansão de um ambiente de Educação a Distância baseado na Web para desktops, em uma situação real. Essa expansão foi realizada para prover mecanismos de acesso ao ambiente através de dispositivos móveis, especificamente telefones celulares. O emprego de dispositivos celulares nesse novo ambiente, como uma forma de auxiliar o processo de ensino-aprendizagem, propõe uma inversão na interação aluno-ambiente. Na interação ambiente-aluno, o ambiente age pró-ativamente nesse processo através do envio de mensagens curtas aos alunos de um curso, com o propósito de motivar a sua participação e reforçar o conteúdo estudado. Os celulares utilizados no acesso ao ambiente ainda apresentam algumas limitações, que impossibilitam a utilização de alguns recursos didático-pedagógicos, mas, por outro lado, esses dispositivos têm a facilidade de atingir o aluno a qualquer momento e em qualquer lugar, devido principalmente à mobilidade oferecida pela Rede Celular.*

Index Terms — Ambiente pró-ativo, apoio ao processo de ensino-aprendizagem, dispositivos móveis, educação a distância.

INTRODUÇÃO

Nos últimos anos, a educação vem passando por um processo de desenvolvimento e modernização devido aos avanços tecnológicos. Com isso, meios mais desenvolvidos e modernos têm sido utilizados no processo de ensino-aprendizagem. A utilização de *desktops* combinada com o uso da Internet possibilita a oferta de cursos a distância, através de ambientes para a EAD (Educação a Distância). Nesses ambientes, o aluno é considerado um ser ativo, responsável pela iniciativa de acesso e uso, podendo utiliza-los pelo tempo que desejar, com periodicidade determinada apenas por ele próprio. Tais ambientes podem fazer o registro do acompanhamento e emitir relatórios gerenciais sobre as atividades dos alunos, mas não chegam a interferir no processo de interação aluno-ambiente, porque os *desktops* não propiciam mobilidade aos alunos [1].

Com o surgimento da Computação Móvel [2], os usuários ganharam acesso a informações e serviços, independentemente de localização física. Esse acesso é possível através da utilização de dispositivos móveis, tais como: laptops, palmtops, telefones celulares e diferentes tipos de PDAs (*Personal Digital Assistants*).

No Ambiente Pró-Ativo para a EAD apresentado neste trabalho, telefones celulares 2G (Segunda Geração) que operam com o WAP (*Wireless Application Protocol*) são empregados para apoio ao processo de ensino-aprendizagem. O emprego desses dispositivos propõe uma inversão na interação aluno-ambiente, na medida em que permite ao ambiente agir pró-ativamente nesse processo.

Os telefones celulares 2G ainda apresentam algumas limitações, que impossibilitam a utilização de alguns recursos didático-pedagógicos. Por outro lado, com o emprego desses dispositivos os alunos podem conciliar estudo e trabalho, mesmo estando em constante deslocamento, devido às vantagens oferecidas pela Rede Celular, que são: mobilidade, flexibilidade, portabilidade, disponibilidade, conforto e comunicação facilitada.

Com o propósito de mostrar a aplicabilidade do Ambiente Pró-Ativo para a EAD em uma situação real e o emprego de telefones celulares como apoio ao processo de ensino-aprendizagem, neste artigo são apresentados a descrição desse novo ambiente, a sua arquitetura, bem como um estudo de caso voltado para a classe de aplicação Treinamento em Vendas. Finalmente, discute algumas conclusões sobre este trabalho.

AMBIENTE PRÓ-ATIVO

O ambiente pró-ativo consiste na expansão de um ambiente de EAD baseado na Web para *desktops* [3], desenvolvido por pesquisadores do GSDR (Grupo de Sistemas Distribuídos e Redes) desta Universidade. Esse novo ambiente permite que os professores e os alunos realizem tarefas relacionadas com o processo de ensino-aprendizagem dentro de um determinado curso, utilizando *desktops* e telefones celulares.

O emprego de dispositivos celulares nesse ambiente, como uma forma de auxiliar o processo de ensino-aprendizagem, propõe uma inversão na interação aluno-ambiente, na medida em que permite ao ambiente agir pró-ativamente nesse processo [1]-[4]-[5].

Nesse novo ambiente, a pró-atividade é estimulada através do envio de mensagens curtas, referentes ao conteúdo das aulas, aos alunos de um curso, com o propósito de motivar a sua participação e reforçar o conteúdo já estudado. Por outro lado, outros tipos de mensagens curtas relacionados com o acompanhamento poderiam ser incorporados ao ambiente para explorar a pró-atividade, tais como: alerta, informativa e congratulação.

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As mensagens do tipo alerta seriam enviadas em duas situações: caso o aluno alcançasse uma porcentagem de acerto em um teste considerada inferior àquela determinada pelo professor ou um teste fosse realizado em um tempo superior ao que o professor estipulou. Já as mensagens do tipo informativa seriam enviadas assim que o aluno revolvesse todos os testes do curso, para informá-lo sobre a média final obtida. Por sua vez, as mensagens do tipo congratulação seriam enviadas quando o aluno realizasse um teste em um tempo inferior àquele estipulado pelo professor.

No processo de ensino-aprendizagem, o professor é responsável pela criação e edição de cursos, determinação da política de autorização de acesso e envio desses cursos para uma área temporária do Servidor Web utilizado pelo ambiente. Ele também pode enviar mensagens curtas a todos os alunos de um curso.

O aluno, por sua vez, deve efetuar seu cadastro no ambiente para poder realizar os cursos oferecidos. No decorrer de um curso, ele pode assistir às aulas, fazer as provas e os testes, receber as mensagens curtas e interagir com o professor e com os outros alunos, utilizando dois tipos de comunicação: unidirecional (*e-mail*) e bidirecional (*chat)*.

O ambiente ainda proporciona funcionalidades relativas ao cadastro e remoção de professores, à publicação, visualização e remoção de cursos, à remoção e visualização de informações sobre os alunos cadastrados, bem como à configuração do Servidor Web.

ARQUITETURA DO AMBIENTE PRÓ-ATIVO

Para realizar a expansão do ambiente de EAD baseado na Web para *desktops*, foi proposta uma extensão da sua arquitetura [6], como ilustra a Figura 1.

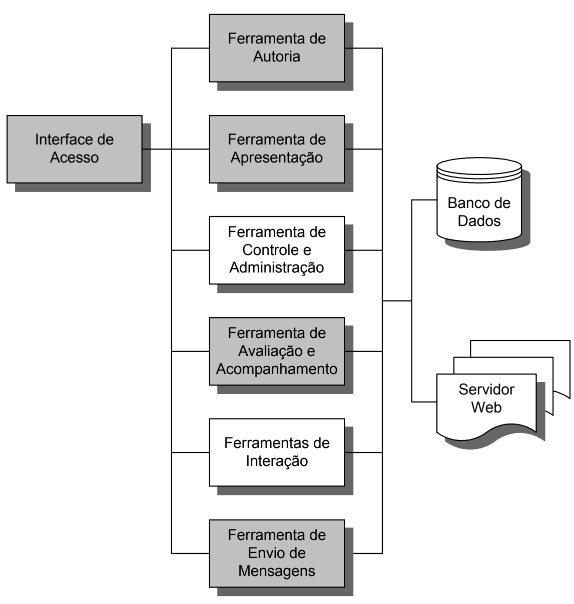

FIGURA. 1
ARQUITETURA DO AMBIENTE PRÓ-ATIVO .

A arquitetura, mostrada na Figura 1, é composta por sete módulos: Interface de Acesso, Ferramenta de Autoria, Ferramenta de Apresentação, Ferramenta de Controle e Administração, Ferramentas de Interação, Ferramenta de Envio de Mensagens e Ferramenta de Avaliação e Acompanhamento. Além desses módulos, essa arquitetura também possui um BD (Banco de Dados) e um Servidor Web. O BD é utilizado para o armazenamento dos dados dos alunos, dos professores e dos cursos, enquanto o Servidor Web contém os arquivos referentes aos cursos.

Os módulos em destaque na Figura 1, como a Interface de Acesso, a Ferramenta de Avaliação e Acompanhamento, a Ferramenta de Apresentação e a Ferramenta de Autoria foram novamente implementados e adequados ao novo ambiente. Por outro lado, a Ferramenta de Envio de Mensagens é um módulo novo acrescentado a essa arquitetura para dar suporte à interação ativa com os alunos. Segue abaixo uma breve descrição sobre cada módulo.

A Interface de Acesso permite o cadastro de novos alunos, a autenticação de alunos já cadastrados, a seleção de cursos e a navegação entre os outros módulos do ambiente. Sua funcionalidade no telefone celular consiste apenas na autenticação do aluno.

A Ferramenta de Autoria auxilia o professor na criação e edição de cursos (aulas e provas), na determinação da política de autorização de acesso e no envio desses cursos para uma área temporária do Servidor Web utilizado pelo ambiente. Com o emprego do telefone celular, algumas novas funcionalidades foram adicionadas: a criação e edição de testes e de mensagens curtas, o envio de mensagens curtas aos alunos de um curso.

A Ferramenta de Apresentação permite a exibição das páginas de aulas e provas que compõem um curso, de acordo com a seqüência e o critério de apresentação previamente determinados pelo professor com o auxílio da Ferramenta de Autoria, através de um *browser*. Por outro lado, no telefone celular os alunos podem, aleatoriamente, realizar os testes, obedecendo apenas o critério de apresentação que o professor definiu.

A Ferramenta de Controle e Administração, desenvolvida para *desktops*, auxilia o administrador na manutenção do ambiente. Para a manutenção, essa ferramenta disponibiliza as seguintes operações: cadastro e remoção de professores, publicação, visualização e remoção de cursos, remoção e visualização de informações sobre os alunos cadastrados e configuração do Servidor Web.

A Ferramenta de Avaliação e Acompanhamento permite a correção das provas feitas por um aluno, calculando a sua nota. Um histórico do aluno contendo dados relativos a sua participação e o seu desempenho no curso também é gerado por essa ferramenta. Já a sua correspondente para telefones celulares provê a correção dos testes realizados por um aluno, exibindo o número de acertos na tela do seu celular.

As Ferramentas de Interação, desenvolvidas para *desktops*, permitem duas formas de comunicação entre as pessoas envolvidas com os cursos: unidirecional através do *e-mail* e bidirecional pelo *chat*.

A Ferramenta de Envio de Mensagens para telefones celulares possibilita o envio de mensagens curtas referentes ao conteúdo das aulas, bem como daquelas do tipo lembrete, criadas pelo professor através da Ferramenta de Autoria, aos alunos de um curso.

ESTUDO DE CASO

Com o objetivo de mostrar a viabilidade da aplicação do Ambiente Pró-Ativo para a EAD em uma situação real e o emprego de telefones celulares nesse ambiente, como uma forma de auxiliar o processo de ensino-aprendizagem, um estudo de caso [6] voltado para a classe de aplicação Treinamento em Vendas é apresentado. Esta seção descreve a aplicação, mostra os processos de elaboração, criação e publicação do curso, além de algumas considerações sobre a interação aluno-ambiente e ambiente-aluno.

Descrição da Aplicação

Tendo como base a classe de aplicação Treinamento em Vendas, foi realizada a simulação da aplicabilidade do Ambiente Pró-Ativo para a EAD em uma distribuidora que comercializa papéis, suprimentos de informática e materiais para escritório, devido às questões práticas e também econômicas da empresa.

Nessa distribuidora, existem três tipos de funcionários: atendentes, entregadores e vendedores. Os atendentes são responsáveis por receber os pedidos dos clientes via telefone. Os entregadores estão encarregados de realizar as entregas dos produtos solicitados pelos clientes, com agilidade e rapidez. Os vendedores se deslocam pela região em que a empresa atua, buscando novos clientes e procurando manter um relacionamento com os clientes já existentes, dispondo de telefones celulares.

Como os vendedores não agendam visitas com os seus clientes, muitas vezes precisam aguardar para serem atendidos. Dessa maneira, o telefone celular pode ser empregado no tempo em que os vendedores ficam aguardando a disponibilidade do cliente. Neste estudo de caso, a aplicação está voltada para esses funcionários, que têm a oportunidade de se aperfeiçoar, mesmo estando em constante deslocamento, devido às vantagens oferecidas pelas Redes Celulares. Segundo Rosenberg [7], a EAD é perfeita para treinar vendedores, que costumam passar muito tempo na rua.

Elaboração, Criação e Publicação do Curso

Para a elaboração do curso, denominado HEV (Habilidades Específicas da Venda), o professor utilizou alguns materiais específicos da área de vendas, disponibilizados pelo SENAC (Serviço Nacional de Aprendizagem Comercial) [8].

Depois de elaborado, o curso HEV foi criado pelo professor com o auxílio da Ferramenta de Autoria, integrada ao ambiente proposto. A estrutura parcial desse curso pode ser visualizada na Figura 2.

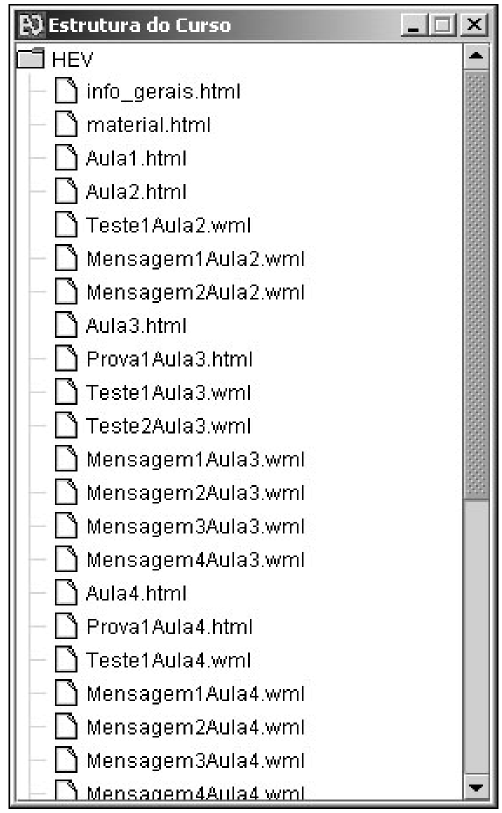

FIGURA. 2
ESTRUTURA PARCIAL DO CURSO.

A estrutura parcial do curso HEV, ilustrada na Figura 2, é composta por informações gerais, material, aulas, provas, testes e mensagens curtas. As informações gerais incluem o objetivo do curso e o seu conteúdo programático. O material contém as referências bibliográficas utilizadas para a sua elaboração. As provas e os testes permitem que os alunos avaliem seu desempenho, enquanto as mensagens curtas reforçam o conteúdo já estudado. As aulas abordam as etapas necessárias para o sucesso no processo de venda.

Para o curso HEV, o professor habilitou a ferramenta de interação *chat* na interface da Figura 3, permitindo uma comunicação bidirecional entre aluno-professor e aluno-aluno. Além disso, o professor também determinou uma política de autorização de acesso ao curso, dividida em três passos: Script de Aulas e Provas, Script de Testes e Script de Mensagens.

No Script de Aulas e Provas, mostrado na Figura 3, duas restrições foram estabelecidas: a aula 4 (Aula4.html) estaria acessível ao aluno se ele tivesse um aproveitamento de no mínimo 70% na prova referente à aula 3 (Prova1Aula3.html) e só assistiria à aula 5 (Aula 5.html) caso alcançasse 100% de acerto na prova da aula 4 (Prova1Aula4.html).

No Script de Testes, foi definido que o aluno realizaria os testes relativos a uma aula do curso somente após ter assistido a ela. Por exemplo: o aluno só poderia resolver o teste 1 (Teste1Aula2.wml) da aula 2 (Aula2.html) ao finalizar essa aula.

No Script de Mensagens, algumas restrições relacionadas com o envio das mensagens curtas aos alunos foram definidas. Assim como no Script de Testes, cada mensagem referente a uma determinada aula só seria enviada ao aluno quando ele terminasse de assistir a ela. Por exemplo: o aluno receberia as mensagens 1 (Mensagem1Aula2.wml) e 2 (Mensagem2Aula2.wml) da aula 2 (Aula2.html) depois de assistir a essa aula.

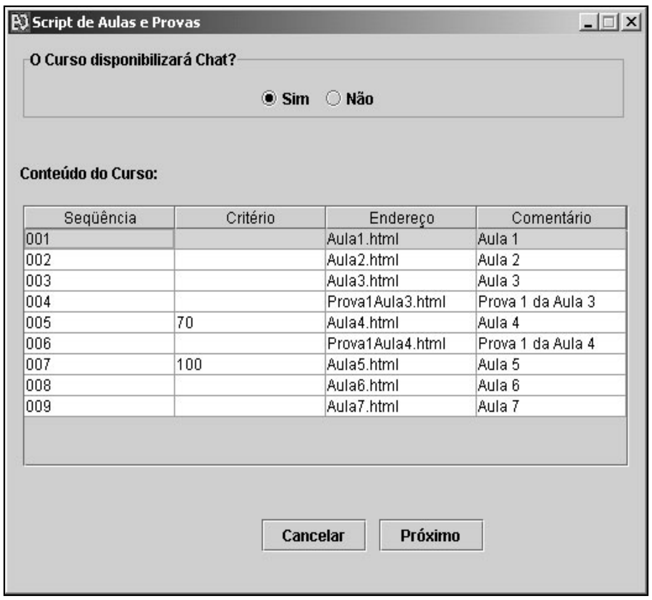

FIGURA. 3.
SCRIPT DE AULAS E PROVAS

Após a determinação da política descrita anteriormente, todos os arquivos gerados durante a criação do curso foram transferidos para uma área temporária do Servidor Web. Por fim, o administrador do ambiente efetuou o cadastro do professor responsável pelo curso e realizou a sua publicação. Nesse momento, o curso tornou-se acessível aos alunos cadastrados no ambiente.

Interação Aluno-Ambiente e Ambiente-Aluno

Na interação aluno-ambiente, o aluno é considerado um ser ativo, responsável pela iniciativa de acesso e uso do ambiente, podendo utilizá-lo pelo tempo que desejar com periodicidade determinada apenas por ele próprio. Inicialmente, os alunos acessaram o ambiente, especificando a URL (http://200.18.98.121/ead/index.html) da página principal (Figura 4) no *browser* de seus *desktops*. Através dessa página, os alunos efetuaram seu cadastro no ambiente, informando seus dados pessoais em um formulário acessível através do link Inscrição, como ilustrado na Figura 4.

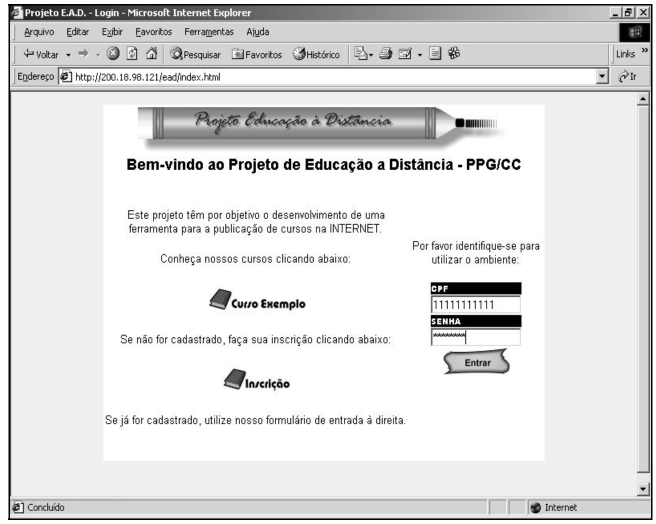

FIGURA. 4
INTERFACE PRINCIPAL DE ACESSO AO AMBIENTE PRÓ-ATIVO.

Em seguida, os alunos realizaram a sua matrícula no curso HEV oferecido pelo ambiente. A partir desse momento, ao informarem CPF (Cadastro de Pessoas Físicas) e senha no formulário de *login*, ilustrado na Figura 4, os alunos tornaram-se aptos a assistir às aulas, a fazer as provas em *desktops* e a realizar os testes nos telefones celulares. A Figura 5 mostra um teste apresentado aos alunos no decorrer do curso HEV.

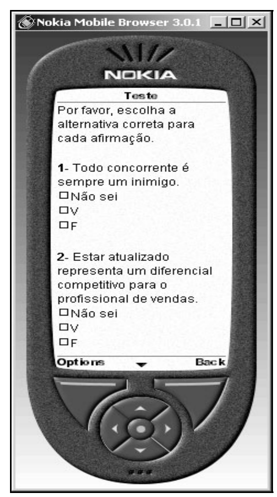

FIGURA. 5
TESTE APRESENTADO.

Enquanto os alunos estavam realizando o curso HEV, puderam se comunicar com o professor e entre si, bem como solucionar suas dúvidas, via *e-mail* e *chat*.

Na interação ambiente-aluno, o ambiente age pró-ativamente no processo de ensino-aprendizagem através do envio de mensagens curtas aos alunos de um curso, com o propósito de incentivar a sua participação e reforçar o conteúdo já estudado. A Figura 6 mostra uma mensagem enviada aos alunos.

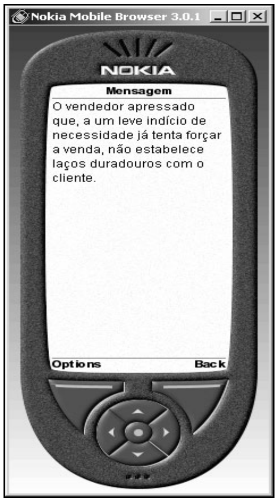

FIGURA. 6
MENSAGEM ENVIADA.

No decorrer do curso HEV, o ambiente realizou as correções das provas e dos testes realizados pelos alunos. Tais correções foram feitas a partir da comparação das respostas dos alunos com as dos arquivos de gabaritos armazenados no Servidor Web. O ambiente também gerou um histórico para cada aluno com dados relativos à sua participação e ao seu desempenho no curso. A Figura 7 apresenta o resultado da correção de um teste realizado por um aluno.

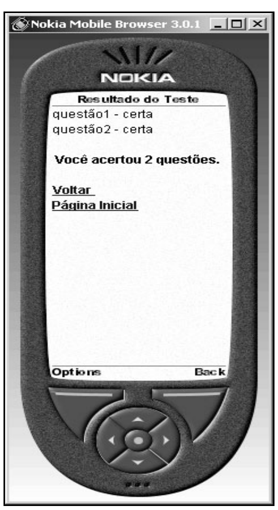

FIGURA. 7
RESULTADO DA CORREÇÃO DE UM TESTE.

CONCLUSÕES

Este artigo apresentou um estudo de caso voltado para a classe de aplicação Treinamento em Vendas, com o propósito de mostrar a viabilidade da aplicação do Ambiente Pró-Ativo para a EAD em uma situação real e o emprego de telefones celulares nesse ambiente como uma forma de auxiliar o processo de ensino-aprendizagem.

Para testar as funcionalidades do ambiente implementado, uma distribuidora que comercializa papéis, suprimentos de informática e materiais para escritório, foi escolhida a partir da classe de aplicação definida. Por questões práticas e também econômicas, decidiu-se simular a aplicabilidade desse ambiente nessa distribuidora. Embora uma simulação tenha sido realizada, o ambiente se comportou de forma esperada durante os testes de utilização das ferramentas que o compõem.

Pelos resultados obtidos na simulação, esse novo ambiente poderia ser facilmente aplicado em uma situação real. Apesar da classe de aplicação Treinamento em Vendas ter sido escolhida como objeto de estudo, outras classes de aplicação poderiam ser utilizadas para testar a aplicabilidade do ambiente, como Apresentações e Ensino de Idiomas.

O emprego de telefones celulares 2G WAP nesse novo ambiente, como uma forma de auxiliar o processo de ensino-aprendizagem, propõe uma inversão na interação aluno-ambiente. Na interação ambiente-aluno, o ambiente age pró-ativamente nesse processo através do envio de mensagens curtas aos alunos de um curso, com o propósito de motivar a sua participação e reforçar o conteúdo já estudado.

Embora telefones celulares ainda limitados tenham sido utilizados no acesso ao ambiente para esse estudo de caso, os alunos puderam conciliar estudo e trabalho, mesmo estando em constante deslocamento, devido principalmente à mobilidade oferecida pela Rede Celular. Segundo Souza e Zorzo [1], as tecnologias tradicionais usadas para oferecer cursos a distância não seriam adequadas para o treinamento de funcionários que se deslocam por uma região.

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APLICATIVO EM PLATAFORMA CAD PARA AUXÍLIO NO DESENHO DE PROJETOS ELÉTRICOS EM BAIXA TENSÃO

Vanderlei César Schmitt[1], Ewerton Eyre de Morais Alonso [2]

Resumo *— O propósito deste trabalho consiste em apresentar o ELE-PROJ, uma ferramenta CAD desenvolvida para auxiliar o desenho de projetos elétricos em baixa tensão, proporcionando agilidade na inserção dos componentes elétricos, eletrodutos e nos desenhos relativos a projetos elétricos, automatizando parte do trabalho através da geração de listas de materiais, quadro de cargas e diagrama unifilar. Este trabalho ainda tem como objetivo proporcionar que engenheiros, arquitetos, professores e alunos que desenvolvem projetos elétricos em baixa tensão possam desfrutar de um ambiente que permite agilidade nas atividades de criação e correção. O sistema foi modelado a partir do diagrama de classes, proposto pela UML, sendo implementado em AUTOLISP e DCL, e executado a partir do ambiente de trabalho do AUTOCAD. O tempo de desenho de um projeto elétrico em baixa tensão foi reduzido significativamente com a utilização do ELE-PROJ, se comparado com o processo de desenho convencional no AUTOCAD.*

Index Terms —AutoCad, AutoLisp, DCL, Projetos Elétricos em Baixa Tensão.

INTRODUÇÃO

Neste trabalho são apresentados alguns conceitos utilizados na elaboração de projetos elétricos em baixa tensão enfatizando a necessidade do mesmo para a execução de uma obra, seja ela residencial ou comercial. São abordados o AutoCAD e as necessidades de uma ferramenta específica para a elaboração de um projeto elétrico de baixa tensão. Além disso, uma breve descrição das ferramentas usadas na implementação do ELE-PROJ [1]: a modelagem a partir do diagrama de classes - proposta pela UML [2]- e a programação através do AutoLISP e da DCL.

O presente trabalho surgiu da constatação de que a maioria dos profissionais de engenharia que atuam no mercado utiliza-se do AutoCAD para a elaboração dos desenhos relativos ao projeto elétrico. Analisando os procedimentos executados pelos profissionais, percebeu-se que muitos deles poderiam ser otimizados ou automatizados através de programação LISP, diminuindo sensivelmente o tempo gasto na elaboração dos desenhos. No mercado existem vários aplicativos específicos para desenvolvimento de projetos elétricos, no entanto, não são utilizados por serem considerados de alto custo para aquisição se comparado ao grau de utilização pela maioria dos profissionais e por exigir que os mesmos “migrem” de plataforma de trabalho e adaptem seus procedimentos ao software escolhido. Dessa forma, o esforço se deu no sentido de fornecer uma ferramenta que agilizasse os procedimentos usuais, sem a necessidade de mudança de procedimentos ou plataformas de trabalho, com baixo custo e de maneira a ser acessível a qualquer profissional – arquiteto, engenheiro, etc. – ou aluno que desenvolva projetos elétricos em baixa tensão.

Através do ELE-PROJ é possível:

- Inserir componentes (tomadas, interruptores, lâmpadas, etc.) do projeto elétrico nos desenhos em CAD;
- Gerar automaticamente através dos cálculos padrões o *dimensionamento de cabos elétricos* em função dos componentes inseridos;
- Elaboração automática do *diagrama unifilar* e do *quadro de cargas* em função dos cabos e componentes inseridos;
- *Lista de materiais* contendo quantidades e especificações dos materiais inseridos e calculados, desde a quantidade de tomadas, de interruptores, até o total em metros de fio necessário para execução do projeto.

Acredita-se que o trabalho aqui proposto irá colaborar, na medida do possível, propondo uma solução baseada num aplicativo computacional de uso freqüente, como é o AutoCAD.

PROJETOS ELÉTRICOS EM BAIXA TENSÃO

Um projeto elétrico em baixa tensão consiste basicamente em representar uma solução da engenharia para problemas da necessidade humana. Dessa forma, o projeto elétrico faz uma mediação entre duas situações ou dois estados, sendo o primeiro a energia elétrica na rede de distribuição e o segundo a energia elétrica na casa do consumidor. Sendo esse projeto bem resolvido, o consumidor terá uma garantia de responsabilidade de um profissional da área, seja ele Engenheiro Civil, Arquiteto, Engenheiro Eletricista ou Mecânico Eletricista – conforme Decreto Federal N. º 23.569/33 de 11/12/1933 [1] - tendo a certeza de que não terá nenhum problema na execução de sua obra.

O projeto da instalação elétrica de uma edificação seja ela residencial ou comercial, consiste basicamente em:

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- *Quantificar:* determinar os tipos e localização dos pontos de utilização de energia;
- *Dimensionar:* definir o tipo e o caminhamento dos condutores e condutos e sua divisão em circuitos;
- *Dimensionar:* definir o tipo e a localização dos dispositivos de proteção, de comando, de medição de energia elétrica e dos demais acessórios.

Conforme Lima [3] "o objetivo de um projeto de instalações elétricas é garantir a transferência de energia desde uma fonte, em geral a rede de distribuição da concessionária ou geradores particulares, até os pontos de utilização (pontos de luz, tomadas, motores, etc.)".

O projeto de instalações elétricas é a previsão escrita da instalação com todos seus detalhes, localização dos pontos de utilização de energia elétrica, comandos, trajetos dos condutores, divisão em circuitos, seção dos condutores, dispositivos de manobra, carga de cada circuito, carga total, etc. [4].

Processos Para Execução de um Projeto Elétrico em Baixa Tensão

Os processos utilizados para se conceber um projeto elétrico em baixa tensão descritos nesta sub-seção tiveram como base o padrão exigido pela concessionária CELESC (Centrais Elétricas de Santa Catarina) [1].

Um projeto elétrico sempre é feito a partir do projeto arquitetônico, que deverá obrigatoriamente conter:

- Planta baixa, contendo a divisão interna dos ambientes da edificação, suas medidas e distribuição do mobiliário (camas, guarda-roupas, tanque, máquina de lavar roupa, máquina de lavar louça, etc.), além de equipamentos especiais a serem instalados (ar-condicionado, torneira elétrica, fornos elétricos, aquecedores, etc.);
- Cortes e fachadas, com cotas e número de pavimentos.

Normalmente na maioria dos projetos existem arquivos eletrônicos, no formato DWG ou DXF, que servirão de base para a elaboração do projeto elétrico. Nos casos em que não exista o projeto arquitetônico em arquivo eletrônico este deverá ser desenhado através do auxilio de algum software específico.

Os procedimentos para a elaboração do projeto elétrico são:

- Eliminação dos elementos de desenho não necessários, constantes do projeto arquitetônico, tais como denominação das dependências, áreas, cotas, dimensões das aberturas, representação de tipo de piso, etc., formando assim a base do projeto elétrico;
- Lançamentos dos elementos do projeto elétrico, de acordo com a disposição dos móveis e aberturas previstos no projeto arquitetônico (tomadas, interruptores, ponto de luz no teto e paredes, tomadas para ar condicionado dentre outras);
- Determinação e lançamento do sistema de alimentação (local do quadro de disjuntores, quadro de medição e entrada de energia);
- Divisão das cargas dos elementos elétricos lançados em circuitos de acordo com sua utilização, localização, carga e características dos mesmos;
- Lançamento dos eletrodutos que servirão de caminho para os cabos elétricos conduzirem a corrente do quadro de disjuntores até o ponto de consumo ou elementos elétricos;
- Determinação dos cabos elétricos de acordo com sua função no circuito quanto ao seu tipo (fase, neutro, retorno, terra) em cada trecho de eletroduto lançado;
- Elaboração do quadro de cargas contendo para cada circuito, sua composição e carga, (carga de iluminação, de tomadas), bem como a dimensão do cabo a ser utilizado e sua proteção (disjuntor);
- Dimensionamento dos eletrodutos em função do número e diâmetro dos cabos elétricos que passam em cada trecho;
- Elaboração do diagrama unifilar de cargas, contendo o número do circuito, carga e proteção de cada um deles. Carga total instalada em cada unidade;
- Cálculo do cabo de alimentação e proteção geral da unidade;
- Elaboração da lista de materiais necessários para execução da obra.

Depois de concluídos todos esses passos o projeto está pronto para ser plotado (impresso) e entregue ao cliente para que possa ser analisado pela concessionária de energia elétrica. Após a aprovação do projeto pela mesma, o cliente pode partir para execução de sua obra e compra dos materiais listados no projeto.

MODELAGEM DO ELE-PROJ

A modelagem é um ponto essencial para uma correta implementação e resultado final de um sistema. Nela é possível solucionar problemas que eventualmente surjam durante a fase de implementação, tornando possível um planejamento mais preciso do sistema. Ela deve apresentar o que o sistema tem como objetivo, os relacionamentos, os atributos e as operações das classes.

O ELE-PROJ foi modelado com base no diagrama de classes, proposto pela UML. A escolha pela UML deveu-se a fácil representação do sistema proposto e a facilidade de compreensão e modelagem que o diagrama de classes fornece sendo muito sucinto e informativo - qualidades desejáveis em uma notação. O diagrama de classes é a essência da UML, sendo esta um padrão que está sendo muito aceito para a modelagem orientada a objeto.

Apesar da modelagem ter sido desenvolvida orientada a objeto, a programação não o foi pelo fato de que a linguagem de programação LISP é uma programação em listas.

O diagrama apresentado na Figura 1 fornece uma modelagem conceitual das classes utilizadas pelo sistema.

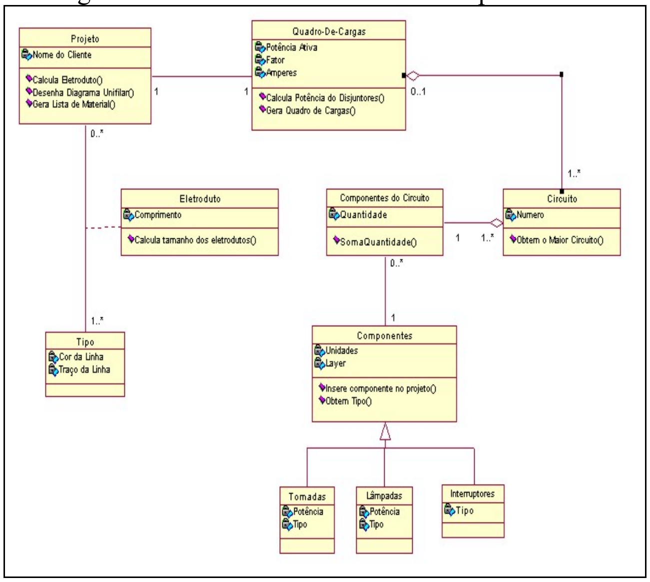

FIGURA 1
MODELAGEM DO ELE-PROJ – DIAGRAMA DE CLASSE.

IMPLEMENTAÇÃO DO ELE-PROJ

O AutoCAD (CAD: Computer Aided Design/Drafting) é uma ferramenta para o auxílio de desenhos e projetos em computador, caracterizando-se numa poderosa ferramenta de computação gráfica que permitiu a substituição da antiga prancheta de desenhos por um computador com um nível de produtividade e qualidade sem precedentes.

A dupla precisão do AutoCAD permite que se trabalhe com desenhos muito grandes facilitando eventuais alterações num projeto, o que na prancheta às vezes se tornaria praticamente impossível sem que o projeto fosse todo redesenhado. É o padrão da indústria para projetos e desenhos auxiliados por computador. Por esta razão é hoje o programa CAD mais sofisticado e flexível que pode ser adquirido no mercado para o uso num computador [5].

O AutoCAD trata cada entidade do desenho como um objeto. Dessa forma, existem vários objetos: uma linha, um arco, um texto, dentre outros. Assim, é possível ler o código DXF de cada objeto, pois para cada componente selecionado existem informações tais como: nome do componente, tipo, coordenada de inserção, tamanho, dentre outras. Baseado nesta característica é que o sistema foi desenvolvido.

Normalmente um grande número de pessoas utiliza o AutoCAD apenas para fins de desenho, tendo pouco convívio com manuais e leitura especializada. Na realidade, o AutoCAD possui um universo de recursos que acabam sendo pouco explorados como é o caso do AutoLISP.

Uma característica importante do AutoLISP que o torna muito interessante é a possibilidade de utilizar comandos que interagem diretamente com o AutoCAD. Através do AutoLISP pode-se construir programas que solicitem ao usuário determinadas informações, processem essas informações e interfiram sobre a área de trabalho do AutoCAD.

Para algumas áreas como a engenharia, por exemplo, esse recurso representa um grande potencial. Pode-se obter informações estratégicas a partir do desenho que permitirão calcular e definir outros elementos que podem ser desenhados automaticamente. Assim, o usuário pode começar um desenho e assistir a conclusão dele numa velocidade bem maior do que se conseguiria fazendo a mesma tarefa manualmente. Com o conhecimento do AutoLISP tornam-se inúmeras as possibilidades de melhoria de performance num projeto.

Com base nessas características, utilizou-se o AutoLISP para implementar funções com a finalidade de gerar o quadro de cargas, lista de materiais, diagrama unifilar, inserção de componentes, desenho dos eletrodutos e cálculo do comprimento dos eletrodutos de um projeto elétrico em baixa tensão desenhado no AutoCAD.

A interface do sistema foi desenvolvida a partir da programação DCL. Pode se dizer que a linguagem DCL é um complemento do AutoLISP ou, ainda, é possível considerar que a linguagem DCL é a ferramenta que gera a interface de um AutoLISP, possibilitando ao usuário implementar interfaces próprias podendo assim fornecer aos elementos personalizados a mesma aparência e facilidade de uso existentes no formato de quadro de diálogo do AutoCAD.

Interface do ELE-PROJ

O ELE-PROJ foi incorporado à interface do AutoCAD, sendo que foram acrescentadas uma abertura no menu superior e uma barra de tarefas, conforme pode ser observado nas Figura 2 e 3, respectivamente.

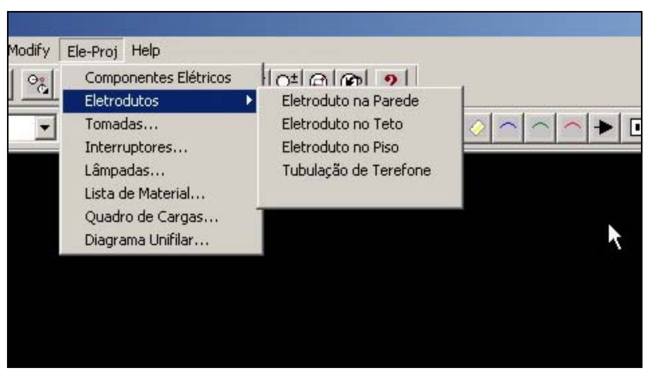

FIGURA 2
MENU SUPERIOR.

As caixas de diálogo, programadas em DCL, são chamadas toda vez que uma função LISP é executada. Conforme exposto em [6], deve-se evitar caixas de diálogos muito complexas e com muitas variáveis, pois a probabilidade de erros aumenta muito. Com base nisso, foi evitado o excesso de caixas de diálogo.

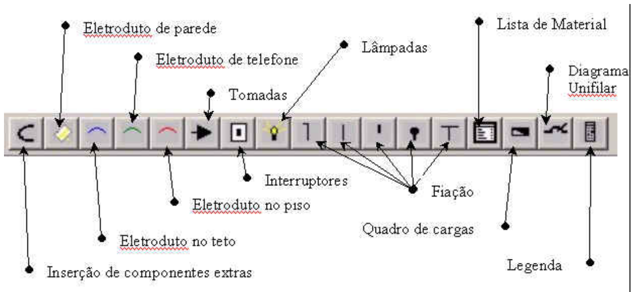

FIGURA 3
BARRA DE TAREFAS.

A Figura 4 apresenta uma das caixas de diálogo do ELE-PROJ.

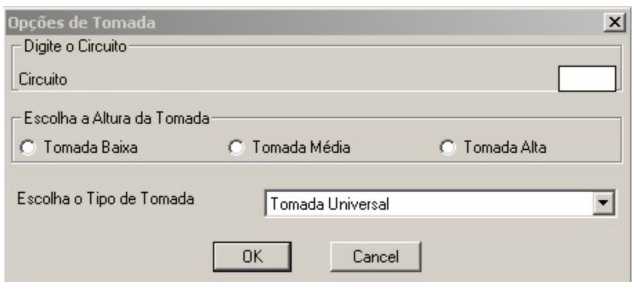

FIGURA 4
CAIXA DE DIÁLOGO PARA INSERÇÃO DE TOMADAS.

FUNCIONAMENTO DO ELE-PROJ

O ELE-PROJ é executado automaticamente com a inicialização do AutoCAD no microcomputador em que ele estiver instalado. Dessa maneira, parte-se do principio que é preciso obter o projeto arquitetônico para, a partir daí, iniciar os procedimentos do desenho de um projeto elétrico em baixa tensão. Na maioria das vezes o projeto arquitetônico já está em um arquivo do AutoCAD, o que facilita o trabalho.

Para usar o ELE-PROJ o usuário deverá ter conhecimentos sobre o ambiente de trabalho do AutoCAD, nem tanto pelo ELE-PROJ que é um sistema simples quanto à utilização, mas devido ao fato de que o arquivo referente a um projeto arquitetônico contém muitas informações desnecessárias para o projeto elétrico devendo-se proceder à eliminação dos mesmos.

A Figura 5 mostra a planta baixa de um projeto arquitetônico padrão pronta para o início do desenho do projeto elétrico.

O próximo passo para o desenho de um projeto elétrico em baixa tensão é o lançamento dos componentes. Efetua-se logo em seguida o lançamento dos eletrodutos/condutores. Dessa forma, o projeto já está quase preparado para que seja possível gerar os cálculos e quantitativos de forma automática, o que por sinal se constitui no ponto forte do sistema ELE-PROJ. Nesses quantitativos é que se torna possível mostrar todo o potencial da programação em AutoLISP.

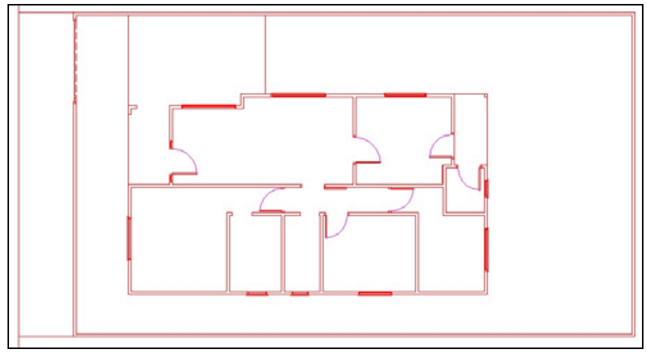

FIGURA 5
PLANTA BAIXA PREPARADA PARA A INICIAÇÃO DO DESENHO DE UM PROJETO ELÉTRICO.

A Figura 6 mostra, em ampliação de parte da planta baixa, o lançamento dos fios sobre dois dormitórios e suas chegadas ao quadro de cargas.

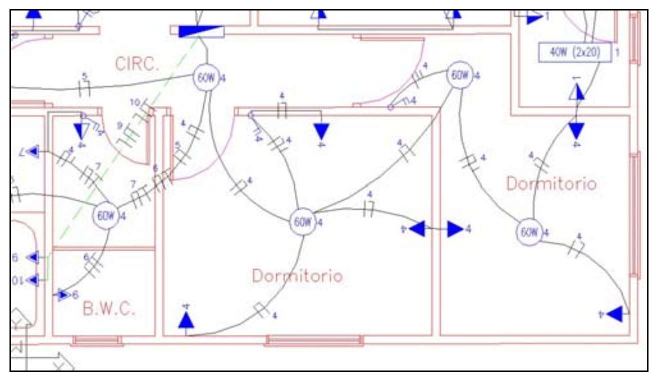

FIGURA 6
LANÇAMENTO DA FIAÇÃO.

Após o lançamento dos fios é possível gerar os quantitativos, ou seja, a lista de materiais, o quadro de cargas e o diagrama unifilar - Figuras 7, 8 e 9 respectivamente.

LISTA DE MATERIAIS	
DESCRIÇÃO	QTD
TOMADA UNIVERSAL	19
TOMADA 2 PINOS + TERRA	4
TOMADA DE 2 PINOS + TERRA DE 30 A	5
TOMADA DE AR CONDICIONADO	1
INTERRUPTOR 1 TECLA SIMPLES	1
INTERRUPTOR 1 TECLA PARALELA	1
INTERRUPTOR 2 TECLAS SIMPLES	6
INTERRUPTOR 1 TECLA SIMPLES E 1 PARALELA	1
INTERRUPTOR 2 TECLA PARALELAS	2
LÂMPADA INCADESCENTE DE 60 W	9
LÂMPADA INCADESCENTE DE 100 W	4
LÂMPADA FLUORESCENTE DE 40 W (2X20)	1
LÂMPADA FLUORESCENTE 80 W (2X40)	1

FIGURA 7
LISTA DE MATERIAIS.

Todos esses desenhos foram gerados a partir de poucas interações com o mouse obtendo, dessa forma, uma agilidade e uma funcionalidade muito grande o que por fim mostra o grande potencial que é a programação em AutoLISP.

QUADRO DE CARGAS

CIRCUITO	LAMPADAS				TOMADAS		AR CONDIC.	CHUVEIRO	POTENCIA ATIVA	FATOR DE POTENCIA	POTENCIA APARENTE	DISJUNTOR	FASES R-S-T
	40(2x20)W	60W	80(2x40)W	100W	100W	200W	900W	4400					
1	1	1	1	0	4	4	0	0	1380	1	1380	10	R
2	0	0	0	0	0	0	0	1	4400	1	4400	20	R
3	0	0	0	4	6	0	0	0	1000	1	1000	10	R
4	0	5	0	0	6	0	0	0	900	1	900	10	R
5	0	3	0	0	3	0	0	0	480	1	480	10	R
6	0	0	0	0	0	0	0	1	4400	1	4400	20	R
7	0	0	0	0	0	0	0	1	4400	1	4400	20	R
8	0	0	0	0	0	0	1	0	900	1	900	10	R
9	0	0	0	0	0	0	0	1	4400	1	4400	20	R
10	0	0	0	0	0	0	0	1	4400	1	4400	20	R

CARGA INSTALADA Ativa= 26660 W Aparente= 26660 W

FIGURA 8
QUADRO DE CARGAS.

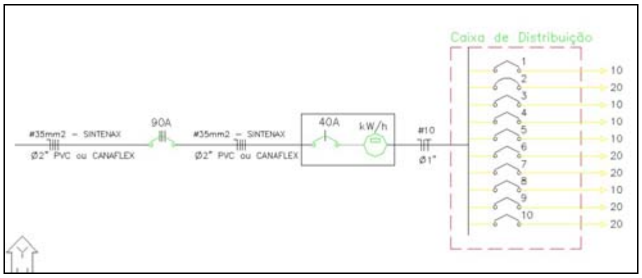

FIGURA 9
DIAGRAMA UNIFILAR.

VALIDAÇÃO E TESTES

Obteve-se um ótimo resultado tendo como referencial nos testes o tempo de trabalho com e sem o sistema ELE-PROJ. O trabalho que levaria de 5 a 7 horas para ser executado – neste caso o projeto apresentado na seção de funcionamento do ELE-PROJ, no ambiente do AutoCAD e sem qualquer ferramenta específica - foi concluído em apenas 1 hora e 30 minutos, tendo assim um excelente ganho de produtividade.

A Tabela 1 contém dados coletados quando foram feitos os testes do sistema ELE-PROJ. Para que se pudesse ter uma idéia exata de horas de trabalho de um determinado projeto foram colocadas as metragens quadradas de cada projeto testado.

TABELA 1
COLETA DE DADOS DOS TESTES DO ELE-PROJ.

Projeto	Horas Trabalhadas sem o ELE-PROJ	Horas Trabalhadas com o ELE-PROJ	m2
Casa 1	08:00	01:50	97,56
Casa 2	09:30	02:30	115,23
Casa 3	07:10	01:30	73,15
Casa 4	10:00	02:55	134,87
Casa 5	09:20	01:45	92,45
Casa 6	10:00	02:40	124,67

Os testes foram feitos em 6 projetos de casas já executados e devidamente aprovados, onde se obteve uma produtividade muito grande com significativa redução da carga horária gasta no desenvolvimento dos projetos – conforme Tabela 1 - pois o que toma tempo é o lançamento dos componentes, sendo que este dependente do usuário. Já os quantitativos estão completamente automatizados, sendo este o maior ganho de produtividade no projeto.

CONCLUSÃO

Considera-se que o ELE-PROJ é um excelente sistema de auxílio para elaboração de projetos elétricos em baixa tensão que pode ser usado por engenheiros, arquitetos, professores e alunos, pois é acessível até mesmo para usuários com pouca experiência em AutoCAD.

O AutoLISP permite muito mais otimizações de serviços e tarefas, mas ressalta-se que esse projeto está em fase inicial de desenvolvimento.

Finalmente, não se tem a pretensão de transformar o ELE-PROJ na solução definitiva para a elaboração de projetos elétricos em baixa tensão porque ele visa apenas auxiliar o projetista nas suas tarefas de desenho. A análise criteriosa dos resultados, feita pelo engenheiro eletricista, é indispensável para o resultado final do projeto.

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O CONCEITO DE GRADUAÇÃO MODULADA E SUA IMPLEMENTAÇÃO EM UM CURSO DE CIÊNCIA DA COMPUTAÇÃO

Roberto Ferrari[1]*, André Luiz Battaiola*[2] *e Patrícia Dátilo*[3]

Abstract *— A Universidade Anhembi-Morumbi adota em todos os seus cursos o conceito de Graduação Modulada, que possibilita ao aluno obter, de forma integrada, dois ou três diplomas de nível superior: diploma de Curso Superior de Formação Específica ao final dos dois primeiros anos, diploma de Curso Superior de Tecnologia ao final de três anos, e diploma de Bacharel ao final de quatro ou cinco anos. Este artigo apresenta o conceito de Graduação Modulada, analisa as questões pertinentes a sua adoção em um plano pedagógico de um curso de Ciência da Computação - a luz da LDB, dos critérios de avaliação estabelecidos pelo INEP e das diretrizes curriculares da SBC de 1999 - e apresenta os resultados preliminares da implantação da Graduação Modulada no curso de ciência da computação da Universidade Anhembi-Morumbi.*

Index Terms — *Ciência da Computação, Cursos Superiores de Formação Específica, Grade Curricular, Graduação Modulada.*

CONCEITO DE GRADUAÇÃO MODULADA

A Graduação Modulada é um conceito de ensino superior que propicia ao aluno a oportunidade de adquirir, de forma integrada, dois ou três diplomas de nível superior - diploma de Curso Superior de Formação Específica (ao final dos dois primeiros anos), diploma de Curso Superior de Tecnologia (ao final de três anos em média) e diploma de Bacharel (ao final de quatro ou cinco anos).

A motivação para a Graduação Modulada é possibilitar ao aluno:

- ingressar no ensino superior sem ficar limitado a um curso de graduação específico, podendo migrar de um curso para outro, aproveitando ao máximo as disciplinas já cursadas;
- ingressar mais rapidamente no mercado de trabalho a partir da capacitação mínima necessária para o exercício de atividades profissionais específicas;
- educação continuada para sua atualização profissional constante;
- suprir suas demandas pessoais por conhecimentos, permitindo-lhe, na sua formação, selecionar as disciplinas mais adequadas ao seu desenvolvimento profissional específico.

A Graduação Modulada é implementada a partir da integração curricular entre cursos de graduação regulares (quatro ou cinco anos de duração) com cursos de formação específica ou de tecnologia (dois anos de duração). Naturalmente, os cursos a serem integrados precisam ser de áreas afins pois o que possibilita a integração curricular é a convergência das áreas do conhecimento ou, na prática, a oferta de disciplinas comuns a vários cursos.

A Figura 1 ilustra, de forma simplificada, o conceito de Graduação Modulada. Ao término de dois anos o aluno completa o primeiro módulo da Graduação Modulada, e recebe um diploma de Curso Superior de Formação Específica (CSFE). Espera-se que neste momento o aluno esteja apto a entrar no mercado de trabalho, se assim desejar ou necessitar. As disciplinas que o aluno cursou nos dois primeiros anos, para o Curso Superior de Formação Específica, compõem também o currículo do curso de graduação regular, de quatro anos (Bacharelado). Assim o aluno tem a possibilidade de continuar estudando por mais dois anos para concluir o seu Bacharelado.

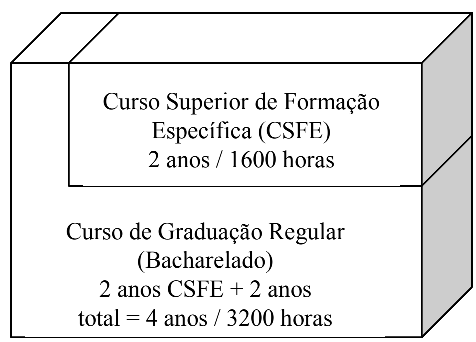

FIGURA. 1
CONCEITO DE GRADUAÇÃO MODULADA.

Uma segunda possibilidade é o aluno optar por um dentre dois ou mais cursos de Formação Específica e então prosseguir por mais dois anos e obter também o Bacharelado. Nestes casos, ambos os cursos de Formação Específica são integrados ao Bacharelado através de conjuntos distintos de disciplinas eletivas. Nos dois

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primeiros anos o aluno precisa cursar apenas um dos dois conjuntos de eletivas (ou seja, o aluno precisa concluir apenas um dos dois Cursos Superiores de Formação Específica) para continuar por mais dois anos e concluir o Bacharelado, como mostra a Figura 2.

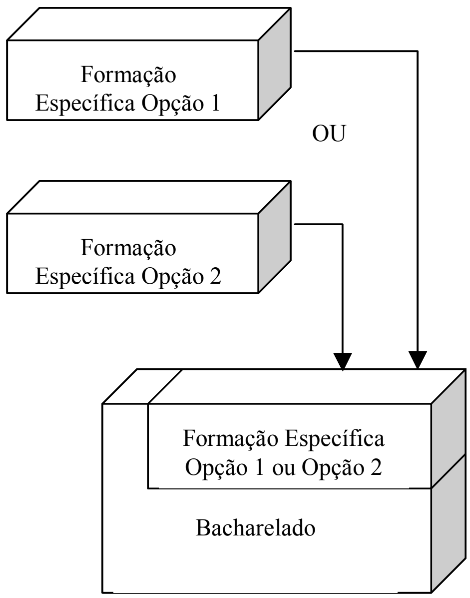

FIGURA. 2
DUAS OPÇÕES PARA CURSOS SUPERIORES DE FORMAÇÃO ESPECÍFICA.

Existe também a possibilidade de implementação de Cursos Superiores de Tecnologia integrados aos dois últimos anos do Bacharelado. Assim como no caso dos Cursos Superiores de Formação Específica, as disciplinas são integradas às disciplinas do Bacharelado. No caso de existirem dois ou mais Cursos Superiores de Tecnologia, a opção do aluno por um desses cursos significa, no Bacharelado, a opção por um dentre dois conjuntos de eletivas.

A integração entre cursos é possibilitada por uma estrutura curricular planejada cuidadosamente, na qual as disciplinas são organizadas em grupos bem definidos. Todos os cursos de graduação, regulares ou de curta duração, têm em suas grades curriculares disciplinas classificadas como:

- **Disciplinas de Fundamentação Geral – FDG.** São disciplinas que compõem o núcleo comum a todos os cursos da Universidade e visam a formação humanista ao aluno. Este núcleo tem carga horária de 400 horas, distribuídas nas disciplinas Comunicação e Expressão, Metodologia Científica, Filosofia, Ciências Sociais e Psicologia;
- **Disciplinas de Fundamentação da Área – FDA.** São disciplinas comuns a vários cursos de uma mesma área do conhecimento (como exatas, humanas, negócios e saúde), que oferecem base teórica e prática para as disciplinas profissionalizantes. Em todos os cursos nos quais são oferecidas, essas disciplinas têm conteúdos iguais, a mesma nomenclatura, carga horária e ementa. Quando possível, são oferecidas nos mesmos períodos das grades curriculares;
- **Disciplinas Eletivas da Formação Específica - ELFE.** São as disciplinas que definem o Curso Superior de Formação Específica. O bloco é composto por até 5 disciplinas, compondo um máximo de 400 horas-aula, dependendo da concepção de cada curso. Essas disciplinas são obrigatórias na Formação Específica, e também compõem o currículo pleno do curso de Graduação Regular; e
- **Disciplinas de Formação Profissional da Graduação – FPRG**. São as disciplinas que definem a formação profissional do aluno e completam a composição do currículo pleno da Graduação Regular.

Como mostra a Figura 3, nos dois primeiros anos os alunos cursam as disciplinas FDG (Fundamentação Geral), que fazem parte do currículo dos Cursos Superiores de Formação Específica (CSFE), do currículo da Graduação Regular e também do currículo de qualquer curso superior da Universidade. Também nos dois primeiros anos o aluno cursa as disciplinas FDA (Fundamentação da Área), que também compõem ambos os CSFE, a Graduação Regular, e currículos de outros cursos na mesma área (exatas, negócios, humanas ou saúde). As disciplinas ELFE fazem parte de um dos CSFE e da Graduação Regular. Nos dois últimos anos o aluno cursa as disciplinas FPRG para concluir a Graduação Regular. Outras classes de disciplinas, omitidas da Figura 3 para simplificação, são ELTC (Eletivas da Tecnologia), ELGR (Eletivas da Graduação), além das Atividades Complementares.

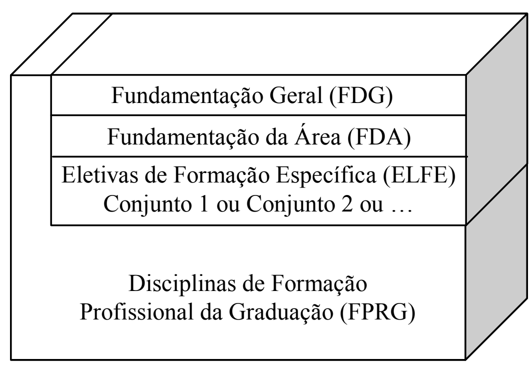

FIGURA. 3
CLASSES DE DISCIPLINAS.

FUNDAMENTAÇÃO LEGAL

Graduação modulada não é algo usual no ensino superior no Brasil. Assim, para que a sua adoção não infrinja normas e critérios estabelecidos, três documentos devem ser considerados: a LDB, a proposta de diretriz curriculares elaborada pela SBC em 1999 e em exame no CNE e o relatório do sistema de avaliação de cursos de Bacharelado em Ciência da Computação (BCC) definido pelo INEP.

Lei de Diretrizes e Bases da Educação

O Art. 208, parágrafo V da Constituição Federal [1] explicita que o Estado deve garantir *acesso aos níveis mais elevados do ensino, da pesquisa e da criação artística**, segundo a capacidade de cada um***. Ao analisar a nova LDB [5], com a finalidade de fundamentar o Parecer CES/CNE 968/98 [6], do qual emanou a Resolução Nº 1, de 27 de janeiro de 1999 [7], que regulamentou os cursos seqüenciais, o então Conselheiro da Câmara de Educação Superior do Conselho Nacional de Educação, Jacques Velloso, comentou que a *"redação dada ao art. 44 deve ser interpretada à luz do diapasão que prevalece na maioria dos demais dispositivos do novo diploma legal. Ao leitor atento não escapará a preocupação do legislador com a flexibilidade de que devem gozar os sistemas de ensino e as instituições, em suas formas de organização e modos de atuar. O princípio da flexibilidade reflete-se tanto na letra como no espírito da Lei. Pode ser notado em várias de suas determinações, que freqüentemente admitem mais de uma forma para seu cumprimento, assim como no caráter aberto, intencionalmente inacabado que transparece em diversos de seus dispositivos. A nova figura dos cursos seqüenciais é elemento típico desse espírito...*" [6] (p.2).

Conselheiro argumenta também que "deve-se ter sempre presente que uma pessoa pode realizar vários cursos seqüenciais ao longo da sua vida. Insere-se, assim, na educação continuada de terceiro grau" [6] (p 8). Finalmente, no mesmo parecer, o Conselheiro conclui que "nas instituições onde os cursos de graduação forem oferecidos de forma modular, os diferentes módulos poderão vir constituir e serem ofertados como cursos superiores de formação específica, caso sejam concebidos para tanto, ampliando assim a flexibilidade da oferta destes" [6] (p 12).

Em função deste parecer a Câmara de Ensino Superior/Conselho Nacional de Educação do MEC aprovou a Resolução Nº 1 de 27 de janeiro de 1999 [7], homologada pelo Ministro Paulo Renato, regulamentando os cursos seqüenciais com duração mínima de 1600 horas e 400 dias letivos.

A LBD – Lei 9394/96 [5] prevê a oferta de educação profissional, conduzindo ao permanente desenvolvimento de aptidões da vida produtiva. O Parecer CNE/CES 436/01 [8], homologado pelo Ministério da Educação em 06/04/01 trata da oferta dos Cursos Superiores de Tecnologia, voltados para áreas de uso intenso de tecnologias e permitindo uma formação especializada em consonância com as necessidades do mercado de trabalho em áreas como lazer, gestão, saúde, agropecuária, indústria, construção civil e outras. Os Cursos Superiores de Tecnologia se pautam pela flexibilidade na oferta e na organização curricular, com duração variável de 1600 a 2400 horas, conforme a área.

Critérios de Avaliação do INEP

O INEP, através de um processo denominado Avaliação das Condições de Ensino, verifica, *in loco*, a situação dos cursos de graduação, levando em conta três grandes dimensões: 1) a Organização Didático-Pedagógica, 2) a Qualificação do Corpo Docente e 3) as Instalações Físicas, com ênfase na biblioteca. Realizada por uma comissão de professores, a avaliação é um instrumento utilizado pelo Ministério da Educação para reconhecer ou renovar o reconhecimento de um curso.

A graduação modulada afeta a dimensão 1, Organização Didático-Pedagógica, a qual se subdivide em três categorias: 1.1) Administração-Acadêmica, 1.2) Projeto do Curso e 1.3) Atividades Acadêmicas articuladas ao Ensino de Graduação. Destas, somente a categoria 1.2 é afetada substancialmente pela graduação modulada. Neste contexto, os parâmetros de avaliação se relacionam essencialmente com a coerência entre a concepção do curso (objetivos e perfil do egresso), a grade curricular e o sistema de avaliação. Assim, se a graduação modulada estiver obedecendo esta coerência, o processo de avaliação do INEP não deve constituir um obstáculo para a aprovação do curso.

Diretrizes Curriculares para Computação e Informática

As diretrizes curriculares definem os princípios, fundamentos, condições e procedimentos da formação de um determinado egresso.

Como mencionado anteriormente, os cursos de BCC não possuem ainda uma diretriz curricular aprovada pelo CNE, dado que a proposta elaborada pelo SBC em 1999 ainda se encontra em exame neste conselho.

A diretriz proposta pela SBC define um perfil para o egresso em BCC baseado em quatro categorias de cursos para a área de computação: 1) os cursos que têm predominantemente a computação como atividade fim; 2) como atividade meio; 3) os cursos de Licenciatura em Computação e 4) os Cursos de Tecnologia (cursos seqüenciais). Sendo BCC e Engenharia de Computação considerados como cursos onde computação é atividade fim, a SBC planejou estes cursos como aqueles onde o aluno deve ter uma forte formação teórica em conceitos considerados como fundamentais da área. A exposição destes conceitos obedece a uma sequência pouco flexível, em especial nos dois primeiros anos de curso, o que dificulta a elaboração de grades curriculares radicalmente diferenciadas das convencionais. Esta questão é o ponto central para se incorporar o conceito de graduação modulada a um curso de BCC, o que é tratado a seguir.

GRADUAÇÃO MODULADA NO BACHARELADO EM CIÊNCIA DA COMPUTAÇÃO DA UNIVERSIDADE ANHEMBI MORUMBI

A Graduação Modulada é um conceito que faz parte do plano pedagógico institucional da Universidade Anhembi Morumbi. Cursos como os bacharelados em Administração, Comunicação Social, Turismo e Moda são integrados a três ou quatro áreas alternativas para a Formação Específica nos dois primeiros anos. Outros cursos como o Bacharelado em Economia e Bacharelado em Marketing possuem uma única alternativa para a Formação Específica, como mostra a Tabela 1 [4].

O conceito de Graduação Modulada foi implementado no curso de BCC da Universidade Anhembi Morumbi no ano de 2002, a partir de uma reestruturação curricular. Um dos objetivos fundamentais da reestruturação curricular era implementar a Graduação Modulada, garantindo-se o respeito aos critérios do de avaliação do INEP [2] e às Diretrizes Curriculares [3].

TABELA I
EXEMPLOS DA INTEGRAÇÃO ENTRE BACHARELADOS E CURSOS SUPERIORES DE FORMAÇÃO ESPECÍFICA NA UNIVERSIDADE ANHEMBI MORUMBI

Bacharelado	Alternativas para a Formação Específica nos Dois Primeiros Anos
Administração	Gestão e Planejamento Financeiro
	Gestão e Planejamento de Marketing e Vendas
	Gestão de Sistemas Administrativos e Tratamento da Informação
Economia	Análise de Indicadores Socioeconômicos
Marketing	Gestão e Planejamento de Marketing e Vendas
Turismo	Gestão Hoteleira
	Organização e Gestão de Eventos
	Gestão dos Negócios de Viagens e Turismo
	Planejamento de Marketing Turístico
Comunicação Social	Criação de Roteiros para Produções
	Gestão de Comunicação Empresarial
	Pesquisa de Mercado
Moda	Criação e Desenvolvimento de Produto de Moda
	Merchandising, Comunicação Visual e Vitrinismo
	Produção de Moda
	Varejo de Moda

A Escolha do Tema para a Formação Específica

As Diretrizes Curriculares [3] recomendam, para cursos de BCC, uma formação sólida nos fundamentos da computação (algoritmos, programação, arquitetura de computadores, matemática). As disciplinas que tratam esses fundamentos são classificadas como sendo da área de formação Básica. Além dos fundamentos da computação os BCCs precisam oferecer disciplinas nas áreas de formação Tecnológica (engenharia de software, banco de dados, redes de computadores), Complementar (administração, negócios ou outras áreas) e Humanística (ética, sociologia, empreendedorismo).

Para cumprir as orientações das Diretrizes, na área de formação Básica não há muita flexibilidade em termos de seleção de disciplinas e carga horária. Além disso, há uma indicação implícita ("fundamentos", formação "básica") de que este conjunto de disciplinas deve ser oferecido antes das disciplinas que compõem as outras áreas de formação. Nas áreas de formação Tecnológica, Complementar e Humanística o espaço para alterações em função da vocação institucional ou outros fatores é maior.

O processo de reestruturação curricular para implantação do conceito de Graduação Modulada no BCC iniciou com a identificação de três alternativas quanto ao foco do Curso Superior de Formação Específica – CSFE – que seria integrado aos dois primeiros anos do Bacharelado:

- Foco em algum tema específico da área de formação tecnológica, como redes de computadores, por exemplo;
- Foco em algum tema multidisciplinar, como multimídia ou design de jogos;
- Foco em algum tema da área de formação Básica, como algoritmos e programação.

Sendo a Formação Específica implantada nos dois primeiros anos do Bacharelado, a primeira alternativa para o tema do CSFE (redes de computadores) foi descartada pois implicaria em uma alteração na seqüência lógica das disciplinas do Bacharelado. Disciplinas da área de formação Tecnológica (como Redes de Computadores) precisariam ser oferecidas antes de algumas das disciplinas da área de formação Básica (Matemáticas, Arquitetura de Computadores, Programação).

A segunda alternativa (temas multidisciplinares como Multimídia, Design de Jogos) seria a mais apropriada para a oferta em paralelo de duas ou mais opções de temas para a Formação Específica, porém também foi descartada pelo inconveniente de "empurrar" disciplinas básicas do Bacharelado para os dois últimos anos.

A estratégia adotada foi a terceira alternativa – um tema da área de formação Básica – e o tema escolhido foi Desenvolvimento de Software. Esse tema não implicaria em uma alteração significativa na seqüência "natural" para as disciplinas do Bacharelado. Porém, esse tema não possibilita a oferta de duas ou mais "opções" para a Formação Específica nos dois primeiros anos. As disciplinas que compõem a formação em Desenvolvimento de Software são obrigatórias para o Bacharelado. Não seria cabível dar ao aluno a opção de escolher entre Desenvolvimento de Software e um outro tema.

Curso Superior de Formação Específica em Desenvolvimento de Software

As disciplinas que caracterizam a formação em Desenvolvimento de Software nos dois primeiros anos são:

- 1º semestre: Introdução à Ciência da Computação; Construção de Algoritmos;
- 2º semestre: Programação de Computadores I;
- 3º semestre: Estruturas de Dados; Programação de Computadores II;
- 4º semestre: Programação Avançada; Banco de Dados; e Pesquisa, Ordenação e Técnicas de Armazenamento.

O objetivo da disciplina Construção de Algoritmos é capacitar o aluno no desenvolvimento de algoritmos. Em paralelo – e de forma integrada - o aluno cursa a disciplina Introdução à Ciência da Computação, que inclui aulas de programação em laboratório, levando o aluno a implementar algoritmos em uma linguagem de programação. Ambas as disciplinas são oferecidas no primeiro semestre. No segundo semestre o aluno aumenta suas habilidades em programação através da disciplina Programação de Computadores II. Estruturas de Dados e Pesquisa, Ordenação e Técnicas de Armazenamento, no terceiro e quarto semestres, apresentam ao aluno conceitos sobre armazenamento e manipulação de dados em algoritmos e programas. A disciplina Programação Avançada é administrada de forma integrada à disciplina Banco de Dados. Juntas, essas disciplinam capacitam os alunos ao desenvolvimento de aplicações de software, a partir de linguagens visuais, conexas a bancos de dados implementados em sistemas de gerenciamento de banco de dados – tecnologia adotada em boa parte dos produtos comerciais de software hoje em dia.

Nos dois primeiros anos o aluno está capacitado ao desenvolvimento de software com produtos e conceitos tecnológicos utilizados comercialmente. A capacitação precoce do aluno, associada à credibilidade outorgada pelo diploma de Formação Específica em Desenvolvimento de Software, facilita e antecipa seu ingresso no mercado de trabalho. Assim, a implementação da Graduação Modulada cumpre a meta de oferecer mecanismos para antecipar o tanto quanto possível o ingresso dos alunos no mercado de trabalho da área de computação, sem abrir mão da solidez e abrangência de sua formação.

Bacharelado em Ciência da Computação

Nos dois últimos anos, além de disciplinas em outras áreas do conhecimento, o aluno cursa disciplinas que complementam sua formação em Desenvolvimento de Software. As disciplinas Engenharia de Software e Projeto de Sistemas de Informação fornecem ao aluno conceitos sobre o desenvolvimento de produtos de software, possivelmente no contexto de sistemas de informação. As disciplinas Introdução à Teoria dos Grafos, e Computabilidade e Análise de Algoritmos fornecem aos alunos condições de amadurecer suas habilidades relativas ao desenvolvimento de software através de uma visão formal e analítica do tema. A disciplina optativa Tópicos em Programação e Linguagens permite, aos alunos que se dispuserem a cursá-la, o estudo ou atualização em conceitos, técnicas e produtos emergentes na área. Assim, nos dois últimos anos o aluno complementa sua formação em desenvolvimento de software, aproveitando integralmente a formação dos dois primeiros anos, e possivelmente a experiência profissional resultante do ingresso precoce do aluno no mercado de trabalho.

CONCLUSÕES

Um dos resultados da implantação da Graduação Modulada é a flexibilização curricular, o que permite ao aluno migrar de um curso para outro aproveitando ao máximo as disciplinas já cursadas. Essa possibilidade de escolha transfere ao aluno a responsabilidade sobre suas escolhas profissionais. A flexibilização curricular ocorre por meio da adoção de disciplinas de fundamentação geral comuns a todos os cursos, disciplinas básicas de tronco comum a uma mesma área do conhecimento (exatas, negócios, etc.), e através da cuidadosa integração dos currículos de cursos superiores de curta duração com currículos de cursos de graduação de maior duração (Bacharelados).

O conceito de Graduação Modulada foi implementado no âmbito do curso de BCC da Universidade Anhembi Morumbi através da integração de seu currículo com o de um Curso Superior de Formação Específica em Desenvolvimento de Software. A escolha do tema Desenvolvimento de Software foi motivada, principalmente, por preservar a seqüência "natural" das disciplinas do Bacharelado, segundo o recomendado pelas Diretrizes Curriculares.

As disciplinas dos dois primeiros anos do Bacharelado se equivalem às disciplinas necessárias para a conclusão da Formação Específica em Desenvolvimento de Software. Nos dois primeiros anos o aluno está capacitado ao desenvolvimento de software com produtos e conceitos tecnológicos utilizados comercialmente. A capacitação precoce do aluno, associada à credibilidade outorgada pelo diploma de Formação Específica em Desenvolvimento de Software, facilita e antecipa seu ingresso no mercado de trabalho, sem abrir mão da solidez e abrangência de sua formação.

Embora um único curso de Formação Específica tenha sido integrado ao Bacharelado, a estrutura curricular desenvolvida permite a integração de novas opções, sobretudo aos dois últimos anos do curso, aumentando ainda mais as possibilidades para o aluno compor o seu próprio currículo, segundo sua vocação, maturidade e interesses, preparando-o para uma formação profissional continuada.

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AVALIAÇÃO TEMPORAL DOCENTE ATRAVÉS DE QUESTIONÁRIOS COM ESCALAS NÃO-NUMÉRICAS

Fabiana Queiroga[1] e Ronei Marcos de Moraes[2]

Resumo — *Diversos são os estudos na literatura que buscam compreender o processo de aprendizagem bem como os métodos mais adequados de avaliação da mesma. Assim, o presente trabalho apresenta a proposta do uso de escalas não-numéricas como instrumento para avaliar o conhecimento transmitido pelo professor e a receptividade deste por parte dos alunos. Para tanto é apresentada a evolução temporal de um docente no decorrer de uma disciplina ou nas diversas vezes que leciona esta disciplina, conforme respostas fornecidas por alunos que utilizaram a escala não-numérica. Através dos resultados pôde-se verificar a estabilidade do comportamento do docente durante as várias vezes que ministrou a disciplina, permitindo observar a eficácia da utilização dos questionários com escalas não-numéricas visto que com uso destas escalas o índice de respostas válidas ficou muito próximo a 100%, fato que pode ser atribuído a maior liberdade do sujeito para expressar suas respostas.*

Palavras-Chave — Escalas não-numéricas, aprendizagem, comportamento docente, evolução temporal.

INTRODUÇÃO

No âmbito acadêmico, diversas são as discussões a respeito da maneira mais adequada de avaliar o desempenho do estudante como também a qualidade de tais avaliações. Apesar das práticas docentes não serem condizentes com esta preocupação, a literatura tem apontado vários estudos que caminham no sentido de melhor compreender o processo de aprendizagem bem como os seus métodos de mensuração [3, 4, 1, 11].

De acordo com Luckesi [3, p.33], a avaliação constitui-se "num processo de julgamento de valor sobre manifestações relevantes da realidade, tendo em vista uma tomada de decisão". No caso da avaliação da aprendizagem, essa tomada de decisão se refere à decisão do que fazer com o aluno frente a sua manifestação de aprendizagem, seja ela satisfatória ou não. De acordo com este autor, quando se omite esta tomada de decisão o ato de avaliar tem seu ciclo constitutivo incompleto. Todavia, há também que se ressaltar que as práticas docentes em sala de aula estão diretamente relacionadas com a quantidade e principalmente com a qualidade da aprendizagem apreendida pelos alunos.

Outros estudos têm sido realizados nessa linha na tentativa não apenas de compreender a postura do professor em sala de aula, mas também de avaliar o conhecimento transmitido pelo docente e a receptividade deste por parte dos alunos [ver 5, 6, 7, 10,]. Trata-se de estudos menos preocupados com os aspectos sociais da aprendizagem e mais voltados para uma discussão sobre um instrumento alternativo de avaliação deste construto.

No trabalho realizado por Moraes [5], este tema é abordado a partir da utilização do modelo de Questionário com Respostas em Escalas Não-numéricas. Diferente dos questionários convencionais que utilizam questões fechadas que não necessariamente contemplam a realidade do aluno, este modelo de questionário visa analisar o comportamento do professor dentro e fora da sala de aula através das repostas fornecidas pelos alunos para os quais eram ministradas as aulas. Para manter a fidedignidade de tais respostas foram instituídas perguntas de "cheque" com relação à ementa, freqüência do aluno, interesse pela disciplina, entre outras.

Neste trabalho são apresentadas algumas alternativas para o uso da escala não-numérica: fazer uma análise pergunta a pergunta do questionário, utilizando uma turma de cada vez; trabalhar uma turma em dois momentos diferentes ou em duas ou mais turmas fazendo uma comparação entre elas das respostas obtidas nas questões.

Visando contribuir para a melhoria do ensino no âmbito acadêmico, o presente estudo procura analisar como o professor transmite o conhecimento em sala de aula e a receptividade deste por parte dos alunos, apresentando para tanto a evolução temporal de um docente no decorrer de uma disciplina (ou seja, dentro da turma), bem como nas diversas vezes que leciona esta disciplina (ou seja, entre as turmas), acordo com as respostas obtidas com os alunos, através do uso de uma escala não-numérica [5].

INSTRUMENTO

O instrumento utilizado para a realização deste estudo foi o Questionário com Escalas Não-Numéricas proposto por Moraes [5], onde o comportamento do docente é analisado

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dentro e fora da sala de aula partindo das respostas dadas pelos alunos. Além do comportamento do professor são enfocados também alguns comportamentos dos alunos.

O questionário é composto ao todo por 21 questões, sendo 13 delas respondidas numa escala fixa possuindo 8cm de comprimento onde o aluno expressa a resposta que melhor condiz com a sua realidade. Conforme o que mostra Figura 1 [5], as repostas próximas a "zero" são as entendidas como a Atitude Fortemente Positiva ao passo que a pontuação máxima expressa a Atitude Fortemente Negativa. As demais perguntas seguem o padrão de múltipla escolha ou de resposta aberta.

|---|

Atitude Fortemente Positiva — Atitude Fortemente Negativa

FIGURA. 1

O TIPO DE ESCALA UTILIZADO, COM AS EXTREMIDADES DO SEGMENTO DE RETA IDENTIFICADOS RESPECTIVAMENTE, COMO UMA ATITUDE POSITIVA E ATITUDE NEGATIVA POR PARTE DO PROFESSOR.

AMOSTRA

Os alunos que participaram deste estudo pertenciam às turmas da disciplina de Estatística IV onde eram ministradas aulas por um mesmo professor sendo grande maioria dos alunos do curso de Psicologia da UFPB.

A coleta dos dados foi realizada em dois momentos para cada uma das três turmas consideradas neste estudo que foram: a turma da manhã do período 98.2 e do período 99.2 as turmas da manhã e noite. A referência que separa as coletas dos dados é a realização de uma prova, que no caso da turma da manhã do período 98.2 trata-se da primeira prova realizada na turma enquanto que nas demais a referência é a segunda das três provas realizadas.

Durante a primeira aplicação do questionário, participaram do estudo um total de 54 alunos distribuídos da seguinte forma: 26 pertencentes a turma da manhã do período 98.2, 15 alunos da turma da manhã e 13 da turma da noite, sendo ambas do período 99.2. Na segunda aplicação, a turma da manhã do período 98.2 teve a participação de 24 alunos, a turma da manhã do período 99.2 teve 15 alunos e a da noite 14, perfazendo um total de 53 estudantes.

PROCEDIMENTO

O próprio professor se encarregou da aplicação dos questionários e de passar as instruções de como respondê-lo. Ficou também a cargo deste esclarecer as eventuais dúvidas dos alunos e fazer as devidas observações.

A aplicação foi realizada coletivamente na sala onde ocorriam as aulas da disciplina Estatística IV. Os alunos foram avisados que seria dado início a uma coleta de informações sobre o que eles pensavam a respeito da disciplina visando um melhor andamento desta. Em média foi necessário um tempo de 20 minutos para que cada aluno respondesse o questionário por completo.

ANÁLISE E DISCUSSÃO DOS RESULTADOS

Procurando verificar o uso das escalas não-numéricas na aplicação de questionários, este estudo propõe-se observar a estabilidade do comportamento de um docente com o passar do tempo, segundo a opinião dos alunos para os quais ele ministra as aulas.

Visando um conhecimento mais amplo deste tipo de escala, ou seja, a escala não-numérica, foi verificada a estabilidade das respostas a respeito do comportamento do professor e dos alunos tanto entre as turmas quanto dentro delas. Para tanto fez-se necessário a utilização dos testes não-paramétricos de Kruskal-Wallis (para a análise entre as turmas) e o Teste de Postos Sinalizados de Wilcoxon para Dados Emparelhados (para a análise dentro das turmas) [12].

Para a realização das análises entre as turmas foi requerida a versão 8.0 do *SPSSSWIN* onde também foram gerados dos histogramas referentes a freqüência das repostas de cada turma. No entanto, não foi possível utilizar o mesmo programa para realizar as análises dentro das turmas, dado a particularidade deste tipo de análise. Visto que o número de questionários disponíveis para analisar a estabilidade dentro das turmas é inferior a 20, não pode ser feita a aproximação para a distribuição normal [2], que é realizada pelo programa *SPSSWIN*.

Portanto, o Teste de Postos Sinalizados de Wilcoxon para Dados Emparelhados teve sua execução realizada com o auxílio de uma planilha eletrônica de acordo com os métodos propostos pelo próprio Wilcoxon. A tabela utilizada para a verificação da estatística de prova *Vs* foi a Tabela H impressa no livro de Lehmann e D'Abrera [2].

A seguir são mostrados separadamente os resultados encontrados nas duas análises realizadas – entre as turmas e dentro delas, utilizando a questão 2.1. *O seu professor preocupa-se com seu desempenho na sala de aula?* para exemplificação.

ANÁLISE ENTRE AS TURMAS

Visto que os dados obtidos neste estudo são de amostras não-emparelhadas e o número das turmas é superior a dois, o teste mais adequado é o Teste de Kruskal-Wallis. A hipótese nula (H_0) a ser testada será a mesma em cada questão para as três turmas: de acordo com as respostas dadas pelos alunos, existe uma estabilidade de comportamento docente com o passar do tempo entre as três turmas analisadas; contra uma hipótese alternativa (H_1): não existe uma estabilidade de comportamento docente em pelo menos uma das turmas analisadas, segundo a opinião do alunado.

Portanto, a aceitação da hipótese nula não está vinculada à uma boa postura por parte do professor mas enfatiza apenas a *manutenção* do comportamento conforme as respostas obtidas pelos alunos. O nível de significância (designado pela letra grega α) utilizado foi fixado em 0,05 (5%) para as três turmas em todas questões.

Uma vez que a coleta dos dados foi realizada em dois momentos, a execução do teste de Kruskal-Wallis foi realizada tanto antes da prova tida como referência (que contou com um número de questionários de N = 54) como depois deste (N = 53). Para uma maior evidência do trabalho realizado, será exposto adiante os resultados encontrados em cada questão bem como os histogramas referentes à freqüência das respostas dos alunos em cada turma.

De acordo com o resultado mostrado na Tabela 1 sobre a realização do Teste de Kruskal-Wallis para a primeira aplicação, podemos observar que houve a aceitação da hipótese nula, ou seja, o professor manteve uma postura constante para esta questão nas três turmas em que ministrou a disciplina, segundo a opinião dos alunos.

TABELA 1
Resultado da primeira aplicação do Teste de Kruskal-Wallis para a questão 2.1

Turmas*	1	2	3	Total	Graus de Liberdade	Qui-Quadrado
Número de Observações	26	15	13	54	2	2,954
Postos Médios	28,85	30,70	21,12	-	-	-

* Os números 1,2 e 3 referem-se as turmas da manhã 98.2 e manhã e noite 99.2, respectivamente.

Embora as respostas não tenham apresentado rigorosa homogeneidade, não chegaram a se distanciar negativamente do ponto médio da escala, que seria de 4 cm.

As análises efetuadas para a segunda aplicação mostraram novamente a aceitação de H_0, ou seja, a opinião dos alunos sobre a preocupação do professor com desempenho deles é constante entre as três turmas também neste segundo momento Seguem os resultados na Tabela 2:

TABELA 2
Resultado da segunda aplicação do Teste de Kruskal-Wallis para a questão 2.1

Turmas*	1	2	3	Total	Graus de Liberdade	Qui-Quadrado
Número de Observações	24	15	14	53	2	2,825
Postos Médios	28,85	29,57	21,07	-	-	-

* Os números 1,2 e 3 referem-se as turmas da manhã 98.2 e manhã e noite 99.2, respectivamente.

ANÁLISE DENTRO DAS TURMAS

Outra maneira de observar a utilização das escalas não-numéricas é verificar a estabilidade das respostas dos alunos dentro das turmas. Para tanto, foi tomado como referência a aplicação de uma prova e feito o emparelhamento dos questionários obtidos *antes* com aqueles obtidos *depois* desta prova. No caso da primeira turma, a manhã do período 98.2, a prova considerada como referência foi a primeira realizada nesta turma e para as demais, a manhã e noite do período 99.2, a prova referenciada é a segunda das três realizadas nestas turmas.

O número total de questionários utilizados para a realização das análises em cada turma ficou distribuído da seguinte forma: 13 questionários para a turma da manhã do período 98.2, 9 para a turma da manhã do período 99.2 e para turma na noite deste mesmo período, 8 questionários.

Frente a esses fatos, julga-se que o teste mais adequado para efetuar as análises dos comportamentos do docente e dos discentes com o passar do tempo seria o Teste de Postos Sinalizados de Wilcoxon para Dados Emparelhados.

A hipótese nula (H_0)a ser testada será a mesma para as questões de cada uma das turmas: segundo a opinião dos alunos, existe uma estabilidade do comportamento docente na turma ora analisada após a realização da prova tida como referência; contra uma hipótese alternativa (H_1): não existe uma estabilidade de comportamento na turma ora analisada após a realização da prova tida como referência, segundo a opinião dos alunos. Também será fixado um nível de significância (designado pela letra grega α), para todas as questões nas três turmas, igual a 5%. Adiante seguem os resultados encontrados na questão 2.1 para cada uma das turmas.

De acordo com o que é apresentado na Tabela 3, os alunos da turma da manhã do período 98.2 não apresentaram respostas constantes com o passar do tempo, corroborando dessa forma, na rejeição da hipótese nula.

TABELA 3
Resultado do Teste de Wilcoxon para a turma da manhã de 98.2 para a questão 2.1

Depois – Antes*	1	2	3	Total de observações	Vs**
Número de Observações	1	10	2	13	0,0002
Soma dos Postos	1	90	-	-	-

Nota: * Os números 1, 2 e 3 referem-se aos postos negativos, positivos e o número de empates, respectivamente
** Baseado nos postos negativos

Como se pode observar, no total das 13 observações obtidas nesta turma, houve dois postos empatados com sinal positivo. O que se pode inferir a partir destes resultados é que os alunos desta turma mudaram de opinião sobre a preocupação do professor com o desempenho deles na sala de aula após a realização de uma prova. Vale ressaltar que se trata da primeira prova realizada nesta turma.

A respeito da turma da manhã do período 99.2, já havia sido realizada a primeira prova quando ocorreu a primeira aplicação dos questionários e talvez este seja um dos fatores que explique a diferença dos resultados obtidos nesta turma. Conforme o que mostra a Tabela 4, houve a aceitação de H_0

e, os momentos considerados nesta turma são antes e depois da *segunda* prova.

TABELA 4
Resultado do Teste de Wilcoxon para a turma da manhã de 99.2 para a questão 2.1

Depois – Antes*	1	2	3	Total de observações	Vs**
Número de Observações	5	4	-	9	0,4551
Soma dos Postos	24,0	21,0	-	-	-

Nota: * Os números 1, 2 e 3 referem-se aos postos negativos, positivos e o número de empates, respectivamente
** Baseado nos postos positivos

Estes resultados indicam que houve a aceitação da hipótese nula para esta turma.

Em relação ao momento das provas, os alunos da turma da noite do período 99.2 estavam em situação semelhante quando responderam aos questionários: também já haviam feito uma prova. Não houve diferença na decisão da aceitação da hipótese nula em relação a turma anterior. Os resultados são apresentados na Tabela 5:

TABELA 5
Resultado do Teste de Wilcoxon para a turma da noite de 99.2 para a questão 2.1

Depois – Antes*	1	2	3	Total de observações	Vs**
Número de Observações	4	4	-	8	0,2734
Soma dos Postos	23,0	13,0	-	-	-

Nota: * Os números 1, 2 e 3 referem-se aos postos negativos, positivos e o número de empates, respectivamente
** Baseado nos postos positivos

Portanto, tanto na turma da manhã quanto na turma da noite do período 99.2, os alunos tiveram uma opinião constante com o passar do tempo, a respeito da preocupação do professor com desempenho deles na sala de aula.

CONCLUSÃO

Frente aos resultados expostos, julga-se que o objetivo do presente estudo foi cumprido. Através das análises efetuadas a partir das respostas dos alunos de três turmas diferentes, onde eram ministradas aulas da disciplina de Estatística IV por um mesmo professor, foi possível verificar a estabilidade do comportamento do docente utilizando os questionários com escalas não-numéricas.

O uso destas escalas permitiu observar um índice de respostas válidas muito próximo a 100%, fato que pode ser atribuído a maior liberdade que o aluno teve para expressar suas respostas. Por não apresentarem "níveis" explícitos de reposta (mas apenas dois extremos que expressam sua negatividade e positividade), as escalas não-numéricas eliminam também a dúvida sobre a quantificação dos níveis entre um intervalo e outro observados, por exemplo, nas escalas do tipo *likert* [8, 9].

No entanto, ao mesmo tempo que a ausência de níveis apresenta-se como uma vantagem para o pesquisador, constitui-se também numa desvantagem, pois torna-se problemático interpretar o que o aluno está pretendendo responder quando indica sua resposta neste tipo de escala.

É preciso ressaltar ainda que a coleta dos dados não ter sido realizada no mesmo momento para todas as turmas pode ser uma variável externa responsável pela produção de um efeito importante nas respostas. A primeira turma (manhã do período 98.2) teve a coleta dos dados feita antes e depois da *primeira* prova enquanto que nas demais turmas (manhã e noite do período 99.2) esta ocorreu antes e depois da s*egunda*.

É possível que este fato seja a explicação para que nas análises dentro das turmas, realizadas através do Teste de Postos Sinalizados de Wilcoxon para Dados Emparelhados, as duas últimas turmas apresentarem resultados semelhantes no que diz respeito a aceitação da hipótese nula, já que elas estavam em situações similares e diferente da primeira turma. Além disso, este fato também torna mais fácil a visualização da mudança de opinião nas respostas dos alunos da turma da manhã do período 98.2, pois se tratam de alunos que estavam em contextos bastante distintos (antes de uma prova e depois dela).

No geral, tanto nos resultados obtidos no teste do Kruskal-Wallis como no teste do Wilcoxon, houve um maior índice de aceitação da hipótese nula. No entanto, isto não significa que aconteceu a predominância de uma atitude *positiva*, mas que se observou uma *estabilidade* de comportamento, tanto do docente como dos discentes. Talvez a verificação da predominância de comportamento que se manteve sirva de tema para estudos posteriores.

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LIA - UM SISTEMA ADAPTATIVO APLICADO AO ENSINO A DISTÂNCIA

Aline Donini Valsirolli[1],Claudia Midori Nakahata[2] ,Cristiane Gomes Bastos[3],Margaret Yea Wei Ng[4]

Abstract*—This project shows an adaptive system that supports learning features by using Intelligent Tutorial System techniques. The knowledge base is modeled using Conceptual Maps, which leads to a more efficient apprentice modeling. The main goal is to optimize the learning process in a way that it would be possible to divide the knowledge in interdependent levels. Thus, intelligent tests can be used to determine in which level of knowledge apprentices' skills must be classified, as well as to evaluate if the student has the needed skills to start learning at some desired level, or if it is advisable to review some previous topics, in order to get the expected background for learning at such level. The work proposes a reusable, adaptive framework for supporting pedagogical contents' modeling. In this way, it is expected to increase students' motivation, since they can start accessing such contents in a more profitable, individualized form, according to their own learning needs.*

Index Terms— *Adaptive Systems, Apprentice Modeling, Intelligent Tutorial Systems, Learning by Distance.*

1. INTRODUÇÃO

Com as crescentes mudanças na sociedade, muitas formas de treinamento e ensino generalizado não se justificam mais. Perde-se muito tempo ensinando, desperdiça-se muito dinheiro com cursos e acaba-se aprendendo pouco, muito menos do que o esperado**.**

Isto vem acontecendo porque encontram-se pessoas em vários graus de maturidade, motivação e de competência. Assim torna-se cada vez mais difícil colocá-las em uma única sala de aula para aprenderem as mesmas coisas.

Para uniformizar os níveis de conhecimento dessas pessoas, é necessário utilizar abordagens diferenciadas. que atendam às necessidades específicas de cada aluno. Desta forma, este artigo vem apresentar um sistema adaptativo de apoio ao aprendizado caracterizado pela utilização de técnicas de ITS – (*Intelligent Tutoring System* - Sistemas Tutores Inteligentes).

Na segunda seção será feita uma explanação do problema a ser abordado . A seção 3 mostrará como é obtida a adaptabilidade do sistema através dos Sistemas Tutores Inteligentes. A seção 4 apresenta um exemplo de modelagem para a base do conhecimento do sistema. A seção 5 trata da arquitetura do sistema. A seção 6 mostra como o sistema funciona. A seção 7 tem como objetivo apresentar as tecnologias utilizadas no protótipo do sistema. A seção 8 apresenta as considerações finais.

2. CONSIDERAÇÕES INICIAIS

Atualmente encontramos sistemas de ensino generalizados, isto é, que procuram atender a todos sem se interessar com as necessidades de cada aprendiz individualmente.

Estes sistemas de ensino, geralmente apoiados em uma estratégia pedagógica expositivista, exibem o mesmo conteúdo para todos os aprendizes e não se preocupam em analisar o aproveitamento deste, tampouco analisar se o mesmo possui certas competências prévias necessárias ao aprendizado do conteúdo em questão. Não existe um mecanismo nestes sistemas de ensino que guiem - o aprendiz - ao ponto do conteúdo mais adequado, a fim de ajuda-lo a tirar maior proveito.

Conforme já mencionado acima, em geral, esses sistemas educacionais sugerem uma abordagem linear e expositiva. Isto pode fazer com que o aprendiz perca a motivação para continuar a estudar, uma vez que todo o processo de ensino-apredizagem torna-se rotineiro e massificado.

3. ADAPTABILIDADE DO SISTEMA

A adaptabilidade do sistema está baseada na utilização de técnicas dos Sistemas Tutores Inteligentes(ITS), que são sistemas computacionais com modelos de conteúdo instrucionais que especificam o que ensinar e estratégias de ensino que especificam como ensinar. Esses sistemas educacionais são modelados de maneira a levar em consideração o tipo de aluno que está interagindo com o sistema.

Estes sistemas estão divididos em 4 módulos: módulo *tutor,* módulo *aprendiz*, módulo *domínio* e módulo *comunicação* ou *interface[1]*.

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O *módulo tutor* faz o reconhecimento do usuário, no caso o aprendiz, e suas necessidades para que se possa propor conteúdo, percursos ou mesmo uma estratégia de aprendizado adequada a cada tipo de aprendiz.

O *módulo aprendiz* guarda as informações de cada aprendiz. Mantém um histórico de todas as ações do aprendiz: seus erros, seus acertos, o que já estudou e o que falta aprender. Representa o conhecimento e as competências do aprendiz. Já o *módulo domínio* armazena todo o conteúdo que precisa ser ensinado ao aprendiz, ao passo que o *módulo de comunicação (interface)* é a interação entre o módulo tutor e o módulo aprendiz, mostrando o conteúdo adequado ao conhecimento do aprendiz.

A interação centre estes módulos pode ser vista na Figura 1[1].

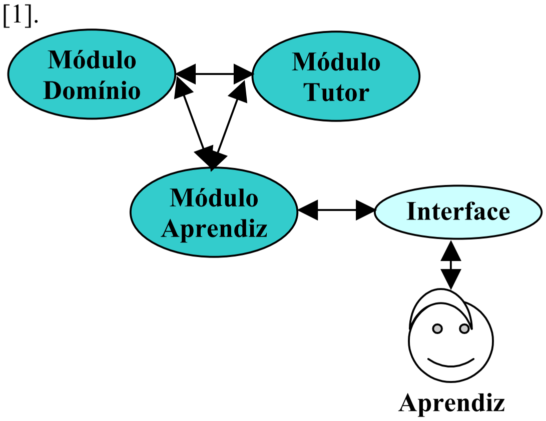

FIGURA 1
ARQUITETURA CLÁSSICA DE STI

A Figura 1 mostra como os módulos são relacionados em um Sistema Tutor Inteligente, mas para obtermos a adaptabilidade desejada, é necessário um relacionamento diferente. Este relacionamento pode ser observado na Figura 2.

A Figura 2 mostra que a adaptabilidade do sistema de ensino é obtida através da ligação direta do módulo interface com o módulo tutor. Assim, o módulo tutor consulta o modelo estático do aluno no módulo aprendiz e acessa o conteúdo disponível no módulo domínio. Com essas duas informações ele provê avaliações e fornece o conteúdo adequado ao aprendiz .

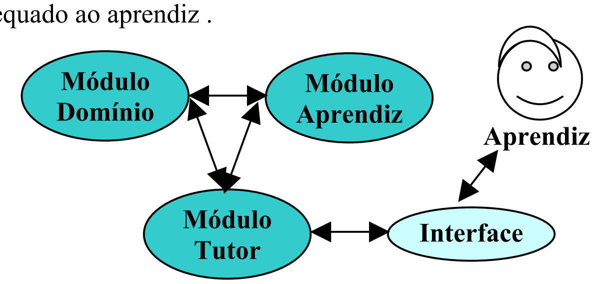

FIGURA 2
ARQUITETURA DOS SISTEMAS ADAPTATIVOS

O módulo tutor obtém algumas dessas necessidades do aprendiz através de avaliações eletrônicas. Vários métodos de avaliação podem ser utilizados como: questionários, entrevistas com alunos, comparação com resultados de cursos tradicionais e observação direta do instrutor online. Com vários tipos de questões, pode-se tentar aproximar o ambiente cibernético com a situação real do aluno . Alguns tipos de questões são: corrigir uma frase invertida, completar frases, verdadeiro ou falso. As questões podem ter vários graus de dificuldades como: fácil, médio, difícil [8] .

4. MODELAGEM DO CONHECIMENTO

A base de conhecimento do sistema é modelada usando Mapas Conceituais. Isto permite uma modelagem do aprendiz eficaz o suficiente para otimizar o processo de aprendizado, de forma que torna possível dividir o conhecimento em níveis.

Esses Mapas Conceituais são representações gráficas que auxiliam na ordenação e na sequenciação hierarquizada dos conteúdos do ensino, de forma a oferecer estímulos ao aprendiz [6].

Os Mapas Conceituais servem como instrumentos para facilitar o aprendizado do conteúdo sistematizado em conteúdo significativo para o aprendiz.

Esse tipo de modelagem do conhecimento torna a aprendizagem mais significativa, pois ajuda o aprendiz a fazer ligações entre o novo conhecimento e o conhecimento que já possui.

Os Mapas Conceituais podem ser descritos sob 3 perspectivas diferentes [3]:

- sob uma perspectiva abstrata, onde o mapa é constituído por nós ligados por arcos, podendo ser visto como hipergrafos ordenados, sendo que a ligação entre eles pode ser direcionada ou não;
- sob perspectiva de visualização, onde o mapa pode ser visto como diagramas; e
- sob a perspectiva dialética, onde os mapas conceituais são considerados uma forma de representação e comunicação do conhecimento através de linguagens visuais.

O nível pelo qual o aprendiz deverá começar é definido através de testes inteligentes, na qual é possível identificar por quais níveis o aluno deve passar ou não, ou ainda avaliar se o aluno tem condições de dar início ao aprendizado na etapa em que ele deseja, ou se deve rever alguns tópicos necessários, para só então aprender o que deseja de forma mais proveitosa.

O primeiro protótipo do LIA(*Learning by Intelligent Adaptiveness*) baseia-se em um conteúdo relativo ao ensino de matemática, tendo como sub-domínio específico o estudo de matrizes para ilustrar o uso dos Mapas Conceituais.

A Figura 3 ilustra a modelagem do conhecimento em níveis.

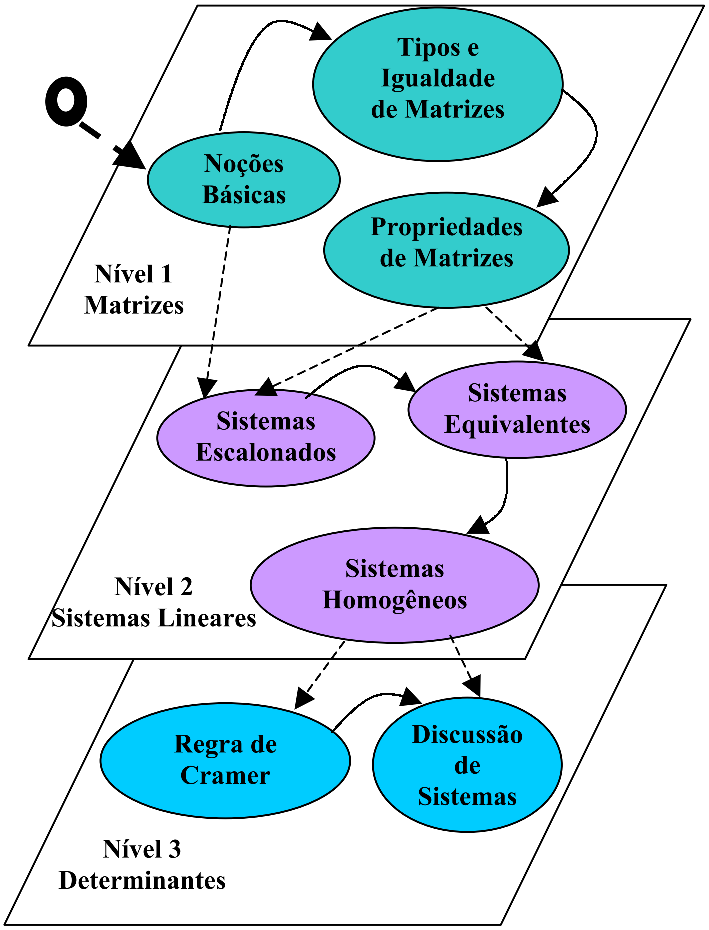

FIGURA 3
MODELAGEM DO CONHECIMENTO EM NÍVEIS

Pode-se notar na Figura 3 que há certas prioridades nos tópicos mostrados. Por exemplo, para o aprendiz aprender sobre *sistemas equivalentes* que está no nível 2, ele precisa ter conhecimento sobre *sistemas escalonados*, que por sua vez, tem como pré-requisito as *propriedades de matrizes* que está no nível 1, que por sua vez, necessita de *tipos e igualdade de matrizes*, que por sua vez requer o conhecimento de *noções básicas* . Assim, para o aprendiz estudar o tópico de sistemas equivalentes, ele precisa ter conhecimento de *sistemas escalonados*, *propriedades de matrizes, tipos e igualdades de matrizes* e *noções básicas*.

5. ARQUITETURA DO SISTEMA

Do ponto de vista da arquitetura, esse sistema está dividido em três camadas[7]:

- a primeira camada é a de apresentação. Esta contém toda a implementação relacionada com o *lay-out* do sistema, como ele é apresentado ao usuário aprendiz;
- a segunda camada é a de negócio. Esta camada é o local onde são feitos todos os processamentos e funções do programa, guardando toda a implementação relacionada a estas funções. É a interação entre a primeira camada e a terceira camada; e
- a terceira camada é a de dados. Nesta camada são guardadas as implementações relacionadas com o armazenamento de dados e acesso a esses dados, além de demais informações do sistema.

Uma demonstração dessa estrutura de camadas é dada na Figura 4.

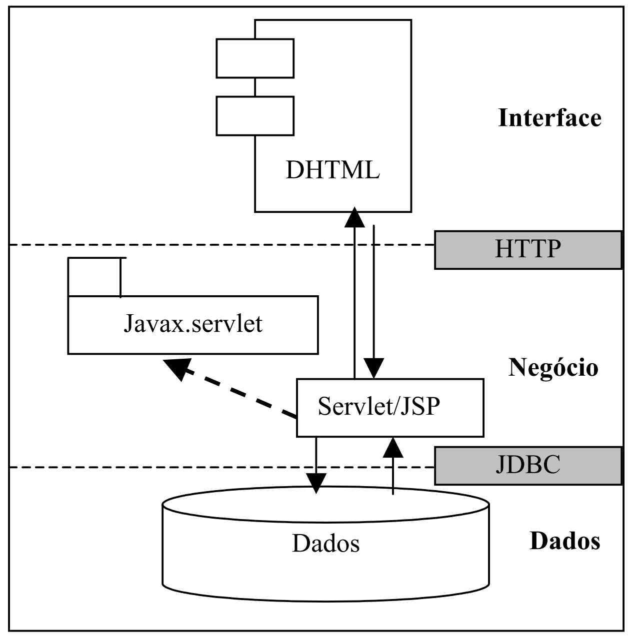

FIGURA 4
ARQUITETURA DE CAMADAS

Pode-se analisar uma ligação entre esta arquitetura de camadas e a divisão dos módulos de um Sistema Tutor Inteligente, explicados na seção 3 .

A camada de dados representa o módulo aprendiz e o módulo domínio, haja visto que o módulo aprendiz armazena os dados sobre o aprendiz e o seu nível de conhecimento, já o módulo de domínio armazena todo o conteúdo a ser ensinado.

A camada de negócio representa o módulo tutor, pois busca os dados do aluno e cruza essas informações com o conteúdo do conhecimento e o mostra através da interface ao aprendiz. Já a camada de interface representa o módulo de comunicação, sendo implementada através da página DHTML em si.

6. FUNCIONAMENTO DO SISTEMA

Ao entrar no sistema pela primeira vez, o aprendiz precisa realizar seu cadastro. Em seguida, lhe é exibido um menu com todos os tópicos disponíveis no sistema, de forma a que o mesmo possa escolher o tópico que mais lhe interessa.

É a partir dessa escolha, que depende unica e exclusivamente do arbítrio do aprendiz, que o LIA gera exercícios de acordo com os pré-requisitos do tópico escolhido, analisando os mapas conceituais relativo ao domínio do conhecimento mapeado. Tais exercícios têm caráter avaliativo, pois pretendem verificar se o aprendiz possui as competências necessárias para estudar o tópico desejado.

Caso o aprendiz demonstre tais competências, o LIA permite a entrada deste no tópico desejado. O aprendiz pode, inclusive, visitar o tópico desejado mesmo que não demonstre as competências requeridas para tal. Porém, o LIA gera mensagens de avisos, indicando quais tópicos seriam mais proveitosos ou até quais tópicos o aprendiz deveria revisar, deixando assim o aprendiz com o direito de escolha , mas consciente de suas necessidades. Tal estratégia é adotada, entre outras razões, de forma a não frustrar as expectativas do aprendiz em relação ao aprendizado.

As avaliações eletrônicas são o cerne do processo de modelagem heurística do aprendiz no LIA, sendo que durante todo o processo o aprendiz passa por diversos testes que qualificam o nível de seu conhecimento dentro do mapa conceitual sob o qual está organizado o currículo da área de conhecimento sendo estudada..

Todas as informações do aprendiz são armazenadas em um banco de dados, para um acompanhamento continuado do mesmo, de modo a poder informar quais competências já foram adquiridas, quais ainda necessitam ser, além de fornecer uma avaliação de até como foi seu desempenho nas avaliações realizadas. A adaptabilidade do LIA depende grandemente da manutenção e recuperação de tais as informações, assim como o acompanhamento de todas as ações por ele efetuadas.

7. Tecnologias Utilizadas

Nos sistemas adaptativos é necessário usar técnicas de inteligência artificial para se obter um resultado como visto anteriormente. Dentro deste ramo, tem-se por base as técnicas de modelagem do aprendiz, que usualmente são utilizadas em Sistemas Tutores Inteligentes. No LIA, o modelo do aprendiz é construído a partir de Mapas Conceituais implementados como grafos, onde cada nós do mesmo representa uma competência dentro de um dado currículo.

Em termos de implementação, conforme já demonstrado anteriormente na Figura 4, a interface da ferramenta é feita utilizando-se DHTML e Javascript. A camada de negócio é implementada em Servlets/JSP. A ligação da camada de negócio e a camada de dados é feito através do padrão JDBC.

Os tópicos a seguir irão explanar brevemente sobre cada uma dessas tecnologias.

DHTML

DHTML, ou HTML Dinâmico, é uma tecnologia da *Web* que torna os elementos de uma página muito mais dinâmicos que em HTML padrão[2]. Algumas das características principais de DHTML são:

Performance: O processamento é realizado localmente, ou seja, no *browser* do usuário, o que garante boa performance já que não exige o tráfego de informações pela rede durante a interação. Dado que o DHTML funciona no *browser* do lado cliente, uma vantagem pode ser imediatamente apontada: a redução drástica dos tempos de resposta. Utilizando o DHTML para deslocar a maior parte do trabalho para o lado cliente, torna-se possível proporcionar ao utilizador novos graus de interatividade. Por exemplo, a utilização de "*pre-caching*", que faz o carregamento em *background* de conteúdo, permite ao utilizador navegar entre páginas com um tempo de espera mínimo. Finalmente, não sendo menos importante, esta tecnologia abre novas perspectivas no que se refere ao desenvolvimento de conteúdo para operar do lado do cliente. Utilizando *scripts* (Em Javascript, por exemplo) combinados com DHTML é perfeitamente viável desenvolver aplicações *Internet* completas.

Compatibilidade: O DHTML não apresenta boa compatibilidade entre os *browsers*. Na verdade não existe um padrão para o DOM (*Document Object Model)*, que é o centro dessa tecnologia. Tanto a *Microsoft* como a *Netscape* já suportam esse padrão a partir das versões 4.0 de seus *browsers*, mas cada uma com seu modelo de objetos. Logo, o código *client scripting* deve ser escrito de acordo com o *browser* destino, a menos que se faça uso das propriedades protegidas, que são um subconjunto das funcionalidades comuns a ambos os *browsers*.

Baseado em objetos: Cada elemento de uma página HTML é visto como um objeto, que pode ser acessado e ter suas propriedades, como cor e posicionamento, alteradas dinamicamente.

SERVLETS/JSP

Servlets são módulos escritos em Java que estendem as funcionalidades de servidores orientados a requisição/ resposta [4]. São usadas basicamente para tratar dados de formulários HTML, sendo uma alternativa viável aos *scripts* CGI.

Virtualmente qualquer aplicação sob o paradigma cliente-servidor pode ser escrita em Servlets. Por exemplo, Servlets podem suportar videoconferência, pois uma servlet pode manipular múltiplas conexões e tratá-las concorrentemente através de *threads*, além de reenviar requisições para outros servidores.

As servlets são fáceis de programar, são mais rápidas de serem executadas e adicionam grande nível de portabilidade do lado servidor.

Toda servlet tem o mesmo ciclo de vida: o servidor carrega e inicializa a servlet; a servlet manipula zero ou mais requisições de clientes; e o servidor remove a servlet. Cada um destes estados é governado por um método específico da servlet.

Já JSP é uma tecnologia que oferece uma maneira simples para se trabalhar com uma arquitetura similar à de Servlets, consistindo em código Java *server-side* incorporado em páginas HTML [5].

A arquitetura do LIA conta com implementações do lado do servidor utilizando Servlets e JSPs, notadamente para fazer a montagem dinâmica das páginas.

JDBC

O padrão JDBC (*Java DataBase Connectivity*) permite aos programadores se conectarem com um banco de dados, consultá-lo ou atualizá-lo, usando SQL *standard*[4]. A grande vantagem de adotar um padrão como o JDBC é a total independência de plataforma e modelo de BDs.

JDBC consiste em duas camadas: a camada superior é a API (interface de programação) do JDBC. Essa API se comunica com a API do driver gerenciador JDBC enviando para ela as diversas instruções SQL. O gerenciador deve se comunicar com os vários *drivers* de terceiros que efetivamente se conectam com o banco de dados, e retornam as informações da consulta ou executam a ação especificada pela interface.

Pode-se usar o JDBC em aplicativos e *applets*. Em uma *applet*, todas as restrições de segurança se aplicam. Em particular, uma *applet* que usa JDBC só pode abrir uma conexão de banco de dados ao servidor a partir da qual foi descarregada. Isto significa que o servidor *web* e o servidor de banco de dados devem estar na mesma máquina, o que não é uma configuração recomendável. Os aplicativos, por outro lado, têm completa liberdade para acessar servidores de banco de dados remotos. Para programas cliente-servidor fará mais sentido usar um aplicativo para acesso ao banco de dados.

No LIA, tais restrições não se aplicam, uma vez que não se utilizam applets em sua interface. Contudo, por se tratar de uma interface baseada em DHTML, futuras versões do sistema que porventura incorporem o uso de *applets* deverão tratar da questão de segurança.

O uso de tais tecnologias traz diversas vantagens para a implementação do modelo de arquitetura em três camadas:

- Separa-se a camada de interfaces (no cliente) da lógica de negócios e dos dados. Portanto torna-se possível acessar os mesmos dados e as mesmas regras de negócio de multiplos clientes.
- Caso se queira substituir a comunicação via HTTP entre o cliente e a camada de negócio, pode-se implementá-la através de RMI (*Remote Method Invocation*) ou algum outro mecanismo, uma vez que se trata de camadas desacopladas e independentes. Da mesma maneira, como se utilizou a ponte JDBC para fazer a conexão com o repositório de dados, o mesmo pode ser trocado, se necessário, bastando uma alteração de *driver*.

8. CONCLUSÃO

Com o crescimento do interesse pelo ensino a distâ ncia, o aumento da necessidade de criação de sistemas que se adaptem às habilidades e competências de cada aprendiz tem sido muito grande, pois cada vez mais é necessário a criação de sistemas que não só cativem a atenção do aprendiz, como também sejam eficientes no que diz respeito à eficácia do aprendizado obtido através da indicação de conteúdo individualizado, adequado às necessidades de cada aprendiz. Espera-se que o uso da ferramenta apresentada neste trabalho produza bons resultados no sentido de obter um melhor aprendizado, graças à adpatabilidade individualizada.

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DA IMPORTÂNCIA DO USO DE SIMULADORES EM PESQUISA E ENSINO UNIVERSITÁRIOS NA ÁREA DE COMUNICAÇÕES ÓPTICAS

Tarcísio Cordaro[1] e Luiz Sergio Zasnicoff[2].

Abstract *— O alto desempenho dos programas simuladores no setor de comunicações ópticas, e a grande capacidade de processamento dos computadores pessoais, têm viabilizado a reprodução de complexos sistemas ópticos com ótima fidelidade. Este fato tem permitido que os estudantes vivenciem situações virtuais muito próximas da realidade, contribuindo na sedimentação de conceitos recém adquiridos, bem como que pesquisadores realizem suas pesquisas com a precisão necessária. Tal fato era até então impraticável, quer pelos altíssimos custos da instrumentação necessária, quer pelas circunstâncias, como exemplo cito a reprodução de sistemas ópticos transoceânicos, ficando tais pesquisas restritas á poucas empresas ou laboratórios no mundo. Este artigo relata, de modo resumido, o trabalho que está sendo realizado na Universidade Presbiteriana Mackenzie na área de comunicações ópticas, mais especificamente na transmissão de solitons com taxa de transmissão de 40 Gbits/s e longa distância (10.000 Km). A Amplificação Raman Distribuída (DRA) é utilizada. Será dada ênfase na importância do uso de simuladores na condução de ensino e da pesquisa.*

Index Terms *— Fotônica, Fibras Ópticas, Amplificação Raman, Soliton.*

INTRODUÇÃO

O aplicativo utilizado como simulador é um PTDA, - *Photonic Transmission Design Suite* – que leva em consideração em seus cálculos:

- Não-Linearidades na Fibra
- Ruído
- Dispersão de segunda e terceira ordem
- Efeito Raman
- Polarização

A interface com o usuário reproduz um ambiente de laboratório de medidas. Alguns de seus instrumentos virtuais são mencionados a seguir:

- Osciloscópio
- Analisador de Espectro
- Freqüencímetros
- Medidor de Potência
- Fontes com diodos Laser
- Medidor de taxa de erro de bit

Internamente, a equação não-linear de Schroedinger generalizada é resolvida numericamente.

$$\frac{\partial A}{\partial z}+\frac{i}{2}\beta_2\frac{\partial^2 A}{\partial T^2}+\frac{\alpha}{2}A-\frac{1}{6}\beta_3\frac{\partial^3 A}{\partial T^3}=i\gamma\left[|A|^2 A+\frac{i}{w_0}\frac{\partial}{\partial T}(|A|^2 A)-T_R A\frac{\partial |A|^2}{\partial t}\right] \qquad (1)$$

Eq. (1) rege a propagação dos sinais na fibra.[1], [2]

A figura 1 mostra a implementação do circuito básico utilizado no trabalho e consiste de um gerador de pulso soliton, um circuito em anel composto dos lasers de bombeamento Raman direto e reverso, uma fibra óptica e um filtro óptico ideal, e a cada volta percorrida pelo soliton neste circuito analisamos seu formato e sua potência através de um osciloscópio e um medidor de potência.

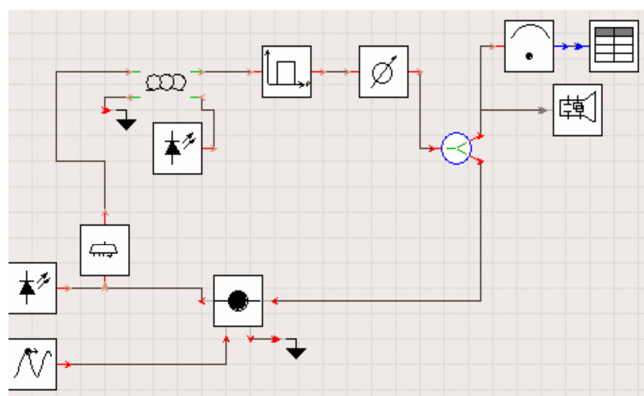

FIGURA 1
EXEMPLO DE CIRCUITO DE SIMULAÇÃO DE UM SISTEMA ÓPTICO DE TRANSMISSÃO

DESCRIÇÃO DE SOLITONS

Aproximadamente 170 anos atrás (1834), enquanto conduzindo experimentos para determinar o modo mais eficiente de projetar canais para barcos, um jovem engenheiro escocês de nome John Scott Russel (1808-1882) fez uma impressionante descoberta científica. Como ele mesmo as chamou *Report on Waves* (relata do 14° Encontro da Associação Britânica para o Avanço da Ciência, N. York, setembro de 1844, pp 311-390, plates XLII-LVII).

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Durante toda sua vida Russel permaneceu convencido de que sua descoberta, denominada Onda Solitária ou *Wave of Translation* era de importância fundamental. Entretanto, até o começo do século 20, poucos cientistas concordaram com ele. Sua fama originou-se de outras realizações.

Nos anos 60, quando os cientistas iniciaram o uso de computadores digitais para estudar fenômenos não-lineares, tais como a propagação de ondas, que as idéias de Russel começaram a ser apreciadas. Ele entendia sua onda solitária como uma entidade dinâmica auto-suficiente, algo com propriedades típicas de partículas. Do ponto de vista moderno, ela tem sido usada como um elemento construtivo na formulação de complexos comportamentos de sistemas ondulatórios através da ciência, indo da hidrodinâmica à óptica não-linear, dos plasmas às ondas de Shock, dos tornados à grande mancha vermelha em Júpiter e, sobretudo, nas partículas elementares da matéria.

BREVE HISTÓRICO DE SOLITONS EM ÓPTICA

Alguns aspectos sobre solitons e algumas curiosidades históricas são mencionadas:

- Em 1964, dois pesquisadores da universidade de Princeton, Zabuski e Kruskal, observaram ondas cujo comportamento era similar a de partículas (Russel, *Soliton Propagation in Optical Fibers*). Também notaram que uma solução numérica das equações Kdv satisfazia tal fenômeno.
- Em 1969, San MacCall e Erwin Hahn descobriram um importante caso na propagação de solitons em óptica.
- Em 1973, A. Hasegawa e F. Tappert propuseram a aplicação de solitons em fibras ópticas. Neste artigo, cálculos teóricos e simulações numéricas foram apresentados mostrando que, utilizando a dependência não-linear do índice de refração com a intensidade do campo aplicado, era possível transmitir pulsos da ordem de picosegundos de duração em fibras, sem que ocorressem distorções. Mostrou ainda que, acima de certo limiar de potência, tais pulsos tornavam-se estáveis, mesmo sob a influencia de perturbações do meio. [3].
- Em 1980, Linn F. Mollenauer, R. H. Stolen e J. P. Gordon fizeram a primeira demonstração da propagação de solitons em fibras ópticas com comprimento de 700 m. [4].

Desde então, diversos trabalhos têm sido apresentados sobre a propagação de solitons em fibra óptica, sempre se procurando aumentar as taxas de transmissão e as distâncias percorridas. [5]-[13].

UTILIZAÇÃO DE SOLITONS EM TRANSMISSÃO POR FIBRAS ÓPTICAS

As fibras ópticas atingiram um nível baixo de perdas, entretanto os pulsos tendem a se espalhar ou alongar-se devido á dispersão das fibras prejudicando a performance do sistema. Tal fenômeno é mais intenso para pulsos estreitos. Ora, à medida que as taxas de transmissão se elevam, impulsionadas pela crescente demanda de serviços de transmissão de dados, os pulsos tendem a se estreitar. Por outro lado os sistemas de transmissão de longa distância necessitam de regeneradores elétricos periodicamente ao longo do percurso da fibra. Estes Regeneradores são mais tanto mais complexos e caros quanto maiores são as taxas de transmissão.

Os solitons lidam bem com a dispersão, mantendo o formato do pulso ao longo a fibra, permitindo eliminar tais regeneradores elétricos. Contudo é necessário compensar a atenuação da fibra, pois à medida que evoluem na fibra vão tendo sua amplitude atenuada, até um ponto onde entram em colapso, por deixam de atender o requisito fundamental para sua existência, ou seja, o equilíbrio entre a dispersão e as não-linearidades.

Neste caso citado, a dispersão prevalece sobre a não-linearidade, fazendo o pulso se alargar mais rapidamente.

Os amplificadores ópticos têm sido estudados exaustivamente nos últimos anos e demonstraram ser viáveis tecnicamente e bem mais baratos que os sistemas com regeneradores.

Este conjunto Soliton mais amplificador óptico torna-se uma alternativa bastante atraente para sistemas de transmissão de longa distância, pois teria em tese seus preços bem mais baixos que os atuais sistemas com uma performance bastante boa.

Um recente estudo mostra a viabilidade de se transmitir Solitons em taxas de 40 Gbits/seg e longas distâncias, utilizando-se uma fibra levemente dopada com érbio, de modo a conseguir uma amplificação distribuída [11].

Este trabalho mostrará a possibilidade de se transmitir solitons em distâncias superiores a 10.000 km, utilizando-se de Amplificação Ramam Distribuída, com bombeamento a cada 50 Km para minimizar a variação da potência do soliton ao longo da fibra. Posteriormente será demonstrada a possibilidade de aumentar esta distância para 75 Km, utilizando duas fibras diferentes.

CONCEITO DO SOLITON

Em sua forma ideal, (2) representa o comportamento do soliton, e é definida por uma função do tipo secante hiperbólica, segundo mostra a figura 2. [1],[2].

$$\Phi(z,t) = \Phi_0 \operatorname{sec} h(\frac{t - v_g}{\tau_0}).e^{-i\frac{z}{2z0}} \quad (2)$$

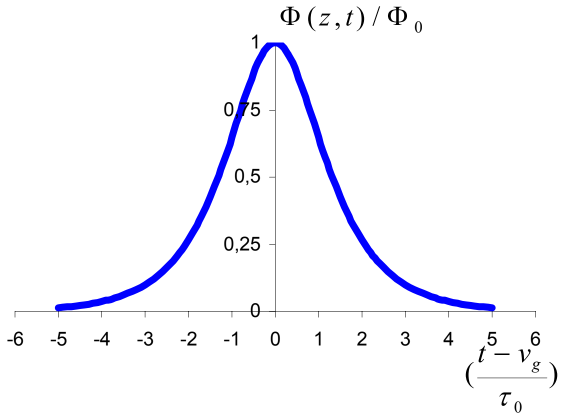


FIGURA 2
SOLUÇÃO DA EQUAÇÃO DE SCHROEDINGER SIMPLIFICADA

Usualmente, (2) é a solução da equação não-linear de Schrodinger para o caso onde N=1, sendo N definido como:

$$N^2 = \frac{\gamma P_0 T_0^2}{\beta_2} = \left(\frac{4\pi^2 c}{\lambda^3}\right)\cdot\left(\frac{n_2}{A_{aff}|D|}\right)\cdot\left(P_0.T_0^{\ 2}\right) = \frac{L_D}{L_{NL}} \quad (3)$$

Onde:

- $D = -\frac{\beta_2 \pi c}{\lambda^2}$ (4)

é a Dispersão Cromática;

- $L_D = \frac{T_0^2}{|\beta_2|}$ (5)

é o Comprimento de Dispersão, e indica a partir de que distância de propagação na fibra, a dispersão é relevante,

- $L_{NL} = \frac{1}{\gamma P_0}$ (6)

é o Comprimento Não-Linear, e indica a partir de que distância de propagação na fibra as não-linearidades são relevantes, e

- $T_0 = \frac{1}{q_0 B}$ (7)

é a Largura do Pulso, conforme mostrado na fig.2, B é a Taxa de Transmissão e q_o é um fator de ocupação.

Se N=1, vem:

$$P_0 = \frac{\beta_2}{\gamma T_0^2} = \left(\frac{\lambda^3}{4\pi^2 c}\right)\cdot\left(\frac{A_{aff}|D|}{n_2}\right)\cdot\left(\frac{1}{T_0^{\ 2}}\right) \quad (8)$$

De um modo simplificado a pesquisa consiste em encontrar os parâmetros do soliton, ou seja, conseguir um equilíbrio entre dois fenômenos que isoladamente são grandes ofensores na propagação em fibra óptica, mas que para este caso particular eles se compensam. A Dispersão e as Não-Linearidades.

Entretanto, conseguir com que este balanceamento permaneça ao longo da fibra, para longas distâncias é o maior desafio, pois como sabemos toda fibra tem atenuação.

Aqui, os simuladores são fundamentais, pois permitiram:

- Verificar a teoria ideal de solitons,
- Dimensionar a melhor condição da DRA,
- Verificar, em condições com perdas e amplificação, a propagação do soliton.

RESULTADOS PRELIMINARES

Os valores utilizados na simulação são:

D = 0.5 ps/(nm.km), T_0= 3 ps e P_0=31 mW.

Assim, obtemos $L_D = L_{NL}$ = 15 km, ou seja, caso as não-linearidades não compensem a dispersão, a partir de 15 km o pulso sofrerá distorções.

Na fig.3, verificamos a propagação do soliton em 10.000 km de fibras, sem perdas. Entretanto, todos os fenômenos não-lineares e a dispersão estão presentes. Verifica-se o perfeito casamento entre estes dois mecanismos, de modo a se compensarem.

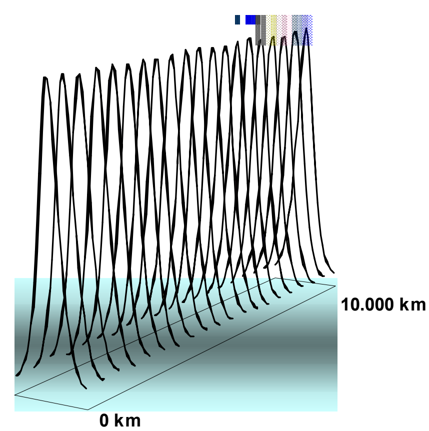


FIGURA 3
PROPAGAÇÃO DE SOLITON EM FIBRA SEM PERDAS

A fig.4 representa a simulação da propagação em fibra com dispersão nula (D=0). Verificamos, então, que as não-linearidades deformam o pulso antes de alcançar 30 km. Neste caso, também a atenuação é nula.

Na fig.5, a simulação considera ativos todos os fenômenos na fibra. Para compensar a atenuação, é utilizada a Amplificação Raman Distribuída (DRA), com bombeamento direto e reverso a cada 50 km.

A fig.6 mostra a propagação quando aumentamos a distância de bombeamento para 75 km. Para conseguir a equalização necessária e suficiente para a propagação, e manutenção do soliton, utilizamos dois trechos de fibras dimensionados para dois regimes de transmissão.

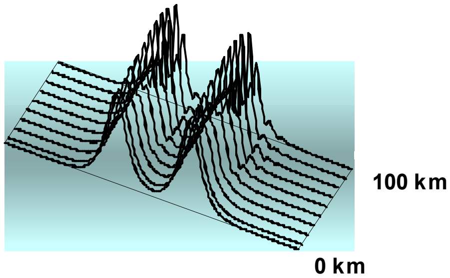


FIGURA 4
SOLITON EM FIBRA SEM PERDAS E DISPERSÃO NULA

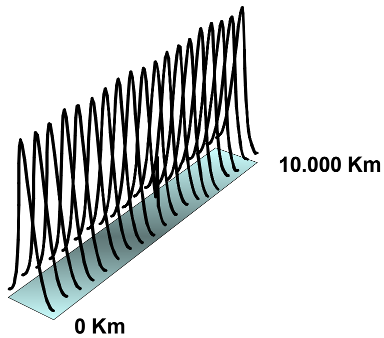


FIGURA 5
PROPAGAÇÃO DE SOLITON COM DRA.

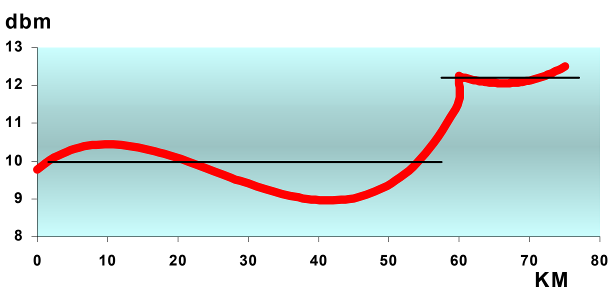
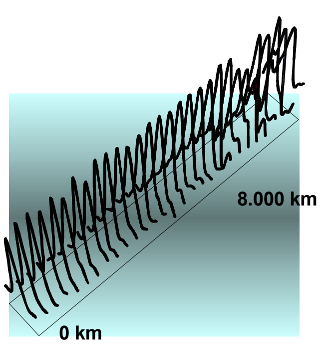


FIGURA 6
ATENUAÇÃO X COMPRIMENTO PARA DUAS FIBRAS E DRA.



Na fig.7 são apresentados os resultados nesse regime misto de transmissão.

FIGURA 7
SOLITON COM DRA E 75 KM DE BOMBEAMENTO

Percebe-se que o sinal sofre degeneração somente a partir dos 8.000 km. Tal pesquisa ainda está em curso, de modo que acreditamos ser perfeitamente possível atingir uma distância maior que 10.000 km de propagação, sem deformações substanciais no soliton, mantidos os 75 km de distância de bombeamento.

CONCLUSÕES

Foram mostrados alguns resultados que validam a Tese proposta. Acreditamos que as distâncias de bombeamento podem ser aumentadas para 100 km ou mais, caso utilizemos três regimes de transmissão solitônico.

Este e outros trabalhos que vêm sendo elaborados em ambientes virtuais evidenciam o quão importante é a utilização de simuladores em Pesquisa e Ensino.

Mais que apenas importante, acredita-se que, sem tais ferramentas, o ensino e pesquisas estariam incompletos, pois permitem uma vivência, que de outro modo seria muito difícil ao aluno ou pesquisador aprimorar-se.

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MELHORAMENTO NO PROCESSO DE UM PRODUTO UTILIZANDO AS FERRAMENTAS DE ENGENHARIA SIMULTÂNEA NUMA INDÚSTRIA ELETRÔNICA

Cassandra R. dos Santos[1] *e R. Radharamanan*[2]

Resumo *— Diante de vários fatores como evolução tecnológica e concorrência entre as indústrias, empresas com melhores produtos fabricados em tempo cada vez menores levam vantagem, já que assim introduzem com maior freqüência seus produtos no mercado. Baseados nesse desafio este projeto de pesquisa foi desenvolvido afim de orientar as indústrias de pequeno e médio porte da região sul do Brasil a desenvolverem produtos e processos que atendam as necessidades do mercado consumidor através da metodologia e de algumas ferramentas de engenharia simultânea. Foram utilizados as ferramentas como projeto para montagem manual, padrão de qualidade internacional (ISO 9002) e desdobramento de função de qualidade com o intuito de melhorar os problemas relacionados ao produto e processo de uma indústria de equipamentos eletrônicos que fabrica alarmes e sirenes para carros. Os resultados obtidos como melhoria no processo e mais qualidade no produto foram discutidos, e finalmente foram apresentados as recomendações feitas baseadas no estudo.*

Palavras Chaves — Engenharia simultânea, indústria eletrônica, melhoramento no processo e produto, projeto para montagem, desdobramento de função de qualidade, e padrão de qualidade internacional.

INTRODUÇÃO

O conceito básico de engenharia simultânea consiste numa abordagem sistemática para o desenvolvimento integrado e simultâneo do projeto de um produto e processos relacionados, incluindo fabricação e atividades de apoio [2]. Esta abordagem faz com que as pessoas envolvidas no desenvolvimento do projeto considerem, desde o início, todos os elementos do ciclo de vida do produto, da concepção ao descarte, incluindo qualidade, custo, prazos e exigências (requisitos) dos consumidores [Figura 1]. Porém, o conceito de engenharia simultânea tornou-se mais abrangente, podendo incluir a cooperação e o consenso entre os envolvidos no processo, o emprego de recursos computacionais e a utilização de outras metodologias [3]. Para implementar com sucesso este conceito, os integrantes da administração, operários e assessoria técnica, devem desenvolver uma percepção profundamente diferente, chamada "percepção do processo", dentro da natureza da atividade industrial.

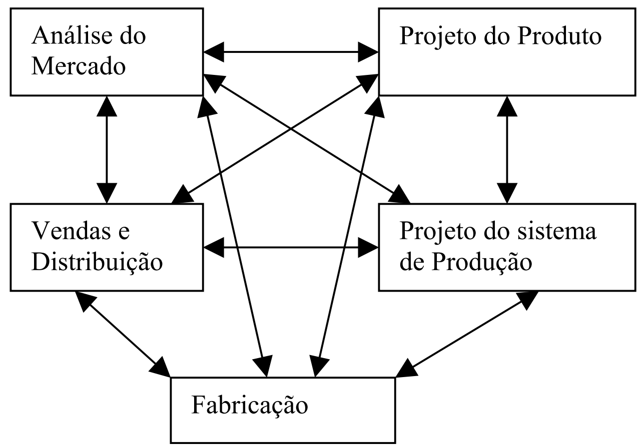

FIGURA. 1
O MODELO DE ENGENHARIA SIMULTÂNEA

Os critérios conceituais para o desenvolvimento da engenharia simultânea são: Identificação das exigências do mercado; Definição e cronograma do projeto para satisfazer as necessidades do mercado; Seleção de tecnologia/ arquitetura satisfatória; Preço/desempenho/confiabilidade satisfatórios; Viabilização das técnicas comprovadas; e Retorno sobre o investimento do projeto adequado [2, 19].

Os benefícios da engenharia simultânea são instantâneos para volumes maduros, aumentando a complexidade do projeto, reduzindo suas interações e aumentando a sua qualidade [10, 12]. Um ciclo típico do projeto de um produto é mostrado na Figura 2.

As empresas brasileiras empenham-se na adaptação à nova realidade da competição internacional. Trata-se de uma questão de sobrevivência para a empresa, seja qual for seu ramo, lançar seus produtos em tempo para atender as demandas do mercado e, ainda, garantir o atendimento das metas do custo e da qualidade para os mesmos. Na busca por maior competitividade, muitas empresas têm investido

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fortemente em ferramentas computacionais e em treinamentos para seus engenheiros na utilização das mesmas. Entretanto, a utilização de modernas ferramentas não é suficiente para atingir os objetivos de redução do tempo de desenvolvimento e melhoria da qualidade que o mercado exige. É necessária a prática da engenharia simultânea, pois ela pressupõe que várias atividades sejam desenvolvidas em paralelo, em oposição ao método tradicional de seqüenciamento de etapas. Dessa forma, é possível a realimentação de uma atividade pela outra. Isso é vantajoso por evitar os desperdícios de tempo e recursos, causados pelo não envolvimento completo dos vários setores nas etapas iniciais do ciclo. O tempo e os recursos gastos para executar tarefas que posteirormente precisarão ser refeitas jamais serão recuperados. Foi baseando-se neste contexto, que se decidiu aplicar a abordagem da engenharia simultânea em indústrias de pequeno e médio porte da região sul, a fim de orientá-las a produzirem produtos/processos que atendam as exigências do mercado consumidor.

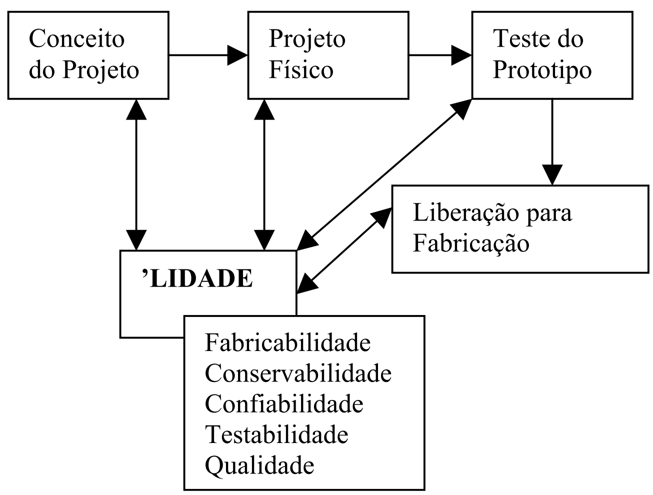

FIGURA. 2
CICLO DO PROJETO DE UM PRODUTO

METODOLOGIA

O processo de desenvolvimento de produtos envolve diferentes áreas da empresa. O departamento de marketing é importante na captação das necessidades dos consumidores (entrada) e no repasse dessas necessidades aos projetistas. A função dos projetistas é processar ou transformar essas necessidades dos consumidores, informações, e materiais em produtos e/ou serviços (saída) – Figura 3. Um fator importante para redução no tempo do desenvolvimento das atividades envolvidas será a velocidade com que estas são elaboradas pelas equipes que participam no projeto.

As ferramentas do Projeto Para Fabricação (PPF) e de Engenharia Simultânea utilizadas neste trabalho são discutidos em seguintes seções.

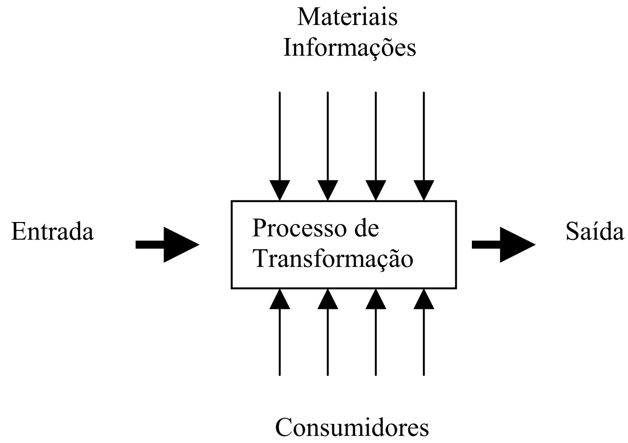

FIGURA. 3
PROCESSO/SISTEMA DE TRANSFORMAÇÃO

Projeto Axiomático

Esta abordagem baseia-se na condição de que: a) existem princípios ou axiomas do bom projeto; b) o emprego de axiomas para guiar e avaliar decisões dos projetos conduz a bons projetos. Os axiomas devem ser aplicáveis a toda o conjunto de decisões do projeto e a todos os estágios, fases e níveis do processo do projeto [6, 7, 16]. Os conceitos de axiomas hipotéticos são:

- **Axioma 1:** no bom projeto é mantida a independência de requisitos funcionais.
- **Axioma 2:** entre os projetos que satisfazem o axioma 1, o melhor projeto é aquele que tem o mínimo conteúdo de informações.

As etapas do projeto de axiomas são: 1. Identificar os requisitos e restrições funcionais; 2. Prosseguir com o projeto, aplicando os axiomas a cada uma das decisões do projeto.

Diretrizes do PPF

Afirmações sistemáticas e codificadas da prática de bons projetos que tenham sido derivadas, empiricamente, anos de experiência em projeto e fabricação. São diretrizes, atuando tanto para estimular a criatividade quanto para mostrar o caminho para o desenvolvimento de um bom projeto, que resultam em um produto que é inerente, mais fácil de fabricar [17, 18]. Algumas das diretrizes do PPF são: Projetar para um número mínimo de peças; Desenvolver um projeto modular; Minimizar as variações das peças; Projetar peças para serem multifuncionais; Projetar peças de uso múltiplo; Projetar peças fáceis de fabricar; Evitar separar os prendedores; Minimizar as instruções de montagem (projeto para montagem de alto a baixo); Maximizar a conformidade (projeto para facilidade de montagem); Minimizar o manuseio (projeto para o manejo e a apresentação); Avaliar os métodos de montagem; Eliminar ou simplificar regulagens; e Evitar componentes flexíveis.

Projeto para Montagem (PPM)

Desenvolvido por Boothroyd e Dewhurst, no MIT, este método baseia-se, nas técnicas de estudo dos tempos e movimentos da Engenharia Industrial. Procura minimizar os custos de montagem dentro das restrições impostas por outros requisitos do projeto [5, 14]. O método PPM é dividido em três seções:

- **Escolha do Método de Montagem :** é um procedimento de escolha entre a montagem manual, a montagem automática com finalidade especial e a montagem automática programável. As informações básicas necessárias são: volume de produção por turno, número de peças na montagem, produto único ou variedade de produtos, número de peças necessárias a diferentes estilos, número das principais modificações esperadas no projeto ao longo da vida do produto e política de investimento da empresa com relação ao emprego de máquinas em substituição à mão-de-obra.
- **Projeto para Montagem Manual:** consiste em comparar o tempo ideal calculado de montagem requisitado pelo projeto de um produto em particular e o tempo atual. O tempo ideal é calculado pelo número teórico de peças em relação ao movimento relativo, diferentes materiais e a necessidade de manufatura e concerto. O tempo atual é calculado para cada peça, dividido entre operações de manuseio e encaixe. Para cada dificuldade associada a cada operação, penalidades, em segundos, são acrescentadas ao valor básico.
- **Projeto para Montagem Automática:** consiste em: Estimar o custo do manuseio automatizado do volume e de sua entrega orientada; Estimar o custo do encaixe automático de peças; Decidir se a peça deve ser separada de todas as outras na montagem; Combinar os três resultados acima para calcular o custo total da montagem.

Após estimar a eficiência do PPM, o quociente de contagem de peças é calculado do seguinte modo: Quociente de Contagem de Peças

$$= \frac{\text{Número Teórico Mínimo de Peças}}{\text{Número Atual de Peças}}$$

Se estas duas medidas estiverem de acordo, valores para elas são fixados como meta. Esta abordagem fornece um alvo quantitativo para a equipe e se torna a base para a aceitação de um projeto particular.

Padrão de Qualidade Internacional (ISO 9000)

Qualidade é uma vantagem competitiva no mercado, isto significa que as indústrias devem ter a mesma ou melhor qualidade do que os seus competidores, observando que a qualidade dos competidores vêm melhorando contínuamente. Para ser competitivo, um programa viável de melhoramento contínuo deve ser desenvolvido e implementado na prática [20].

Os padrões ISO-9000 existem principalmente para facilitar os comércios internacionais. As mudanças devido a globalização são: novas tecnologias em todos os setores das indústrias ; redes de comunicações eletrônicas mundias; viagens mundias; aumento dramático na papulação mundial; redução nas reservas de recursos naturais; uso intensivo de terra, água, energia, e ar (problemas de ambiente comuns); redução de mão-de-obra em empresas grandes; número e complexidade entre as línguas, cultura, jurídica, e social encontrado na economia global com diversidade como fator principal permanente; e países em desenvolvimento tornando uma maior proporção da economia global com novos tipos de competidores e novos mercados. Essas mudanças necessitam melhor qualidade nos seus produtos [13]. Visão 2000 tem quatro metas que relaciona para manter os padrões ISO-9000 para atender contínuamente as necessidades do mercado: aceitação universal, compatibilidade atual, compatibilidade no futuro, e flexibilidade [8, 13]. Um fornecedor certificado pelo padrão ISO-9000 (ISO-9001 ou ISO-9002 ou ISO-9003) é considerado como um fornecedor confiável mundialmente para fornecer produtos e serviços com qualidade; os consumidores podem reduzir ou eliminar as inspeções de componentes comprados resultando um sistema eficiente para comércio global [9, 20]. As 20 cláusulas de padrão ISO 9001, mais compreensivas de três padrões, são encontradas em [9, 13].

Desdobramento de Função de Qualidade

Medida e avaliação da qualidade de um produto não é difícil, então podemos estabelecer padrões de conformidade, inspecionar e testar os produtos, idenficar as taxas de defeitos, corrigir erros, e impor nível de desempenho. O desdobramento da função de qualidade (DFQ) permite reunir uma quantidade de informações em uma forma concisa, em um pequeno número de documentos – os diagramas de DFQ. Sendo a forma gráfica a mais efetiva na simplificação de informações complexos [1, 4].

O DFQ é dirigido ao consumidor, basicamente para ouvir a "voz do consumidor" durante o desenvolvimento de produtos e processos, identificar e enfocar os detalhes e decidir o que é importante. Essa ferramenta simplifica um conjunto de informações através do uso de gráficos baseados em matrizes. O DFQ é um sistema que traduz os requerimentos dos consumidores e identifica as modificações necessárias antes da ocorrência de desperdícios, reduzindo os riscos durante a fase de desenvolvimento, criando um conhecimento básico dos produtos, introduzindo a "voz do consumidor" no processo de desenvolvimento [4, 14].

Esse método permite reunir uma quantidade de informção maiorsendo que é em forma de gráficos. Como cada consumidor é diferente em suas expectativas e necessidades, consequentemente, em requerimentos, identifica consumidores em vários estágios do cíclo de vida do desenvolvimento, e emprega técnicas para compilar os requerimentos dos consumidores. O DFQ exige uma lista de "QUES" e "COMOS", onde os ítens "QUES" são as necessidades e os "COMOS" são os requisitos mensuráveis dos consumidores [1, 4].

O desdobramento de função de qualidade – especificamente, a casa de qualidade – é uma ferramenta efetiva de administração no qual as expectativas dos consumidores são utilizados para dirigir o processo em consideração. Algumas vantagens e benefícios da implementação de DFQ são: uma maneira ordenada de obter e apresentar informações; cíclo de desenvolvimento reduzido; redução considerável em custo; mudanças mínimas no processo; redução nos descuidos durante execução de processo; um ambiante de trabalho em grupo; decisões consensos; e preservação de tudo em forma escrita, ou seja, a implantação de DFQ resulta em consumidores satisfeitos [1, 15].

RESULTADOS

Um estudo foi feito para a implantação de algumas ferramentas de engenharia simultânea e projeto para manufatura numa indústria eletrônica localizado no Rio Grande do sul. Foi utilizada a metodologia de montagem manual de engenharia simultânea durante a fabricação dos produtos "alarme/sirene" de carros com componentes eletrônicos. O estudo inicial com a administração e com os grupos do projeto e manufatura indicaram o seguinte:

- **Tipos de Problemas com Respeito ao Produto:** componentes plásticos defeituosos recebidos de fornecedores, acabamento externo visual, materia prima e placa eletrônica defeituosa, e uso não próprio do produto.
- **Fatores que Influenciam o Custo do Produto:** materil prima, treinamento de mão-de-obra, transporte, programa de qualidade, re-trabalho, tempo ocioso na linha de montagem, marketing, impostos, e garantia do produto.
- **Problemas Relacionados ao Processo de Produção:** resistores queimados, máquinas e equipamentos obsoletos, falta de manutenção preventiva, e falta de ferramentas.
- **Tipos de Reclamações dos Consumidores:** Atraso na entrega do produto, alta custo do produto, concorrência com melhor produto, e produtos defeituosos.

Algumas ferramentas de engenharia simultânea foram adotadas e aplicadas na indústria eletrônica selecionada. Diretrizes do projeto para fabricação foram utilizados inicialmente para re-projetar os produtos existentes. Todas as pessoas da industria, incluindo mão-de-obra até administradores da empresa foram treinados através de um programa de treinamento intensivo. A linha de montagem foi re-projetada incluindo novas ferramentas e equipamentos. Os procedimentos para testar o produto final foram modificados. A qualidade do produto foi melhorada através da certificação ISO 9002. Finalmente, os conceitos de desdobramento de função de qualidade (DFQ) foram implantados para satisfação das necessidades dos consumidores.

Antes da implantação do conceito de engenharia simultânea entre 35-40% de itens fabricados e vendidos voltavam para reparo e re-trabalho dentro de três meses de venda hoje este valor foi reduzido significativamente, com a implantação dos padrões de qualidade, do re-projeto de linhas de montagem, e uso dos conceitos de DFQ.

As reclamações dos consumidores foram reduzidos significativamente, e os reparos e retrabalhos diminuidos entre 5-10%. Atualmente, a empresa esta exportando seus produtos para outros países da America Latina.

CONCLUSÕES

Neste projeto, vários conceitos foram discutidos sobre engenharia simultânea. Estes conceitos quando aplicados adequadamente a indústrias de pequeno porte ajudam ao grupo de projetistas a elaborar um projeto ótimo para cada produto. Os conceitos e métodos aqui abordados tem mostrado alta eficiência quando aplicados em situações práticas. Os benefícios são obtidos aplicando-se e implementando-se corretamente a engenharia simultânea. Somente pela integração do projeto, manufatura, e marketing uma indústria pode, hoje, sobreviver neste mercado altamente competitivo onde custo, tempo de entrega e qualidade são indispensáveis á sobrevivência de qualquer indústria.

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AVALIAÇÃO INSTITUCIONAL EM UM CURSO DE MESTRADO EM ENGENHARIA DE PRODUÇÃO – METODOLOGIA E RESULTADOS

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Resumo *– Este ensaio se fundamenta na descrição de um processo de avaliação institucional realizado no Programa de Pós-graduação em Engenharia de Produção da UNIMEP, campus Santa Bárbara d´Oeste. O processo envolve a avaliação do curso de mestrado em Engenharia de Produção em cinco eixos principais propostos pela instituição, tendo como base a Política Acadêmica da Universidade e o Projeto Pedagógico do curso, por meio de um questionário respondido pelos discentes e outro pelos docentes. Dado o caráter transformador da avaliação, o que se pretende, por meio dos resultados obtidos, é enfatizar o uso de métodos e processos de gestão da qualidade, no intuito de alinhar e direcionar o curso de forma a contribuir com a missão da universidade em prestar serviços que atendam os requisitos da sociedade, no sentido da construção da cidadania.*

Palavras-chave – Avaliação Institucional, Engenharia de Produção, Mestrado, Qualidade.

1. Introdução

O desenvolvimento da avaliação institucional tem proporcionado um desafio extremamente complexo na maneira como tem sido conduzido o processo administrativo-pedagógico das instituições de ensino superior. Desta forma, deve-se promover a articulação dos elementos centrais da vida universitária como o ensino, pesquisa e extensão, sendo destacado também a sua gestão.

A necessidade da Avaliação Institucional, segundo Sobrinho & Balzan (1995) passou a ser discutida na década de 80, mas foi a partir da década de 90 que vem se acumulando e ganhando consistência a temática da avaliação institucional em relação a questões de autonomia e de qualidade.

Na verdade, segundo Graeff (2001), o sucesso e a melhoria de uma instituição associa-se a sua capacidade de auto-percepção, de ver-se em sua extrema realidade, sendo a qualidade largamente condicionada ao investimento que faz na avaliação de si mesma, em seus processos e resultados e, a partir disso, no realismo dos objetivos a que se propõe.

A própria avaliação, praticada por iniciativa da instituição, conforme destaca Graeff (2001) evidencia a importância do auto-conhecimento institucional, além de ser uma exigência do Ministério da Educação, relacionando-se a um processo mais amplo que envolve a renovação do reconhecimento de cursos e o recredenciamento das universidades.

Por esse motivo, o objetivo deste estudo, é descrever o processo de avaliação institucional realizado no programa de Pós-graduação em Engenharia de Produção da Universidade Metodista de Piracicaba (UNIMEP), *campus* Santa Bárbara d'Oeste, desenvolvido em cinco eixos principais: currículo, ações do processo de ensino-aprendizagem, projetos e atividades, operacionalização da gestão do curso e estrutura e apoio, tendo como base a Política Acadêmica da Universidade e o Projeto Pedagógico do curso.

O processo de avaliação utiliza como instrumento de coleta de dados um questionário respondido pelos discentes e outro pelos docentes, a partir desses cinco eixos. O desenvolvimento do questionário é apresentado, bem como a realização de um pré-teste, além dos resultados finais de sua aplicação. Dado o caráter transformador da avaliação, o que se pretende, é enfatizar o uso de métodos e processos de gestão da qualidade, no intuito de alinhar e direcionar o curso de forma a contribuir com a missão da universidade.

2. Procedimentos básicos sobre a sistemática da avaliação institucional

Todos os sistemas de avaliações até então empregados visam a construção de uma cultura Institucional participativa, tendo por objetivo o permanente aperfeiçoamento das Instituições através da identificação e resolução de problemas. Deste modo, o sucesso deste sistema de avaliação depende do estabelecimento e a efetivação de metas podendo defini-las em etapas, descritas a seguir (UNIMEP, 2000):

- Momento preparatório – efetivação de um Comitê de Avaliação Institucional (estruturação);
- Sensibilização – momento de busca da participação da comunidade envolvida;
- Avaliação interna – ou auto-avaliação, que consiste na análise do contexto e dos resultados das ações até então tomadas;
- Avaliação externa – consiste na avaliação por profissionais externos;
- Análise dos resultados da Avaliação e tomadas de decisão – consiste na análise da avaliação seguida pelo rearranjo e tomada de decisões.

A obediência às etapas favorecem o desenvolvimento da Avaliação, porém previamente é necessário reconhecer que os parâmetros de qualidade são definidos pelos clientes ou usuários (aqui sendo discentes, empresas e comunidade em geral) de modo a valorizar e/ou permitir suas participações, se possível em todos os níveis do desenvolvimento da avaliação (UNIMEP, 2000).

Segundo dados do INEP (2002), do ano de 1996 (ano em que instituiu o Provão) até o ano de 2000, observou-se

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um grande crescimento quanto à titulação dos professores envolvidos no ensino superior, Porém, conforme destaca Costa & Júnior (2000) é importante salientar que a qualificação por si só não garante a qualidade do ensino, ou seja, somados a esta são requisitos fundamentais o investimento em infra-estrutura física e tecnológica (laboratórios, bibliotecas etc.) e a capacitação metodológica no processo ensino-aprendizagem.

Entretanto, avaliar não é apenas observar e coletar dados. Conforme afirma Ximenes (2000), a partir das interpretações ou explicações dos fatos, tendo por base parâmetros de referência, a avaliação aproxima-se de seu principal desafio que é o de propor alternativas, permitindo a retroalimentação dos processos de tomada de decisão.

Por extensão, a implementação e manutenção de procedimentos adequados de avaliação, revestidos de seriedade, correção e eficácia, seriam a única forma efetiva de levar ao conhecimento da coletividade, de maneira clara, os resultados alcançados pelo desempenho das instituições de ensino.

3. O processo de avaliação institucional aplicado a um curso de mestrado em Engenharia de Produção

A metodologia descrita a seguir, é o resultado do processo de Avaliação Institucional realizado por meio da auto-avaliação do curso de mestrado em Engenharia de Produção da Universidade Metodista de Piracicaba (UNIMEP), *campus* Santa Bárbara d'Oeste.

3.1. Historicidade do Curso de Mestrado em Engenharia de Produção da UNIMEP

O Curso de Mestrado em Engenharia de Produção da UNIMEP foi criado a partir de março de 1994 e, em dezembro de 1997 ocorreu o seu credenciamento, com vistas a melhoria da qualidade dos profissionais formados e ao desenvolvimento de pesquisas.

O corpo docente é formado basicamente por 13 professores doutores, em regime de dedicação de 40 horas (tempo integral) à universidade. O curso é oferecido na área de concentração de Gerência da Produção, Estratégia e Organizações, Gestão Ambiental e Qualidade e possui cadastradas 48 disciplinas, todas de 03 créditos, sendo exigidos 24 créditos para o mestrado.

O quadro discente do mestrado apresenta 93 alunos. O tempo médio de titulação é de 40 meses para não bolsistas e 33 meses para bolsistas. Estima-se que cerca de 70% estão atuando junto às empresas da região, e o restante em outras áreas. Até agosto de 2002, foram defendidas 58 dissertações.

O tópico seguinte apresenta a metodologia utilizada na condução do processo de avaliação pelo curso de mestrado em Engenharia de Produção.

3.2. Metodologia de Condução do Processo de Avaliação pelo Curso

O processo de Avaliação Institucional deve ser realizado através da auto-avaliação do Curso, conforme documentação do Comitê de Avaliação Institucional (UNIMEP, 2001). A seguir, destaca-se os documentos referenciais para o Processo de Avaliação Institucional do Curso de Mestrado em Engenharia de Produção:

- Política Acadêmica da UNIMEP;
- Programa de Avaliação Institucional (UNIMEP, 2000);
- Projeto Pedagógico do curso, (UNIMEP, 1998);
- Resolução do Conselho Universitário 28/01 (CONSUN - UNIMEP, 2001);
- Minutas de reuniões e correspondências da Coordenação e do Comitê de Avaliação Institucional.

O instrumento escolhido para coleta dos dados foi um questionário, considerando questões abertas, de múltipla escolha, dicotômicas ou tricotômicas, com mais de uma resposta, questões quantitativas e qualitativas, tendo como ponto de partida o seu desenvolvimento os eixos propostos pela instituição, anteriormente citados. Para que fosse elaborado um instrumento de fácil entendimento e com informações necessárias, foi aplicado um pré-teste, para que posteriormente fosse construído o instrumento final.

Cabe ressaltar que o Curso de Mestrado em Engenharia de Produção esteve sempre alinhado com a Política Acadêmica Institucional, e que o Programa de Avaliação Institucional, é um programa essencialmente interno, mas que vem do encontro com as avaliações realizadas pela CAPES.

3.3. Apresentação e Análise dos Resultados

Esse tópico é dividido em duas partes: resultados referentes à avaliação feita pelos discentes e outro pelos docentes, subdivididos de acordo com os eixos de avaliação propostos pela instituição.

3.3.1. Resultados Referentes a Avaliação feita pelos Discentes

Esse tópico evidencia inicialmente o perfil dos discentes, demonstrado na Tabela I. Para essa amostra, o retorno dos questionários foi da ordem de 42,8%.

TABELA I
PERFIL DOS DISCENTES ABRANGIDOS PELA PESQUISA

Perfil dos discentes	**Amostra**
Sexo	80% do sexo masculino
Faixa Etária	27,3% - de 36 a 40 anos; 24,2% - mais de 41 anos; 24,2% - 26 a 30 anos; 21,2% - 31 a 35 anos; 3% - menos de 25 anos.
Áreas de Concentração	36,4% - Estratégias e Organizações; 30,3% - Qualidade; 21,2% - Gerência da Produção; 12,1% - Gestão Ambiental.

TABELA I
PERFIL DOS DISCENTES ABRANGIDOS PELA PESQUISA

Formação	33% - Engenharias (Mecânica, Produção, Elétrica...); 24% - Administração de Empresas; 43% - outras áreas.
Origem da formação na IES	85% - IES particular; 12% - IES pública.
Bolsa de Estudos	30% - Bolsistas.
Atividade Profissional	31% - trabalham na área de formação; 28% - trabalham no ensino superior; 18% - trabalham, mas não em sua área de formação; 18% - não trabalham.

A seguir, os resultados serão apresentados referente a avaliação frente aos cinco eixos de análise, sendo que a tabulação dos resultados apresenta, sempre que se achar necessário, uma discussão em relação ao cruzamento de dados, neste caso, por área de concentração do curso.

3.3.1.1. Operacionalidade da Gestão do Curso

Com relação ao Conselho do Curso, pode-se considerar desfavorável, pois a maior parte dos alunos "não tem clareza do papel desse conselho" (pouco mais de 57%), além de aproximadamente um quarto dos alunos desconhecerem a existência do conselho (por áreas de concentração, as mais acentuadas são Gestão Ambiental - 100% dos alunos e 71,4% dos alunos de Estratégias e Organizações).

Na questão da participação dos alunos no Conselho do Curso, foi apontado que os discentes não procuram tomar conhecimento das decisões das reuniões (57% na área de Gerência da Produção e 50% em Gestão Ambiental).

Vale a pena ressaltar que, na visão dos alunos, a Secretaria e a Coordenação foram bem avaliados, resultando num bom percentual na somatória de "ótimo" e "bom".

3.3.1.2. Projetos e Atividades

As questões que mais contribuíram negativamente nesse eixo foram:

- *Participação em projetos de extensão*, onde 75% responderam que não participam desse tipo de projeto, havendo uma maior concentração na área de Gerência da Produção (aproximadamente 85%); sendo que 60% declararam que o curso tem incentivado esse tipo de participação;
- *Desenvolvimento em projetos de pesquisa com alunos da graduação*, sendo que quase 80% dos alunos declaram que não participam. As áreas que mais e menos respectivamente demonstraram esse pronunciado foram a de Estratégia e Organizações (92%) e a de Gestão Ambiental (50%).

Uma questão relativamente positiva foi a contribuição que o EME (Encontro de Mestrandos em Engenharia) proporciona ao trabalho de pesquisa dos alunos, sendo relevante para 91% desses alunos.

3.3.1.3. Estrutura e Apoio

Neste quesito, pode-se destacar os seguintes pontos negativos apontados pelos discentes:

- o item que mais contribuiu negativamente está relacionado a Livraria e Papelaria, sendo que de 70% dos usuários, 40% consideraram "preço" e "opções de oferta" de regulares a ruim;
- com relação ao uso do laboratório de informática, dos 50% de alunos que o utilizam, a maior parte o considera no mínimo regular;
- em relação a biblioteca, onde 100% da amostra a utiliza, quase a metade a consideraram regular frente aos itens avaliados, tais como quantidade de títulos, periódicos na área e estrangeiras etc.

3.3.1.4. Currículo

Esse foi o eixo de maior impacto positivo na avaliação discente, embora seja evidenciado também pontos críticos, demonstrados a seguir:

- mais de 75% dos discentes indicaram que o Curso de Mestrado em Engenharia de Produção atende um de seus principais objetivos, que é o de "formar recursos humanos com competência em pesquisa científica e tecnológica e ensino em Engenharia de Produção e áreas correlatas";
- no entanto, ficou claro que um terço dos discentes desconhecem os cincos objetivos do curso, principalmente na área de concentração em Gestão Ambiental (75%). Conseqüentemente, um percentual de discente também não souberam avaliar se esses objetivos estão sendo atingidos, enquanto que para uma parte (50%) o curso atinge satisfatoriamente. O mesmo, para um pouco mais de 42% consideraram que as disciplinas oferecidas atendem "parcialmente" aos objetivos do Projeto Pedagógico.

3.3.1.5. Ações do Processo de Ensino e Aprendizagem

Esse foi outro eixo que teve um impacto positivo segundo a visão dos alunos, nos seguintes pontos:

- os alunos dedicam, em média, 8,6 horas por semana para o estudo das disciplinas do curso;
- Os alunos dedicam, em média, 10,8 horas por semana para a condução de seu projeto de pesquisa;
- Com relação as práticas discentes (como tempo para estudo, iniciativa como pesquisador, integração nos trabalho de equipe etc.) mais de 50% avaliaram como "regular".

3.3.2. Resultados Referentes a Avaliação feita pelos Docentes

Esse tópico evidencia inicialmente o perfil dos docentes, demonstrado na Tabela II. Para essa amostra, o retorno dos questionários foi da ordem de 92,3%.

TABELA II
PERFIL DOS DOCENTES ABRANGIDOS PELA PESQUISA

Perfil dos docentes	**Amostra**
Regime de dedicação	100% - dedicação em tempo integral
Titulação	100% - titulação de doutor 25% - pós-doutorado
Sexo	92% - sexo masculino
Faixa etária	75% - de 41 a 55 anos
Tempo de docência acadêmica na UNIMEP	58% - 11 a 20 anos
Experiência não acadêmica	42% - de 01 a 05 anos 33% - de 06 a 10 anos

Igualmente, como foi feito com a avaliação realizada com os discentes, a seguir, os resultados sobre a avaliação feita pelos docentes, serão apresentados frente aos cinco eixos de análise. Onde for considerado pertinente, a discussão considera o cruzamento por tempo de docência na universidade.

3.3.2.1. Operacionalidade da Gestão do Curso

Inicialmente, foi considerado o nível de participação dos professores nos diversos Colegiados da Instituição, apresentado os seguintes resultados:

- para todos os tipos de colegiados da instituição, o nível de participação é considerado, para mais de 50% dos docentes, como "parcial". Isso pode ser constatado, pois 16% dos respondentes tem um tempo de docência de 04 a 10 anos na instituição.

Por outro lado, ao se avaliar o trabalho realizado pela coordenação do curso, pode se constatar que praticamente mais de dois terços dos professores aprovaram o seu trabalho.

3.3.2.2. Estrutura e Apoio

No que se refere a organização e disponibilização do acervo bibliotecário, verificou-se o seguinte:

- dentre os itens avaliados (acervo de livros, periódicos, disponibilidade de livros, quantidade, atualização etc.) todos tiveram indicação "regular" a "ruim", apontados por mais de 50% dos docentes em praticamente todas as faixas de tempo de docência;
- um aspecto positivo refere-se a recente permissão de acesso para a UNIMEP na base de dados da CAPES, o que resolve parte dos problemas relacionados aos periódicos.

Outra questão analisada neste eixo refere-se a adequação da estrutura e organização da sala de aula, observados pela insatisfação dos seguintes pontos a seguir:

- 83% com a ventilação (direcionados apenas para os alunos);
- 75% com o nível de ruído externo;
- 67% para a acústica;
- 58% com relação ao espaço das salas de aula (menores que as outras);
- 58% para a disposição e *lay out* das carteiras;
- 58% sobre as condições de uso dos recursos audiovisuais.

Como fator positivo, pode-se destacar a avaliação feita pela estrutura e organização dos laboratórios pelas áreas de concentração que os utilizam, sendo relativamente bem estruturados, pois têm recebido investimentos institucionais e dos próprios pesquisadores via projeto de pesquisa.

3.3.2.3. Projetos e Atividades

Neste eixo de análise, primeiramente verificou-se as razões que dificultam o envolvimento dos docentes em Projetos de Pesquisa e Extensão, verificando as seguintes razões:

- a universidade/curso não dispõe de docentes em regime de dedicação em número suficiente para propor projetos (possivelmente os docentes estariam se referenciando ao corpo docente da instituição, pois todos os professores do curso trabalham em regime integral);
- para 58% dos docentes, faltam condições de apoio aos projetos (seria necessário entender melhor quais seriam essas condições, pois algumas solicitações de apoio podem ser feitas);
- para 67% as ações do processo burocrático administrativo acontecem com urgência maior que a acadêmica, dificultando o trabalho acadêmicos dos docentes.

Outro item analisado, refere-se ao interesse pela extensão e disponibilidade dos docentes para realizá-la, verificando as seguintes respostas:

- para 42% dos docentes há poucas condições para a realização das atividades de extensão;
- 25% admitem não se identificarem com essa prática (observado em todas as faixas de tempo de experiência docente).

Outra questão pertinente a este eixo, é relativa a percepção da indissociabilidade entre ensino, pesquisa e extensão no curso, apontada nas seguintes atividades:

- para 58% dos docentes ocorre em sala de aula;
- para 67% no projeto pedagógico.

Com relação ao interesse dos docentes pela pesquisa e sua disponibilidade para realizá-la, observou-se o seguinte:

- 83% disserem ter grande disponibilidade e que vem realizando essa prática;
- 42% indicaram ter grande disponibilidade, mas a universidade oferece poucas condições para realizá-la.

Diante desta última questão, as respostas foram apontadas por todas as faixas de tempo de docência na Universidade.

3.3.2.4. Ações do Processo de Ensino e Aprendizagem

Neste eixo, primeiramente foi averiguado a questão da utilização de conceitos na avaliação dos alunos, o que resultou em:

- 68% indicaram que há um predomínio de conversão de notas para conceitos, por parte dos docentes (uma situação que deve ser melhor investigada, porque as avaliações da pós graduação em outros cursos são realizadas por meio de conceitos);

- 60% disseram que há incompatibilidade entre o número de alunos existentes em sala de aula e a proposta de avaliação de conceitos (em princípio, uma avaliação inadequada, pois as turmas da pós-graduação são, em geral, pequenas);
- 35% ressaltaram que o conceito possibilita uma melhor avaliação do processo ensino/aprendizagem.

As práticas relacionadas ao plano de ensino, determinou-se o seguinte:

- 91,7% afirmaram que o plano de ensino é apresentado aos alunos com discussão, no início da disciplina;
- 67% disseram que as alterações no plano ocorrem durante o desenvolvimento da disciplina;
- 33% que as alterações ocorrem frente a sugestões apresentadas pelos alunos.

Na relação entre professores e alunos, constatou-se que:

- 100% afirmaram o predomínio de uma relação aberta, menos hierarquizada, com diálogo;
- 33% disseram que há conflitos, mas que o mesmo enrique o processo.

3.3.2.5. Currículo

Correspondendo ao elenco de disciplinas oferecidas, este eixo abordou primeiramente a avaliação da grade curricular, que indicou os seguintes resultados:

- 75% dos docentes avaliaram a grade curricular como coerente com o projeto pedagógico do curso;
- 67% afirmaram que a grade curricular está ajustada às necessidades do mercado profissional;
- 17% assinalaram que a grade curricular é pouco conhecida pelos professores, mas que seria importante conhecê-la.

Por último, foi perguntado sobre a existência de compatibilidade entre os objetivos do curso, a estrutura curricular e o perfil do profissional desejado, onde se verificou que:

- 75% dos docentes responderam que há compatibilidade;
- 25% responderam que a compatibilidade é parcial.

4. Considerações Finais

É necessário destacar que, pela amplitude da amostra e pelo próprio espaço aqui definido, foram apresentados apenas os resultados mais relevantes, não sendo abordado a pesquisa como um todo.

Ao analisar-se os resultados do processo de avaliação conduzido pelo curso, através dos resultados em seus cinco eixos de avaliação, nota-se que o eixo que está mais relacionado com os aspectos do projeto pedagógico é o do Currículo, em ambas as avaliações, discentes e docentes. Entretanto, existiram alguns aspectos onde a relevância social do projeto institucional da Universidade não tem atingido o alcance desejado, tendo em vista que os objetivos do Projeto Pedagógico não são conhecidos (notadamente por uma parcela dos discentes) ou, mesmo quando conhecidos, não são cumpridos na sua plenitude. As recomendações nesse sentido, é uma análise crítica de onde o Projeto Pedagógico pode ser melhorado no sentido de rever algumas das práticas acadêmicas e administrativas, identificadas na avaliação dos eixos pelos docentes e discentes.

Na análise das três vertentes, Ensino, Pesquisa e Extensão, e sua indissociabilidade, nota-se uma grande interação entre duas delas, Ensino e Pesquisa. No caso da avaliação docente, os resultados apresentados com relação as atividades de extensão, pode-se afirmar que parte desse resultado é explicado pelo entendimento do que vem a ser as atividades de extensão para os cursos de engenharia, sejam de graduação ou pós graduação. De qualquer modo, a presença da extensão como atividade cotidiana é uma ação que deve ser intensificada no Curso de Mestrado em Engenharia de Produção, como também, o Projeto Pedagógico do curso também merece ser reavaliado de forma a direcionar, mais claramente, algumas ações voltadas para a extensão, buscando encontrar quais são suas perspectivas de extensão na universidade, a partir dos objetivos identificados.

Portanto, o processo avaliativo denota uma maior compreensão do objeto avaliado, prestando contas a comunidade, contribuindo para que se busque a minimização de suas deficiências e a maximização de sua produtividade. Ao se destacar a continuidade da avaliação institucional como um processo cultural, um favorável desempenho pode ser auferido pela atividade acadêmica, o que condiciona um compromisso social e ético por parte da instituição de ensino.

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NOVA CONFIGURAÇÃO DE FIBRAS ÓPTICAS COM AMPLIFICAÇÃO RAMAN, SIMULADA COM O SOFTWARE *VPI*, UTILIZADO NA INDÚSTRIA E NO ENSINO.

Laércio Alves Nogueira [1] e Luiz Sérgio Zasnicoff [2]

Abstract — As p*erdas em fibras ópticas constituem fatores limitantes em transmissões de longa distância. Uma maneira prática de transmitir sinais com perdas reduzidas é a utilização de Amplificação Raman Distribuída. Como forma de se realizar uma transmissão otimizada, uma nova configuração híbrida de fibras ópticas é avaliada para sistemas de longa distância. Uma solução simples, e que apresenta bom resultado, é a configuração híbrida com apenas dois tipos de fibras em cascata, com bombeamento Raman por meio de um diodo laser. O objetivo é uma transmissão com perda desprezível, mantendo-se a variação total da potência do sinal de entrada, ao longo do enlace, menor que 2 dB, numa distância de 50 km. A linha é composta por um trecho de fibra monomodo (SMF – Single-Mode Fiber), e uma fibra com dispersão compensada (DCF-Dispersion-Compensating Fiber), com bombeamento Raman reverso (backward). Este trabalho apresenta as simulações desse experimento, por meio de simulações com o programa VPI.*

Index Terms — *Amplificadores ópticos, bombeamento reverso, fibras ópticas, espalhamento Raman.*

INTRODUÇÃO

Com a popularização da Internet, a tecnologia da camada física, ou de base, para a comunicação entre os usuários tem se tornado motivo de intensa pesquisa, visando à melhoria constante da rede, de forma a se atender cada vez mais um número maior de pessoas, com um aumento do tráfego e prestação de serviço com mais qualidade. Atualmente, IP (*Internet Protocol*) sobre WDM (*Wavelength-Division Multiplexing*) está recebendo muita atenção [1], pois neste esquema de comunicação uma grande capacidade de tráfego está ligada aos serviços IP. Num futuro próximo, a capacidade demandada será ainda maior, e para se conseguir este aumento de capacidade nos sistemas WDM, diminui-se a largura de espaçamento entre os canais.

No entanto, efeitos não-lineares, tais como FWM (*Four-wave mixing*) e XPM (*Cross-Phase Modulation*), entre outros, aumentam com a diminuição do espaçamento entre canais, limitando assim a distância de transmissão. A Amplificação Raman Distribuída (DRA) tem o potencial de aumentar consideravelmente a distância de transmissão. Ela permite diminuir perdas nas fibras pela utilização do próprio meio físico como um amplificador. Como resultado, o sinal necessário na entrada para se conseguir certo valor da relação sinal/ruído óptica, é reduzido, o que diminui o aparecimento dos outros tipos de efeitos não-lineares.

O ruído óptico causado pelo DRA é menor do que o ruído dos EDFAS (*Erbium-Doped Fiber Amplifiers*). Assim, DRA permite não somente que se eliminem outros efeitos não-lineares, mas também melhora a relação sinal/ruído. As simulações forma realizadas por meio do *software VPITransmissonMaker*™, um produto da empresa Virtual Photonics, Inc. A configuração utilizada para o DRA é a de bombeamento reverso (*backward*), porque o bombeamento Raman direto (*forward*) é geralmente menos eficiente em termos da relação sinal/ruído [2]. Costuma-se operar com um ganho do DRA abaixo de 20 dB, para se evitar espalhamento de Rayleigh.

Neste artigo, para se conseguir uma transmissão com perdas praticamente desprezíveis, uma configuração híbrida é utilizada, como esquema principal das simulações. Dois diferentes tipos de fibras são conectados em série, e adiciona-se a elas um DRA para compensar as perdas do enlace total. Utiliza-se uma fibra de sílica tipo monomodo (SMF – *Single Mode Fiber*), que apresenta relativamente alta dispersão cromática no comprimento de onda de 1.5 μm, mas que é efetiva na redução de efeitos não-lineares, em cascata com uma fibra de dispersão deslocada (DCF - Dispersion-Compensating Fiber), que compensa a dispersão acumulada.

O *software* VPI é a ferramenta utilizada para obtenção dos valores práticos. Os resultados da simulação validam os valores experimentais reportados nos artigos de Okuno [3], Tsukitani [4] e Kato [5].

TEORIA

Espalhamento Raman estimulado (SRS, *stimulated Raman scattering*) é um processo não linear importante que pode transformar fibras ópticas em amplificadores Raman de banda larga e lasers Raman sintonizáveis.

Em muitos meios não lineares o espalhamento Raman espontâneo converte uma pequena fração ($\sim 10^{-6}$) da onda incidente para uma outra onda a uma freqüência deslocada de um valor determinado pelos modos vibracionais do meio. Este processo é o denominado efeito Raman e é descrito pela

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mecânica quântica como o espalhamento de um fóton incidente por uma molécula para um fóton de freqüência menor enquanto ao mesmo tempo as moléculas fazem uma transição entre seus dois estados vibracionais. A onda incidente atua como bombeio para gerar a radiação com freqüência deslocada chamada onda Stokes.

O crescimento inicial da onda Stokes é descrito por:

$$\frac{dI_s}{dz} = g_R I_p I_s \qquad (1)$$

onde I_s é a intensidade de Stokes, I_p é a intensidade de bombeio e g_R é o coeficiente de ganho Raman. O coeficiente de ganho Raman está relacionado à parte imaginária da susceptibilidade não linear de terceira ordem.

A interação entre as ondas Stokes e a onda de bombeamento é dada pelas seguintes equações:

$$\frac{dI_s}{dz} = g_R I_p I_s - \alpha_s I_s \qquad (2)$$

$$\frac{dI_p}{dz} = -\frac{\omega_p}{\omega_s} g_R I_p I_s - \alpha_p I_p \qquad (3)$$

onde os coeficientes de absorção α_s e α_p representam as perdas nas fibras, nas freqüências do bombeio e Stokes.

Estas equações podem ser derivadas rigorosamente utilizando as equações de Maxwell. A propriedade Raman de uma fibra óptica é representada pelo fator de amplificação Raman G_R (1/W/km). O coeficiente de ganho Raman, g_R (m/W) dividido pela área efetiva, A_{eff}, resulta no fator de Raman. Partindo-se da equação do fator de amplificação de Raman [6], dado pela equação (4), chega-se à equação da intensidade de sinal $I_s(z)$ local a uma distância Z (km):

$$G_A = \frac{I_s(L)}{I_s(0)\exp(-\alpha_s L)} = \exp(g_R P_0 L_{eff} / A_{eff}) \qquad (4)$$

onde: $0 < z \le L'$, na primeira fibra.

$$I_S(z) = I_S(0)\exp[-a'_S + G'_R P_P A e^{-a_P(L-L')} e^{-a'_P L'} \cdot (e^{a'_P z} - 1)/a'_P] \qquad (5)$$

onde: $L' < z \le L$, na segunda fibra.

$$I_S(z) = BI_S(L')\exp[-a'_S(z-L') + G_R P_P A e^{-a_P(L-L')} \cdot (e^{a_P(z-L')} - 1)/a_P] \qquad (6)$$

onde A e B são valores lineares de perda na emenda entre as duas fibras e L_{eff} é conhecido como comprimento efetivo de interação, e é dado por:

$$L_{eff} = \frac{1}{\alpha_p}[1 - \exp(-\alpha_p L)] \qquad (7)$$

O circuito da configuração híbrida é mostrado na figura 1, segundo a montagem utilizada por Okuno em 2001 e Kato, 1999.

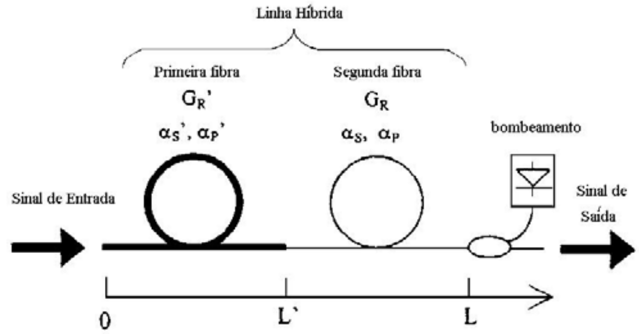

FIGURA 1.
CONFIGURAÇÃO HÍBRIDA COM DRA E BOMBEIO REVERSO.

SIMULAÇÕES

O *software* VPI disponibiliza para simulações modelos de fibras ópticas, dos quais foi utilizado nas simulações um modelo denominado de fibra NLS bidirecional (*Nonlinear Dispersive Fibe*r, NLS). Este modelo de fibra simula a transmissão de um sinal não linear de banda larga em fibras ópticas, levando em consideração o fluxo de sinal bidirecional, espalhamento de Rayleigh múltiplo, espalhamento Raman estimulado e espontâneo, não linearidades de Kerr e efeitos de dispersão. O método de cálculo numérico utilizado é o "*split-step Fourier*".

Com este *software* da VPI, o circuito mostrado na figura 1 foi implementado utilizando-se os blocos operacionais internos ao programa, e simulado com a configuração indicada na figura 2. Esta configuração representa o circuito real experimentado. O diagrama de blocos ilustra os componentes típicos existentes na biblioteca do VPI. Podemos notar os transmissores laser da banda C (1530-1570 nm), os lasers de bombeio DRA reversos, analisadores de espectro, trechos de fibras ópticas, osciloscópios etc.

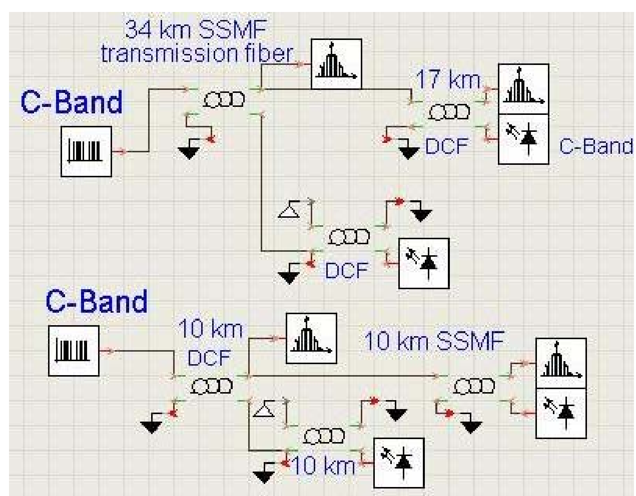

FIGURA 2
CIRCUITO COM CONFIGURAÇÃO HÍBRIDA UTILIZADO PELO VPI.

Os parâmetros estabelecidos foram os mesmos utilizados pelos autores [3,4,5].

O enlace do primeiro trecho-circuito da figura 2 é composto por uma fibra SMF de 34 km acoplada a uma fibra DCF de 17 km. Para o segundo circuito da mesma figura 2, os dois comprimentos das duas fibras possuem 10 km, cada.

A figura 3 mostra a distribuição de potência do sinal observada pelo *Visualizer* do software VPI.

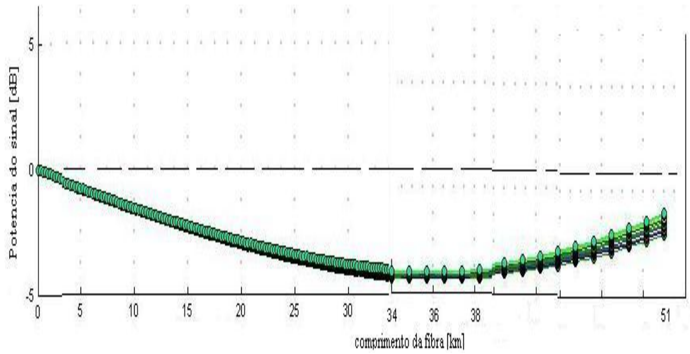

FIGURA 3
VARIAÇÃO DO SINAL DE ENTRADA NA FIBRA AO LONGO DO ENLACE DE 51 KM; ORDEM DA CONFIGURAÇÃO SMF NA FRENTE DA DCF.

Na figura 4, o sinal é observado internamente às duas fibras, no trecho de 10 km cada.

Duas configurações híbridas foram simuladas: a primeira, com 34 km de fibra SMF no primeiro trecho, e outra com 17 km adicionais de fibra DCF no segundo trecho; a segunda configuração utilizando utiliza um trecho de fibra DCF com 10 km de comprimento, à frente de um trecho de fibra SMF, também com 10 km.

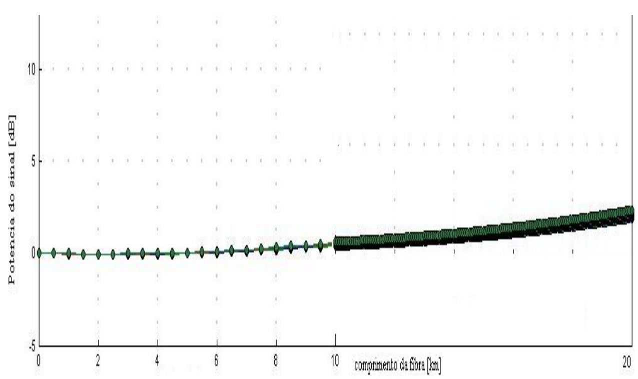

FIGURA 4
VARIAÇÃO DO SINAL DE ENTRADA NA FIBRA AO LONGO DO ENLACE DE 20 KM; ORDEM DA CONFIGURAÇÃO DCF NA FRENTE DA SMF.

Os parâmetros estabelecidos para as simulações são mostrados nas tabelas I e II.

TABELA I
PARÂMETROS UTILIZADOS NA PRIMEIRA CONFIGURAÇÃO

	α_s	L
Primeira fibra SMF	0,2	34 km
Segunda fibra DCF	0,3	17 km

TABELA II
PARÂMETROS UTILIZADOS NA SEGUNDA CONFIGURAÇÃO

	α_s	L
Primeira fibra DCF	0,3	10 km
Segunda fibra SMF	0,2	10 km

Os valores de bombeio utilizados foram de 20,4 dBm para as duas configurações.

O coeficiente α_s adotado para a fibra DCF é de 0,26, e para a fibra SMF, é 0,20.

Os resultados ficaram muito próximos dos obtidos por Okuno em seu trabalho de 2001 [3].

A figura 3 mostra que a variação do sinal, para um enlace híbrido de aproximadamente 50 km, tem variação máxima de cerca de 5 dB.

Na figura 4, com a sugestão dada por Okuno de se utilizar a fibra DCF à frente da SMF, e para um enlace de 20 km, o amplificador Raman praticamente eliminou as perdas do sistema: a variação do sinal ficou abaixo de 2 dB.

Os resultados experimentais simulados com o software VPI mostram concordância com os valores calculados e simulados por Okuno e colaboradores.

CONCLUSÕES

Uma nova configuração híbrida de fibras ópticas foi analisada por meio de simulação utilizando o software VPI. O sistema utilizou um laser de bombeio para originar o DRA, com o esquema de bombeamento reverso. Os valores obtidos indicam que a perda de energia do sinal pode ser confinada para valores menores que 2 dB, em enlaces de até 20 km de extensão, ou para menos que 5 dB, em enlaces de até 51 km.

Os resultados experimentais validam o uso da configuração para compensar perdas nas fibras e uso adequado em sistemas práticos.

Com as ferramentas do software VPI, específicas para comunicações ópticas, foi possível medir todas as variações dos sinais internamente às fibras dos enlaces, e observar o comportamento de suas possíveis interações. A utilização do software tornou o experimento mais rápido e confiável, pois o método de cálculo numérico utilizado por ele, “split-step Fourier” está sendo amplamente usado em implementações similares. Com os resultados obtidos através do VPI temos segurança em propor a configuração para implementação prática para a diminuição das perdas em sistemas de grande capacidade.

O software VPI tem enorme potencial para o ensino, e pesquisa na área de sistemas comunicações ópticas.

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A Mídia Eletrônica e as Comunidades Virtuais como Fonte e Manifestação de Conhecimento

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Resumo: O desenvolvimento das novas tecnologias de informação trouxe novos horizontes e desafios para a educação. Assim, faz-se necessário refletir sobre a melhor forma de incorporá-las ao processo de ensino-aprendizagam. Nesse contexto, parece auspicioso discutir quais as metodologias capazes de levar adiante a alfabetização nas linguagens visuais e prover os cidadãos de novos saberes e competências.

Palavras-chave: educação, computação, revolução tecnológica.

O Olhar Questionador

Como sustenta o jornalista e historiador José Arbex Jr., a Guerra do Golfo (janeiro/ fevereiro de 1991) pode ser tomada como o ponto de partida para compreender, com mais nitidez, o poder da mídia no mundo contemporâneo. De fato, a cobertura jornalística desse conflito consolidou um novo paradigma. Em outras palavras, demonstrou, por um lado, que as novas tecnologias de comunicação permitem o registro de eventos, em qualquer parte do planeta e, concomitantemente, a sua imediata retransmissão em tempo real e, por outro, que as fontes de saber e informação estão passando por um momento de grandes e aceleradas transformações. A utilização das mídias eletrônicas com o objetivo de criar, induzir e manipular fatos coloca uma série de novas questões para os educadores e todos os profissionais, cujas atividades estão, direta ou indiretamente, relacionados a compreensão e operacionallização das complexidades do mundo contemporâneo.

O maior desafio para Douglas Kellner, cujas idéias são fundamentais para discutir as questões relacionadas acima, é estar preparado para a emergência das alfabetizações e das inteligências múltiplas[1]. Os educadores, em geral, necessitam interpretar criticamente as construções e as linguagens elaboradas pela mídia, lançar mão da internet, de filmes e telejornais - que desempenham papel central na forma como as crianças e os jovens concebem e interpretam o mundo. Essas questões são especialmente relevantes, pois os produtos da mídia são empregados cotidianamente nas escolas e, na maioria das vezes, como simples ilustrações, portadoras de verdades inquestionáveis. As manipulações e as distorções são ignoradas ou colocadas num plano secundário. Tal fato se deve, em grande medida, à carência de instrumentais teóricos e práticos para uma leitura critica das mídias.

Esse trabalho visa contribuir para o exercício do olhar questionador e, conseqüentemente, propiciar uma reflexão sobre o papel e o lugar da mídia no processo de conhecimento. Tal reflexão se dará por meio da experiência adquirida pelo seu autor como coordenador do módulo: **Mídia na Escola,** do projeto Educar 2002, levado a cabo pela Cidade do Conhecimento, no Instituto de Estudos Avançados (IEA) da Universidade de São Paulo.

O programa **Educar** na Sociedade da Informação é a principal via de acesso à Cidade do Conhecimento da USP para professores e outros profissionais do ensino médio e fundamental. O programa inclui ciclos de palestras, visitas, trabalhos de campo e atividades *online* em comunidades virtuais. Mais que um curso de atualização com pesquisadores de destaque da USP e de outras organizações, é um espaço para a formação de redes de contatos com profissionais que lideram iniciativas educacionais, projetos de pesquisa e ações sociais fazendo uso inteligente das novas tecnologias de informação e comunicação.

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[1] As hipóteses do autor em questão podem ser encontradas na seguinte obra: KELLNER, Douglas- **A Cultura da Mídia.** SP: EDUSC, 2001.

A Revolução da Informação

Em **Ética e Poder na Sociedade da Informação**, Gilberto Dupas discute como a autonomia das novas tecnologias obriga a rever o mito do progresso. A hipótese central está formulada nitidamente no primeiro capítulo: "Apesar de ter sido um período de excepcionais conquistas da ciência, o século XX não terminou bem. O mundo capitalista viu-se novamente às voltas com problemas que parecia ter eliminado: desemprego, depressões cíclicas, população indigente em meio a um luxo abundante e o Estado em crise". As luzes não se irradiaram pela sociedade de forma harmoniosa e justa. A humanidade acabou submetida às engrenagens de um darwinismo econômico que hoje se chama "globalização financeira". O progresso se alimenta do atraso e da riqueza do Centro que cresce com a pobreza da Periferia. O autor retrata vários desdobramentos desse contraste e propõe uma saída: a ética da responsabilidade[2]. A questão ética, colocada em relevo por Gilberto Dupas, está diretamente relacionada à necessidade de expandir para milhões de pessoas o acesso às informações e aos conhecimentos que podem ser coletados no ciberespaço.

Como sustenta o cientista político norte-americano Joseph S. Nye Jr., a característica fundamental da revolução da informação não é a velocidade da comunicação entre ricos e poderosos: há mais de 130 anos que a comunicação instantânea entre a Europa e a América do Norte é possível. A mudança decisiva está na enorme redução do custo da transmissão da informação. O atual custo de transmissão da informação tornou-se insignificante para a totalidade dos fins práticos; portanto, a quantidade de informação que se pode transmitir em todo o planeta é de fato infinita[3].

A atual revolução da informação baseia-se nos rápidos avanços tecnológicos do computador, das comunicações e do *software* que, por sua vez conduziram a extraordinárias reduções no custo do processamento e da transmissão da informação. Como demonstra Nye Jr., o preço de um computador novo vem caindo em aproximadamente um quinto por ano desde 1954. Nos Estados Unidos, por exemplo, os novos investimentos em tecnologias de informação elevaram-se de 7% a quase 50%. Nos últimos trinta anos, o poder da rede de computação tem dobrado a cada dezoito meses e ainda mais rapidamente nos últimos anos, e hoje isso custa menos de 1% do que custava no início da década de 1970. Se o preço dos automóveis tivesse baixado tão depressa quanto o dos semicondutores, um carro estaria custando cinco dólares[4].

Há alguns anos que o tráfego na internet dobra de cem em cem dias. Em 1993, havia cerca de cinqüenta *websites* no mundo, no fim do decênio, esse número já ultrapassava os cinco milhões. As larguras das bandas de comunicação estão se expandindo velozmente, e os custos continuam caindo mais depressa que os do poder de computação. Ainda recentemente, em 1980, os telefonemas por fio de cobre transportavam somente uma página de informação por segundo; hoje em dia, um finíssimo cabo de fibra óptica é capaz de transmitir noventa mil volumes por segundo. Em dólares de 1990, o custo de uma chamada transatlântica de três minutos caiu de 250, em 1930, para bem menos que um dólar no fim do século[5].

Nesse cenário, se for levado em consideração tanto o paradigma da velocidade, no qual pode-se detectar que apenas uma pequena parcela da humanidade está a 120km/h e a imensa maioria está a 5 km/h, como a hipótese da redução acelerada dos custos da transmissão da informação, cuja realidade é a constatação de que a redução propalada tem beneficiado a mesma diminuta parte e, simultaneamente, excluído milhões de pessoas.

Essa dupla constatação remete à seguinte questão central: passamos por uma revolução tecnológica que tem no seu centro o computador, a informação, a comunicação e as tecnologias multimídias. Os indicam mais confiáveis sugerem que não estamos suficientemente preparados para aproveitar o rico potencial regenerador que tal revolução propicia,

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2 Ver: DUPAS, Gilberto-**Ética e Poder na sociedade da Informação.** SP: Ed. UNESP, 2001.

3 In: NYE Jr., Joseph S.- **O Paradoxo do Poder Americano.** SP: Ed UNESP, 2002, p.86.

4 Em 1980, um gigabyte de armazenamento ocupava o espaço equivalente ao de uma sala; atualmente, cabe num dispositivo do tamanho de um cartão de crédito e pode ser levado no bolso. Sobre esse assunto ver: NYE Jr, JOSEPH S- O paradoxo do poder americano. SP: UNESP, p.86.

5 NYE Jr., Joseph S. **O Paradoxo do poder americano**. SP: UNESP, p.85.

principalmente quando o campo em questão é o educacional.

De fato, a revolução tecnológica em curso traz novos e instigantes desafios. Cabe destacar, em especial, a necessidade de prover tanto as crianças, como os adultos com as ferramentas e as competências que abram as portas para a participação ativa no século XXI. Pois, as exigências históricas, afloradas principalmente pelo processo de globalização, impõem a existência de cidadãos informados e ativos. A rigor, é mister sublinhar, a revolução me questão, torna indispensável a reestruturação do sistema educacional que predominou nos últimos dois séculos.

Por uma teoria crítica da tecnologia

O filósofo Douglas Kellner, tem razão quando sustenta que nesse tempo de rápidas e profundas mudanças é necessário enfrentar o desafio da experimentação. Em outras palavras, urge questionar as práticas existentes, os sistemas pedagógicos e as filosofias educacionais e de construir novas formas. Nesse cenário, cabe testar o que funciona e o que não funciona no novo milênio. É tempo de refletir sobre metas e, ao mesmo tempo, discernir o que queremos alcançar com a educação. Mas, de forma aparentemente contraditória, é também a época de voltar à filosofia da educação clássica que insere as reflexões sobre a educação nas reflexões sobre a vida e a sociedade e, concomitantemente, refletir sobre como podemos transformar a educação no dispositivo central da sociedade contemporânea.[6]

Nesse contexto, dois grupos estão em litígio: os tecnofóbicos que têm como premissa à oposição às novas tecnologias e os apologistas que, por sua vez, pregam que às novas tecnologias são as caixas de pandora do novo milênio. Nesse cenário bipolarizado, a virtude, tudo indica, está na terceira via, isto é, sustentar que a tarefa prioritária é a investigação sobre as possibilidades e os limites das novas o desenvolvimento das tecnologias. Seguindo tal pressuposto, deve-se rejeitar o exagero e as pretensões das novas tecnologias, pois vê as limitações das propostas pedagógicas e educativas baseadas primeiramente na tecnologia sem ênfase adequada no pedagógico, no professor e no fortalecimento do estudante.

A alfabetização crítica da mídia deve ser um projeto pedagógico que tem como premissas fundamentais a participação e o trabalho em conjunto. Assistir a programas de televisão ou a filmes em grupo, promover discussões produtivas entre professores e alunos, com ênfase no ato de trazer à tona as visões que os estudantes sistematizam, ou seja, permitir variadas interpretações dos textos midiáticos. Assim, como urge formar comunidades virtuais e grupos de discussão. De fato, parece nítido, que tanto as crianças como os jovens conhecem mais a cultura midiática do que seus professores[7]. Dessa forma, as atividades pedagógicas, acima descritas, poderão trazer contribuições significativas para o processo de ensino-aprendizagem e, concomitantemente, iniciar a alfabetização nas linguagens visuais: “Para desenvolver a alfabetização midiática, é preciso desenvolver a sensibilidade à imagística visual, ao som e ao discurso, bem como quanto à estrutura narrativa e aos significados e efeito de texto. Desse modo, recorre-se à estática desenvolvida em literatura, filme, vídeo e em estudos de arte, combinando tal material ao se referir a especificidades do texto particular ou de artefato em questão”.[8]

A partir dessa perspectiva, a alfabetização em informática deve ser orientada e conduzida de forma global e total. Aprender como usar computadores, acessar informações e material educativo, usar correio eletrônico e, até a construção de *websites,* o acesso e o processamento de diversos tipos de informações que, embora, abundantes na “sociedade de informação”, ficam restritos a um número reduzido de privilegiados. Em outras palavras, a alfabetização em questão, inclui a informação de como encontrar fontes de informação desde locais tradicionais, como: as bibliotecas, a mídia impressa, os novos *websites* de internet e os mecanismos de busca. Assim como, envolve aprender onde encontrar a informação, como acessá-la e como organizar, interpretar e avaliar a informação que se procura.

[6] KELLNER, Douglas- “Novas tecnologias: novas alfabetizações. Centro Universitário Sul de Minas, p.05.

[7] Idem, ibidem.
[8] Idem, ibidem.

Mas, não basta o domínio eminentemente técnico. Nessa cultura multimídia computadorizada, a alfabetização visual passa a ocupar posição central na educação. Afinal, como sustenta o autor de **Cultura da Mídia,** as telas dos monitores são mais gráficas, visuais e interativas do que os campos impressos convecionais. Tais fatos confundem os cidadãos, quando esses são confrontados com novos ambientes da *web*, isto é: ícones, janelas, mouses e os vários comandos, conexões e interações presentes na linguagem do hipertexto e mediados pelo computador; fenômenos que ditam novas competências e exigem uma dramática expansão da nova alfabetização. A rigor, postula-se a alfabetização múltipla, ou seja, as alfabetizações necessárias para acessar, interpretar, criticar e participar das novas formas emergentes de cultura e sociedade. As multialfabetizações e as novas pedagogias devem tornar-se reflexivas e críticas e, dessa forma, discuti, a natureza e efeitos das novas tecnologias e sistemas pedagógicos, sem fazer tabula rasa, como foi discutido ao longo desse trabalho, da revolução tecnológica.

O ENGENHEIRO COMO UM "NÓ" NA TEORIA DAS REDES INSERIDO NO MERCADO DE TRABALHO GLOBAL

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***Resumo**: A reestruturação produtiva desenha atribuições profissionais diferenciadas para o engenheiro pleno, levando-o a atuar de forma estratégica nas empresas, atendendo às demandas do mercado de trabalho global, com foco na qualidade agregada à produção e em especial ao meio ambiente. Esse profissional atua com uma visão empreendedora e com características e habilidades complementares à sua formação plena acadêmica. Com perspectiva humanista sob ótica sistêmica, apresenta capacidade de relacionamento interpessoal e forte liderança, atuando em todos os segmentos dos processos produtivos e gerenciais das empresas, como um verdadeiro "nó" de uma rede, ratificando a Teoria de Callon. O presente artigo pretende investigar a convergência dessas competências e atribuições, sugerindo metodologias no processo de ensino-aprendizagem desses profissionais de engenharia, de forma aprimorar as discussões em sala de aulas.*

Palavras-chave: Empreendedorismo, Gestão; Metodologia

Introdução

Face às novas diretrizes da economia mundial, as empresas passam pela necessidade de expandir e aprimorar seus negócios e primordialmente seus métodos e processos produtivos, inovando cada vez mais, para que possam garantir seus mercados, priorizando a qualidade de seus produtos e serviços, com desenvolvimento sustentável, isto é, preservando o meio ambiente para gerações futuras. Desta forma, procura criar e adequar novos postos de trabalho, com objetivo de se obter mais qualidade e vantagem competitiva.

Em busca desta modernização e flexibilização de seus pátios de produção, as empresas investem no aperfeiçoamento de sua mão de obra, principalmente aquela responsável pela sistematização de seus processos produtivos, criando e remodelando equipamentos de forma aumentar a produção e os lucros das empresas, alicerçando, cada vez mais, as estruturas de seus negócios. Nesse contexto prima-se pela necessidade de formação de um profissional que atue como um verdadeiro "nó" de uma rede produtiva nas empresas, atento à questões ambientais. Esse profissional além de suas atribuições técnicas, deve ter uma visão empreendedora, ampliando desta forma as competências de sua formação tradicional.

Este profissional com habilidades próprias às demandas de mercado organiza tática e estrategicamente as metas a serem alcançadas pela filosofia da empresa, apóia-se na ciência e na tecnologia conduzindo os trabalhos como um líder eficaz, capaz de motivar seus subordinados, unindo todos os departamentos e setores de trabalho, objetivando melhorias contínuas dos resultados atingidos nos processos produtivos de forma sustentável, preservando as características originais do meio ambiente.

Assim, para formação desse engenheiro, propõe-se aprimorar as discussões em sala de aulas, sugerindo metodologias capazes de integrar seu mundo de trabalho ao ensino-aprendizagem no processo de sua formação acadêmica.

"A Atuação do Engenheiro como um Nó de uma Rede Produtiva"

As empresas buscam obter vantagem competitiva obrigando-se a atender aspectos qualitativos promovendo inovações de seus processos produtivos e formas de trabalho. Para isso exigem velocidade em sua atuação, custos competitivos e ainda a satisfação de seus investidores e clientes, tanto internos como externos, tendo como prioridade a vantagem competitiva aliada à conservação ambiental; até porque, o atendimento à ISO 14000 é priorizada como diferencial entre as empresas.

Cabe ao engenheiro que lida com essas expectativas, atuar de forma sistêmica para atendimento às demandas e necessidades de mercado, administrando recursos materiais e humanos para realização dessas tarefas. Os

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movimentos ambientalistas, em contraste, historicamente têm apresentado discussões para participar da administração dos negócios. Estes movimentos procuram soluções para evitar resíduos tóxicos; promovem a utilização racional e eficiente dos recursos naturais, nem sempre maximizando os lucros em curto prazo às empresas, porém de conseqüências fundamentais à qualidade de vida do homem. Segundo Marsh [5] os efeitos negativos não planejados das atividades econômicas humanas no ambiente são sempre maiores que os benefícios. Por exemplo, há ligações entre a derrubada de florestas e a erosão dos solos e entre a drenagem de pântanos e lagos e o declínio da vida animal. Neste contexto apresenta-se o engenheiro como um "nó" de uma rede de trabalho, produzindo sob constante pressão, exercitando suas habilidades em questões de conflitos, que, bem gerenciadas, possibilita o sucesso de sua empresa e conseqüentemente sua progressão profissional.

Bruno [2] ratifica essa pressão emocional em que esses profissionais trabalham em atendimento a cumprimento de prazos de seus projetos, agindo como um condutor de negócios, envolvido em questões próprias de um empreendedor, comprometido com o desenvolvimento e desempenho das atividades das empresas, conflitando muitas vezes com interesses pessoais e sociais.

"Os engenheiros[...]quanto às condições sob as quais trabalham, estas se caracterizam por grande carga de tensão, em cumprimento de prazos cada vez mais curtos para concepção e execução de projetos... "[2].

O engenheiro deve possuir ampla visão técnica e gerencial da produção, envolvido diretamente com a estratégia, qualidade e gestão dos negócios da organização.

Embora esse profissional tenha sua atuação focada em conhecimentos técnicos específicos, como gestor ele atua nas questões ambientais agregadas aos mecanismos de atualização de tecnologia, apropriados à qualidade, pois o uso inadequado dessas tecnologias implica, muitas vezes, em desperdícios às indústrias, à natureza e à própria sociedade.

Sem gestão dos processos produtivos e de controle do meio ambiente, danos irreparáveis à natureza podem ocorrer, em prejuízo aos ecossistemas e à sobrevivência humana. Assim, esses engenheiros trabalham com conhecimentos que envolvem novas tecnologias, conduzindo essas inovações à melhor aplicação na produção, qualificando seus subordinados em seu próprio posto de trabalho, conduzindo-os ao aperfeiçoamento profissional, com objetivo de mantê-los em seus próprios postos de trabalho. Cabe aplicar essas tecnologias, de forma gradual e consciente, de forma reduzir os impactos ambientais a natureza.

Assim, quando de uma nova aquisição tecnológica, a participação desse engenheiro é fundamental, pois com seus conhecimentos técnicos possibilita a adequação de custos e benefícios que esse novo produto de investimento possa proporcionar a curto, médio e longo prazos, tomando assim a melhor decisão para aplicação dos recursos destinados a esses novos projetos de desenvolvimento, para crescimento econômico e competitividade das empresas no mercado de trabalho.

Anderson [1] já apontava que o engenheiro estendia seu campo de atividade, incluindo nele relações humanas e gerenciais em geral, eles se têm inclinado a ampliar o título de engenheiro para cobrir suas atividades, quaisquer que elas possam ser.

Com a reestruturação produtiva, esse engenheiro apresenta-se como um agente de mudanças para a organização, transformando as relações de trabalho puramente técnicas em relações complementares administrativas, assumindo o papel, muitas vezes, central de gestão, com total ampliação de suas funções profissionais, liderando e motivando sua equipe, aproximando as estruturas hierárquicas em seu ambiente de trabalho, comprometendo-se sistematicamente com a produção, objetivando organizar a rede por ele coordenada. Esse profissional tem informações globalizadas, que o coloca integrado ao seu mercado e a sua equipe produtiva, como já citamos, como um verdadeiro "nó" de uma rede, devendo tomar decisões acertadas, para melhor desempenho de seus projetos, sempre buscando a qualidade, a preservação ambiental e, conseqüentemente, a vantagem competitiva.

Callon [3], cientista proeminente do Centro de Estudos da Inovação de Paris, um dos mais renomados pesquisadores da sociologia da ciência e da tecnologia, defende a "teoria das redes", com vistas ao entendimento dos sistemas laboratoriais que conduzem ao desenvolvimento de inovações.

Segundo Callon, o sucesso ou o insucesso das instituições que trabalham com C&T está diretamente ligado à compreensão das chamadas redes. Para ele, os chamados porta-vozes (*porteparoles*) de sistemas que atuam na organização, são elementos fundamentais para funcionamento de um laboratório ou instituição dessa natureza, podendo ser humanos ou não humanos, porém plenamente operantes em sua atuação, para sucesso da pesquisa.

"Na minha visão, de nada adianta se dispor de um grupo de renomados doutores, detentores de Prêmios Nobel, se a rede que opera o laboratório tem um ou mais porta-

vozes inoperantes. Dessa forma, o sucesso das organizações que atuam em C&T está na estrita dependência da adequada coordenação de todos esses elementos da rede".[3]

Portanto, a chamada *Teoria das Redes* que serve para ampliar o entendimento sobre o atual desempenho do pesquisador, clarifica, em certa medida, a figura do engenheiro pleno.

"Muito embora a teoria de Callon tenha sido desenvolvida com vistas ao entendimento dos sistemas laboratoriais que conduzem ao desenvolvimento de inovações, seus princípios têm sido hoje em dia muito usados em analogias a outras atividades que envolvem parceiros em atividades simultâneas em uma mesma organização ou em redes de organizações atuando em parcerias".[6]

O engenheiro faz parte dessa rede, surgindo como agente empreendedor e de mudanças, pois trabalha no limite de suas atribuições técnicas, de gestão ambiental e de negócios, com vistas à qualidade e competitividade estratégica. Atua com propriedade em conflitos sociais e humanos na empresa, conforme ratificado por [4].

"[...] Além do saber técnico-científico necessário à realização industrial, os engenheiros podem intervir com maior propriedade nos conflitos das relações sociais no trabalho, quanto à harmonia dos procedimentos e atitudes do trabalhador" [4]

Este profissional possui raciocínio abstrato, buscando caminhos alternativos não puramente cartesianos ou matemáticos para resolução de suas tarefas, com ótica humanista, não discriminando raças, crenças e valores, podendo assim, organizar e planejar a diversidade de seus clientes. Envolve-se de forma sistêmica em seu trabalho, conhecendo todos os processos de fabricação, possibilitando a dinamização da produção sem prejuízo para a natureza. Por ser criativo, possui uma incrível capacidade de trabalhar equipe, coordenando todos os projetos da empresa.

Robert L. Swiggett, presidente da Kollmorgen Corporation, *apud* [5] diz que *"a função do líder é criar uma visão"*, palavra, até poucos anos, não ouvida entre os gestores. Hoje se sabe que ter uma visão do futuro, sem prejuízos produtivos e também ambientais, é atitude essencial do engenheiro uma postura de liderança agregada aos conhecimentos técnicos adquiridos, além de muita motivação no trabalho, que aliadas ao bom relacionamento interpessoal, constrói-se uma rede produtiva de primordial importância para a empresa.

Visão é sinônimo de negócios, é uma imagem mental de um futuro possível e desejável para uma organização. Atuando como líderes, esses engenheiros imaginam o ideal de futuro para as suas organizações, criando alternativas diferentes do que os outros possam ter considerado como única estratégia ou solução possível. Lutam incessantemente para concretizar realizações importantes que outros não conseguiriam. Procuram olhar à frente e em todas as direções para atingir seus objetivos. Essa visão está centrada na natureza que não deve ser subjugada e sim conservada não apenas para a utilização econômica, mas também por ela própria, isto é, pelo que as pessoas possam aprender com ela.

"Metodologias em Sala de Aulas de Engenharia"

Devido às ampliações nas atribuições profissionais dos engenheiros plenos exigidos pelas empresas no mercado de trabalho globalizado, pode-se constatar a necessidade de aprimorar sua formação acadêmica tradicional, focando o empreendedorismo como condição essencial de sobrevivência em seu mundo de trabalho. Esse aprimoramento envolve dinâmicas em sala de aulas, de forma a criar simulações de situações reais cotidianas vivenciadas em uma empresa; discutindo-se os problemas apresentados e debatendo-os, em busca de soluções ideais ou, muitas vezes, a única possível para sua resolução. Estabelecem-se relações com e entre situações, fenômenos e pessoas, contextualizando *teorias, leis e experiências pessoais*, complementando suas competências e habilidades. Essa simulação mostra a participação do aluno em uma rede produtiva, conduzindo-o a agir de forma construtiva e empreendedora. Essa experiência em sala de aulas induz à reflexão dos problemas e suas alternativas de soluções no processo de trabalho, com ênfase no desenvolvimento sustentável, ligadas a questões ambientais, em conformidade com a ISO 14000, as quais exigem atenções redobradas de seus gestores, pois um erro operacional pode resultar em prejuízos irreparáveis à natureza. Essas dinâmicas devem ser ministradas em disciplinas, tanto técnicas como de ênfase em gestão nos cursos de formação plena, preparando conscientemente o profissional demandado no presente.

Conclusão

O engenheiro atua como um "nó" de uma rede produtiva assumindo os mais abrangentes compromissos em seu mundo do trabalho, agregando-se diretamente à suas tarefas tradicionalmente atribuídas em sua função técnica tradicional, justamente por trabalhar suas habilidades e competências, através de experiências e simulações vivenciadas em sala de aulas. Essas situações, uma vez encontradas em seu mundo de trabalho, tornam-se menos impactativas à sua atuação profissional. Esse profissional direciona suas atividades profissionais como um empreendedor e principalmente como um prestador de serviços às questões ambientais. Atuação esta, que pode diferenciar as lideranças das empresas, promovendo sobrevivência e vantagem competitiva em seus mercados de atuação.

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O ENGENHEIRO COMO UM "NÓ" NA TEORIA DAS REDES INSERIDO NO MERCADO DE TRABALHO GLOBAL

Carlos Roberto Jóia Hozumi[1] , Vânia Maria Rocha Gomes Hozumi[2]
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***Resumo**: A reestruturação produtiva desenha atribuições profissionais diferenciadas para o engenheiro pleno, levando-o a atuar de forma estratégica nas empresas, atendendo às demandas do mercado de trabalho global, com foco na qualidade agregada à produção e em especial ao meio ambiente. Esse profissional atua com uma visão empreendedora e com características e habilidades complementares à sua formação plena acadêmica. Com perspectiva humanista sob ótica sistêmica, apresenta capacidade de relacionamento interpessoal e forte liderança, atuando em todos os segmentos dos processos produtivos e gerenciais das empresas, como um verdadeiro "nó" de uma rede, ratificando a Teoria de Callon. O presente artigo pretende investigar a convergência dessas competências e atribuições, sugerindo metodologias no processo de ensino-aprendizagem desses profissionais de engenharia, de forma aprimorar as discussões em sala de aulas.*

Palavras-chave: Empreendedorismo, Gestão; Metodologia

Introdução

Face às novas diretrizes da economia mundial, as empresas passam pela necessidade de expandir e aprimorar seus negócios e primordialmente seus métodos e processos produtivos, inovando cada vez mais, para que possam garantir seus mercados, priorizando a qualidade de seus produtos e serviços, com desenvolvimento sustentável, isto é, preservando o meio ambiente para gerações futuras. Desta forma, procura criar e adequar novos postos de trabalho, com objetivo de se obter mais qualidade e vantagem competitiva.

Em busca desta modernização e flexibilização de seus pátios de produção, as empresas investem no aperfeiçoamento de sua mão de obra, principalmente aquela responsável pela sistematização de seus processos produtivos, criando e remodelando equipamentos de forma aumentar a produção e os lucros das empresas, alicerçando, cada vez mais, as estruturas de seus negócios. Nesse contexto prima-se pela necessidade de formação de um profissional que atue como um verdadeiro "nó" de uma rede produtiva nas empresas, atento à questões ambientais. Esse profissional além de suas atribuições técnicas, deve ter uma visão empreendedora, ampliando desta forma as competências de sua formação tradicional.

Este profissional com habilidades próprias às demandas de mercado organiza tática e estrategicamente as metas a serem alcançadas pela filosofia da empresa, apóia-se na ciência e na tecnologia conduzindo os trabalhos como um líder eficaz, capaz de motivar seus subordinados, unindo todos os departamentos e setores de trabalho, objetivando melhorias contínuas dos resultados atingidos nos processos produtivos de forma sustentável, preservando as características originais do meio ambiente.

Assim, para formação desse engenheiro, propõe-se aprimorar as discussões em sala de aulas, sugerindo metodologias capazes de integrar seu mundo de trabalho ao ensino-aprendizagem no processo de sua formação acadêmica.

"A Atuação do Engenheiro como um Nó de uma Rede Produtiva"

As empresas buscam obter vantagem competitiva obrigando-se a atender aspectos qualitativos promovendo inovações de seus processos produtivos e formas de trabalho. Para isso exigem velocidade em sua atuação, custos competitivos e ainda a satisfação de seus investidores e clientes, tanto internos como externos, tendo como prioridade a vantagem competitiva aliada à conservação ambiental; até porque, o atendimento à ISO 14000 é priorizada como diferencial entre as empresas.

Cabe ao engenheiro que lida com essas expectativas, atuar de forma sistêmica para atendimento às demandas e necessidades de mercado, administrando recursos materiais e humanos para realização dessas tarefas. Os

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movimentos ambientalistas, em contraste, historicamente têm apresentado discussões para participar da administração dos negócios. Estes movimentos procuram soluções para evitar resíduos tóxicos; promovem a utilização racional e eficiente dos recursos naturais, nem sempre maximizando os lucros em curto prazo às empresas, porém de conseqüências fundamentais à qualidade de vida do homem. Segundo Marsh [5] os efeitos negativos não planejados das atividades econômicas humanas no ambiente são sempre maiores que os benefícios. Por exemplo, há ligações entre a derrubada de florestas e a erosão dos solos e entre a drenagem de pântanos e lagos e o declínio da vida animal. Neste contexto apresenta-se o engenheiro como um "nó" de uma rede de trabalho, produzindo sob constante pressão, exercitando suas habilidades em questões de conflitos, que, bem gerenciadas, possibilita o sucesso de sua empresa e conseqüentemente sua progressão profissional.

Bruno [2] ratifica essa pressão emocional em que esses profissionais trabalham em atendimento a cumprimento de prazos de seus projetos, agindo como um condutor de negócios, envolvido em questões próprias de um empreendedor, comprometido com o desenvolvimento e desempenho das atividades das empresas, conflitando muitas vezes com interesses pessoais e sociais.

"Os engenheiros[...]quanto às condições sob as quais trabalham, estas se caracterizam por grande carga de tensão, em cumprimento de prazos cada vez mais curtos para concepção e execução de projetos... "[2].

O engenheiro deve possuir ampla visão técnica e gerencial da produção, envolvido diretamente com a estratégia, qualidade e gestão dos negócios da organização.

Embora esse profissional tenha sua atuação focada em conhecimentos técnicos específicos, como gestor ele atua nas questões ambientais agregadas aos mecanismos de atualização de tecnologia, apropriados à qualidade, pois o uso inadequado dessas tecnologias implica, muitas vezes, em desperdícios às indústrias, à natureza e à própria sociedade.

Sem gestão dos processos produtivos e de controle do meio ambiente, danos irreparáveis à natureza podem ocorrer, em prejuízo aos ecossistemas e à sobrevivência humana. Assim, esses engenheiros trabalham com conhecimentos que envolvem novas tecnologias, conduzindo essas inovações à melhor aplicação na produção, qualificando seus subordinados em seu próprio posto de trabalho, conduzindo-os ao aperfeiçoamento profissional, com objetivo de mantê-los em seus próprios postos de trabalho. Cabe aplicar essas tecnologias, de forma gradual e consciente, de forma reduzir os impactos ambientais a natureza.

Assim, quando de uma nova aquisição tecnológica, a participação desse engenheiro é fundamental, pois com seus conhecimentos técnicos possibilita a adequação de custos e benefícios que esse novo produto de investimento possa proporcionar a curto, médio e longo prazos, tomando assim a melhor decisão para aplicação dos recursos destinados a esses novos projetos de desenvolvimento, para crescimento econômico e competitividade das empresas no mercado de trabalho.

Anderson [1] já apontava que o engenheiro estendia seu campo de atividade, incluindo nele relações humanas e gerenciais em geral, eles se têm inclinado a ampliar o título de engenheiro para cobrir suas atividades, quaisquer que elas possam ser.

Com a reestruturação produtiva, esse engenheiro apresenta-se como um agente de mudanças para a organização, transformando as relações de trabalho puramente técnicas em relações complementares administrativas, assumindo o papel, muitas vezes, central de gestão, com total ampliação de suas funções profissionais, liderando e motivando sua equipe, aproximando as estruturas hierárquicas em seu ambiente de trabalho, comprometendo-se sistematicamente com a produção, objetivando organizar a rede por ele coordenada. Esse profissional tem informações globalizadas, que o coloca integrado ao seu mercado e a sua equipe produtiva, como já citamos, como um verdadeiro "nó" de uma rede, devendo tomar decisões acertadas, para melhor desempenho de seus projetos, sempre buscando a qualidade, a preservação ambiental e, conseqüentemente, a vantagem competitiva.

Callon [3], cientista proeminente do Centro de Estudos da Inovação de Paris, um dos mais renomados pesquisadores da sociologia da ciência e da tecnologia, defende a "teoria das redes", com vistas ao entendimento dos sistemas laboratoriais que conduzem ao desenvolvimento de inovações.

Segundo Callon, o sucesso ou o insucesso das instituições que trabalham com C&T está diretamente ligado à compreensão das chamadas redes. Para ele, os chamados porta-vozes (*porteparoles*) de sistemas que atuam na organização, são elementos fundamentais para funcionamento de um laboratório ou instituição dessa natureza, podendo ser humanos ou não humanos, porém plenamente operantes em sua atuação, para sucesso da pesquisa.

"Na minha visão, de nada adianta se dispor de um grupo de renomados doutores, detentores de Prêmios Nobel, se a rede que opera o laboratório tem um ou mais porta-

vozes inoperantes. Dessa forma, o sucesso das organizações que atuam em C&T está na estrita dependência da adequada coordenação de todos esses elementos da rede".[3]

Portanto, a chamada *Teoria das Redes* que serve para ampliar o entendimento sobre o atual desempenho do pesquisador, clarifica, em certa medida, a figura do engenheiro pleno.

"Muito embora a teoria de Callon tenha sido desenvolvida com vistas ao entendimento dos sistemas laboratoriais que conduzem ao desenvolvimento de inovações, seus princípios têm sido hoje em dia muito usados em analogias a outras atividades que envolvem parceiros em atividades simultâneas em uma mesma organização ou em redes de organizações atuando em parcerias".[6]

O engenheiro faz parte dessa rede, surgindo como agente empreendedor e de mudanças, pois trabalha no limite de suas atribuições técnicas, de gestão ambiental e de negócios, com vistas à qualidade e competitividade estratégica. Atua com propriedade em conflitos sociais e humanos na empresa, conforme ratificado por [4].

"[...] Além do saber técnico-científico necessário à realização industrial, os engenheiros podem intervir com maior propriedade nos conflitos das relações sociais no trabalho, quanto à harmonia dos procedimentos e atitudes do trabalhador" [4]

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Conclusão

O engenheiro atua como um "nó" de uma rede produtiva assumindo os mais abrangentes compromissos em seu mundo do trabalho, agregando-se diretamente à suas tarefas tradicionalmente atribuídas em sua função técnica tradicional, justamente por trabalhar suas habilidades e competências, através de experiências e simulações vivenciadas em sala de aulas. Essas situações, uma vez encontradas em seu mundo de trabalho, tornam-se menos impactativas à sua atuação profissional. Esse profissional direciona suas atividades profissionais como um empreendedor e principalmente como um prestador de serviços às questões ambientais. Atuação esta, que pode diferenciar as lideranças das empresas, promovendo sobrevivência e vantagem competitiva em seus mercados de atuação.

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TENDÊNCIAS DO ENSINO DO DESENHO NOS CURSOS DE ENGENHARIA: INSERÇÃO DE MÉTODOS COMPUTACIONAIS

Carlos Roberto Jóia Hozumi[1], Vânia Maria Rocha Gomes Hozumi[2]

Resumo: *Com a velocidade das informações no mundo de trabalho dos engenheiros, tornam-se imprescindíveis ao exercício de suas funções profissionais, ferramentas computacionais auxiliando-os à construção técnica de máquinas e equipamentos necessários à cadeia produtiva. Sabido que, em sua formação acadêmica, o estudante de engenharia trabalha com desenho básico, desenho técnico, geometria descritiva e ainda desenho mecânico, faz-se necessário agregar aos seus estudos tradicionais o uso dessas ferramentas. As formas tradicionais de ensino / aprendizagem do desenho não encontram mais espaço em sala de aulas, fazendo com que professores e alunos convirjam para novos métodos e técnicas computacionais no desempenho de suas tarefas com aplicações práticas, dos trabalhos acadêmicos, atendendo ao mercado de trabalho. Esse artigo sugere metodologias para aplicação dessas tendências tecnológicas em sala de aulas, auxiliando professores e alunos no desenvolvimento de seus trabalhos.*

Palavras-chave: Computação, Ensino do Desenho, Metodologia.

Introdução

Participando de forma significativa de vários aspectos do desenvolvimento da sociedade humana, O desenho com suas especificidades próprias, torna-se a base ou até mesmo a matéria-prima para o desenvolvimento do trabalho humano.

Com esse conceito propõe-se contextualizar o Desenho e sua evolução histórica à Teoria do Conhecimento Humano, discutindo-se Desenho Linguagem e Ferramenta de Produção, como pressuposto da caracterização do Conhecimento Desenho.

Esse estudo aborda a aplicabilidade do Desenho em cursos de Engenharia, tornando-se ferramenta operativa e de projeto para condução do processo de transição prancheta/computador. Refletindo acerca do Desenho como desenvolvimento social, propõe-se contribuir para o despertar de uma relação de conhecimento com base na transdisciplinaridade, atentos a condições que favoreçam buscar novos conhecimentos.

Faz-se uma apresentação acadêmica e descontextualizada desses saberes técnico-semiológicos; conectando-os à um trabalho reflexivo e prático nos processos de comunicação geral, nas necessidades informacionais e representacionais particulares em situação de trabalho, propondo ao aluno de engenharia a construção de sua própria formação, mais completa e mais perceptiva em seu mundo do trabalho.

"O Desenho na Teoria do Conhecimento"

O *Desenho* participa de forma significativa de vários aspectos do desenvolvimento da sociedade humana. As especificidades próprias de sua natureza tornaram-se a "base" e até mesmo a "matéria prima" para o desenvolvimento de vários setores do trabalho. O *Desenho* ora se caracteriza como um "conhecimento" inerente à ciência, ora converte-se em uma tecnologia operacional, às vezes referenciado como uma própria manifestação de arte. Em todas as facetas expostas, fica, contudo, patente o forte componente de linguagem presente no *Desenho*. Reside nesta abrangência a face positiva deste ramo do conhecimento humano, porém contraditoriamente a amplitude gerada por esta situação dificulta o estabelecimento concreto do universo teórico - filósofo desta matéria.

As tentativas de analisar o panorama do *Desenho Moderno* dentro da complexidade do mundo das idéias no Século XX esbarram numa concepção difusa e simplista acerca do seu universo, onde predominam idéias antagônicas, advindas das reflexões efetivas através de um método de análise, o qual não se mostra capaz de evidenciar as definições, as delimitações e a compreensão deste universo. A isto, acrescenta-se o fato de o *Desenho Moderno* transitar num vasto campo que vai das ciências às artes, o que certamente dificulta ainda mais esta tarefa, tornando esta leitura fragmentada linear, dificultando, assim, a compreensão acerca da *Linguagem Desenho*, resultando em uma classificação, uma divisão e uma conceituação, as quais não reflete a natureza e a abrangência da matéria *Desenho.*

"O atual sistema de ensino e pesquisa da área da representação gráfica, ainda divide-se em Linguagem Instrumental das Técnicas de Representação Gráfica (Desenho Geométrico , Geometria Descritiva, Perspectiva e Sombra, Homologia) e Técnicas de Representação Gráfica (Desenho Técnico Mecânico, Elétrico e Civil, Desenho Arquitetônico, etc.). Esse sistema foi criado no final do século passado, para atender às necessidades da Era da Indústria, seguindo um procedimento metodológico coerente com os instrumentos e suportes gráficos tradicionais, não acompanhando, portanto, a evolução científica e tecnológica responsável pela reengenharia em todos os sistemas e organizações".[6]

Partindo do pressuposto de que o *Desenho*, no Século XXI, transita pelos universos da Arte, da Ciência e da Tecnologia, fez-se necessário um estudo acerca do *Desenho*, tomando como substrato de análise e Teoria Semiótica Pierciana. Buscando percorrer esta trilha, tenta-se percebê-lo enquanto significação, discutindo as tendências definidas pelos campos da estética, da epistemologia e da produção, evidenciando, desta maneira, o sentido da *Linguagem Desenho* no contexto da Teoria do Conhecimento Humano. Com esse propósito, contextualiza-se o que conota e o que denota o *Desenho* nos vários momentos históricos do Século XX.

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Desta forma, pode-se caracterizar na ciência, um conhecimento tão antigo quanto o homem, o Desenho, que carrega em si o elo capaz de exteriorizar idéias, que o homem foi sofisticado com o crescimento de seu potencial de pensar, de laborar e de realizar. Começa com a cinza, com um bastão, com um osso, riscando o chão, as paredes das cavernas, evoluindo para as cerâmicas, as tintas, as canetas sofisticadas. Hoje inserindo no processo digital.

A tecnologia do desenho teve grande apelo industrial no século XX que culminou com a imposição de uma cadeia produtiva cuja determinação de natureza funcional e morfológica que fosse capaz de permitir o estabelecimento de parâmetros de controle. Influenciado pela ideologia instituída, entre os séculos XVIII e XIX, pelo pensamento que notabilizou o movimento que chamamos hoje de Revolução Industrial, o *Desenho* enfrenta uma ruptura e passa a ser percebido pelo que pode ou não ser padronizado. Nesse movimento, está demarcada a fronteira entre as constituintes: produção artesanal e produção industrial.

A primeira, precedente à revolução industrial, notabilizou-se pelo domínio indissociável dos dois momentos determinantes de um processo construtivo, ou seja, cabia ao artesão o domínio das etapas de desenho, enquanto caráter de registro das idéias, e produção caracterizada pela manufatura do produto, a segunda, por questões impostas pelo sistema, já não comportava situar-se nas mãos de uma única pessoa o domínio de todo um processo.

Sob esta perspectiva, o desenho tem estado, desde então, por um lado, a reboque do desenvolvimento tecnológico sendo em alguns casos alvo de interpretações reducionistas por parte das várias áreas que se supõem detentoras da capacidade de projetar e conceber idéias. Por outro lado, tem sido sistematicamente desafiado a apresentar respostas satisfatórias às várias questões que emergem desse mesmo contexto sob o qual a tecnologia se encontra inserida atendendo não somente aos reclamos da indústria, mas também, a outros segmentos e movimentos que o século XX tem protagonizado.

Entretanto, tem prevalecido o entendimento do Desenho produzido como uma tecnologia aplicada apropriada pelas Engenharias para atender às suas necessidades no mundo do trabalho.

"CAD como Ferramenta de Projeto"

A invenção de Gutemberg acabou com a profissão dos copistas. Não foi, logicamente, uma coisa de momento, houve sim uma transição suave que culminou com o domínio inconteste da prensa tipográfica. Da mesma forma observa-se na atualidade o declínio da profissão de desenhista técnico. A mudança teve início com o advento da computação gráfica na década de setenta, intensificou-se no início da década de noventa e hoje fica claro o destino desses profissionais.

Ao fazer-se um retrospecto dos últimos dez anos pode-se, generalizando, descrever o que aconteceu na maioria das empresas: num primeiro momento após a implantação de um sistema CAD a empresa treinou metade de seus desenhistas e a outra metade permaneceu na prancheta. Num segundo momento, segura da confiabilidade e eficiência do CAD ela deixou uma única prancheta para situações de emergência, ou saudosismo, e redistribuiu os demais desenhistas para outros setores da empresa ou os dispensou. Nesta fase os desenhistas cadistas trabalhavam de duas a três vezes mais rápido que na prancheta, porém o trabalho era semelhante ao desenho convencional. Eles recebiam um esboço do engenheiro ou projetista e executavam um desenho mais elaborado.

O que se observa na atualidade é a elaboração do desenho em CAD pelo próprio engenheiro ou projetista. De uma maneira tímida a princípio estes foram buscando o auxílio do computador para agilizar o processo de criação. Com ferramentas de visualização e cálculo, os programas de CAD tornaram-se, em pouco tempo o braço direito desses profissionais. Assim, os desenhistas tiveram que se readaptar e fazer, às vezes de projetistas para permanecer nas empresas.

Com a vantagem adicional de não ser necessário chamar um desenhista ou cadista para passar a limpo, pois a apresentação está pronta para ser impressa, em cores e de excelente qualidade. Como ele, todo o dia centenas de engenheiros descobrem a vantagem de projetar diretamente em CAD.

Existem hoje programas que geram automaticamente as vistas isométricas, perspectivas, cortes e dimensionamentos a partir de um desenho em 3D. O engenheiro mecânico - aeronáutico Cláudio Stio Adamatsu [1] diz que além de programas, é necessário que a empresa tenha os profissionais qualificados, que os projetistas, por exemplo, sejam capazes de fazer todo o projeto dentro de um ambiente CAD, gerando assim o modelo tridimensional da peça juntamente com os cálculos. Os últimos desenhistas que sobreviviam do detalhamento de projetos agora têm fortes motivos para se reciclarem e passar a atuar como cabeças pensantes e não como trabalhadores braçais.

Por outro lado o que se vê é o desconhecimento e inércia da maioria dos usuários de CAD que ainda desenham em 2D (desenho bidimensional) e não procuram aprender o desenho em 3D (tridimensional) que tantas propicia. Com certeza estas pessoas serão preteridas quando as empresas exigirem profissionais completos que projetem e expressem suas idéias em forma de desenhos elucidativos e que possam servir de base para a produção.

Para o desenvolvimento das idéias do projeto é necessário, um meio simples e rápido de expressão, o esboço. Este tem o propósito de fixar as idéias abstratas, dar formas, possibilitar seu exame, também testar a teoria pela demonstração.

Uma maneira excelente de "esboçar conceitos" consiste em utilizar programas CAD paramétricos. A parametrização interliga certas características da geometria de uma peça e estabelece restrições geométricas e dimensionais. Ao permitir a entrada de valores arbitrários em determinadas cotas todo o desenho é automaticamente atualizado para se adaptar à nova medida. Isto permite a uma equipe trabalhar conceitos rapidamente em frente à tela do computador e ter um nível de visualização e entendimento não alcançados com simples esboços.

Como o objetivo deste desenho é fazer uma previsão de dimensões, nada mais lógico do que faze-lo diretamente em 3D e em escala de 1:1. Isto dá uma noção de espaço que até pessoas leigas tem compreensão. Também permite avaliar possíveis interferências que no desenho convencional apareceriam somente na fase de protótipo exigindo um re-projeto demorado e oneroso.

Os desenhos de fabricação dependem de uma série de fatores, como, por exemplo, da quantidade de peças a serem fabricadas, do processo de fabricação, do nível de automação na fabricação, dos recursos disponíveis para o desenho, do nível da mão-de-obra, do tipo de controle de qualidade, do uso e do armazenamento dos desenhos, etc. O formato de papel, seu dobramento, representação de cortes, cotagem, legendas, letras e indicação de acabamentos superficiais são encontrados nas normas de desenho técnico da ABNT.

Uma vez executado o desenho em 3D a maioria dos programas de CAD gera automaticamente as vistas e cortes desejados. Geralmente pode-se configurar pela ABNT as opções de dimensionamento. Quando a fabricação se dará por métodos convencionais, isto é, máquinas operadas manualmente pelos operários, o projetista deverá saber qual o processo de fabricação se dará por máquinas de Comando Numérico Computadorizado (CNC) o projetista pode contar com o auxílio de programas de conversão CAD/CAM (Desenho/ Manufatura) que geram automaticamente o código CN (Comando numérico) a partir do desenho feito no computador.

Com a implantação de sistemas de qualidade a maioria das empresas foi obrigada a registrar seus processos, inclusive os de montagem. Neste ponto o uso do CAD permitiu a execução de planos de montagem com extrema facilidade aproveitando os desenhos já existentes com pouquíssimas modificações. Também os clientes passaram a receber manuais muito melhor ilustrados.

Conclusão

De todos os ramos do conhecimento que obtiveram a chancela de disciplina independente na modernidade, o Desenho é um dos poucos que não foi submetido a um estudo sistêmico. Apenas o Desenho ligado à produção industrial foi reflexionado esteticamente ficando todos os outros compartimentos de sua constituição, submersos na condição de disciplina subsidiária.

Assim, no presente momento, procurou-se refletir acerca do Desenho, afim de entendê-lo como linguagem encetada no labor humano, tomando por pressuposto as dimensões da tecnologia, do conhecimento, da expressividade, do símbolo e do visual ali encerrados.

Verificou-se nos últimos tempos, que os engenheiros tiveram uma visão um tanto quanto deturpada das suas atribuições. Atuavam como capatazes, apenas gerenciando os subordinados. É verdade que a ascensão profissional conduz a áreas gerenciais e administrativas, porém muitas pessoas foram impedidas de demonstrar sua sabedoria em questões técnicas para enfronhar-se em pouco produtivas questões burocráticas.

Agora, podemos observar um início de mudança com a preferência pela contratação de profissionais que dominam, além do conhecimento específico à sua área de atuação, desenho 3D e respectiva interação na manufatura. Ao projetar diretamente em 3D pode-se, posteriormente, obter qualquer vista desejada. Pode-se utilizar o desenho para gerar um programa CN para alimentar as máquinas - ferramenta CNC ou obter um modelo através da prototipagem rápida.

Espera-se que este Artigo possa contribuir para o despertar de uma relação de conhecimento com base na transdisciplinaridade, atentos a condições que favoreçam buscar novos conhecimentos, agregando às disciplinas técnicas o uso de meios computacionais para munir os profissionais de engenharia com ferramentas de construção de suas tarefas diárias.

Com este enfoque o engenheiro estará construindo sua própria formação; mais completa e com melhor percepção para o seu mundo do trabalho, consciente de que não pode deter-se a uma visão fragmentada e sim sistêmica em sua atuação profissional.

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UM AMBIENTE DE ENSINO PARA COMPUTAÇÃO MÓVEL INTEGRANDO J2ME E COMPONENTES DE SOFTWARE

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Resumo *— Este artigo descreve a implementação de um aplicativo que possibilita a criação de conteúdo didático para ambientes de Computação Móvel, oferecendo mobilidade aos estudantes no processo educacional. Embora parte deste aplicativo tenha sido desenvolvida para ser utilizada em computadores de mesa convencionais, o conteúdo didático gerado pela aplicação é direcionado para ser visualizado em dispositivos que utilizam a Comunicação Sem Fio para acessar a Rede Mundial de Computadores, notadamente os Palmtops. Com isso, deseja-se que os usuários destes dispositivos possam obter material didático em qualquer lugar onde estejam, usufruindo das vantagens inerentes às Redes de Comunicação Sem Fio, tais como independência de uma conexão cabeada convencional e mobilidade. O ambiente descrito foi implementado utilizando-se as técnicas do Desenvolvimento de Software Baseado em Componentes, explorando este método de desenvolvimento em conjunto com a Java 2 Micro Edition, versão da tecnologia Java voltada especificamente para a criação de aplicações para dispositivos móveis.*

Palavras-Chave — Componentes de Software, Computação Móvel, Educação a Distância, Java 2 Micro Edition, Mobilidade dos Estudantes

INTRODUÇÃO

A Educação a Distância (EAD) é uma modalidade de ensino consagrada e consolidada em diversas partes do mundo [1]. Há tempos, educadores e outros profissionais perceberam as vantagens de se oferecer cursos a distância, e sentiram a necessidade de utilizar novas tecnologias no processo educacional. Quanto às vantagens dos cursos a distância, podem-se destacar: os aspectos econômicos, já que os estudantes não precisam ter custos com viagens e hospedagem, a possibilidade de o aluno poder estudar nos momentos que melhor lhe convierem e o fato de cada um poder seguir seu próprio ritmo de aprendizado, entre outros fatores.

As novas tecnologias, principalmente os computadores e as redes de computadores, ampliaram ainda mais as possibilidades e as vantagens da Educação a Distância. As redes de computadores, notadamente a World Wide Web, tornam possível que qualquer pessoa, em qualquer parte do mundo onde seja possível acessar a rede mundial de computadores, tenha fácil acesso a uma grande quantidade de conteúdo didático.

A utilização das tecnologias de comunicação sem fio e de computação móvel ampliam ainda mais os horizontes das aplicações de Educação a Distância, uma vez que, ao se utilizar meios de comunicação sem fio, o único limitante para a distribuição de conteúdo didático passa a ser a área de cobertura de uma Rede Sem Fio, e não mais a existência de uma conexão cabeada convencional com uma rede de computadores.

O objetivo principal deste artigo é apresentar um ambiente, baseado em componentes de software, que possibilita a criação de conteúdo educacional de forma rápida, eficiente e intuitiva. Este material didático, no entanto, não é direcionado para ser utilizado em microcomputadores de mesa ou quaisquer outros dispositivos semelhantes. A preocupação é criar-se conteúdo educacional que possa ser visualizado em pequenos dispositivos dedicados, com tela pequena e características arquiteturais próprias, especificamente os Palmtops.

Dispositivos como este estão capacitados, atualmente, a receber dados da World Wide Web através de um acesso sem fio, o que possibilita a seus usuários receber o material didático onde quer que se encontrem, independentemente de possuírem a sua disposição uma rede de computadores convencional ou não.

O ambiente proposto neste artigo conta com dois módulos: o Módulo do Professor e o Módulo do Aluno. O Módulo do Professor foi desenvolvido para ser utilizado em *desktops*, e permite que os professores criem listas de exercícios com questões de verdadeiro ou falso e de múltipla escolha, e as disponibilizem em Servidores Web. O Módulo do Professor também permite a geração de relatórios de desempenho individuais e coletivos dos alunos na resolução das listas de exercícios geradas, o que oferece subsídios para que o professor possa aprimorar o processo educacional.

O Módulo do Aluno, por sua vez, permite que os alunos acessem as listas de exercícios geradas e as resolvam em seus Palmtops. O ambiente se encarrega de fazer uma correção automática das resoluções dos alunos, bem como de gerar um relatório a respeito do desempenho dos estudantes na resolução destas listas.

Este artigo descreverá brevemente a Java 2 Micro Edition, os Componentes de Software e apresentará uma Descrição Informal, a Arquitetura e a Interface do ambiente

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proposto, expondo ainda um exemplo da criação de uma lista de exercícios e da sua resolução por parte dos alunos, bem como da geração dos relatórios de desempenho.

JAVA 2 MICRO EDITION

O ambiente descrito conta com dois módulos: o Módulo do Professor e o Módulo do Aluno. O Módulo do Professor permite ao educador criar listas de exercícios para avaliação dos alunos e, posteriormente, levantar dados estatísticos a respeito do desempenho dos estudantes. Este módulo é executado em computadores de mesa tradicionais (*desktops*). Já o Módulo do Aluno, desenvolvido com o auxílio da tecnologia Java 2 Micro Edition (J2ME), é executado em Palmtops. Esta seção apresenta esta tecnologia, mostrando as suas principais características. A J2ME foi criada para o desenvolvimento de aplicações a serem exibidas em dispositivos pequenos, tais como Palmtops e telefones celulares, que possuem pequenos computadores dedicados e que freqüentemente utilizam baterias como fonte de energia.

A primeira característica que se destaca nesta tecnologia é que as suas aplicações provêem interfaces gráficas de qualidade, com gráficos coloridos e diversos componentes de interface, o que facilita a interação dos usuários com as aplicações [2]. O fato de a J2ME oferecer interfaces gráficas de qualidade pode vir a resolver um dos maiores problemas práticos encontrados por desenvolvedores de aplicações para dispositivos de tela pequena: criar projetos que realmente atraiam a atenção dos usuários, acostumados a aplicativos multimídia em seus *desktops*.

Outra característica importante da J2ME é que suas aplicações podem comunicar-se com *Servlets*, o que permite que estes aplicativos acessem Servidores Web e bancos de dados remotos através da World Wide Web [3]. *Servlets* são classes baseadas em tecnologia Java que são executadas e instanciadas em associação com Servidores Web, atendendo a requisições realizadas por meio do protocolo HyperText Transfer Protocol (HTTP). Com isso, as aplicações móveis passam a ter muito mais alcance e tornam-se tão poderosas quanto aquelas desenvolvidas para computadores convencionais.

COMPONENTES DE SOFTWARE

O desenvolvimento de componentes de software, ou, simplesmente, componentes vem ganhando notoriedade nos estudos de Engenharia de Software, por oferecer, principalmente, grande possibilidade de reuso de código e redução nos custos de implementação. Os componentes são, basicamente, trechos de código previamente testados, que podem ser instalados e executados em diversas aplicações distintas [4]. Esta propriedade, aliada ao fato de que um componente deve ser tão genérico quanto possível, faz com que o desenvolvedor poupe tempo e recursos de implementação. Atualmente, existem desenvolvedores que se dedicam exclusivamente à criação de componentes, que posteriormente podem ser comprados e utilizados pelos mais diversos usuários, de acordo com as necessidades individuais de cada um. Um componente oferece serviços aos usuários através da sua interface. A interface de um componente é composta por um conjunto de operações que determinam quais são os serviços que um determinado componente pode oferecer.

Independentemente da metodologia adotada para o desenvolvimento de componentes de software, os desenvolvedores devem ter em mente alguns princípios gerais que tornam o uso de componentes realmente atrativos:

- um componente deve ser simples de ser compreendido, para que possa ser facilmente implementado;
- um componente deve ser genérico, para que possa ser reutilizado em um grande número de aplicações com propósitos distintos;
- quando se desenvolve um conjunto de componentes independentes, estes devem ser facilmente combináveis, para facilitar a montagem da aplicação;
- embora devam ser facilmente combináveis, diferentes componentes devem ter suas dependências minimizadas ou, se possível, evitadas;
- deve haver uma preocupação em se criar componentes que possam ser facilmente estendidos, para que novos serviços possam ser adicionados a eles, em caso de necessidades futuras;
- os componentes devem ser portáveis para diversas plataformas distintas, o que aumenta ainda mais as possibilidades de reuso.

O ambiente descrito neste artigo foi implementado utilizando componentes de software tanto no desenvolvimento do Módulo do Professor quanto no Módulo do Aluno. Com isso, exploram-se as vantagens deste método de desenvolvimento de aplicações, expostas nesta seção.

DESCRIÇÃO INFORMAL DO AMBIENTE

Os dois atores que interagem com o ambiente descrito neste artigo são o Professor e o Aluno. O Professor é identificado pelo seu nome, pela disciplina que ministra, pelo código desta disciplina e pela turma pela qual é responsável. O ambiente proporciona ao Professor a criação de uma ou mais Listas de Exercícios, que possuem os seguintes atributos: um código para identificação da lista, o seu título, a sua data de criação e a sua data de entrega. As Listas são compostas por uma ou mais Questões.

Cada Questão possui um número único para identificá-la e é de um determinado tipo (Questão de Verdadeiro ou Falso ou Questão de Múltipla Escolha). As Questões de Verdadeiro ou Falso têm como atributos o texto da questão, uma justificativa que explica qual é a razão do texto da questão ser verdadeiro ou falso, e qual é a resposta correta à questão (verdadeiro ou falso). Já as Questões de Múltipla

Escolha, por sua vez, têm como atributos o texto da questão, uma justificativa que explica porque determinada alternativa é considerada correta, os textos das cinco alternativas a serem apresentadas ao Aluno e a resposta correta da Questão (alternativa A, B, C, D ou E).

Os Alunos são identificados pelo seu código de aluno e pelo seu nome. O Aluno resolve uma Lista de Exercícios, gerando, com isso, uma Resolução, que contém o seu índice de acertos e um relatório a respeito do seu desempenho, indicando, por exemplo, quais foram as questões respondidas corretamente, quais foram respondidas incorretamente e uma justificativa para o fato de a resposta dada à questão ter sido considerada incorreta.

O ambiente também fornece ao professor estatísticas relativas ao desempenho individual e coletivo dos alunos na resolução das Listas de Exercícios, o que oferece subsídios que auxiliam o professor na tarefa de aperfeiçoar o processo educacional.

A ARQUITETURA DO AMBIENTE

Baseado na Descrição Informal da aplicação, definiu-se, para o ambiente descrito neste artigo, a arquitetura exibida na Figura 1:

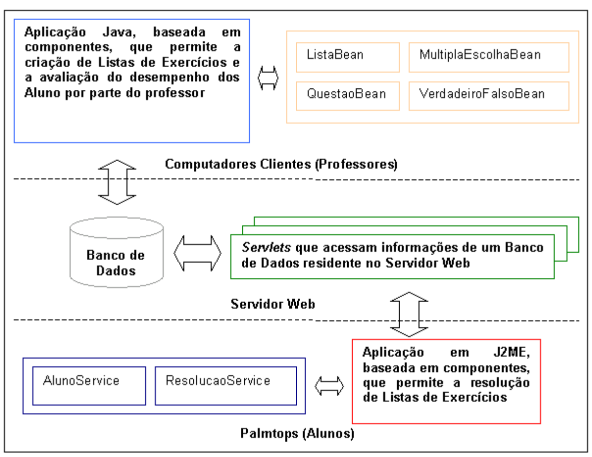

FIGURA. 1
ARQUITETURA DO AMBIENTE DESCRITO, UTILIZANDO COMPONENTES DE SOFTWARE.

O Módulo do Professor previamente mencionado baseia-se em *JavaBeans*, e permite que professores criem listas de exercícios, contendo questões de verdadeiro ou falso e de múltipla escolha. A tecnologia *JavaBeans* foi responsável pela introdução do conceito de componentes em Java. Utilizando-se *JavaBeans*, pode-se criar componentes de software reutilizáveis e independentes de plataforma [5]. Esta aplicação conta com os seguintes *JavaBeans*: ListaBean, QuestaoBean, MultiplaEscolhaBean e VerdadeiroFalsoBean. Cada um destes *JavaBeans* possui alguns atributos específicos e métodos para inserir, alterar, recuperar e excluir informações de um banco de dados que armazena as listas de exercícios criadas pelos professores.

Estas listas de exercícios ficam disponíveis em um banco de dados localizado em um Servidor Web remoto, no qual também residem *Servlets* que podem recuperar, alterar e armazenar informações neste banco de dados.

A arquitetura da Figura 1 exibe ainda o Módulo do Aluno, desenvolvido em J2ME, que faz uso de componentes de software especialmente desenvolvidos para esta tecnologia, o AlunoService e o ResolucaoService. Na tecnologia J2ME, os componentes de software são chamados de *Services* [6]. O Módulo do Aluno permite que os alunos resolvam as listas de exercícios previamente criadas pelos professores. A aplicação J2ME envia os dados da resolução aos *Servlets* residentes no Servidor Web. Os *Servlets*, por sua vez, recebem estas informações e as armazenam no banco de dados do Servidor Web, deixando-as à disposição do professor. Com isso, o professor pode fazer uma avaliação do desempenho individual e coletivo dos alunos na resolução de uma determinada lista de exercícios, utilizando outra funcionalidade do Módulo do Professor.

A INTERFACE DO AMBIENTE

Esta seção apresenta a interface do ambiente descrito neste artigo, exibindo segmentos tanto do Módulo do Professor quanto do Módulo do Aluno. Quando o professor acessa o ambiente, é apresentada a ele a tela exposta na Figura 2:

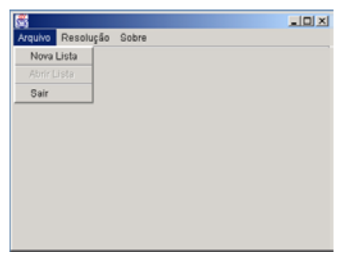

FIGURA. 2
TELA PRINCIPAL DO AMBIENTE.

Conforme pode ser visto na Figura 2, algumas opções são apresentadas ao professor, como, por exemplo, criar uma nova lista (opção "Nova Lista" no Menu "Arquivo" da Figura 2). Quando optar por criar uma nova lista de exercícios, o professor é conduzido à tela apresentada na Figura 3:

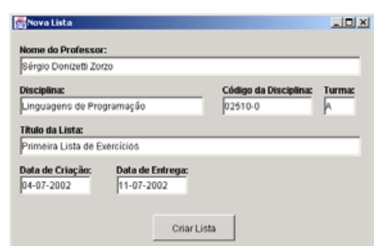

FIGURA. 3
TELA PARA A CRIAÇÃO DE UMA NOVA LISTA DE EXERCÍCIOS.

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Nesta tela o professor fornece os dados relevantes para a criação de uma nova lista de exercícios. Clicando no botão "Criar Lista" uma nova lista de exercícios é criada. A partir daí, o professor pode começar a trabalhar na elaboração das questões que irão compor a lista recém-criada. Se optar por incluir na lista uma questão de verdadeiro ou falso, a tela da Figura 4 será exibida.

O professor deverá escrever o texto da questão e uma justificativa sobre a razão do texto da questão ser verdadeiro ou falso. Esta justificativa será apresentada ao aluno quando este responder de forma incorreta a uma questão. O professor deverá assinalar ainda qual é a resposta correta (verdadeiro ou falso). Clicando no botão "Incluir Questão", esta questão será imediatamente incluída na lista de exercícios. Caso o professor deseje criar uma questão de múltipla escolha, a tela a ser exibida será a da Figura 5, e o procedimento para a criação de uma questão desse tipo será praticamente análogo ao adotado para a criação de uma questão de verdadeiro ou falso.

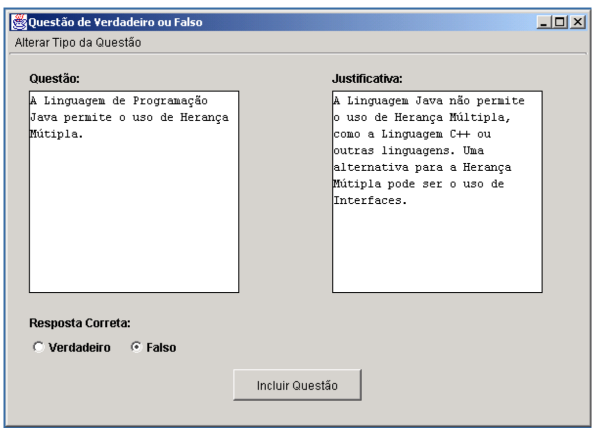

FIGURA. 4
TELA PARA A CRIAÇÃO DE QUESTÕES DE VERDADEIRO OU FALSO.

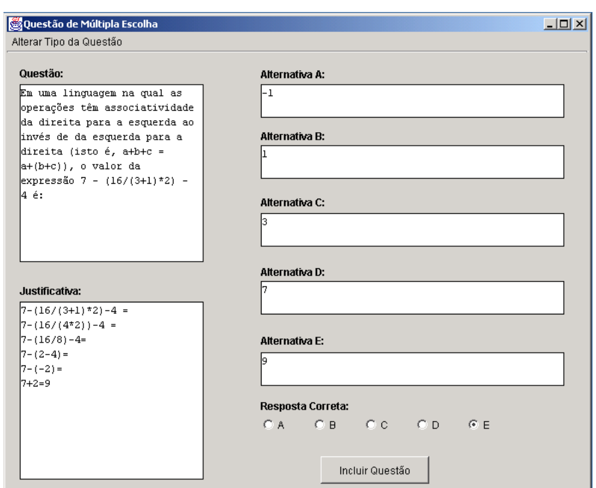

FIGURA. 5
TELA PARA A CRIAÇÃO DE QUESTÕES DE MÚLTIPLA ESCOLHA.

As listas de exercícios criadas com o auxílio deste ambiente ficam armazenadas em um banco de dados residente em um Servidor Web remoto, acessível para os professores que utilizam o ambiente. Todo o processo de armazenamento, consulta, remoção e edição de listas de exercícios é feita com o auxílio do ambiente, que, para isso, utiliza-se de componentes *JavaBeans*. No Servidor Web onde ficam armazenadas as listas de exercícios também residem *Servlets*.

Conforme foi dito anteriormente, aplicações J2ME podem se comunicar com *Servlets*, o que torna possível que essas aplicações acessem bancos de dados remotos na World Wide Web. No caso do ambiente descrito neste artigo, a aplicação J2ME correspondente ao Módulo do Aluno se comunica com *Servlets* que, por sua vez, fazem acesso aos dados das listas de exercícios geradas pelos professores. Estes *Servlets* também são responsáveis por corrigir e por armazenar os dados relativos à resolução dos alunos no Servidor Web, de tal maneira que os professores possam acessar estas resoluções em seus *desktops*, o que lhes permite avaliar o desempenho dos alunos. Dessa forma, o ambiente também permite que os professores possam fazer um acompanhamento e uma avaliação do desempenho dos alunos no processo de resolução dos exercícios. A Figura 6 exibe exemplos de telas dos Palmtops dos alunos acessando uma lista de exercícios:

FIGURA. 6
EXEMPLOS DE TELAS DOS ALUNOS ACESSANDO OS EXERCÍCIOS.

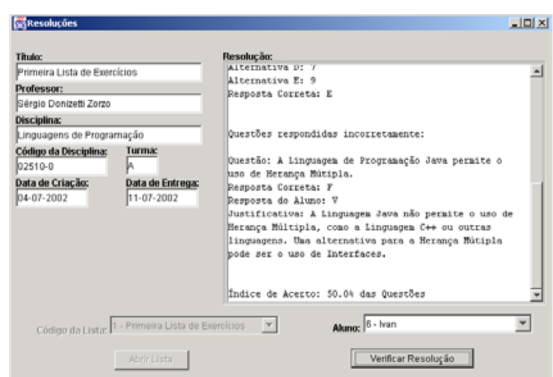

FIGURA. 7
RELATÓRIO DE DESEMPENHO INDIVIDUAL EXIBIDO A UM PROFESSOR.

A Figura 7, por sua vez, mostra a tela que permite ao professor analisar o desempenho individual de um aluno na resolução de uma lista de exercícios, enquanto que a tela exibida na Figura 8 corresponde à interface que possibilita ao professor fazer uma análise coletiva de desempenho.

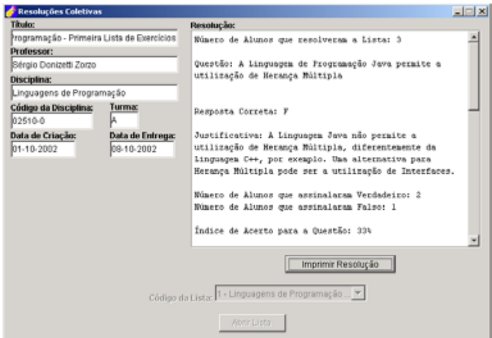

FIGURA. 8
RELATÓRIO DE DESEMPENHO COLETIVO EXIBIDO A UM PROFESSOR.

Conforme mencionado anteriormente, os *Servlets* desenvolvidos para este ambiente também se encarregam de fazer a correção automática das listas de exercícios e de gerar um relatório de desempenho que será visualizado pelos alunos em seus Palmtops. Este relatório traz o índice de acerto de um aluno na resolução de uma determinada lista de exercícios e também todas as questões respondidas correta e incorretamente pelo aluno, bem como as respostas corretas de cada questão e uma justificativa que explica porque uma determinada resposta é considerada correta. A Figura 9 exibe um exemplo de relatório visualizado por um aluno em seu Palmtop.

FIGURA. 9
RELATÓRIO DE DESEMPENHO DE UM ALUNO EXIBIDO EM UM PALMTOP.

Com isso, o ambiente auxilia o aluno no processo de aprendizado, uma vez que os estudantes não apenas respondem às questões, mas também podem verificar quais questões erraram e quais são as razões pelas quais a sua resposta foi considerada incorreta.

CONCLUSÕES

O ambiente descrito neste artigo tem como principal objetivo possibilitar a criação simples e intuitiva de listas de exercícios e é composto por dois módulos distintos: o Módulo do Professor e o Módulo do Aluno. Enquanto o Módulo do Professor é executado em computadores de mesa convencionais, o Módulo do Aluno é direcionado para ser utilizado em Palmtops, e foi desenvolvido com a tecnologia Java 2 Micro Edition (J2ME), também exposta neste artigo. Com isso, expande-se ainda mais a ubiqüidade oferecida pela Educação a Distância (EAD), que tem como uma das suas principais características levar conhecimento para qualquer pessoa, independentemente do lugar onde esta se encontra.

Utilizando-se Palmtops, dispositivos pequenos e capazes de acessar dados da World Wide Web em ambientes sem fio, pessoas interessadas em acessar conteúdo didático poderão fazê-lo facilmente, sem a necessidade de estarem conectadas a redes de computadores convencionais. Com a utilização da tecnologia J2ME, aplicações criadas para dispositivos dedicados adquirem qualidade comparável a aplicativos desenvolvidos para *desktops*.

O processo de criação do ambiente é apoiado pelas técnicas do Desenvolvimento de Software Baseado em Componentes, tanto na aplicação desenvolvida para *desktops* quanto na aplicação para Palmtops. Detalhes relativos a esta técnica também foram expostos neste artigo. Tanto os componentes desenvolvidos para *desktops,* baseados na tecnologia *JavaBeans,* como aqueles desenvolvidos para Palmtops, os chamados *Services*, são facilmente extensíveis e podem ser reutilizados por outras aplicações de EAD.

Foi formulada, ainda, uma descrição informal do ambiente descrito, visando especificá-lo claramente antes de se elaborar uma arquitetura para este ambiente. Esta arquitetura também foi apresentada neste artigo. Por fim, expôs-se a interface dos Módulos do Aluno e do Professor, mostrando-se um exemplo do processo de criação de uma lista de exercícios e da resolução desta lista por parte do aluno. Foram mostradas também as interfaces do ambiente que permitem ao professor avaliar o desempenho individual e coletivo dos alunos na resolução das listas de exercícios criadas.

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UM AMBIENTE DE ENSINO PARA COMPUTAÇÃO MÓVEL INTEGRANDO J2ME E COMPONENTES DE SOFTWARE

Ivan João Foschini[1] e Sérgio Donizetti Zorzo [2]

Resumo *— Este artigo descreve a implementação de um aplicativo que possibilita a criação de conteúdo didático para ambientes de Computação Móvel, oferecendo mobilidade aos estudantes no processo educacional. Embora parte deste aplicativo tenha sido desenvolvida para ser utilizada em computadores de mesa convencionais, o conteúdo didático gerado pela aplicação é direcionado para ser visualizado em dispositivos que utilizam a Comunicação Sem Fio para acessar a Rede Mundial de Computadores, notadamente os Palmtops. Com isso, deseja-se que os usuários destes dispositivos possam obter material didático em qualquer lugar onde estejam, usufruindo das vantagens inerentes às Redes de Comunicação Sem Fio, tais como independência de uma conexão cabeada convencional e mobilidade. O ambiente descrito foi implementado utilizando-se as técnicas do Desenvolvimento de Software Baseado em Componentes, explorando este método de desenvolvimento em conjunto com a Java 2 Micro Edition, versão da tecnologia Java voltada especificamente para a criação de aplicações para dispositivos móveis.*

Palavras-Chave — Componentes de Software, Computação Móvel, Educação a Distância, Java 2 Micro Edition, Mobilidade dos Estudantes

INTRODUÇÃO

A Educação a Distância (EAD) é uma modalidade de ensino consagrada e consolidada em diversas partes do mundo [1]. Há tempos, educadores e outros profissionais perceberam as vantagens de se oferecer cursos a distância, e sentiram a necessidade de utilizar novas tecnologias no processo educacional. Quanto às vantagens dos cursos a distância, podem-se destacar: os aspectos econômicos, já que os estudantes não precisam ter custos com viagens e hospedagem, a possibilidade de o aluno poder estudar nos momentos que melhor lhe convierem e o fato de cada um poder seguir seu próprio ritmo de aprendizado, entre outros fatores.

As novas tecnologias, principalmente os computadores e as redes de computadores, ampliaram ainda mais as possibilidades e as vantagens da Educação a Distância. As redes de computadores, notadamente a World Wide Web, tornam possível que qualquer pessoa, em qualquer parte do mundo onde seja possível acessar a rede mundial de computadores, tenha fácil acesso a uma grande quantidade de conteúdo didático.

A utilização das tecnologias de comunicação sem fio e de computação móvel ampliam ainda mais os horizontes das aplicações de Educação a Distância, uma vez que, ao se utilizar meios de comunicação sem fio, o único limitante para a distribuição de conteúdo didático passa a ser a área de cobertura de uma Rede Sem Fio, e não mais a existência de uma conexão cabeada convencional com uma rede de computadores.

O objetivo principal deste artigo é apresentar um ambiente, baseado em componentes de software, que possibilita a criação de conteúdo educacional de forma rápida, eficiente e intuitiva. Este material didático, no entanto, não é direcionado para ser utilizado em microcomputadores de mesa ou quaisquer outros dispositivos semelhantes. A preocupação é criar-se conteúdo educacional que possa ser visualizado em pequenos dispositivos dedicados, com tela pequena e características arquiteturais próprias, especificamente os Palmtops.

Dispositivos como este estão capacitados, atualmente, a receber dados da World Wide Web através de um acesso sem fio, o que possibilita a seus usuários receber o material didático onde quer que se encontrem, independentemente de possuírem a sua disposição uma rede de computadores convencional ou não.

O ambiente proposto neste artigo conta com dois módulos: o Módulo do Professor e o Módulo do Aluno. O Módulo do Professor foi desenvolvido para ser utilizado em *desktops*, e permite que os professores criem listas de exercícios com questões de verdadeiro ou falso e de múltipla escolha, e as disponibilizem em Servidores Web. O Módulo do Professor também permite a geração de relatórios de desempenho individuais e coletivos dos alunos na resolução das listas de exercícios geradas, o que oferece subsídios para que o professor possa aprimorar o processo educacional.

O Módulo do Aluno, por sua vez, permite que os alunos acessem as listas de exercícios geradas e as resolvam em seus Palmtops. O ambiente se encarrega de fazer uma correção automática das resoluções dos alunos, bem como de gerar um relatório a respeito do desempenho dos estudantes na resolução destas listas.

Este artigo descreverá brevemente a Java 2 Micro Edition, os Componentes de Software e apresentará uma Descrição Informal, a Arquitetura e a Interface do ambiente

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[2] Sérgio Donizetti Zorzo, Universidade Federal de São Carlos, Rodovia Washington Luís (SP-310) – Km 235, 13.565-905, São Carlos, SP, Brasil, zorzo@dc.ufscar.br

proposto, expondo ainda um exemplo da criação de uma lista de exercícios e da sua resolução por parte dos alunos, bem como da geração dos relatórios de desempenho.

JAVA 2 MICRO EDITION

O ambiente descrito conta com dois módulos: o Módulo do Professor e o Módulo do Aluno. O Módulo do Professor permite ao educador criar listas de exercícios para avaliação dos alunos e, posteriormente, levantar dados estatísticos a respeito do desempenho dos estudantes. Este módulo é executado em computadores de mesa tradicionais (*desktops*). Já o Módulo do Aluno, desenvolvido com o auxílio da tecnologia Java 2 Micro Edition (J2ME), é executado em Palmtops. Esta seção apresenta esta tecnologia, mostrando as suas principais características. A J2ME foi criada para o desenvolvimento de aplicações a serem exibidas em dispositivos pequenos, tais como Palmtops e telefones celulares, que possuem pequenos computadores dedicados e que freqüentemente utilizam baterias como fonte de energia.

A primeira característica que se destaca nesta tecnologia é que as suas aplicações provêem interfaces gráficas de qualidade, com gráficos coloridos e diversos componentes de interface, o que facilita a interação dos usuários com as aplicações [2]. O fato de a J2ME oferecer interfaces gráficas de qualidade pode vir a resolver um dos maiores problemas práticos encontrados por desenvolvedores de aplicações para dispositivos de tela pequena: criar projetos que realmente atraiam a atenção dos usuários, acostumados a aplicativos multimídia em seus *desktops*.

Outra característica importante da J2ME é que suas aplicações podem comunicar-se com *Servlets*, o que permite que estes aplicativos acessem Servidores Web e bancos de dados remotos através da World Wide Web [3]. *Servlets* são classes baseadas em tecnologia Java que são executadas e instanciadas em associação com Servidores Web, atendendo a requisições realizadas por meio do protocolo HyperText Transfer Protocol (HTTP). Com isso, as aplicações móveis passam a ter muito mais alcance e tornam-se tão poderosas quanto aquelas desenvolvidas para computadores convencionais.

COMPONENTES DE SOFTWARE

O desenvolvimento de componentes de software, ou, simplesmente, componentes vem ganhando notoriedade nos estudos de Engenharia de Software, por oferecer, principalmente, grande possibilidade de reuso de código e redução nos custos de implementação. Os componentes são, basicamente, trechos de código previamente testados, que podem ser instalados e executados em diversas aplicações distintas [4]. Esta propriedade, aliada ao fato de que um componente deve ser tão genérico quanto possível, faz com que o desenvolvedor poupe tempo e recursos de implementação. Atualmente, existem desenvolvedores que se dedicam exclusivamente à criação de componentes, que posteriormente podem ser comprados e utilizados pelos mais diversos usuários, de acordo com as necessidades individuais de cada um. Um componente oferece serviços aos usuários através da sua interface. A interface de um componente é composta por um conjunto de operações que determinam quais são os serviços que um determinado componente pode oferecer.

Independentemente da metodologia adotada para o desenvolvimento de componentes de software, os desenvolvedores devem ter em mente alguns princípios gerais que tornam o uso de componentes realmente atrativos:

- um componente deve ser simples de ser compreendido, para que possa ser facilmente implementado;
- um componente deve ser genérico, para que possa ser reutilizado em um grande número de aplicações com propósitos distintos;
- quando se desenvolve um conjunto de componentes independentes, estes devem ser facilmente combináveis, para facilitar a montagem da aplicação;
- embora devam ser facilmente combináveis, diferentes componentes devem ter suas dependências minimizadas ou, se possível, evitadas;
- deve haver uma preocupação em se criar componentes que possam ser facilmente estendidos, para que novos serviços possam ser adicionados a eles, em caso de necessidades futuras;
- os componentes devem ser portáveis para diversas plataformas distintas, o que aumenta ainda mais as possibilidades de reuso.

O ambiente descrito neste artigo foi implementado utilizando componentes de software tanto no desenvolvimento do Módulo do Professor quanto no Módulo do Aluno. Com isso, exploram-se as vantagens deste método de desenvolvimento de aplicações, expostas nesta seção.

DESCRIÇÃO INFORMAL DO AMBIENTE

Os dois atores que interagem com o ambiente descrito neste artigo são o Professor e o Aluno. O Professor é identificado pelo seu nome, pela disciplina que ministra, pelo código desta disciplina e pela turma pela qual é responsável. O ambiente proporciona ao Professor a criação de uma ou mais Listas de Exercícios, que possuem os seguintes atributos: um código para identificação da lista, o seu título, a sua data de criação e a sua data de entrega. As Listas são compostas por uma ou mais Questões.

Cada Questão possui um número único para identificá-la e é de um determinado tipo (Questão de Verdadeiro ou Falso ou Questão de Múltipla Escolha). As Questões de Verdadeiro ou Falso têm como atributos o texto da questão, uma justificativa que explica qual é a razão do texto da questão ser verdadeiro ou falso, e qual é a resposta correta à questão (verdadeiro ou falso). Já as Questões de Múltipla

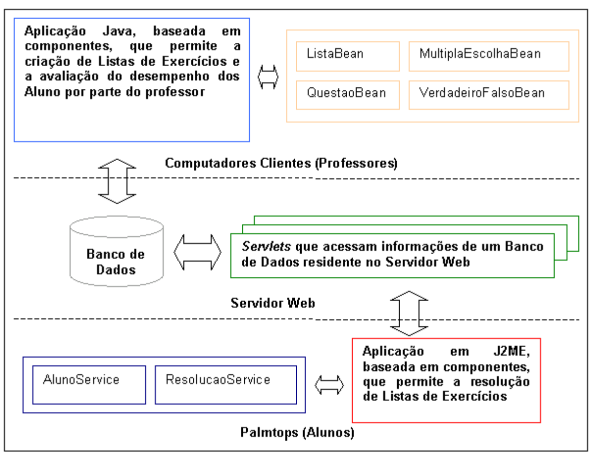
Escolha, por sua vez, têm como atributos o texto da questão, uma justificativa que explica porque determinada alternativa é considerada correta, os textos das cinco alternativas a serem apresentadas ao Aluno e a resposta correta da Questão (alternativa A, B, C, D ou E).

Os Alunos são identificados pelo seu código de aluno e pelo seu nome. O Aluno resolve uma Lista de Exercícios, gerando, com isso, uma Resolução, que contém o seu índice de acertos e um relatório a respeito do seu desempenho, indicando, por exemplo, quais foram as questões respondidas corretamente, quais foram respondidas incorretamente e uma justificativa para o fato de a resposta dada à questão ter sido considerada incorreta.

O ambiente também fornece ao professor estatísticas relativas ao desempenho individual e coletivo dos alunos na resolução das Listas de Exercícios, o que oferece subsídios que auxiliam o professor na tarefa de aperfeiçoar o processo educacional.

A ARQUITETURA DO AMBIENTE

Baseado na Descrição Informal da aplicação, definiu-se, para o ambiente descrito neste artigo, a arquitetura exibida na Figura 1:



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A arquitetura da Figura 1 exibe ainda o Módulo do Aluno, desenvolvido em J2ME, que faz uso de componentes de software especialmente desenvolvidos para esta tecnologia, o AlunoService e o ResolucaoService. Na tecnologia J2ME, os componentes de software são chamados de *Services* [6]. O Módulo do Aluno permite que os alunos resolvam as listas de exercícios previamente criadas pelos professores. A aplicação J2ME envia os dados da resolução aos *Servlets* residentes no Servidor Web. Os *Servlets*, por sua vez, recebem estas informações e as armazenam no banco de dados do Servidor Web, deixando-as à disposição do professor. Com isso, o professor pode fazer uma avaliação do desempenho individual e coletivo dos alunos na resolução de uma determinada lista de exercícios, utilizando outra funcionalidade do Módulo do Professor.

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Esta seção apresenta a interface do ambiente descrito neste artigo, exibindo segmentos tanto do Módulo do Professor quanto do Módulo do Aluno. Quando o professor acessa o ambiente, é apresentada a ele a tela exposta na Figura 2:

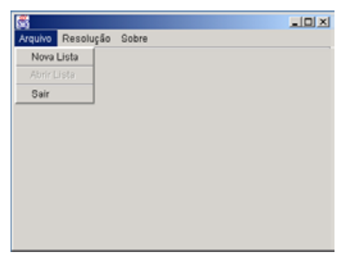

FIGURA. 2
TELA PRINCIPAL DO AMBIENTE.

Conforme pode ser visto na Figura 2, algumas opções são apresentadas ao professor, como, por exemplo, criar uma nova lista (opção "Nova Lista" no Menu "Arquivo" da Figura 2). Quando optar por criar uma nova lista de exercícios, o professor é conduzido à tela apresentada na Figura 3:

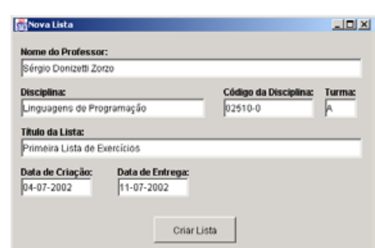

FIGURA. 3
TELA PARA A CRIAÇÃO DE UMA NOVA LISTA DE EXERCÍCIOS.

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Nesta tela o professor fornece os dados relevantes para a criação de uma nova lista de exercícios. Clicando no botão "Criar Lista" uma nova lista de exercícios é criada. A partir daí, o professor pode começar a trabalhar na elaboração das questões que irão compor a lista recém-criada. Se optar por incluir na lista uma questão de verdadeiro ou falso, a tela da Figura 4 será exibida.

O professor deverá escrever o texto da questão e uma justificativa sobre a razão do texto da questão ser verdadeiro ou falso. Esta justificativa será apresentada ao aluno quando este responder de forma incorreta a uma questão. O professor deverá assinalar ainda qual é a resposta correta (verdadeiro ou falso). Clicando no botão "Incluir Questão", esta questão será imediatamente incluída na lista de exercícios. Caso o professor deseje criar uma questão de múltipla escolha, a tela a ser exibida será a da Figura 5, e o procedimento para a criação de uma questão desse tipo será praticamente análogo ao adotado para a criação de uma questão de verdadeiro ou falso.

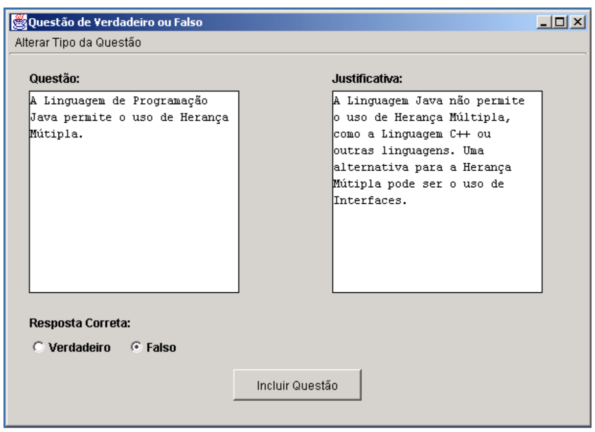

FIGURA. 4
TELA PARA A CRIAÇÃO DE QUESTÕES DE VERDADEIRO OU FALSO.

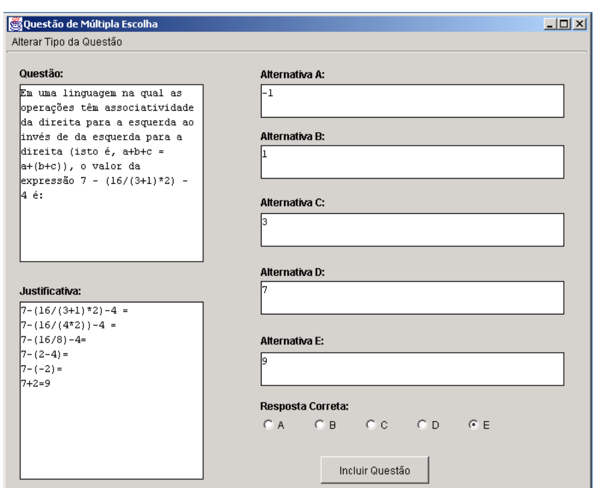

FIGURA. 5
TELA PARA A CRIAÇÃO DE QUESTÕES DE MÚLTIPLA ESCOLHA.

As listas de exercícios criadas com o auxílio deste ambiente ficam armazenadas em um banco de dados residente em um Servidor Web remoto, acessível para os professores que utilizam o ambiente. Todo o processo de armazenamento, consulta, remoção e edição de listas de exercícios é feita com o auxílio do ambiente, que, para isso, utiliza-se de componentes *JavaBeans*. No Servidor Web onde ficam armazenadas as listas de exercícios também residem *Servlets*.

Conforme foi dito anteriormente, aplicações J2ME podem se comunicar com *Servlets*, o que torna possível que essas aplicações acessem bancos de dados remotos na World Wide Web. No caso do ambiente descrito neste artigo, a aplicação J2ME correspondente ao Módulo do Aluno se comunica com *Servlets* que, por sua vez, fazem acesso aos dados das listas de exercícios geradas pelos professores. Estes *Servlets* também são responsáveis por corrigir e por armazenar os dados relativos à resolução dos alunos no Servidor Web, de tal maneira que os professores possam acessar estas resoluções em seus *desktops*, o que lhes permite avaliar o desempenho dos alunos. Dessa forma, o ambiente também permite que os professores possam fazer um acompanhamento e uma avaliação do desempenho dos alunos no processo de resolução dos exercícios. A Figura 6 exibe exemplos de telas dos Palmtops dos alunos acessando uma lista de exercícios:

FIGURA. 6
EXEMPLOS DE TELAS DOS ALUNOS ACESSANDO OS EXERCÍCIOS.

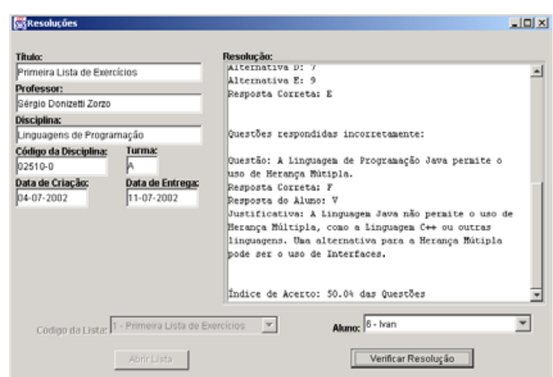

FIGURA. 7
RELATÓRIO DE DESEMPENHO INDIVIDUAL EXIBIDO A UM PROFESSOR.

A Figura 7, por sua vez, mostra a tela que permite ao professor analisar o desempenho individual de um aluno na resolução de uma lista de exercícios, enquanto que a tela exibida na Figura 8 corresponde à interface que possibilita ao professor fazer uma análise coletiva de desempenho.

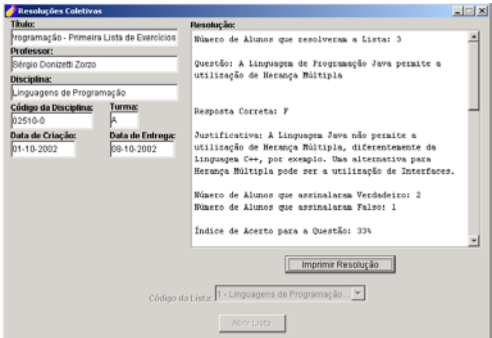

FIGURA. 8
RELATÓRIO DE DESEMPENHO COLETIVO EXIBIDO A UM PROFESSOR.

Conforme mencionado anteriormente, os *Servlets* desenvolvidos para este ambiente também se encarregam de fazer a correção automática das listas de exercícios e de gerar um relatório de desempenho que será visualizado pelos alunos em seus Palmtops. Este relatório traz o índice de acerto de um aluno na resolução de uma determinada lista de exercícios e também todas as questões respondidas correta e incorretamente pelo aluno, bem como as respostas corretas de cada questão e uma justificativa que explica porque uma determinada resposta é considerada correta. A Figura 9 exibe um exemplo de relatório visualizado por um aluno em seu Palmtop.

FIGURA. 9
RELATÓRIO DE DESEMPENHO DE UM ALUNO EXIBIDO EM UM PALMTOP.

Com isso, o ambiente auxilia o aluno no processo de aprendizado, uma vez que os estudantes não apenas respondem às questões, mas também podem verificar quais questões erraram e quais são as razões pelas quais a sua resposta foi considerada incorreta.

CONCLUSÕES

O ambiente descrito neste artigo tem como principal objetivo possibilitar a criação simples e intuitiva de listas de exercícios e é composto por dois módulos distintos: o Módulo do Professor e o Módulo do Aluno. Enquanto o Módulo do Professor é executado em computadores de mesa convencionais, o Módulo do Aluno é direcionado para ser utilizado em Palmtops, e foi desenvolvido com a tecnologia Java 2 Micro Edition (J2ME), também exposta neste artigo. Com isso, expande-se ainda mais a ubiqüidade oferecida pela Educação a Distância (EAD), que tem como uma das suas principais características levar conhecimento para qualquer pessoa, independentemente do lugar onde esta se encontra.

Utilizando-se Palmtops, dispositivos pequenos e capazes de acessar dados da World Wide Web em ambientes sem fio, pessoas interessadas em acessar conteúdo didático poderão fazê-lo facilmente, sem a necessidade de estarem conectadas a redes de computadores convencionais. Com a utilização da tecnologia J2ME, aplicações criadas para dispositivos dedicados adquirem qualidade comparável a aplicativos desenvolvidos para *desktops*.

O processo de criação do ambiente é apoiado pelas técnicas do Desenvolvimento de Software Baseado em Componentes, tanto na aplicação desenvolvida para *desktops* quanto na aplicação para Palmtops. Detalhes relativos a esta técnica também foram expostos neste artigo. Tanto os componentes desenvolvidos para *desktops,* baseados na tecnologia *JavaBeans,* como aqueles desenvolvidos para Palmtops, os chamados *Services*, são facilmente extensíveis e podem ser reutilizados por outras aplicações de EAD.

Foi formulada, ainda, uma descrição informal do ambiente descrito, visando especificá-lo claramente antes de se elaborar uma arquitetura para este ambiente. Esta arquitetura também foi apresentada neste artigo. Por fim, expôs-se a interface dos Módulos do Aluno e do Professor, mostrando-se um exemplo do processo de criação de uma lista de exercícios e da resolução desta lista por parte do aluno. Foram mostradas também as interfaces do ambiente que permitem ao professor avaliar o desempenho individual e coletivo dos alunos na resolução das listas de exercícios criadas.

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ELABORAÇÃO E APLICAÇÃO DE UM MODELO FORMAL DE DESCRIÇÃO SINTÁTICA TRANSFRÁSTICA À INTELIGÊNCIA ARTIFICIAL E AO ENSINO DE REDAÇÃO EM CURSOS DE ENGENHARIA E COMPUTAÇÃO

Aldo Bizzocchi[1] e Eloísa Vecchiato[2]

Resumo — *O presente trabalho procura examinar sob que condições uma dada seqüência de frases constitui um texto e, a partir daí, formula algumas hipóteses sobre as relações sintáticas existentes ao nível transfrástico do texto, para, a seguir, propor um pequeno esboço do que seria um modelo formal (lógico-matemático) de análise e descrição de textos lingüísticos com base em tais relações. Esse modelo pode ter larga aplicação na criação de sistemas de Inteligência Artificial, bem como no ensino de redação em língua pátria ou estrangeira a estudantes de cursos de Engenharia e Ciência da Computação.*

Palavras-chave — *Lingüística textual; sintaxe transfrástica; modelos matemáticos de análise lingüística; Inteligência Artificial; ensino de redação.*

INTRODUÇÃO

O interesse de cientistas, filósofos e homens de cultura em geral pelo objeto *texto* não é novo. Entretanto, somente nas últimas décadas tem sido possível empreender um estudo mais sistemático desse objeto na medida em que a própria ciência lingüística evoluiu, fornecendo as chaves fundamentais de uma nova abordagem desse complexo problema. O grande desafio que se impõe hoje é enunciar as regras de uma sintaxe transfrástica com a mesma precisão e rigor formal com que se pode hoje tratar a sintaxe frástica.

Essa "gramática do texto" deve ser capaz de descrever qualquer texto, independentemente de sua natureza, como uma rede de inter-relações funcionais, isto é, como conjunto de elementos que se articulam entre si mediante relações semânticas e lógicas, formando uma estrutura compacta, uma unidade de comunicação. Em outras palavras, tal gramática deverá reduzir o texto a uma expressão "algébrica".

No presente trabalho pretendemos formular algumas hipóteses sobre as relações sintáticas existentes no nível transfrástico, bem como propor um esboço de modelo formal de descrição de textos com base em tais relações, além de sinalizar a possibilidade de utilizar esse modelo no ensino de redação e de criação de sistemas computacionais dotados de Inteligência Artificial.

COESÃO E COERÊNCIA

Os teóricos que pesquisam no campo da lingüística textual têm perseguido um modelo de estruturação do texto ao mesmo tempo sintática e semântica. Buscam regras que permitam não apenas distinguir entre textos gramaticais e agramaticais mas também entre textos semanticamente aceitáveis e inaceitáveis. Os conceitos de gramaticalidade e aceitabilidade semântica estão intimamente ligados aos de coesão e coerência textual, que passamos a discutir.

Dentre as referências que fazem distinção entre *coesão* e *coerência* está [1], que fala em *conectividade seqüencial* (coesão entre os elementos que ocorrem na superfície textual) e *conectividade conceptual* (coerência entre os elementos cognitivos apresentados pelas ocorrências textuais e o nosso conhecimento do mundo).

Segundo a referência [2], a coerência de um texto está ligada à noção de macroestrutura textual, também definível como a estrutura profunda do texto, ao passo que a coesão diz respeito ao encadeamento linear das frases ao nível da estrutura de superfície do texto.

A referência [3] define coerência como "uma certa capacidade de atuar como unidade, enquanto coesão se refere à existência de conexão entre as diferentes partes. A coerência é antes de natureza semântica, nos remete a um certo significado global do texto; a coesão parece dominada por aspectos sintáticos e relacionais entre os componentes. Entretanto, seria imprudente e simplista considerar a coerência como fenômeno exclusivamente semântico, e a coesão como exclusivamente sintático."

De forma geral, podemos entender a coesão textual como o conjunto de relações sintático-semânticas dos elementos constitutivos do texto entre si, enquanto a coerência textual é a relação entre o texto e o contexto extralingüístico, os sujeitos da enunciação, os dados da experiência acerca do mundo disponíveis aos falantes da língua e as condições objetivas e subjetivas de produção do ato lingüístico.

Discussão semelhante se deu, ainda em nível da gramática intrafrástica, quando se constatou que frases agramaticais podem ser perfeitamente aceitáveis semanticamente, assim como uma frase gramaticalmente bem construída pode conduzir à contradição lógica e ao *nonsense*. A coerência, portanto, depende tanto do contexto do enunciado (por vezes chamado de *co-texto*) quanto da situação de enunciação. Já a coesão textual, embora também

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apresente uma dependência semântica, é de natureza essencialmente gramatical. Por isso, sendo impossível enunciar regras de coerência textual independentes do aspecto pragmático, a busca de um modelo formal de descrição sintática de textos deverá recair na questão da enunciação de regras de coesão textual. O problema se reduzirá assim à descrição das relações estritamente lingüísticas existentes entre as frases de um texto dado, não importando a interpretação subjetiva que dele façamos em função dos diferentes contextos em que possa ocorrer.

PROGRESSÃO TEMÁTICA E NÚCLEOS TEMÁTICOS

Todo discurso parte de um consenso em direção a uma especificidade, vale dizer, parte de uma informação já conhecida por ambos os sujeitos da enunciação sobre a qual se faz o aporte de informação nova, inédita. À informação já conhecida dá-se o nome de *tema* ou *tópico*, e à informação nova dá-se o nome de *rema* ou *comentário*. Evidentemente, toda informação nova torna-se de domínio comum dos sujeitos da enunciação no momento de sua veiculação no texto, transformando-se em suporte de uma nova informação. Portanto, todo rema pode tornar-se tema em relação a novos remas. Por essa razão, distinguiremos entre *tema principal* (aquele que não deriva de outro tema dentro do mesmo texto e *tema secundário* ou *subtema* (aquele que é rema de temas anteriores pertencentes ao mesmo texto) [4]. O constante movimento de tema a rema é o que chamamos de *progressão temática*, condição *sine qua non* da existência do texto.

No nível da superfície textual, os sucessivos temas e remas podem ser detectados através de unidades léxicas que sintetizam e concentram a carga semântica do texto: podemos chamá-las de *núcleos temáticos*. A progressão temática poderá então ser entendida como o encadeamento de tais núcleos ao longo do texto.

Para [5], todo discurso resulta da tensão dialética entre o consenso e a especificidade, que, como vimos, articula o não sabido e o já sabido num mecanismo de *suporte/aporte*.

Assim, é natural que todo texto seja parcialmente profluente e parcialmente redundante. A profluência do texto garante sua informatividade, ao passo que a redundância assegura a fixação do tema e a integração dos constituintes textuais no seu desenvolvimento seqüencial.

A esse respeito, [6] propõe a existência de quatro meta-regras básicas de coerência textual, a saber: a *repetição*, a *progressão*, a *não contradição* e a *relação texto/contexto*. Destas, particularmente as meta-regras de repetição e de progressão dizem respeito mais diretamente à construção gramatical do texto, contemplando assim a citada tensão *redundância/profluência*. Essa tensão se reflete no surgimento progressivo de novos núcleos temáticos ao longo do texto, núcleos estes que no entanto tendem, com maior ou menor freqüência, a se repetir à medida que o texto avança. Aliás, quanto maior a freqüência de repetição de um núcleo temático, maior a sua relevância semântica para o texto e maior a sua pertinência ao tema a que está subordinado. Este é inclusive o princípio de conceituação de *palavra-tema* e *palavra-chave*, de que no entanto o núcleo temático cumpre distinguir-se. De modo geral, todos os elementos léxicos de um texto que se repetem de forma significativa constituem núcleos temáticos. Contudo, [6] distingue três tipos diferentes de repetição: a *definitivização* (reiteração da mesma palavra ou expressão), a *pronominalização* (uso de pronomes e proformas em lugar de um termo), e a *substituição* (quer por sinonímia quer por paráfrase). Numa possível representação esquemática do texto, poderíamos convencionar que os núcleos temáticos fossem representados por algarismos romanos, a cada repetição direta de um núcleo correspondendo a repetição do algarismo. Os núcleos substituídos por pronomes e proformas ou por sinônimos e paráfrases seriam indicados por um algarismo romano precedido do prefixo "sub", ao passo que os núcleos substituídos por 0 (fenômeno a que damos o nome de *elipse*) seriam representados por um algarismo romano entre parênteses. No caso de dois núcleos temáticos serem antônimos, ou apresentarem no texto algum tipo de oposição funcional exclusiva, indicaríamos a ambos com o mesmo algarismo, antepondo a um dos dois um sinal de menos (–).

AS UNIDADES SINTÁTICAS DO TEXTO: FRASEMAS E STRINGS

A concepção do texto como uma estrutura implica a existência de unidades constitutivas que mantêm vínculos funcionais entre si. Tal concepção nos conduz à idéia de uma hierarquia entre essas unidades e, conseqüentemente, à possibilidade de explicitá-la na forma de um esquema ou diagrama. Essa hierarquia subjacente aos elementos constitutivos do texto identifica-se bastante bem ao que [2]-[7] denomina *macroestrutura textual*. Todavia, para que possamos estudar as relações funcionais entre as unidades constituintes do texto, é mister primeiramente definirmos quais são essas unidades. Tradicionalmente, costuma-se considerar o texto como um conjunto de frases, e, portanto, seria a frase a unidade textual por excelência. Tal ponto de vista acarreta inúmeros problemas, a começar da própria conceituação de frase [8]. Mesmo que se adote uma definição consistente de frase, ainda resta o problema da possibilidade de reescritura de uma frase em várias ou vice-versa. Por essa razão, alguns teóricos preferem adotar como unidade textual não a frase mas sim a oração. Tal atitude prende-se em parte à expectativa de que a gramática textual contenha a gramática frasal [9]. Entretanto, o estudo sintático dos períodos compostos revela diferentes tipos de relação entre as orações, e o problema da reescritura se recoloca: há orações subordinadas que podem transformar-se em coordenadas e vice-versa; podem por vezes constituir frases autônomas. Há outras no entanto que permanecem sempre subordinadas a uma oração principal, como elemento sintático obrigatório daquela, não podendo ser reescritas sem que o significado geral do período seja drasticamente modificado. Além disso, embora toda oração subordinada desempenhe uma função sintática no seio da oração principal, alguns tipos de subordinadas podem ser suprimidas *sem prejuízo sintático* da oração principal, embora com evidente prejuízo semântico, ao passo que outras, quando suprimidas, simplesmente destroem a oração principal. Isso revela que, mesmo ao nível da subordinação, há diferentes graus de dependência entre as orações, o que nos sugere adotar como unidade de texto todo segmento sintático que se enquadre em uma das situações abaixo:

(i) período simples;
(ii) oração coordenada;
(iii) oração subordinada passível de supressão sem prejuízo sintático da oração principal;
(iv) oração principal cujas subordinadas se enquadrem em (iii);
(v) período composto por subordinação, não decomponível nos termos de (iii) e (iv).

A essa unidade assim definida daremos o nome de *frasema*, e estabeleceremos sua definição em bases mais rigorosas. Para tanto, partiremos da constatação de que há períodos formados por uma única oração, períodos formados por orações coordenadas e períodos formados por uma oração principal e uma ou mais subordinadas (além, é claro, das várias combinações dessas possibilidades). Especificamente no que tange ao período composto por subordinação, observamos a existência de dois diferentes tipos de relação subordinativa, segundo a oração subordinada exerça uma função sintática fundamental dentro da oração principal ou apenas uma função acessória. Ao primeiro tipo de relação daremos o nome de *subordinação forte* e ao segundo chamaremos de *subordinação fraca*. Podemos dizer que a subordinação forte é uma relação indissociável, ao passo que a subordinação fraca e a coordenação são relações dissociáveis. Se explodirmos a frase de modo que se rompam todas as relações dissociáveis, permanecendo apenas as indissociáveis, cada uma das subdivisões resultantes dessa explosão será uma oração simples ou um conjunto formado por uma oração principal e uma ou mais orações subordinadas fortes. São exatamente essas unidades o que chamamos de frasema.

Da definição que demos de subordinação forte e subordinação fraca resulta que são subordinadas fortes basicamente — mas não exclusivamente — as orações substantivas; as demais subordinadas (adjetivas e adverbiais) são, via de regra, subordinadas fracas.

A partir de agora, representaremos o frasema sempre entre barras verticais (| |). Vejamos os exemplos a seguir:

(1) |Comprei um carro novo.|
(2) |Vim,| |vi,| |venci.|
(3) |Despediu-se de todos| |e partiu.|
(4) |Como estivesse doente,| |João não foi à escola.|
(5) |Se for eleito,| |ele será empossado.|
(6) |Quero que você me faça um favor.|
(7) |É importante que eu vá à reunião.|

A frase (1) constitui um período simples, e portanto, um frasema. Em (2) e (3) temos frasemas coordenados sindética ou assindeticamente. Já as frases (4) a (7) representam períodos compostos por subordinação. Em (4), por exemplo, a oração subordinada "Como estivesse doente", ao ser suprimida, produz a oração simples "João não foi à escola", a qual se mantém perfeitamente gramatical e de sentido completo, o mesmo ocorrendo em (5). Em ambos os casos, temos dois frasemas. Em (6) e (7), ao contrário, a supressão da subordinada conduz a orações incompletas como "Quero" ou "É importante". Neste caso, as frases não são decomponíveis em frasemas menores.

Há casos entretanto em que a decomposição de um período composto em frasemas menores, embora possível, não é necessária. É o caso das orações subordinadas adjetivas, que normalmente vêm encaixadas no meio da principal. Por exemplo, o frasema

(8) |O homem que trabalha vence na vida.|

é perfeitamente decomponível em dois frasemas menores, |O homem vence na vida.| e |que trabalha|, contudo a posição tática da oração adjetiva no interior da principal desaconselha por razões meramente práticas sua decomposição. Aliás, cabe ressaltar que a decomposição de um frasema em frasemas menores é em geral facultativa e depende do tipo de relação existente entre os frasemas constituintes e de sua importância dentro da macroestrutura textual em que se encontram.

Enquanto unidades básicas da sintaxe do texto, os frasemas estabelecem entre si relações lógico-funcionais, que chamaremos de *conexões frásticas*, formando assim cadeias de frasemas. Estas por sua vez também apresentam conexões em relação a outros frasemas e/ou cadeias de frasemas, de modo que tais cadeias comportam-se de forma análoga a um frasema simples. Chamá-las-emos de *strings* (inglês *string* = "fio"), por analogia às cadeias lineares de mesmo nome, propostas por Harris (*apud* Borba [10]). Os *strings* podem combinar-se progressivamente, formando unidades cada vez maiores. Por essa razão, todo *string* pode ser chamado de *substring* em relação ao *string* mais extenso que o contém. Da definição de *string* resulta que todo texto é um grande *string*, subdivisível em *substrings*; por outro lado, todo frasema pode também ser considerado como um *string* unitário. Cumpre lembrar ainda que o conceito de *string* não coincide com o de parágrafo, embora em geral todo parágrafo constitua um *string*.

Núcleo temático, frasema, *string* e conexão são portanto os conceitos básicos de nosso modelo. Na representação esquemática, indicaremos o *string* por colchetes ([ ]) envolvendo os frasemas e/ou *substrings* que o compõem. Isso permite uma hierarquização das conexões do texto, de forma análoga ao procedimento da parentetização em álgebra. Com efeito, uma sentença matemática do tipo

$$3 \times 4 + 2 = 12 + 2 = 14$$

é diferente de

$$3 \times (4 + 2) = 3 \times 6 = 18$$

Os parênteses no segundo caso indicam que operação aritmética deve ser efetuada em primeiro lugar. Conseqüentemente, nessa sentença o fator 3 multiplica todo o conteúdo dos parênteses, ou seja, $4 + 2 = 6$, enquanto no primeiro caso multiplica apenas o 4. Esquemas semelhantes são largamente utilizados em lógica matemática e em seus corolários (teoria da informação, computação, lingüística gerativa, etc.). A resolução de esquemas parentetizados parte sempre dos parênteses mais internos da sentença em direção àqueles mais exteriores. A esse procedimento dão os lógicos o nome de *análise centrípeta*. Por exemplo, na sentença

$$((4 + 6) \times (5 - 3)) + 5$$

resolvem-se primeiro os parênteses internos, isto é, $(4 + 6)$ e $(5 - 3)$, obtendo assim a nova expressão

$$(10 \times 2) + 5 = 20 + 5 = 25$$

Em nosso caso específico, a parentetização dos frasemas, criando *strings*, resulta da própria hierarquia funcional dos frasemas entre si, de forma totalmente análoga a uma sentença matemática. Porém, em lugar de números e operações aritméticas, teremos respectivamente frasemas e conexões frásticas. A exemplo da lógica e da aritmética, cabe lembrar que todo colchete aberto deve ser fechado, de sorte que toda sentença completa (em nosso caso, todo diagrama de texto) deve ter tantos sinais "]" quantos forem os sinais "[". Por conseguinte, os colchetes serão sempre em número par.

AS CONEXÕES FRÁSTICAS

Conforme definimos anteriormente, *conexão frástica*, ou simplesmente *conexão*, é a relação lógico-funcional existente entre duas unidades sintáticas transfrásticas (frasemas ou *strings*), constituindo portanto o liame fundamental de todos os elementos integrantes da armação do texto. Sendo uma relação de caráter essencialmente lógico, a conexão pode ser encarada como uma função análoga à relação entre proposições na lógica matemática. Sobretudo, isso permite que representemos graficamente as conexões através de sinais semelhantes aos dos operadores lógicos. É preciso contudo lembrar que nem sempre o tipo de conexão existente entre os frasemas ou *strings* é detectável na superfície textual através de índices sintáticos (advérbios, conjunções, pontuação, etc.). Na verdade, o estatuto das conexões é fundamentalmente de natureza semântica, conforme assinala [2]; por essa razão, nosso modelo, sendo essencialmente descritivo, não discute quais índices, quer sintáticos quer semânticos quer pragmáticos, determinam tal ou qual tipo de conexão, mas procura apenas enunciar uma operatória dessas conexões.

Passamos a seguir a relacionar os principais tipos de conexões frásticas e sua simbologia, ressaltando que a lista de conexões aqui apresentada não é exaustiva: outros tipos de conexão poderão ser detectados à medida que mais e mais textos forem estudados. Também alertamos para o fato de que nossa classificação é bastante sumária e simplista, estando portanto sujeita a revisões e reformulações. De qualquer maneira, nossa intenção aqui é principalmente demonstrar a possibilidade de descrever a sintaxe transfrástica através de um modelo formal.

As conexões frásticas são as seguintes:

Desenvolvimento ($\rightarrow$): é a conexão que liga um frasema temático ou subtemático, representado graficamente entre barras verticais duplas (|| ||), ao seu rema. O desenvolvimento é o elemento básico do processo de textualização dissertativa e também por vezes narrativa, visto que tal tipo de texto consiste fundamentalmente na apresentação do tema ou assunto a ser tratado (*suporte*) seguido da informação que sobre ele o texto traz (*aporte*). Um exemplo típico de desenvolvimento se dá entre o tópico frasal e o restante do parágrafo.

Síntese ($\leftarrow$): trata-se do inverso do desenvolvimento. Neste caso, as diversas informações aportadas pelo texto confluem para um frasema que as sintetiza e lhes serve de suporte. Na síntese, o tema ou tópico frasal vem posposto ao rema. Por vezes, encontramos na superfície textual índices de síntese que poderíamos chamar de *conectores sintéticos* (expressões tais como *em suma*, *em resumo*, *trata-se portanto de*, etc.).

Conjunção (+): articula seqüencialmente frasemas cujos conteúdos proposicionais se verificam de forma compatível entre si, simultânea ou sucessivamente, na realidade proposta pelo texto. A conjunção é uma das formas mais freqüentes de conexão frástica. Dentre os diversos conectores conjuntivos estão *e*, *a seguir*, *também*, *assim como*, *ao mesmo tempo*, *da mesma forma*, etc.

Disjunção (/): articula seqüencialmente frasemas cujos conteúdos proposicionais estão em relação alternativa, o que equivale a dizer que a ocorrência de um deles pode (e eventualmente deve) excluir a ocorrência de outro. Temos disjunção nas proposições alternativas do tipo *ou... ou*, por exemplo.

Contrajunção (//): conecta frasemas cujos conteúdos proposicionais apresentam oposição contrastiva ou adversativa, sendo entretanto, e à diferença do que acontece na disjunção, co-ocorrentes na mesma realidade dada. Índices freqüentes de contrajunção são os conectivos *mas*, *porém*, *entretanto*, *todavia*, etc.

Implicação (⇒): estabelece entre dois frasemas uma relação de causa e efeito. Verifica-se quando o conteúdo proposicional do frasema antecedente é condição necessária, suficiente ou possível para a ocorrência do conseqüente. Sua definição é portanto semelhante à da implicação lógica e seus conectores principais são *portanto, conseqüentemente, se… então, por isso*, etc.

Contra-implicação (⇐): é o inverso da implicação. Neste caso, o frasema antecedente vem posposto ao conseqüente. O segundo membro da conexão é portanto a causa ou justificativa do primeiro. Seus índices mais comuns são *porque, dado que, visto que*, etc.

Explicação (:): introduz um frasema ou *string* cuja função é a de explicar, detalhar, ampliar a informação contida no frasema precedente. A essa função podemos chamar de *expansão semântica*. Por vezes a explicação desempenha papel redundante, parafraseando metalingüisticamente o conteúdo do frasema antecessor ou introduzindo uma exemplificação do mesmo. Cumpre não confundir a explicação com a implicação ou o desenvolvimento: a explicação não encerra uma relação determinística de causa e efeito nem introduz comentário acerca do tópico. Nem sempre a explicação apresenta conectores sintáticos explícitos, entretanto poderíamos citar os dois pontos (:), além de expressões como *isto é, ou seja, com efeito*, etc.

Pressuposição (➔): mais comum entre *strings,* a pressuposição serve para apresentar um argumento ou raciocínio que dá sustentação ideológica ao tema a ser desenvolvido. Poderíamos dizer que a pressuposição é a "justificativa do texto", ao passo que a implicação introduz a justificativa de um frasema ou *string*. As famosas fórmulas jurídicas do tipo *considerando que… o Presidente resolve…* são exemplos característicos de conexão pressupositiva. Embora em geral não haja nexo semântico de causalidade (ao menos em nível explícito) na pressuposição, esta também expressa uma forma de motivação, porém trata-se aí de uma motivação lógico-psicológica por parte do locutor em relação ao seu texto. A pressuposição é portanto a mais pragmática das conexões frásticas.

Aplicação do Modelo à Inteligência Artificial e ao Ensino de Redação em Cursos de Engenharia e Ciência da Computação

O modelo aqui proposto permite o desenvolvimento de tecnologias que podem apresentar diversas aplicações práticas, dentre as quais destacamos duas que estão diretamente ligadas à nossa prática como professores: *a)* a criação de *softwares* de Inteligência Artificial, em que o computador deve ser capaz de processar (isto é, captar, compreender e responder de forma lógica) enunciados formulados em língua natural, e *b)* o ensino de técnicas de redação que explicitem o caráter lógico da estruturação textual. Estamos realizando ambas as experiências simultaneamente ao utilizarmos este modelo (e outros modelos matemáticos fornecidos pela lingüística) no ensino de gramática e redação dentro da disciplina *Língua Portuguesa* dos cursos de Engenharia de Computação e de Ciência da Computação do Centro Universitário FIEO.

A formação dos alunos se inicia pela gramática da frase, em que utilizamos a sintaxe estrutural-funcional de Tesnière [11], o que ocorre no primeiro semestre da disciplina, para a seguir transpor o conceito de sintaxe ao elemento texto. Isso permite que os alunos adquiram competência redacional em termos de gramaticalidade, coesão e coerência por meio da compreensão das relações lógicas entre as divisões e subdivisões do texto (frases, parágrafos, seqüências, capítulos, etc.) e ainda antevejam a possibilidade de desenvolver algoritmos que permitam, ainda que de forma rudimentar, o processamento automático da linguagem humana. Os resultados que temos obtido, ao menos em termos teóricos, parecem até o momento bastante animadores.

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ENGENHARIA E EMPREENDEDORISMO

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Resumo. *Este trabalho apresenta a importância do empreendedorismo nos cursos de engenharia, tendo em vista que a competitividade atual desencadeou um processo de desemprego também para os engenheiros. Neste contexto, o empreendedorismo pode diminuir o número de engenheiros desempregados no país, porque eles podem montar seus próprios negócios. É comentado ainda que a Universidade deve difundir os estudos do empreendedorismo em sala de aula para despertar nos engenheiros o interesse pelo assunto. Este estudo mostra também que maioria das empresas brasileiras são pequenas ou médias; e que nos Estados Unidos os pequenos empreendimentos desenvolvem altas tecnologias, além de serem muito apoiados pelo governo e pelas Universidades.*

Palavras-chave*: Empreendedorismo, Ensino, Engenharia.*

1. INTRODUÇÃO

Com a competitividade fortemente instalada em todos campos da economia, o emprego tornou-se cada vez mais frágil e mais difícil de ser conseguido. Hoje, mais do que nunca, é preciso ter iniciativa para se conseguir um emprego ou gerar o seu próprio negócio e com isso conseguir uma renda que possa restituir os investimentos aplicados na formação profissional.

No caso dos engenheiros, os desafios não são diferentes. Dos milhares de engenheiros que terminam o curso de graduação, a maioria não tem garantia de emprego. Uma alternativa que pode diminuir o desemprego na área de engenharia é o empreendedorismo, tendo em vista que os engenheiros, devido a sua formação técnica e administrativa, têm condições de aplicar bem os conhecimentos adquiridos no próprio negócio.

Apesar da importância da opção pelo empreendedorismo, nesse momento crítico das economias brasileira e mundial, muitos pesquisadores criticam essa opção porque pensam que ela desvaloriza o engenheiro e a sua profissão. Mas diante da situação atual, ou seja, globalização da economia, vale a pena fazer a seguinte reflexão: É melhor guardar o diploma na gaveta e esperar que as mudanças aconteçam ou montar seu próprio negócio?

No caso de optar pela montagem de seu próprio negócio, o engenheiro precisa conhecer bem os caminhos a serem percorridos para não cair nas terríveis estatísticas de falências de empresas amplamente divulgadas pelo SEBRAE. Segundo este órgão, quem opta por um negócio próprio enfrenta muitas dificuldades e constatou essa realidade em pesquisa sobre o índice de mortalidade dos pequenos negócios. Como as pessoas não estão preparadas para abrir a própria empresa – porque faltam condições financeiras, administrativas e, principalmente, de conhecimento sobre o negócio –, sabe-se que, de cada 100 empresas que são abertas, 95 não resistem aos primeiros cinco anos de vida e fecham, deixando um rombo na conta do proprietário falido e desmotivado, e quase sempre pendências jurídicas e financeiras.

Portanto, é importante que o engenheiro seja orientado sobre esses riscos mesmo antes de concluir seu curso e uma espécie de simulações de negócios e pesquisas de tendências de mercado devem ser desenvolvidas nas rotinas das aulas.

O objetivo desse trabalho é mostrar a importância do empreendedorismo para os engenheiros, caso eles optam em montar seu próprio negócio, tendo em vista que muita coisa pode dar errada caso não sejam devidamente orientados.

Será mostrado ainda que a universidade deve difundir os estudos do empreendedorismo em sala de aula para despertar nos engenheiros o interesse pelo assunto. Este trabalho mostra ainda que a maioria das empresas brasileiras são pequenas ou médias e que nos Estados Unidos os pequenos empreendimentos desenvolvem altas tecnologias.

2. PANORAMA ATUAL

Até os anos 50, a economia do mundo tinha sustentação pelo desempenho das grandes empresas multinacionais ou das empresas estatais. Essas duas grandes forças econômicas ofereciam muitas oportunidades de trabalho, sendo responsáveis pela maioria dos bons empregos. Essas grandes corporações determinavam a organização e os rumos de toda a economia, inclusive no Brasil.

Os tempos, no entanto, mudaram. Hoje existe uma nova ordem mundial, que coloca a responsabilidade pela saúde econômica de um país nas pequenas e médias empresas. Também houve drástica redução no número de empregados nas grandes empresas, tanto privadas quanto estatais, configurando processos tão falados como desregulamentação, reengenharia, entre outros. Como ganharam agilidade e produtividade no processo de conquistar a competitividade, as empresas passaram a trabalhar com menos pessoas, o que representou um

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enorme número de desempregados em todos os países, MEC e SEBRAE (1999) [1].

O que a engenharia tem a ver com essa situação? No contexto geral, a engenharia e os engenheiros sofrem também com essa mudança no panorama atual. Grandes desafios estão surgindo a cada momento. É exatamente nesse contexto de concentração macroeconômica que são geradas as condições para o surgimento e a expansão das pequenas e médias empresas, que podem ser criadas pelos engenheiros. E as faculdades e universidades de engenharia podem atuar como mola propulsora para garantir maior desenvolvimento das atividades dessas empresas, principalmente quando os engenheiros optam em montar seu próprio negócio, orientando e instruindo os estudantes desde o início de sua formação acadêmica.

Para tanto, é preciso adotar mecanismos técnicos e tecnológicos que permitam ampliar o aspecto a que se destina a educação profissional, possibilitando, assim ao engenheiro, a incorporação das noções de mercado, empresa e de conceitos relacionados com aspectos administrativos, buscando sempre a aplicabilidade desses conceitos, de modo a garantir sucessos na obtenção de resultados.

Diante do contexto econômico mundial e nacional em que vivemos, fica confirmada a necessidade de reafirmar a responsabilidade que está sendo direcionada aos pequenos negócios. As empresas de pequeno porte já são responsáveis por 43,4% dos empregos gerados no país, sendo 80,2% dos empregos no comércio e 63,5% da mão-de-obra do setor de serviços, produzindo 48% dos bens de consumo e 42% dos salários de todo o país, Ref. [1].

Os negócios de pequeno porte compõem 98,2% do total das empresas do Brasil. E mais: 57% das indústrias têm menos de quatro empregados registrados. No setor de serviços essa parcela sobe para 74,2% e no comércio, para 82,9%. Ou seja, os pequenos negócios constituem a parcela mais significativa na economia da nação.

Uma relação com essa realidade é mostrada em um artigo de Avancini (2002) [2], em que o medo de não conseguir um emprego após terminar a faculdade é a grande preocupação dos jovens, cujos dados foram retirados de uma pesquisa realizada pelo Centro de Integração Empresa-Escola (CIEE). Segundo o levantamento, 42% dos entrevistados afirmaram estar preocupados com o futuro profissional em curto prazo. Foram ouvidos 500 estudantes de 16 a 25 anos que procuraram a entidade em busca de um estágio.

O desemprego é uma realidade muito próxima de todo mundo hoje em dia e o jovem sabe que um diploma não é mais garantia de emprego. Outros dados do Instituto de Brasileiro de Geografia e Estatística (IBGE) indicam que a preocupação dos jovens tem fundamento. De 1992 a 1999 a taxa de desemprego na faixa dos 18 a 24 anos: saltou de 9,6% para 14,6%.

Para a referida autora [2], a criança é ensinada, desde pequena, que seu futuro reside em conseguir um emprego. Só que o mundo não é mais assim, o que cria um descompasso entre expectativas e realidade. Emprego é como um animal em extinção e praticamente não existem políticas públicas para preservá-lo. Conseguir um emprego continua sendo a meta de boa parte dos estudantes e supera em muito o desejo de realização profissional: apenas 4% disseram se preocupar com isso na pesquisa do CIEE.

As estatísticas, acima mencionadas, são uma preocupação que se traduz em demanda pelo emprego. Apesar do artigo não relacionar as áreas pesquisadas, pode-se deduzir que no caso da engenharia essa preocupação também existe. Portanto, a opção pelo empreendedorismo pode ser uma saída para diminuir o desemprego nesta área tão importante para o desenvolvimento tecnológico do Brasil. Mas para consolidar esse processo é preciso criar condições estruturais para o desenvolvimento das atividades e buscar o envolvimento do engenheiro com conceitos e ambientes relativos ao empreendedorismo.

Nesse sentido, é preciso ainda que se crie um novo conceito para trabalho em engenharia, ao contrário do que se faz hoje, é possível orientar os estudantes para que sejam os futuros empresários do país. Ao contrário do que acontece hoje, é preciso que a criança, que será o engenheiro do futuro, seja orientada no sentido de ser empresária. Mas para isso é preciso ter bases sólidas sobre conhecimentos de administração de seus próprios empreendimentos.

Apesar do engenheiro necessitar de conhecimentos de administração de empresas, Silva Neto (2002) [3] mostra que muitas universidades não têm dado muita importância à disciplina de administração, especificamente nos cursos de engenharia mecânica, em função da baixa carga horária dedicada a esta disciplina.

Só para ter uma idéia inicial dessa realidade, durante a execução da pesquisa foram encontradas universidades que não tinham a administração como disciplina obrigatória e outras que dedicavam apenas 30 (trinta) horas em seu curso de engenharia mecânica.

Mesmo que outras disciplinas enfoquem aspectos de administração em seus conteúdos, tal carga horária dispensada diretamente à administração é muito baixa, visto que em muitas empresas os engenheiros são os gerentes responsáveis pela administração das mesmas.

3. DEFINIÇÕES DE EMPREENDEDORISMO

Embora empreendedorismo seja um tema amplamente discutido nos dias atuais, seu conteúdo, ou seja, o que ele representa, varia muito de um lugar para outro, de país para país, de autor para autor. Isso porque, embora tenha se originado a partir de pesquisas em economia, o empreendedorismo recebeu fortes contribuições da psicologia e da sociologia, o que provocou diferentes definições para o termo. Algumas são: 1.Empreendedor: que empreende; ativo, arrojado. 2. Aquele que empreende. Chefe de uma empresa. Chefe de uma empresa especializada na construção, nos trabalhos públicos, nos trabalhos de habitação. Pessoa que, perante contrato de uma empresa, recebe remuneração para executar determinado trabalho ou aufere lucros de uma outra pessoa, chamada mestre-de-obras, SEBRAE (2002)[4].

Para Dolabela (2002) [5]**,** o empreendedor é essencial ao processo de desenvolvimento das comunidades e países. Essa é uma conclusão que se espalhou pelo mundo e chegou até aos últimos recantos comunistas, onde as empresas estatais dominam o cenário, como em Cuba por exemplo.

O empreendedor é motivado pela auto-realização, desejo de assumir responsabilidades e independência. Considera irresistível assumir novos desafios, estando sempre propondo novas idéias, seguidas pela ação.

De forma genérica, empreendedorismo costuma ser definido como o processo pelo qual indivíduos iniciam e desenvolvem novos negócios. Por isso, o empreendedorismo relaciona-se tanto com a criação de novos negócios quanto com a inovação promovida dentro de empresas já estabelecidas.

4. O PAPEL DA UNIVERSIDADE NA DIFUSÃO DO EMPREENDEDORISMO

Como é do conhecimento geral, a sociedade contemporânea vive momentos de intensas transformações decorrentes da necessidade de se compatibilizar, adequar ou mesmo mudar valores de uma ordem mundial em transição. Nesse contexto, a Universidade não é exceção. Portanto, ela deve encontrar meios de lidar com tais contradições, reais ou aparentes. Se por um lado há consenso sobre importância da Universidade para o desenvolvimento de nosso país de maneira a assegurar-lhe inserção na economia global, por outro questionam-se os meios advindos em especial das atividades relacionadas diretamente da produção do saber inovador.

A visão de Universidade secular, estruturada a partir do princípio de que cabe a ela proteger todo o conhecimento e ciências, dos fatos e princípios, de pesquisa e descobertas, de experimentos e especulações, tem sido confrontada com outro que entende a Universidade como instituição criada para atender às demandas de uma sociedade que hoje deseja consumir produtos que agregam informações de conteúdo tecnológico e é impulsionada cada vez mais pelas necessidades da economia de mercado.

Neste contexto, outro aspecto relevante a ser considerado para avaliar o adequado desempenho da Universidade está relacionado às suas potencialidades em oferecer um conhecimento diversificado. Se, no passado, a Universidade era a principal instituição detentora do conhecimento, hoje o conhecimento se encontra disseminado em toda a sociedade, nas mais variadas formas e disponibilizado através dos meios de comunicação de massa, e dos sistemas e redes de informação.

Essa perda de hegemonia recoloca a questão da missão institucional da Universidade e a maneira de se buscar formas de assegurar um ensino que contemple a diversidade do conhecimento e que, simultaneamente, em nível da individualidade e subjetividade do aluno, forme profissionais com competência em áreas específicas e capazes de incorporar valores que propiciem o pleno exercício de sua cidadania, UFMG (2002) [6].

Além disso, faz-se necessária a adoção de práticas pedagógicas que privilegiem o ensino em forma e ritmo compatíveis com a realidade econômica social e cultural do aluno, e que lhe permitam acompanhar a evolução dos conhecimentos produzidos que mudam numa velocidade sem precedentes na sociedade contemporânea.

No caso da engenharia as necessidades de mudanças também existem, pois é preciso reconhecer que a reformulação de currículos deve acompanhar os processos sociais, políticos e econômicos.

Conforme citado que houve mudanças consideráveis no oferecimento de postos de trabalho, ou seja, diminuição do número de empregados com carteira assinada, é necessário que os cursos de engenharia valorizem o empreendedorismo como alternativa de absorção de maior número de engenheiros graduados no Brasil.

Em um artigo, Behnken (2002) [7] comenta que a falta de perspectivas de emprego para os jovens brasileiros vem dando a chance de pensarmos em alternativas que se caracterizam pela simplicidade e eficácia. Uma dessas opções vem crescendo no meio universitário e tem se destacado por conseguir unir a teoria com a prática: a empresa júnior.

Criadas na década de 60, na França, as empresas juniores passaram a oferecer aos alunos aquilo que eles mais necessitam: oportunidade de exercer a prática de suas carreiras e adquirir vivência na gerência de uma empresa.

Essa experiência se tornou o embrião para desenvolver o potencial empreendedor e motivar a abertura do próprio negócio. Com isso, aquela idéia antiga de estudar para conseguir um bom emprego vai sendo trocada pela visão ser o gestor da própria vida profissional.

O ideal é plantar essa semente desde os primeiros períodos da faculdade, para que a mudança da cultura da dependência seja feita de forma gradativa. Parece fácil, mas não é. Ainda encontram-se muitos alunos que chegam à universidade sonhando com aquele emprego seguro e estável, em que se entra pela manhã para bater o cartão e se sai no final da tarde, só voltando a pensar no trabalho na manhã seguinte.

Por isso, a empresa júnior se apresenta ao estudante universitário como o grande laboratório propício para desenvolver sua autonomia, além de estimular a responsabilidade pelo sucesso de sua vida e pelo sucesso de sua carreira.

Nesse sentido, o papel preponderante da Universidade deve ser o de habilitar os futuros engenheiros de acordo com as necessidades do mercado, ou seja, promover a articulação entre currículo e as transformações deste mercado.

Portanto, no caso específico da engenharia, os currículos mínimos da disciplina de empreendedorismo devem oferecer condições necessárias para envolver o aluno com o assunto. Um conteúdo que pode ser utilizado, apesar de pertencer a um curso de administração, é colocado da seguinte maneira: Introdução às Micros e Pequenas Empresas- Definições: Pequenas empresas. O empreendedor. O papel da pequena empresa na sociedade. Teorias de empreendedorismo. Pequenas empresas na estrutura econômica. Contribuição da pequena empresa para os objetivos econômicos e sociais. Empreendedorismo: Introdução. Empreendedores: Características, competências. Negociação. Imaginação. Criatividade. Cultura empreendedora. Campo do empreendedorismo. Inovação. Detecção de oportunidades. Apoio para empreendedorismo. Alternativas empreendedoras. Planejamento empreendedorial, EFEI (2002) [8].

Outro ponto importante que se refere ao papel da universidade é o estágio curricular. Entende-se por estágio curricular qualquer atividade que propicie ao aluno adquirir experiência profissional específica e que contribua, de forma eficaz, para a sua absorção pelo mercado de trabalho. Enquadram-se nesse tipo de atividade as experiências de convivência em um ambiente de trabalho, cumprimento de tarefas com prazos estabelecidos, trabalho em um ambiente hierarquizado e com componentes cooperativistas ou corporativistas, etc.

O objetivo é proporcionar ao aluno a oportunidade de aplicar seus conhecimentos acadêmicos em situações da prática profissional clássica, criando a possibilidade do exercício de suas habilidades. Espera-se que, com isso, que o aluno tenha a opção de incorporar atitudes práticas e adquirir uma visão crítica de sua área de atuação profissional.

Mas de forma geral, é uma tradição no Brasil os estudantes de engenharia procurarem as grandes empresas para realizar estágio, mas muitas vezes ficam em determinado setor da empresa a maior parte do tempo. Este estágio pode não ser produtivo porque limita a capacidade de envolvimento do estagiário com a maioria dos problemas que ele irá encontrar na profissão. Caso opte em estagiar em uma empresa de pequeno ou médio porte, poderá conviver diretamente com maioria dos problemas enfrentados no dia-a-dia destas empresas.

Nesse sentido, as Universidades podem incentivar essa mudança, selecionado as empresas que possuem condições de oferecer estágios a estudantes e engenheiros. Este procedimento poderia contribuir para melhorar a integração entre empresa e escola. Além disso, seria uma grande oportunidade para faculdades de engenharia incentivarem o desenvolvimento dessas empresas, a partir do conhecimento de sua realidade.

5. EMPREENDEDORISMO NOS ESTADOS UNIDOS

De acordo com Brockhaus (1999) [9], os Estados Unidos são famosos por suas atividades em empreendedorismo. Seus empreendedores são conhecidos mundialmente, desde Henry Ford e Thomas Edison até Seven Jobs e Bill Gates. Além desses gigantes, existem milhões de outros empreendedores americanos fundadores de vários pequenos negócios. Todos os empreendedores têm inicialmente uma idéia de um produto ou serviço e a visão de como transformar essa idéia em um negócio viável. Este processo é orquestrado pelos fundadores, que são freqüentemente a força motora mais importante por trás da criação. Os fundadores não são os únicos participantes desse processo, e a rede de relacionamentos que eles estabelecem é fundamental para a abertura da firma e o início das operações.

O papel da Universidade na difusão do empreendedorismo nos Estados Unidos é um dos fatores mais importantes. O conteúdo do curso ou do programa inclui conhecimentos gerais em negócios ou seja, contabilidade, finanças, marketing, direito empresarial, recursos humanos, operações e administração ou gerenciamento geral. Estes cursos também contêm informações sobre como começar um negócio, como e onde encontrar oportunidades e idéias, como é a vida do empreendedor, o que é um plano de negócios, como obter financiamento inicial, quem são os prováveis primeiros clientes, como desenvolver uma equipe de administração, direitos de propriedade intelectual, e crescimento e metas.

Geralmente, não são ensinadas as oportunidades de mercados específicos nos cursos de administração e empreendedorismo. Os estudantes podem ser encorajados a descobrir essas oportunidades e adquirir uma compreensão de como tirar proveito delas através de pesquisas ou projetos.

Especular com o conhecimento técnico específico também não é matéria lecionada em cursos de administração ou empreendedorismo. Segundo o referido autor, é mais provável que, tanto o reconhecimento da oportunidade quanto o conhecimento técnico, sejam incluídos em um curso de empreendedorismo na área de engenharia.

As Universidades são importantes também para as empresas de tecnologia avançada na medida em que elas se envolvem em atividades de pesquisa e desenvolvimento (P&D) que são transferidas para a aplicação comercial e elas treinam técnicos e funcionários. No que diz respeito à P&D, as Universidades são importantes sob dois aspectos: em primeiro lugar, as empresas precisam ter acesso ao corpo docente para receber consultoria, elaborar projetos conjuntos, e assim por diante; em segundo lugar, as empresas precisam ter acesso aos equipamentos e instalações universitárias, como os laboratórios, sistemas de informação e bibliotecas.

Empresas de tecnologia avançada também valorizam as Universidades, porque elas precisam de funcionários altamente qualificados. Os estudantes universitários e os já formados são potenciais funcionários para trabalhar em tempo integral ou meio período. O acesso a um trabalhador qualificado e que receba um salário relativamente baixo já é uma preciosidade. Além disso, as empresas podem obter informações de primeira mão sobre as características dos potenciais empregados. Para formar um grupo de novos funcionários, as Universidades oferecem treinamento para aqueles já empregados através de estágios e cursos de extensão.

As Universidades também ajudam as empresas de tecnologia avançada a encontrar o funcionário ideal, atraindo profissionais altamente qualificados para uma determinada área. Para profissionais que receberam treinamento avançado, a oportunidade de garantir uma atividade complementar ou ensinar por meio-período na Universidade, pode ser um fator importante na hora de escolher o empregador, Ref [9].

Além disso, metade dos alunos de MBA da Escola de Negócios de Harvard, nos Estados Unidos, opta por tocar seu negócio próprio. Os cursos de caráter empreendedor são febre nos Estados Unidos: 1 100 faculdades oferecem cursos desse tipo, e em 30 dos 50 estados americanos já existem cursos para crianças e adolescentes, Ref. [5]

6. PRINCIPAIS ORIENTAÇÕES AOS ENGENHEIROS EMPREENDEDORES

Em função do que foi exposto até agora, pode-se observar que existem muitas dificuldades para abertura e manutenção de um negócio. Nesse sentido, o engenheiro precisa ficar atento às necessidades do mercado e oferecer, justamente, aquilo que o consumidor realmente necessita. Uma boa idéia não garante o sucesso do empreendimento. É preciso conhecer todos os pontos positivos e negativos do negócio.

Portanto, nota-se que este assunto é muito complexo para ser abordado somente em um trabalho como este. Por isso, o engenheiro deve procurar outros manuais, livros, realizar cursos, participar de palestras e seminários, entre outros, para consolidar seus conhecimentos sobre este tema, que conforme citado, é de grande importância para desenvolvimento tecnológico do país.

Mesmo assim, algumas orientações podem ser colocadas, com o objetivo de esclarecer os engenheiros na abertura e administração de seu empreendimento. Inicialmente, para qualificar-se como uma boa oportunidade de investimento, o produto ou serviço deve atender a uma necessidade real com respeito à funcionalidade, à qualidade, à durabilidade e ao preço.

A oportunidade, em última instância, depende da habilidade para convencer os consumidores (o mercado) dos benefícios do produto ou serviço. É o mercado quem determina se uma idéia tem potencial para tornar-se uma oportunidade de investimento, ou seja, apenas o mercado dirá se a idéia gera valor para o usuário final do produto ou serviço.

À primeira vista, uma oportunidade pode parecer inviável, mas, graças ao esforço nela concentrado, suas possibilidades de sucesso tendem a aumentar. Portanto, a receptividade é a habilidade para identificar oportunidades. Ela é fundamental para quem deseja ser empresário. É com ela que se aproveita todo e qualquer momento para observar e conhecer negócios, seja no caminho de casa, no trabalho, nas compras, nas férias, lendo revistas, jornais ou assistindo televisão.

Outros pontos também importantes que devem ser observados pelos engenheiros empreendedores são:

-Permitir que os funcionários tomem decisões de acordo com o nível de seus cargos. Confiar na capacidade dos profissionais contratados ou então rever o processo seletivo.

-Utilizar a informação para dar mais acertividade à experiência ou "*feeling*".

-Perceber que outros fatores também podem atrair os consumidores além do preço, tais como: produtos diferenciados, atendimento, *lay-out* de loja, etc.

-Contratar ou manter os funcionários por sua competência técnica.

-Não pensar apenas no hoje. Dedicar parte do seu tempo útil para elaborar planos para o futuro do negócio.

-Perceber que o consumidor é o maior aliado, pois se ele estiver satisfeito e se sentindo bem atendido ele irá voltar inúmeras outras vezes.

-Praticar o jogo do ganha-ganha. Em uma negociação ambas as partes devem sair satisfeitas para que os bons negócios se repitam, César (2002) [10].

7. CONCLUSÕES E SUGESTÕES

- É preciso valorizar o ensino de empreendedorismo nos cursos de engenharia;
- As universidades devem oferecer consultorias às pequenas e médias empresas criadas, principalmente, pelos engenheiros empreendedores;
- A criação de disciplinas eletivas/obrigatórias relativas ao empreendedorismo deve fazer parte da reestruturação dos currículos das Universidades;
- As Empresas Juniores devem ser valorizadas;
- As Universidades devem incentivar o estágio dos estudantes de engenharia nas pequenas e médias empresas.

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UM AMBIENTE DE ENSINO PARA COMPUTAÇÃO MÓVEL INTEGRANDO J2ME E COMPONENTES DE SOFTWARE

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Resumo *— Este artigo descreve a implementação de um aplicativo que possibilita a criação de conteúdo didático para ambientes de Computação Móvel, oferecendo mobilidade aos estudantes no processo educacional. Embora parte deste aplicativo tenha sido desenvolvida para ser utilizada em computadores de mesa convencionais, o conteúdo didático gerado pela aplicação é direcionado para ser visualizado em dispositivos que utilizam a Comunicação Sem Fio para acessar a Rede Mundial de Computadores, notadamente os Palmtops. Com isso, deseja-se que os usuários destes dispositivos possam obter material didático em qualquer lugar onde estejam, usufruindo das vantagens inerentes às Redes de Comunicação Sem Fio, tais como independência de uma conexão cabeada convencional e mobilidade. O ambiente descrito foi implementado utilizando-se as técnicas do Desenvolvimento de Software Baseado em Componentes, explorando este método de desenvolvimento em conjunto com a Java 2 Micro Edition, versão da tecnologia Java voltada especificamente para a criação de aplicações para dispositivos móveis.*

Palavras-Chave — Componentes de Software, Computação Móvel, Educação a Distância, Java 2 Micro Edition, Mobilidade dos Estudantes

INTRODUÇÃO

A Educação a Distância (EAD) é uma modalidade de ensino consagrada e consolidada em diversas partes do mundo [1]. Há tempos, educadores e outros profissionais perceberam as vantagens de se oferecer cursos a distância, e sentiram a necessidade de utilizar novas tecnologias no processo educacional. Quanto às vantagens dos cursos a distância, podem-se destacar: os aspectos econômicos, já que os estudantes não precisam ter custos com viagens e hospedagem, a possibilidade de o aluno poder estudar nos momentos que melhor lhe convierem e o fato de cada um poder seguir seu próprio ritmo de aprendizado, entre outros fatores.

As novas tecnologias, principalmente os computadores e as redes de computadores, ampliaram ainda mais as possibilidades e as vantagens da Educação a Distância. As redes de computadores, notadamente a World Wide Web, tornam possível que qualquer pessoa, em qualquer parte do mundo onde seja possível acessar a rede mundial de computadores, tenha fácil acesso a uma grande quantidade de conteúdo didático.

A utilização das tecnologias de comunicação sem fio e de computação móvel ampliam ainda mais os horizontes das aplicações de Educação a Distância, uma vez que, ao se utilizar meios de comunicação sem fio, o único limitante para a distribuição de conteúdo didático passa a ser a área de cobertura de uma Rede Sem Fio, e não mais a existência de uma conexão cabeada convencional com uma rede de computadores.

O objetivo principal deste artigo é apresentar um ambiente, baseado em componentes de software, que possibilita a criação de conteúdo educacional de forma rápida, eficiente e intuitiva. Este material didático, no entanto, não é direcionado para ser utilizado em microcomputadores de mesa ou quaisquer outros dispositivos semelhantes. A preocupação é criar-se conteúdo educacional que possa ser visualizado em pequenos dispositivos dedicados, com tela pequena e características arquiteturais próprias, especificamente os Palmtops.

Dispositivos como este estão capacitados, atualmente, a receber dados da World Wide Web através de um acesso sem fio, o que possibilita a seus usuários receber o material didático onde quer que se encontrem, independentemente de possuírem a sua disposição uma rede de computadores convencional ou não.

O ambiente proposto neste artigo conta com dois módulos: o Módulo do Professor e o Módulo do Aluno. O Módulo do Professor foi desenvolvido para ser utilizado em *desktops*, e permite que os professores criem listas de exercícios com questões de verdadeiro ou falso e de múltipla escolha, e as disponibilizem em Servidores Web. O Módulo do Professor também permite a geração de relatórios de desempenho individuais e coletivos dos alunos na resolução das listas de exercícios geradas, o que oferece subsídios para que o professor possa aprimorar o processo educacional.

O Módulo do Aluno, por sua vez, permite que os alunos acessem as listas de exercícios geradas e as resolvam em seus Palmtops. O ambiente se encarrega de fazer uma correção automática das resoluções dos alunos, bem como de gerar um relatório a respeito do desempenho dos estudantes na resolução destas listas.

Este artigo descreverá brevemente a Java 2 Micro Edition, os Componentes de Software e apresentará uma Descrição Informal, a Arquitetura e a Interface do ambiente

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proposto, expondo ainda um exemplo da criação de uma lista de exercícios e da sua resolução por parte dos alunos, bem como da geração dos relatórios de desempenho.

JAVA 2 MICRO EDITION

O ambiente descrito conta com dois módulos: o Módulo do Professor e o Módulo do Aluno. O Módulo do Professor permite ao educador criar listas de exercícios para avaliação dos alunos e, posteriormente, levantar dados estatísticos a respeito do desempenho dos estudantes. Este módulo é executado em computadores de mesa tradicionais (*desktops*). Já o Módulo do Aluno, desenvolvido com o auxílio da tecnologia Java 2 Micro Edition (J2ME), é executado em Palmtops. Esta seção apresenta esta tecnologia, mostrando as suas principais características. A J2ME foi criada para o desenvolvimento de aplicações a serem exibidas em dispositivos pequenos, tais como Palmtops e telefones celulares, que possuem pequenos computadores dedicados e que freqüentemente utilizam baterias como fonte de energia.

A primeira característica que se destaca nesta tecnologia é que as suas aplicações provêem interfaces gráficas de qualidade, com gráficos coloridos e diversos componentes de interface, o que facilita a interação dos usuários com as aplicações [2]. O fato de a J2ME oferecer interfaces gráficas de qualidade pode vir a resolver um dos maiores problemas práticos encontrados por desenvolvedores de aplicações para dispositivos de tela pequena: criar projetos que realmente atraiam a atenção dos usuários, acostumados a aplicativos multimídia em seus *desktops*.

Outra característica importante da J2ME é que suas aplicações podem comunicar-se com *Servlets*, o que permite que estes aplicativos acessem Servidores Web e bancos de dados remotos através da World Wide Web [3]. *Servlets* são classes baseadas em tecnologia Java que são executadas e instanciadas em associação com Servidores Web, atendendo a requisições realizadas por meio do protocolo HyperText Transfer Protocol (HTTP). Com isso, as aplicações móveis passam a ter muito mais alcance e tornam-se tão poderosas quanto aquelas desenvolvidas para computadores convencionais.

COMPONENTES DE SOFTWARE

O desenvolvimento de componentes de software, ou, simplesmente, componentes vem ganhando notoriedade nos estudos de Engenharia de Software, por oferecer, principalmente, grande possibilidade de reuso de código e redução nos custos de implementação. Os componentes são, basicamente, trechos de código previamente testados, que podem ser instalados e executados em diversas aplicações distintas [4]. Esta propriedade, aliada ao fato de que um componente deve ser tão genérico quanto possível, faz com que o desenvolvedor poupe tempo e recursos de implementação. Atualmente, existem desenvolvedores que se dedicam exclusivamente à criação de componentes, que posteriormente podem ser comprados e utilizados pelos mais diversos usuários, de acordo com as necessidades individuais de cada um. Um componente oferece serviços aos usuários através da sua interface. A interface de um componente é composta por um conjunto de operações que determinam quais são os serviços que um determinado componente pode oferecer.

Independentemente da metodologia adotada para o desenvolvimento de componentes de software, os desenvolvedores devem ter em mente alguns princípios gerais que tornam o uso de componentes realmente atrativos:

- um componente deve ser simples de ser compreendido, para que possa ser facilmente implementado;
- um componente deve ser genérico, para que possa ser reutilizado em um grande número de aplicações com propósitos distintos;
- quando se desenvolve um conjunto de componentes independentes, estes devem ser facilmente combináveis, para facilitar a montagem da aplicação;
- embora devam ser facilmente combináveis, diferentes componentes devem ter suas dependências minimizadas ou, se possível, evitadas;
- deve haver uma preocupação em se criar componentes que possam ser facilmente estendidos, para que novos serviços possam ser adicionados a eles, em caso de necessidades futuras;
- os componentes devem ser portáveis para diversas plataformas distintas, o que aumenta ainda mais as possibilidades de reuso.

O ambiente descrito neste artigo foi implementado utilizando componentes de software tanto no desenvolvimento do Módulo do Professor quanto no Módulo do Aluno. Com isso, exploram-se as vantagens deste método de desenvolvimento de aplicações, expostas nesta seção.

DESCRIÇÃO INFORMAL DO AMBIENTE

Os dois atores que interagem com o ambiente descrito neste artigo são o Professor e o Aluno. O Professor é identificado pelo seu nome, pela disciplina que ministra, pelo código desta disciplina e pela turma pela qual é responsável. O ambiente proporciona ao Professor a criação de uma ou mais Listas de Exercícios, que possuem os seguintes atributos: um código para identificação da lista, o seu título, a sua data de criação e a sua data de entrega. As Listas são compostas por uma ou mais Questões.

Cada Questão possui um número único para identificá-la e é de um determinado tipo (Questão de Verdadeiro ou Falso ou Questão de Múltipla Escolha). As Questões de Verdadeiro ou Falso têm como atributos o texto da questão, uma justificativa que explica qual é a razão do texto da questão ser verdadeiro ou falso, e qual é a resposta correta à questão (verdadeiro ou falso). Já as Questões de Múltipla

Escolha, por sua vez, têm como atributos o texto da questão, uma justificativa que explica porque determinada alternativa é considerada correta, os textos das cinco alternativas a serem apresentadas ao Aluno e a resposta correta da Questão (alternativa A, B, C, D ou E).

Os Alunos são identificados pelo seu código de aluno e pelo seu nome. O Aluno resolve uma Lista de Exercícios, gerando, com isso, uma Resolução, que contém o seu índice de acertos e um relatório a respeito do seu desempenho, indicando, por exemplo, quais foram as questões respondidas corretamente, quais foram respondidas incorretamente e uma justificativa para o fato de a resposta dada à questão ter sido considerada incorreta.

O ambiente também fornece ao professor estatísticas relativas ao desempenho individual e coletivo dos alunos na resolução das Listas de Exercícios, o que oferece subsídios que auxiliam o professor na tarefa de aperfeiçoar o processo educacional.

A ARQUITETURA DO AMBIENTE

Baseado na Descrição Informal da aplicação, definiu-se, para o ambiente descrito neste artigo, a arquitetura exibida na Figura 1:

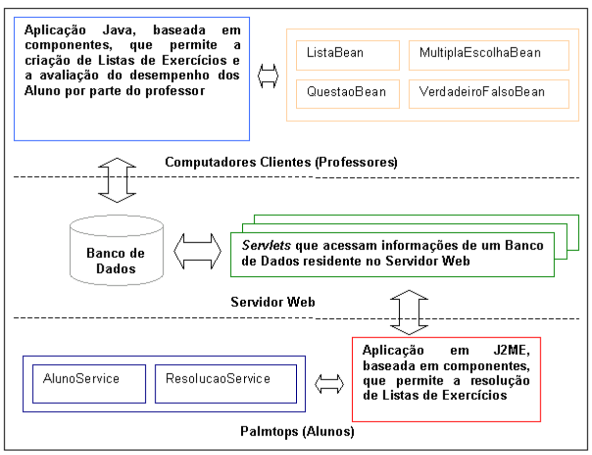

FIGURA. 1
ARQUITETURA DO AMBIENTE DESCRITO, UTILIZANDO COMPONENTES DE SOFTWARE.

O Módulo do Professor previamente mencionado baseia-se em *JavaBeans*, e permite que professores criem listas de exercícios, contendo questões de verdadeiro ou falso e de múltipla escolha. A tecnologia *JavaBeans* foi responsável pela introdução do conceito de componentes em Java. Utilizando-se *JavaBeans*, pode-se criar componentes de software reutilizáveis e independentes de plataforma [5]. Esta aplicação conta com os seguintes *JavaBeans*: ListaBean, QuestaoBean, MultiplaEscolhaBean e VerdadeiroFalsoBean. Cada um destes *JavaBeans* possui alguns atributos específicos e métodos para inserir, alterar, recuperar e excluir informações de um banco de dados que armazena as listas de exercícios criadas pelos professores.

Estas listas de exercícios ficam disponíveis em um banco de dados localizado em um Servidor Web remoto, no qual também residem *Servlets* que podem recuperar, alterar e armazenar informações neste banco de dados.

A arquitetura da Figura 1 exibe ainda o Módulo do Aluno, desenvolvido em J2ME, que faz uso de componentes de software especialmente desenvolvidos para esta tecnologia, o AlunoService e o ResolucaoService. Na tecnologia J2ME, os componentes de software são chamados de *Services* [6]. O Módulo do Aluno permite que os alunos resolvam as listas de exercícios previamente criadas pelos professores. A aplicação J2ME envia os dados da resolução aos *Servlets* residentes no Servidor Web. Os *Servlets*, por sua vez, recebem estas informações e as armazenam no banco de dados do Servidor Web, deixando-as à disposição do professor. Com isso, o professor pode fazer uma avaliação do desempenho individual e coletivo dos alunos na resolução de uma determinada lista de exercícios, utilizando outra funcionalidade do Módulo do Professor.

A INTERFACE DO AMBIENTE

Esta seção apresenta a interface do ambiente descrito neste artigo, exibindo segmentos tanto do Módulo do Professor quanto do Módulo do Aluno. Quando o professor acessa o ambiente, é apresentada a ele a tela exposta na Figura 2:

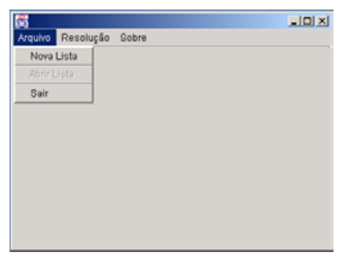

FIGURA. 2
TELA PRINCIPAL DO AMBIENTE.

Conforme pode ser visto na Figura 2, algumas opções são apresentadas ao professor, como, por exemplo, criar uma nova lista (opção "Nova Lista" no Menu "Arquivo" da Figura 2). Quando optar por criar uma nova lista de exercícios, o professor é conduzido à tela apresentada na Figura 3:

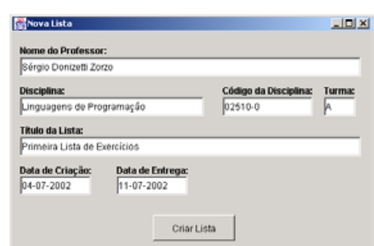

FIGURA. 3
TELA PARA A CRIAÇÃO DE UMA NOVA LISTA DE EXERCÍCIOS.

Nesta tela o professor fornece os dados relevantes para a criação de uma nova lista de exercícios. Clicando no botão “Criar Lista” uma nova lista de exercícios é criada. A partir daí, o professor pode começar a trabalhar na elaboração das questões que irão compor a lista recém-criada. Se optar por incluir na lista uma questão de verdadeiro ou falso, a tela da Figura 4 será exibida.

O professor deverá escrever o texto da questão e uma justificativa sobre a razão do texto da questão ser verdadeiro ou falso. Esta justificativa será apresentada ao aluno quando este responder de forma incorreta a uma questão. O professor deverá assinalar ainda qual é a resposta correta (verdadeiro ou falso). Clicando no botão “Incluir Questão”, esta questão será imediatamente incluída na lista de exercícios. Caso o professor deseje criar uma questão de múltipla escolha, a tela a ser exibida será a da Figura 5, e o procedimento para a criação de uma questão desse tipo será praticamente análogo ao adotado para a criação de uma questão de verdadeiro ou falso.

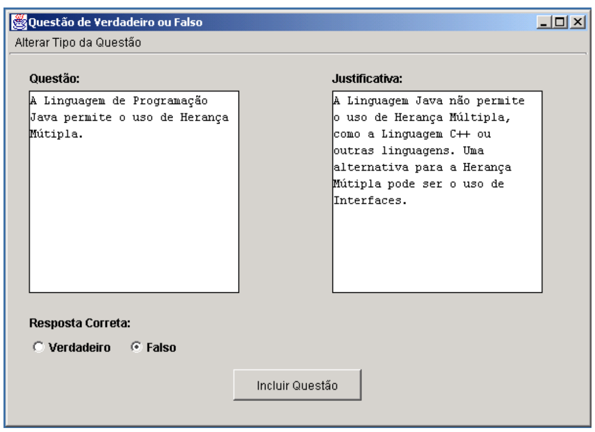

FIGURA. 4
TELA PARA A CRIAÇÃO DE QUESTÕES DE VERDADEIRO OU FALSO.

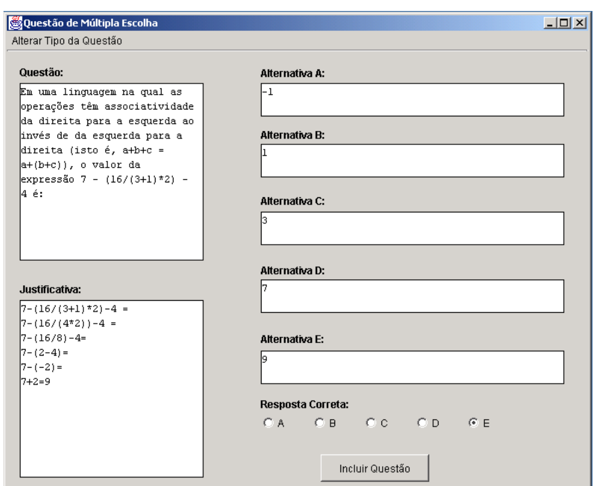

FIGURA. 5
TELA PARA A CRIAÇÃO DE QUESTÕES DE MÚLTIPLA ESCOLHA.

As listas de exercícios criadas com o auxílio deste ambiente ficam armazenadas em um banco de dados residente em um Servidor Web remoto, acessível para os professores que utilizam o ambiente. Todo o processo de armazenamento, consulta, remoção e edição de listas de exercícios é feita com o auxílio do ambiente, que, para isso, utiliza-se de componentes *JavaBeans*. No Servidor Web onde ficam armazenadas as listas de exercícios também residem *Servlets*.

Conforme foi dito anteriormente, aplicações J2ME podem se comunicar com *Servlets*, o que torna possível que essas aplicações acessem bancos de dados remotos na World Wide Web. No caso do ambiente descrito neste artigo, a aplicação J2ME correspondente ao Módulo do Aluno se comunica com *Servlets* que, por sua vez, fazem acesso aos dados das listas de exercícios geradas pelos professores. Estes *Servlets* também são responsáveis por corrigir e por armazenar os dados relativos à resolução dos alunos no Servidor Web, de tal maneira que os professores possam acessar estas resoluções em seus *desktops*, o que lhes permite avaliar o desempenho dos alunos. Dessa forma, o ambiente também permite que os professores possam fazer um acompanhamento e uma avaliação do desempenho dos alunos no processo de resolução dos exercícios. A Figura 6 exibe exemplos de telas dos Palmtops dos alunos acessando uma lista de exercícios:

FIGURA. 6
EXEMPLOS DE TELAS DOS ALUNOS ACESSANDO OS EXERCÍCIOS.

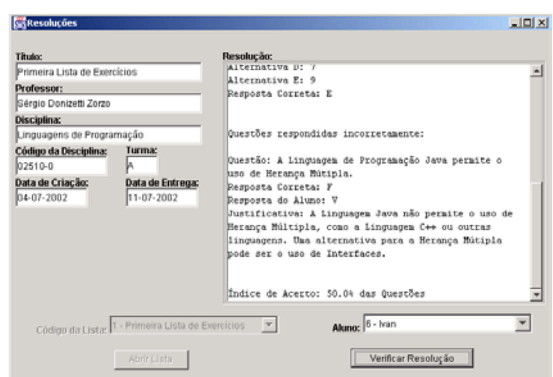

FIGURA. 7
RELATÓRIO DE DESEMPENHO INDIVIDUAL EXIBIDO A UM PROFESSOR.

A Figura 7, por sua vez, mostra a tela que permite ao professor analisar o desempenho individual de um aluno na resolução de uma lista de exercícios, enquanto que a tela exibida na Figura 8 corresponde à interface que possibilita ao professor fazer uma análise coletiva de desempenho.

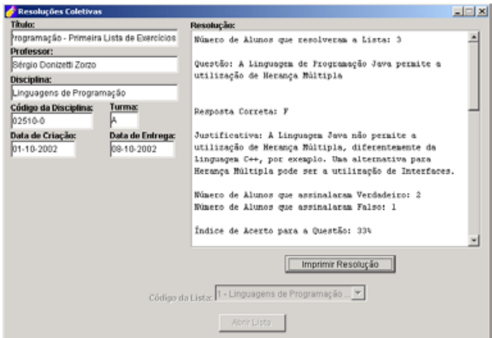

FIGURA. 8
RELATÓRIO DE DESEMPENHO COLETIVO EXIBIDO A UM PROFESSOR.

Conforme mencionado anteriormente, os *Servlets* desenvolvidos para este ambiente também se encarregam de fazer a correção automática das listas de exercícios e de gerar um relatório de desempenho que será visualizado pelos alunos em seus Palmtops. Este relatório traz o índice de acerto de um aluno na resolução de uma determinada lista de exercícios e também todas as questões respondidas correta e incorretamente pelo aluno, bem como as respostas corretas de cada questão e uma justificativa que explica porque uma determinada resposta é considerada correta. A Figura 9 exibe um exemplo de relatório visualizado por um aluno em seu Palmtop.

FIGURA. 9
RELATÓRIO DE DESEMPENHO DE UM ALUNO EXIBIDO EM UM PALMTOP.

Com isso, o ambiente auxilia o aluno no processo de aprendizado, uma vez que os estudantes não apenas respondem às questões, mas também podem verificar quais questões erraram e quais são as razões pelas quais a sua resposta foi considerada incorreta.

CONCLUSÕES

O ambiente descrito neste artigo tem como principal objetivo possibilitar a criação simples e intuitiva de listas de exercícios e é composto por dois módulos distintos: o Módulo do Professor e o Módulo do Aluno. Enquanto o Módulo do Professor é executado em computadores de mesa convencionais, o Módulo do Aluno é direcionado para ser utilizado em Palmtops, e foi desenvolvido com a tecnologia Java 2 Micro Edition (J2ME), também exposta neste artigo. Com isso, expande-se ainda mais a ubiqüidade oferecida pela Educação a Distância (EAD), que tem como uma das suas principais características levar conhecimento para qualquer pessoa, independentemente do lugar onde esta se encontra.

Utilizando-se Palmtops, dispositivos pequenos e capazes de acessar dados da World Wide Web em ambientes sem fio, pessoas interessadas em acessar conteúdo didático poderão fazê-lo facilmente, sem a necessidade de estarem conectadas a redes de computadores convencionais. Com a utilização da tecnologia J2ME, aplicações criadas para dispositivos dedicados adquirem qualidade comparável a aplicativos desenvolvidos para *desktops*.

O processo de criação do ambiente é apoiado pelas técnicas do Desenvolvimento de Software Baseado em Componentes, tanto na aplicação desenvolvida para *desktops* quanto na aplicação para Palmtops. Detalhes relativos a esta técnica também foram expostos neste artigo. Tanto os componentes desenvolvidos para *desktops,* baseados na tecnologia *JavaBeans,* como aqueles desenvolvidos para Palmtops, os chamados *Services*, são facilmente extensíveis e podem ser reutilizados por outras aplicações de EAD.

Foi formulada, ainda, uma descrição informal do ambiente descrito, visando especificá-lo claramente antes de se elaborar uma arquitetura para este ambiente. Esta arquitetura também foi apresentada neste artigo. Por fim, expôs-se a interface dos Módulos do Aluno e do Professor, mostrando-se um exemplo do processo de criação de uma lista de exercícios e da resolução desta lista por parte do aluno. Foram mostradas também as interfaces do ambiente que permitem ao professor avaliar o desempenho individual e coletivo dos alunos na resolução das listas de exercícios criadas.

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OBJETOS DE APRENDIZAGEM PARA O ENSINO DE PROGRAMAÇÃO EM ENGENHARIA E COMPUTAÇÃO

Ivan Carlos Alcântara de Oliveira[1], *Carlos Fernando de Araújo Jr.* [2] *e Manuel Fernández Paradela Ledón* [3]

Resumo — *Este trabalho descreve um framework para ambientes de aprendizagem baseado na Web que integra um objeto de interface para inserção de conteúdos digitais, a modelagem deste conteúdo e um interpretador de algoritmos com recursos para o aluno exercitar a solução de problemas representados em pseudocódigo. O objeto de interface foi desenvolvido com HTML (Hypertext Markup Language), JavaScript e CSS (Cascading Styles Sheets) permitindo a criação de arquivos pequenos e interfaces interativas seguindo critérios de design com o objetivo de facilitar a procura de partes do conteúdo modelado. O interpretador de algoritmos foi desenvolvido com a tecnologia Java, possibilitando a análise léxica e sintática de um programa escrito em uma linguagem algorítmica estruturada denominada PoStWEL (Português Estruturado do Projeto WEL). Sua interface simples e robusta possibilita ao aluno escrever e compilar facilmente seus exercícios.*

Palavras Chaves — conteúdo digital, ensino de programação, interpretador, objetos de aprendizagem.

1. INTRODUÇÃO

Nos últimos anos, o constante crescimento do número de cursos que se utilizam das tecnologias baseadas na *web*, vêm provocando uma verdadeira revolução nas mais diversas áreas da educação [1]. A crescente popularização de tecnologias hipermídia vem provocando uma demanda cada vez maior por cursos a distância, cuja qualidade é medida não somente pelo conteúdo, mas também por seu *design*, navegabilidade, organização e clareza das informações [2].

Um fator relevante é que uma vasta gama de recursos computacionais podem ser utilizados na preparação de materiais e em geral não o são. Exemplos disso são: simulações em tempo real, modelos tridimensionais, avaliações eletrônicas, animações e gráficos, recursos de grande importância no processo de aprendizagem e que dificilmente são reproduzidos em sala de aula no ensino tradicional [3]. Isto Posto, o Núcleo de Pesquisa em Computação e Tecnologia da Informação (NCTI) da UNICSUL (Universidade Cruzeiro do Sul) propôs um projeto temático, chamado Projeto WEL (*Web Engineering for Learning*) que engloba basicamente a produção de conteúdo digital para algumas disciplinas dos cursos de graduação em Engenharia e Computação e a construção de alguns componentes de software, denominados objetos de aprendizagem, com o intuito de facilitar o entendimento dos alunos em algumas disciplinas científicas e técnicas [4][5][6]. Os objetos de aprendizagem desenvolvidos neste trabalho são:

- Um objeto de interface para disponibilizar conteúdo digital. Para este objeto também foi modelado o conteúdo de uma disciplina básica relacionada a programação dos cursos de Computação e Informática chamada Estruturas de Dados [7].
- Um objeto de simulação que envolve um interpretador de algoritmos baseado na *Web* onde o aluno pode testar os algoritmos descritos no material das disciplinas e/ou desenvolvê-los na linguagem algorítmica PoStWEL (*Português Estruturado do Projeto Wel*) [8].

Este artigo está organizado em seções conforme segue:

- Na seção 2 são fornecidos detalhes sobre o projeto temático WEL e onde os objetos de aprendizagem descritos estão inseridos.
- Os conceitos relacionados a objetos de aprendizagem e as tecnologias que foram utilizadas na criação destes objetos são introduzidos na seção 3.
- A proposta e os resultados obtidos com a implementação são descritos na seção 4.
- A conclusão obtida com o desenvolvimento e a respectiva continuidade em trabalhos futuros são especificados na seção 5.

2. PROJETO WEL (*WEB ENGINNERING FOR LEARNING*)

O projeto WEL (*Web Engineering for Learning*) é um projeto temático financiado pela UNICSUL (Universidade Cruzeiro do Sul) que propõe o desenvolvimento de software baseado na Web, com uso das metodologias, técnicas e métricas de qualidade da área de *Web Engineering*, para disponibilizar material "instrucional" direcionado ao aprendizado e apoio às disciplinas técnicas e científicas nas áreas de Computação e Engenharia [2]. Este projeto foi

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[2] Carlos Fernando de Araújo Jr., Universidade Cruzeiro do Sul - UNICSUL, Av. Dr. Ussiel Cirilo, 225 – 08060-070, São Paulo, SP, Brazil, carlos.araujo@unicsul.br
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subdividido em quatro projetos de pesquisa conforme Fig. 1. Da figura observa-se o item "Engenharia da Informação e Modelagem de conteúdos" onde se encaixa o objeto de interface e a modelagem do conteúdo e o item "Construção de Programa de Simulação para Apoio ao Aprendizado" onde o interpretador está inserido. Neste projeto foram selecionadas disciplinas de graduação relacionadas ao desenvolvimento de algoritmos, programação, física e cálculo numérico. A disciplina, associada a programação, Estruturas de Dados foi a escolhida como objeto inicial para a modelagem de conteúdo.

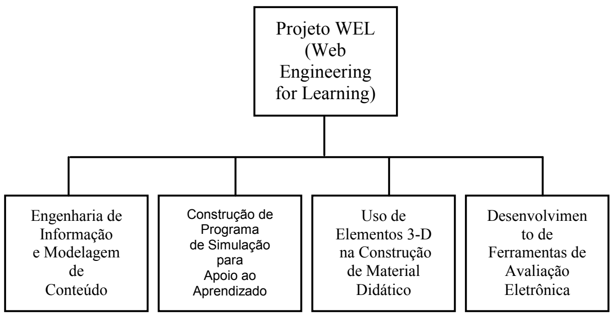

FIGURA. 1
SUBDIVISÃO DOS PROJETOS DE PESQUISA DENTRO DO PROJETO TEMÁTICO WEL

3. OBJETOS DE APRENDIZAGEM E TECNOLOGIAS PARA A WEB: ESTADO ATUAL

3.1 Objetos de Aprendizagem

Objetos de aprendizagem são elementos de um novo tipo de aprendizagem baseado em computador utilizando conceito de orientação à objetos como, por exemplo, a criação de componentes. Estes objetos são, normalmente, pequenos, específicos e podem ser reutilizados em contextos diferentes. [6]

Objetos de aprendizagem podem ser definidos como entidades digitais com acesso via Web, de forma que inúmeras pessoas possam usufruir dos seus benefícios simultaneamente [6]. Para que um objeto possa ser reusável deve ser flexível, interoperável e possuir facilidade de atualização e busca.

Alguns exemplos de objetos de aprendizagem são:

- Fotos ou imagens digitais, animações e pequenas aplicações.
- Páginas *web* que combinam texto, imagens e outros meios ou aplicações.
- Sistemas de treinamento por computador, ambientes de aprendizagem interativos, sistemas inteligentes de instrução com o auxílio do computador.

Algumas organizações internacionais voltadas a padronização, como o LTSC (*Learning Tecnology Standard Commitee*), estão desenvolvendo padrões abertos para os objetos de aprendizagem, focando a sua reusabilidade, permitindo que ocorra a redução de tempo no desenvolvimento e facilidade na sua distribuição e adaptação [9].

3.2 Tecnologias para Desenvolvimento Web

O desenvolvimento de objetos de aprendizagem para a Internet pode ser realizado utilizando vários tipos de tecnologias. Pode-se gerar poderosas aplicações com CGI (*Common Gateway Interface*) e Servlets (*Dynamic WebPages in Java*) do lado servidor com a inclusão de Applets Java e JavaScript/CSS (*Cascading Styles Sheets*) do lado cliente permitindo a modificação ou adaptação do conteúdo a ser apresentado ao aluno dependendo de suas ações. O foco deste trabalho está no desenvolvimento de dois objetos de aprendizagem utilizando principalmente as tecnologias JavaScript e Java.

JavaScript é uma linguagem interpretada que associada ao CSS possibilita desenvolver páginas dinâmicas com maior interação permitindo a criação de interfaces mais atraentes com recursos de navegação mais simples e interativos que podem motivar o aprendizado e prender a atenção do aluno[10][11].

Java pode ser executado do lado cliente na forma de um *applet,* inserido em páginas *web*, ser carregado e processado em browsers a partir da solicitação do usuário[12]. O uso de *applets* tem como vantagens a criação de interfaces mais complexas, a independência de plataforma, não necessita instalação e atualização pelo aluno além de ser removido depois do término do seu processamento. Há algumas restrições de segurança que impedem ler ou escrever arquivos no disco local e a comunicação fica restrita somente ao servidor de origem do *applet*. Para contornar esta restrição esquemas de autenticação e modificação da política de segurança da JVM (*Java Virtual Machine*) podem ser implementados. Além das classes Java comuns para geração do *applet* foram utilizados duas ferramentas JFlex e Cup que são distribuídos gratuitamente e são escritas em Java [13][14]. A importância destas duas ferramentas auxiliares está ligada ao código em Java que elas geram para os analisadores léxico e sintático. Atualmente estas ferramentas se encontram nas versões CUP 0.10, para gerar o analisador sintático, e JFlex 1.3.5, para gerar o analisador léxico. Na geração dos analisadores é necessária a definição de dois arquivos de configuração, um com extensão ".flex" e outro com a extensão ".cup" onde são especificadas as informações necessárias à criação destes analisadores.

O desenvolvimento do objeto de interface foi baseado em HTML, JavaScript e CSS e o interpretador em *applet* Java com o Jflex e o Cup.

4. PROPOSTAS E RESULTADOS

4.1 Objeto de Interface e o Conteúdo Digital Modelado

O objeto de aprendizagem para inserção de conteúdo digital foi construído para possibilitar a modelagem de conteúdos de cursos e disciplinas, subdivididos em módulos e submódulos pequenos utilizando uma interface padronizada [2]. Esta padronização é uma tentativa de facilitar a navegação e a procura de informação pelo aluno dentro do conteúdo.

A Fig. 2 ilustra um modelo do arquivo CSS utilizado para padronizar determinados itens de interface como menus, títulos, tipos e cores das fontes do conteúdo digital [10][11].

```
<style type="text/css">
<!--
.curso {position:absolute; top:0px; left:334px;
visibility:visible; width:58%;}
.nav1 {position:absolute; top:25px; left:334px;
...
.variavel{position:absolute; top:0px; left:0px;
visibility:hidden;}
li.inside{list-style-position:inside;}
body {background-color:lightblue;}
a,font {color:black; font-family:verdana; font-
size:12pt; text-decoration:none;}
a:hover {color:blue;}
-->
</style>
```

FIGURA. 2
ARQUIVO CSS ANEXADO A UMA PÁGINA WEB PARA PADRONIZAR COMPONENTES DO OBJETO DE INTERFACE.

Como forma de testar este objeto foi modelado o assunto "árvore" da disciplina Estruturas de Dados. Este assunto possui um conteúdo relativamente complexo e um caráter de abstração considerável onde nem sempre o professor consegue que os alunos compreendam de forma clara as operações ocorridas em cada estrutura.

A Fig. 3 ilustra três modelos de interface obtidos com o desenvolvimento deste objeto de aprendizagem. No modelo de interface (1) observa-se: o logo da instituição, título da disciplina, navegação entre módulos (anterior, próximo), título do módulo, quantidade de submódulos com possibilidade de navegação seqüencial ou aleatória pelo aluno, ligações para exemplos e exercícios relacionados a disciplina, possibilidade de retornar ao índice. O modelo de interface (2) demonstra a organização do conteúdo na forma de um índice. No modelo (3) observa-se um exemplo que permite ao aluno interagir com o conteúdo obtendo informações sobre o desenho da árvore como por exemplo, grau de parentesco, grau de um nó, altura da árvore e outros.

A modelagem da interface e do conteúdo seguiu critérios de *design* envolvendo, principalmente, usabilidade, comunicabilidade e navegação, como tentativa de gerar um ambiente com conteúdo capaz de prender a atenção do aluno, possibilitar uma maior interação com o material e deixar a navegação mais intuitiva e simples [2].

4.2 Interpretador de Algoritmos: Um objeto de Simulação

O interpretador é um objeto de aprendizagem que lê um conjunto de símbolos descrito em uma determinada linguagem, analisa e informa se a junção destes símbolos está léxico, sintático e semanticamente corretos. Não gera um programa executável mas deseja-se que ele seja capaz de executar o programa gerando algum tipo de resultado. No estágio atual de desenvolvimento foi implementado somente os analisadores léxico e sintático [15].

Inicialmente foi criada uma gramática para uma linguagem algorítmica, denominada PoStWEL, desenvolvido um *applet* Java constando de um editor de texto e dos analisadores léxico e sintático [12].

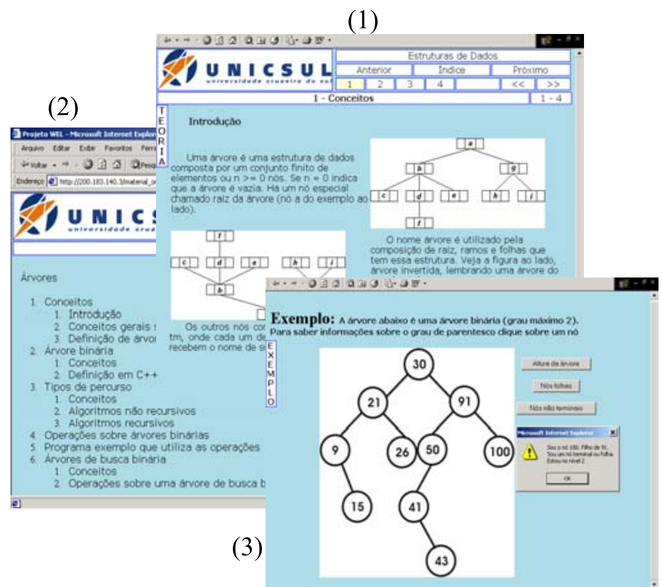

FIGURA. 3
OBJETO DE INTERFACE E A MODELAGEM COM CONTEÚDO E EXEMPLO INTERATIVO.

4.2.1 Gramática da linguagem PoStWEL (Português Estruturado do Projeto WEL)

A gramática da PoStWEL segue a estrutura de uma gramática livre de contexto, como definida pelo lingüista Noam Chomsky [8], onde uma determinada cadeia segue regras para sua formação, como descrito abaixo:

$$A \rightarrow \beta \qquad (1)$$

Em (1) "A" representa um conjunto de símbolos denominados não terminais e "β" uma combinação de símbolos terminais e não terminais. Podemos dizer que um símbolo terminal é qualquer palavra reservada, símbolo especial, operador que pertença a linguagem descrita. E os não terminais são os símbolos utilizados durante o processo de derivação das produções no reconhecimento de uma dada cadeia.

A tabela I ilustra algumas produções desta gramática utilizando a notação BNF (*Backus Normal Form*) onde o símbolo inicial é <postwel>.

TABELA I

ALGUMAS PRODUÇÕES DA POSTWEL

Simbolos não-terminais (A)	Regras de produção (β)
<postwel> ::=	ALGORITMO <nome> ; <bloco>
<bloco> ::=	INICIO <corpo> FIM
<corpo> ::=	<declaraçãoCorpo> | <comds>
<comds> ::=	<atribuição> ; <comds> | <seCondicional> <comds> | ...
<seCondicional> ::=	SE (<expressaoLogica>) ENTAO <acao> | SE (<expressaoLogica>) ENTAO <acao> SENAO <acao>
<acao>::=	<comandoSimples> | <blocoComandos>
<blocoComandos> ::=	INICIO <comds> FIM

Um exemplo de programa escrito em PoStWEL que calcula o fatorial de um número é ilustrado na Fig. 4.

```
algoritmo "Calcula fatorial de um Número" ;
inicio
     inteiro num, fat, i;
     escreva ( "Digite um Numero : " );
     leia ( num );
     fat = 1;
     i = 1;
     enquanto (i <= num) faca
     inicio
        fat = fat * i;
        i = i + 1;
     fim
     escreva ("O Fatorial deste numero é: ", fat);
fim
```

FIGURA. 4

ALGORITMO EXEMPLO NA LINGUAGEM POSTWEL QUE CALCULA O FATORIAL DE UM NÚMERO.

4.2.2 Processo de Interpretação: Análise Léxica e Sintática

O mecanismo de interpretação representado na Fig. 5 segue com o pedido de verificação pela *applet* que envia o arquivo (*reader*) a ser avaliado ao analisador sintático, este segue com a captação dos símbolos ou *tokens* do arquivo de entrada pelo analisador léxico (*scanner*) que envia token a *token* ao analisador sintático (*parser*) que reconhece uma sentença através do conjunto de símbolos definidos pela linguagem algorítmica ao passo que a cada verificação de um conjunto de símbolos (*yybuffer*) interpretados poderá surgir inconsistências com a gramática fazendo com que o analisador sintático gere erros sintáticos mostrando o local através da linha (*yyline*) onde existe a inconsistência [15].

Um manipulador de erros é ativado sempre que for detectado um erro no programa fonte, avisando ao programador da ocorrência do erro e emitindo uma mensagem. O procedimento construído para o tratamento de erros foi interromper a análise léxica e sintática quando um erro é encontrado.

Um trecho do arquivo relativo ao analisador léxico que ilustra algumas definições de *tokens* no formato de expressões regulares são exibidos na Fig. 6 e outro trecho do arquivo para o analisador sintático mostrando as regras para a formação dos elementos sintáticos podem ser visualizados na Fig. 7.

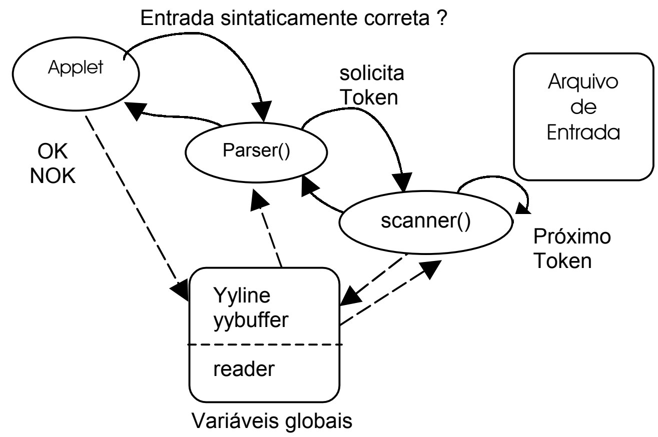

FIGURA. 5

ALGORITMO EXEMPLO NA LINGUAGEM POSTWEL QUE CALCULA O FATORIAL DE UM NÚMERO.

```
...
/* identifiers */
Identifier = [:jletter:][:jletterdigit:]*
/* integer literals */
DecIntegerLiteral = 0 | [1-9][0-9]*
%state STRING, CHAR
%%
/* ------------------------Lexical Rules Section-------*/
<YYINITIAL> {
/* palavras chaves */
"algoritmo"                 { return symbol(ALGORITMO); }
"inicio"            { return symbol(INICIO); }
"fim"                       { return symbol(FIM); }
…
```

FIGURA. 6

TRECHO DO ARQUIVO DE CONFIGURAÇÃO ".JFLEX" (ANALISADOR LÉXICO).

```
...
non terminal var_caracter;
non terminal var_logica;
non terminal var_numerica;
non terminal vetor;
/* start with algoritmo; */
start with postwel;
/****** gramatica ******/
postwel ::= ALGORITMO nome PONTO_VIR  bloco;
nome  ::= _STRING_ ;
bloco ::= INICIO corpo FIM;
bloco_comandos ::= INICIO comds FIM;
corpo  ::=   declaracao corpo
          | comds;
comds ::= | atribuicao PONTO_VIR comds
          | entradaSaida comds
          | se_condicional comds
...
```

FIGURA. 7

TRECHO DO ARQUIVO DE CONFIGURAÇÃO ".CUP" (ANALISADOR SINTÁTICO).

4.2.3 Modelagem, desenvolvimento e resultado do Interpretador

O interpretador foi modelado utilizando a linguagem UML (*Unified Modeling Language*). Uma parte do diagrama obtido é descrito na Fig. 8 [16]. O desenvolvimento foi realizado com Java, utilizando Jflex e Cup, a interface gráfica foi implementada utilizando o pacote Swing e um componente do pacote AWT [12][13][14].

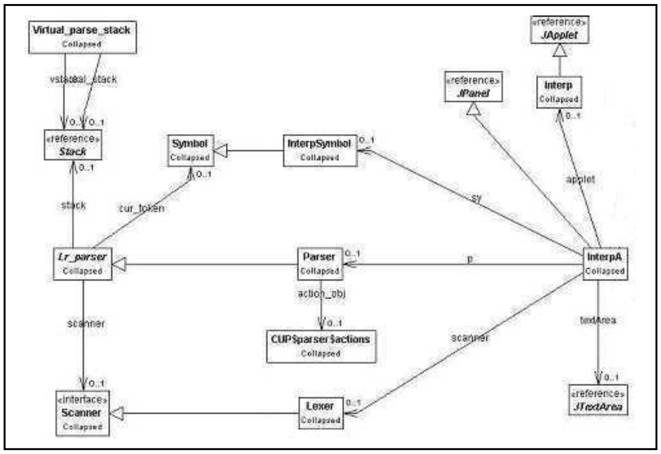

FIGURA. 8

DIAGRAMA DE CLASSES EM UML QUE MODELA O INTERPRETADOR DE ALGORITMOS.

O resultado da interface para o interpretador e a execução de um algoritmo é ilustrada na Fig. 9.

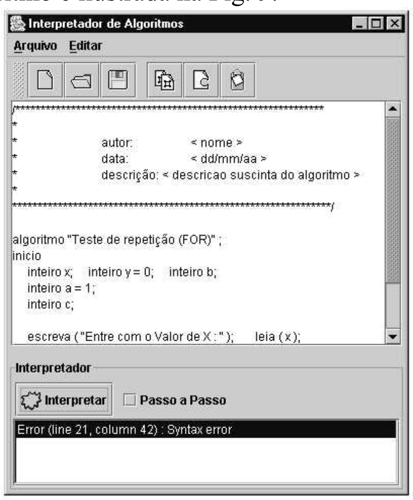

FIGURA. 9

INTERFACE DO INTERPRETADOR , NO FORMATO DE APLICAÇÃO, ILUSTRANDO A COMPILAÇÃO DE UM ALGORITMO.

5. CONCLUSÕES E TRABALHOS FUTUROS

A utilização dos objetos em disciplinas presenciais ou semi-presenciais possibilitará ao professor ilustrar determinadas situações nem sempre tão claras quando a aula é apresentada de maneira tradicional [3].

A possibilidade de maior interação, facilidade de navegação e simplicidade permitirá que o aluno fique mais estimulado a estudar conteúdos de difícil compreensão.

Os objetos construídos poderão ser reusados como um *framework* em disciplinas técnicas e/ou científicas com pouca ou nenhuma alteração interna.

Como trabalhos futuros pretende-se:

- Acrescentar a analise semântica ao interpretador.
- Possibilitar a conversão dos algoritmos criados em PoStWEL para linguagens de programação tipo C/C++ e Java de forma automática.
- Possibilitar a execução passo a passo do algoritmo previamente compilado dentro do interpretador.
- Aplicar o material modelado em disciplinas presenciais avaliando o desempenho dos alunos e comparando ao ensino tradicional.

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TECNOLOGIA PORTÁTIL E A REOGANIZAÇÃO DO PENSAMENTO

Fernanda Cesar Bonafini[1]

Resumo — *Neste artigo apresenta-se primeiramente os instrumentos denominados no título por tecnologia portátil, que são: a Calculadora Gráfica, o MBL (Microcomputer Based Laboratory), o CBR (Calculator Based Ranger) e o CBL (Calculator Based Laboratory). Destacando em seguida suas possibilidades como: recolher, trabalhar e trocar dados com professores e alunos dentro e fora da sala de aula. Após isso, faz-se uma revisão de literatura empregando o uso desses instrumentos e destacando suas potencialidades propostas por alguns autores, tais como: a utilização como instrumento pedagógico, a alteração da dinâmica da sala de aula, o uso na construção e re-construção de gráficos, sua efetividade na condução de experiências cinestésicas envolvendo o tema movimento, entre outras. Num terceiro momento, apresenta-se as idéias de reorganização do pensamento também presente no título do artigo. Nas considerações finais, elabora-se um entrecorte da revisão de literatura sob a ótica da reorganização do pensamento pontuando algumas analogias e colocando neste bojo a pergunta de pesquisa da autora.*

Index Terms — *tecnologia portátil, calculadoras gráficas, cbl, reorganização do pensamento.*

INTRODUÇÃO

Este artigo é parte de minha pesquisa de mestrado, na qual tenho como objetivo principal analisar, *como estudantes podem trabalhar conceitos matemáticos e físicos ao utilizarem o CBL (Calculator Based Laboratory) e a Calculadora Gráfica em atividades de experimentação*.

Entendo por experimentação "uma prática onde problemas abertos são propostos pelo professor e onde há uma exploração em grupo de temas relacionados com a matemática" (BORBA, 1999, p.26). O objetivo geral dessas atividades de experimentação é encontrar o melhor ajuste de funções para dados experimentais, modelando o fenômeno, validando a teoria e interpretando os valores dos parâmetros dessas funções.

Para que isso ocorra, será necessário que o aluno combine conhecimento de diferentes tipos de funções com conhecimento sobre experimentos físicos. As atividades de experimentação poderão facilitar a interdisciplinaridade, integrando a Matemática à Física, pois ao experimentar, os alunos poderão verificar as aplicações da Matemática na prática para um dado conceito desenvolvido.

A pesquisa será desenvolvida numa perspectiva qualitativa, pois como GOLDENBERG (2000) afirma nesta abordagem "a preocupação do pesquisador não é com a representatividade numérica do grupo pesquisado, mas com o aprofundamento da compreensão de um grupo social, de uma organização, de uma trajetória etc" (p. 14). Sabendo que a abordagem qualitativa em uma pesquisa também *"*consiste em descrições detalhadas de situações com o objetivo de compreender os indivíduos em seus próprios termos*"* (GOLDENBERG, 2000, p. 53), acredito ser esta a metodologia mais indicada para esta investigação.

Neste artigo apresentarei brevemente os instrumentos que denomino no título por tecnologia portátil, uma revisão parcial de literatura, as idéias de reorganização do pensamento também presente no titulo do artigo e finalmente nas conclusões finais faço um entrecorte da revisão de literatura sob a ótica da reorganização do pensamento.

TECNOLOGIA PORTÁTIL

A tecnologia portátil ou tecnologia de mão presente nas calculadoras gráficas, dá ao aluno a possibilidade de recolher, trabalhar e trocar dados com professores e colegas dentro e fora da sala de aula, não só nas atividades de Matemática, mas também em aulas de Física, Química, Biologia e disciplinas afins de cada currículo.

As calculadoras gráficas são superiores às calculadoras científicas, pois possuem além de inúmeras funções adicionais (como por exemplo, as funções estatísticas) a propriedade de confeccionar diversos tipos de gráficos a partir de funções ou tabela de dados, ambos inseridos pelo aluno.

Outro instrumento portátil é o CBR (Calculator Based Ranger). Ele é um detector sônico, sendo geralmente utilizado para estudo das leis de movimento (medição de distância) e suas análises posteriores como velocidade e a aceleração. Com o CBR é possível fazer a coleta de dados e visualizá-la através de uma calculadora gráfica conectada a ele, designando assim, um sistema CBR.

Além do CBR citado acima, destaco o CBL (Calculator Based Laboratory) que é também um dispositivo utilizado para coleta de dados. Este sendo um aparelho portátil, funciona com pilhas, sendo assim um instrumento autônomo na coleta de dados (medição de grandezas).

Possuindo dimensões compactas ele pode ser usado em atividades de Matemática e Ciências, de um modo geral. Esse dispositivo pode ser conectado à vários sensores (ponta de prova), dentre eles: detector de movimento, tensão, luz, pH, pressão, condutividade, temperatura, força, batimentos cardíacos e muitos outros, possibilitando que a sala de aula se transforme em um laboratório.

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É importante elucidar que somente os sensores acima, não são capazes de efetivar um experimento, sendo necessário que eles estejam conectados ao CBL. Para a visualização e armazenamento dos dados coletados poderemos utilizar um microcomputador, o que caracteriza um sistema MBL (Microcomputer Based Laboratory) ou uma calculadora gráfica, caracterizando um sistema CBL.

PESQUISAS REALIZADAS

Inicio esta seção, com a revisão de literatura que emprega o uso das calculadoras gráficas, do MBL, do CBR e finalmente do CBL. Na segunda parte, proponho as idéias de Tikhomirov (1981) que questiona se o computador afeta a atividade intelectual humana, e se sim, de que maneira. Num terceiro momento, evidencio as teorias desse autor enquanto perpasso por pontos principais da literatura. Desta maneira, informo ao leitor que as pesquisas com o uso desses instrumentos (calculadoras gráficas, MBL, CBR e CBL), se misturam ao longo dessa relação.

Calculadoras Gráficas

O uso de tecnologia portátil, como as calculadoras gráficas, vem sendo objeto de estudo de vários pesquisadores. Dentre eles destaco as pesquisas de Kemp, Kissane e Bradley (1996) que procuraram incorporar o uso da calculadora gráfica na estrutura curricular, possibilitando que o aluno a utilizasse inclusive nas provas. Waits (1992), em um de seus trabalhos, enumera dez tópicos que podem ser explorados com a calculadora gráfica em sala de aula, dentre eles a modelagem, simulação, condução de experiências matemáticas, onde o aluno pode formular e testar suas próprias conjecturas.

Sustentam Dunham e Dick (1994), que as calculadoras gráficas podem facilitar a mudança do papel do professor e do aluno na sala de aula, resultando em um ambiente de maior interação e exploração. Relata, que observações feitas em sala de aula, mostram que a calculadora gráfica tem mudado significativamente o relacionamento dos alunos em sala.

Do mesmo modo, Watanabe (1996) enfatiza a importância da presença das calculadoras gráficas como elemento transformador na educação matemática japonesa, que tem como característica um ensino formal e fortemente centrado na resolução de exercícios. Salienta, com exemplos, o uso da calculadora gráfica em aulas de pré-calculo, cálculo diferencial e resolução de problemas, criando um ambiente que pôde despertar a criatividade dos alunos e fazê-los 'perceber', realmente, a Matemática existente nos problemas apresentados.

Sestokas-Filho e Bonafini (2000, 2001 e 2002), destacam o uso de calculadoras gráficas em atividades de sala de aula. Os autores aconselham que, nessas atividades, de 15 a 20 minutos de duração, os alunos trabalhem em pequenos grupos enquanto o professor percorre a sala de aula auxiliando-os. Salientam que, deste modo, os alunos têm a oportunidade de negociar idéias, formular conceitos e construir seu próprio conhecimento em um ambiente favorável à experimentação.

Nota-se, nas pesquisas acima, que o uso da calculadora gráfica, acabou por provocar uma alteração na dinâmica da aula e no relacionamento dos alunos. Assim, procurando utilizar a calculadora gráfica como um instrumento pedagógico em sala de aula, Souza (1996), Souza e Borba (1998) propõem seu uso envolvendo o estudo de funções e de funções quadráticas. Nessas atividades, os alunos analisam famílias de funções, estabelecendo relações entre as representações gráficas e algébricas dessas famílias. Os autores afirmam que a calculadora gráfica, quando utilizada como instrumento pedagógico, permite que os alunos durante a construção dos gráficos, re-avaliem constantemente suas hipóteses e conjecturas possibilitando assim, um método empírico de aprender matemática. O caráter empírico, para esses autores, deve-se a possibilidade de o aluno experimentar a construção de gráficos, funções e tabelas... em sala de aula com o uso da calculadora gráfica.

Sendo a construção de gráficos uma habilidade fundamental tanto no ensino de Física como no ensino de Matemática, Adie (1997, p. 213) postula que "o processo de construção de um gráfico envolve uma série de conhecimentos que não contribuem realmente para um profundo entendimento do conteúdo da Física". As habilidades não Físicas usadas quando desenhamos um gráfico no papel, também descritas em Sestokas-Filho e Bonafini (2002) são: desenho de linhas retas (com régua) para os eixos x e y, trabalho com escalas, desenho dos pontos no gráfico, cálculo da barra de erro, desenho da 'melhor linha' entre os pontos e interpretação da inclinação do gráfico se este for uma reta. Adie (1997) confere a calculadora o poder de cerrar esse ritual, sustentando que o aluno deve conceder mais tempo para concentrar-se na Física presente na atividade.

Uma alternativa para o desenho de gráficos em papel seria utilizar um programa de computador como o excel ou uma calculadora gráfica. Sabendo que geralmente o uso de gráficos em Física e/ou Matemática envolvem a procura de uma função, o cálculo da área sobre uma curva ou a procura da inclinação num ponto particular, Adie (1997) reforça que as calculadoras gráficas fazem todas estas operações facilmente pressionando alguns botões, mas os alunos ainda necessitam um entendimento fundamental do significados dos gradientes, coeficientes, áreas e unidades para interpretar sensivelmente os resultados. Usando uma calculadora gráfica ao invés de lápis e papel, esse autor afirma que a rota pedagógica para a compreensão será diferente, mudando a ênfase do ensino no processo de conseguir resultados para uma solução qualitativa, onde o aluno pode indagar quão bom o resultado significa. Assim, pode-se estabelecer novos tipos de perguntas baseadas na sondagem e na análise de dados.

Para esse autor "os alunos perdem muito tempo nos aspectos matemáticos dos problemas físicos. A calculadora os livra disto permitindo que eles despendam mais tempo entendendo ou explicando Física" (p. 203).

Noto nos trabalhos acima, uma forte recorrência no uso da calculadora gráfica com características de simulação na construção de gráficos, de modo a fazer o estudante entender os processos matemáticos essenciais. No ensino superior, na Física há muitas oportunidades para o uso de cálculos de simulação, exemplos são mostrados no trabalho de Sestokas-Filho e Bonafini (2002).

Simulações com calculadoras gráficas são válidas, pois elas complementam os caminhos de estudo possibilitando que o aluno entenda os fenômenos físicos e os processos matemáticos presente em uma determinada atividade.

MBL/CBR

Além da simulação, possível com o uso de uma calculadora gráfica, nota-se em um curso de Física tradicional que um dos primeiros tópicos ensinados tanto em nível universitário quanto em nível médio é o tema movimento, incluindo os conceitos de posição, velocidade e aceleração. Sabendo que o gráfico é a melhor sintetização da relação funcional entre duas variáveis, muitos professores consideram o uso de gráficos num cenário de laboratório sendo de alta importância para reforçar e desenvolver um entendimento de muitos tópicos da Física, especialmente o movimento.

Se a construção de gráficos é uma capacidade valiosa nos estudantes, cabe saber qual é o nível dessas habilidades. Estudos têm identificado dificuldades nos alunos com tais habilidades gráficas. A dificuldade do estudante em fazer conexões entre gráficos de diferentes variáveis, conceitos físicos e mudo real faz com que eles percebam os gráficos como uma figura. (Linn, Layman, e Nachmias, 1987; McDermott, Rosenquist e van Zee, 1987).

Com estudantes do nível médio ou universitário, o MBL tem demonstrado a potencialidade de elevar os conhecimentos dos alunos em Física e habilidades cognitivas tais como a observação e a predição. Esses autores tomam uma efetividade do MBL, que é a de mostrar os dados graficamente, enquanto o movimento é realizado, dessa maneira a atividade torna-se uma experiência cinestésica, elevando assim as habilidades gráficas dos estudantes (Friedler, Nachmias e Linn, 1990; Mokros e Tinker, 1987; Brasell, 1987).

Linn, Layman e Nachmias (1987); Mokros e Tinker (1987); Brasell (1987), apresentam em seus trabalhos resultados das interpretações gráficas produzidas pelo MBL. Os autores realizaram testes de conteúdo de movimento em turmas com e sem o uso do MBL. Deste modo eles indicaram diferenças significativas entre o laboratório tradicional (sem tecnologia) e laboratório baseado em MBL, sendo o último mais efetivo na mudança conceitual dos estudantes.

Observo, nos artigos de Mokros e Tinker (1987), Brasell (1987) e Thornton (1987) que – segundo Elliott (2000) – em cada um foi feita análise estatística limitada pelos pontos de pré e/ou pós testes para aferir as habilidades dos estudantes em conceitos físicos quando estes utilizavam o MBL.

Percebe-se que os autores tiveram a intenção que seus trabalhos fossem lidos por professores, assim à pesquisa de cada um é claramente baseada em sala de aula, sendo ela o ensino médio ou a universidade.

De um outro lado Bassok e Holyoak (1989) utilizaram o MBL para verificar as dificuldades dos estudantes na conexão de gráficos com conceitos físicos e constataram que conceitos isomórficos na sala de aula de Matemática permitiram que os alunos transferissem os conceitos matemáticos da Álgebra para as aulas de Física. Contudo, quando conteúdos físicos isomórficos ao currículo de Matemática foram trabalhados primeiramente na aula de Física, os alunos não conseguiam estabelecer as relações com o conteúdo matemático. Eles acreditam que, se usarmos a Matemática para apoiar os conceitos vindos de outras disciplinas, como a Física, a transferência de conceitos físicos para conceitos matemáticos venha a existir.

Em suas pesquisas, Dykstra, Bolye e Monarch apud Hale (2000) chegaram à conclusão de que atividades com MBL permitem uma abordagem mais efetiva, procurando ajudar os estudantes a ter uma visão diferenciada do comportamento da velocidade e aceleração por exemplo, o que às vezes não é possível somente ao olhar um gráfico pronto. Acreditam que as atividades com MBL são usadas para ajudar os estudantes a confrontar conflitos que surgem quando eles vêem gráficos similares representando grandezas distintas.

Ainda no veio do conceito de movimento e da construção de gráficos, tomo o trabalho de doutorado de Scheffer (2001) que pesquisou a relação entre os movimentos corporais e as representações gráficas cartesianas desses movimentos, quando produzidos com o uso do CBR. Seu estudo mostra o fato de os estudantes, às vezes, associarem o movimento com a figura de sua trajetória quando utilizam o sensor, fato que vem corroborar com as pesquisas de Mokros e Tinker (1987); Linn, Layman e Nachmias (1987); McDermott, Rosenquist e van Zee (1987). A autora declara que isso se justifica, se nesses momentos os alunos estiverem representando o desenho de uma trajetória e não um gráfico, no plano cartesiano, que descreve uma função a partir de uma variável.

Neste ambiente de discussão, criado pelas mídias os estudantes observaram, analisaram e estabeleceram relações, enriquecendo-se suas concepções acerca do tema movimento.

Esses alunos realizaram experiências cinestésicas, como as discutidas com o uso do MBL em Linn, Layman e Nachmias (1987); Mokros e Tinker (1987); Brasell (1987).

CBL

O sistema CBL surge após o desenvolvimento do sistema MBL e com o uso desse novo sistema, encontro algumas pesquisas no ensino de Química e suas aplicações. Pesquisas como a de Cortés-Figueroa e Moore (1999) e Sales, Ragan e

Murphy (2001), enfatizaram com exemplos que o CBL vem facilitar a execução de experimentos em Química, devido ao seu baixo custo quando comparado a um computador ou a instrumentação de coleta de dados específica da área de Química. Sabendo que a instrumentação laboratorial é de extrema importância para o futuro pesquisador químico, esses autores enfatizam o uso do CBL em atividades durante a graduação salientando que com este uso há um aumento no aprendizado analítico dos estudantes.

Além do uso em Química, exponho a pesquisa de Giorgetti (2002), que descreve a estrutura, objetivo e metodologia para uma nova disciplina presente nos cursos de Engenharia, utilizando o CBL e a calculadora gráfica. O propósito desta disciplina é de sintetizar tópicos da matemática e desenvolver a habilidade da formulação de problemas nos alunos, desta maneira a disciplina assume um caráter de facilitadora integrando disciplinas básicas com as disciplinas da Engenharia.

Na condução desta disciplina, relata o autor, que o docente, adota o papel "de um treinador dos estudantes para a arte da formulação de problemas ou modelagem, desenvolvida com forte apelo ao uso de leis de conservação" (p. 01). Neste artigo são feitos três experimentos, que foram "planejados para serem executados facilmente na sala de aula com a participação intensa dos estudantes na seqüência fundamental da observação de fatos ou fenômenos, escolha de parâmetros para a quantificação dos mesmos, medição e aquisição de dados, e finalmente, modelagem (formulação) e simulação" (p. 01).

É enfatizado o processo de obtenção de resultados, o qual o autor nomeia de 'seccionamento' em suas fases, a primeira trabalhando com uma lei fundamental e a segunda adentrando uma lei particular ambas utilizando a calculadora gráfica e o CBL.

Por outro lado na disciplina de Matemática, Caldwell (1996) afirma que com o uso do CBL e da calculadora gráfica os estudantes estão aptos a observar fisicamente a relação funcional entre duas variáveis e, então, observar uma representação gráfica dessa relação, como um gráfico de pontos (*scatter plot)*. Os estudantes também podem observar a representação numérica dessa relação, pelo traço entre os pontos do gráfico e pela observação das listas, nas quais os dados foram armazenados. Dessa maneira, os estudantes podem então usar a calculadora gráfica para determinar uma equação de modo a ajustar os pontos coletados através do CBL e obter então, uma representação simbólica dessa relação.

Corroborando com a pesquisa de Caldwell (1996), Doerr e Zangor (2000) pesquisaram qual o significado da calculadora gráfica como uma ferramenta de coleta e análise de dados experimentais e observaram que nas atividades propostas os estudantes coletaram, armazenaram, compararam e re-coletaram dados até que eles pudessem decidir se tinham adquirido um conjunto satisfatório de dados. Na maioria das atividades, elas perceberam que os estudantes repetiam o mesmo experimento muitas vezes, até que o conjunto de dados por eles coletados combinasse com as expectativas que eles tinham sobre o comportamento do fenômeno. Neste tipo de uso do sistema CBL, os estudantes necessitaram se engajar no entendimento do contexto da atividade e na decisão a ser tomada, embora, o processo de conjecturas, refinamento e negociação tenha se constituído somente para escolher um conjunto satisfatório de dados.

Os resultados desse estudo sugerem que a natureza das atividades matemáticas, o papel, o conhecimento e as crenças do professor influenciaram no uso dos instrumentos. As autoras também perceberam que o uso da calculadora gráfica, como um dispositivo pessoal, pode inibir a comunicação em um pequeno grupo, em contrapartida o uso desta ferramenta como dispositivo coletivo permite o aprendizado matemático e a interação da classe.

Assim, Hale (2000) também ressalta um benefício dos dispositivos de coleta de dados, como sendo, uma maior interação dos estudantes incorporando conceitos gráficos. Para ela, fica evidente, que o sistema CBL com a comunicação dos estudantes favoreceram o desenvolvimento do conhecimento matemático e científico nos alunos que participaram das atividades.

Neste trabalho, ela examina como os estudantes constroem e reconstroem entendimentos conceituais usando o discurso juntamente com o sistema CBL. Hale (2000) encontrou no uso do CBL grupos cooperativos de alunos, porém os discursos de alguns alunos, nas atividades, poderiam levar outros a concepções errôneas e a autora aproveitou esses momentos para esclarecer os conceitos sem esquecer que as concepções erradas fazem parte da construção do conhecimento e que não devem ser eliminadas do processo de aprendizagem.

Tecnologias e a Reorganização do Pensamento

Nesta seção, exibo as idéias de Tikhomirov (1981), que propôs três teorias para questionar se o computador afeta a atividade intelectual humana. Esse autor utiliza o computador em sua teoria, porém amplio essa idéia para qualquer instrumento informático, que neste artigo são as calculadoras gráficas, o MBL/CBR e o CBL, porém continuarei nesta seção a utilizar a nomenclatura computador para ficar mais fiel ao autor.

A primeira teoria é considerada a teoria da substituição. Nesta teoria, como o próprio nome já diz, o computador substituiria o ser humano no âmbito intelectual. Neste caso, Tikhomirov (1981) leva em consideração que computador é capaz de chegar aos mesmos resultados que o ser humano na resolução de certos tipos de problemas, porém, ele rejeita esta teoria argumentando que os processos utilizados pelo ser humano, na busca da solução de um problema, não são os mesmos processos usados pelo computador na resolução de um mesmo problema. Por este motivo a teoria é rejeitada, pois ela não expressa a relação entre o trabalho do computador e o pensamento humano.

Assim, Tikhomirov (1981) apresenta uma segunda teoria, denominada por teoria da suplementação. Nesta teoria o computador complementa o ser humano, onde o primeiro resolve problemas que são de difícil solução para o segundo. Borba (1999) esclarece que nesta teoria algumas partes do processo são realizadas pelo ser humano, enquanto outras são realizadas pelo computador. A união dessas partes equivale ao resultado final que, anteriormente, era realizado somente pelo ser humano.

Nesta visão, há uma justaposição entre o computador e ser humano. O computador vem suplementar o pensamento humano no processamento de informação, com isso aumentando a velocidade e o volume deste processo, permitindo ao ser humano processar informações, cada vez mais rápido e, talvez, com mais precisão. Nota-se aqui, que há somente um aumento quantitativo da atividade humana não considerando os aspectos qualitativos do pensamento, tais como a busca de possíveis soluções de um determinado problema.

Assim, Tikhomirov (1981) argumenta que as duas teorias anteriores - da substituição e a da suplementação – fracassam, pois não consideram o papel essencial da mediação numa atividade humana. Para o autor, não se trata apenas de considerar o computador substituindo processos mentais, ou então permitir um aumento puramente quantitativo nos processos psicológicos já existentes. O foco deve ser enxergar o computador como um novo tipo de mídia que pode mediar a atividade humana.

Tikhomirov (1981) sustenta, então que o computador não apenas expande a capacidade da atividade existente. O computador, atuando como mediador, faz também emergir um novo estágio de pensamento.

Trago agora a terceira teoria de Tikhomirov (1981), que é a teoria da reorganização, onde o computador é visto como uma nova mídia mediando as atividades humanas. Esse caráter mediador – originado pela teoria Vygotskiniana - produz uma reorganização dos processos de criação, armazenamento de informação e nas relações humanas. Neste caso é possível argumentar que o computador provoca uma reorganização da atividade humana, definida por Borba (1999) como "moldagem recíproca" entre computadores e seres humanos, onde o computador é visto como algo que "molda o ser humano e que ao mesmo tempo é moldado por ele" constituindo assim o sistema ser-humano-computador.

Nesse sentido, não assumo as tecnologias apenas como meios, visto que a produção de conhecimento é permeada por elas. No veio de Tikhomirov (1981), Borba e Penteado (2001) propõem a metáfora seres-humanos-com-mídias. Colocando em voga que uma nova tecnologia não somente se justapõe aos seres humanos, mas interagem com eles, os autores propõem que o pensamento é exercido pelo sistema seres-humanos-com-mídias. Este sistema torna-se uma ampliação do sistema ser-humano-computador proposto por Tikhomirov (1981), considerando o pensamento como algo coletivo do qual fazem parte as tecnologias da inteligência disponíveis ao longo da história (BORBA, 1999). É com esse olhar que passo a seção seguinte onde procuro relacionar as pesquisas realizadas com as teorias apontadas por Tikromirov (1981).

CONSIDERAÇÕES FINAIS

Influenciada por Tikhomirov (1981), retomo a terceira seção, pontuando algumas analogias entre pesquisas realizadas e a reorganização do pensamento.

Ao se tratar da teoria da substituição, não evidencio nenhum trabalho nesta categoria, o que evidentemente não contemplaria atividades em sala de aula com o uso desses instrumentos (calculadora gráfica, MBL/CBR e CBL).

Passando para a teoria da suplementação, percebo que o trabalho proposto por Adie (1998), concebe o uso de calculadoras gráficas para os alunos utilizando a concepção fixada nesta teoria, isso fica presente no recorte: "os alunos perdem muito tempo nos aspectos matemáticos dos problemas físicos. A calculadora os livra disto permitindo que eles despendam mais tempo entendendo ou explicando Física" (p. 203).

Ilustrando esta teoria - a da suplementação - vem o artigo de Giorgetti (2002), quando o autor declara que na condução da disciplina, o docente adota o papel "de um treinador dos estudantes para a arte da formulação de problemas ou modelagem, desenvolvida com forte apelo ao uso de leis de conservação" (p. 01). Nota-se então, que neste contexto a calculadora está complementando o aluno, resolvendo tarefas matemáticas.

Neste momento é importante salientar ao leitor que ambos autores (Adie, 1998; Giorgetti, 2002), relatam o uso de calculadoras gráficas e CBL em disciplinas de aplicação. Nestas disciplinas, na maioria dos casos a Matemática assume o caráter de ferramenta para um objetivo maior, no caso entender a Física presente em um determinado experimento, isso também é notado no trabalho de Bassok e Holyoak (1989). Então, sob o viés das teorias de Tikhomirov (1981), creio que não se pode justificar o uso de um instrumento em sala de aula levando em conta somente que esse instrumento possa favorecer o ensino de outra disciplina à alunos deficientes em conhecimentos matemáticos ou somente com o intuito de enfatizar a prática.

Dirigindo-me agora para a terceira teoria de Tikhomirov (1981), percebo no relato de Dunham e Dick (1994), Watanabe (1996), Souza e Borba (1996, 1998) e Sestokas-Filho e Bonafini (2000, 2001 e 2002), que a calculadora não foi um instrumento neutro, ela reorganizou o pensamento dos alunos na execução das tarefas e modificou o relacionamento deles em sala de aula.

Observo em Caldwell (1996); Doerr e Zangor (2000) e Hale (2000) que a calculadora e o CBL, reorganizaram o pensamento dos estudantes e a sua forma de participação e refinamento (construção e reconstrução) de suas conjecturas estabelecendo assim, grupos colaborativos. Enfatizo nestes trabalhos os instrumentos tendo o caráter de mídias, percebendo que a calculadora e o CBL não somente complementam os estudantes, mas interagem com eles, dessa forma o pensamento é exercido pelo sistema seres-humanos-com-mídias[2].

Noto nos trabalhos de Friedler, Nachmias e Linn (1990); Linn, Layman e Nachmias (1987); Mokros e Tinker (1987); Brasell (1987), Scheffer (2001), a influência da mídia, no caso o MBL nas habilidades cognitivas tais como a observação e a predição, além da possibilidade da atividade tornar-se um experimento cinestésico, o que só é possível com o uso de uma determinada mídia.

Sob o olhar da teoria da reorganização, procuro encerrar esse artigo retomando meu objetivo principal de pesquisa que visa compreender *como estudantes podem trabalhar conceitos matemáticos e físicos ao utilizarem o CBL e a Calculadora Gráfica em atividades de experimentação.*

Deste modo, acredito finalmente que essa pesquisa possa acrescentar contribuições importantes, uma vez que, poucos são ainda os trabalhos acadêmicos com o uso de dispositivos de coleta de dados que relacionam a Matemática e a Física no Ensino Superior.

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Educação a Distancia para Deficientes Visuais

Vera R. N. Schuhmacher [1], M. Inés Castiñeira [2], Jakson Hüntemann [3] and Rangel Roecker [4]

Abstract *— Apesar dos grandes avanços existentes na informática e de toda a tecnologia disponível, existe um grande grupo de pessoas que possuem um acesso limitado ao uso das mesmas, e muitas vezes nenhum acesso. Parte deste grupo é formado por deficientes visuais, no Brasil este número chega a 750.000 pessoas abruptamente excluídas do processo de inclusão digital em áreas fundamentais como o uso do ensino a distância. Hoje, mais de 80 países, nos cinco continentes, adotam a educação a distância em todos os níveis de ensino, em programas formais e não formais, atendendo a milhões de estudantes. A educação a distância tem sido usada em situações como treinamento até o aperfeiçoamento de profissionais em serviço.*

A partir do estudo serão apresentadas considerações que possam facilitar a utilização dos recursos tecnológicos disponíveis no mercado para pessoas com deficiência visual. Essas considerações possibilitarão um futuro desenvolvimento de ferramentas que melhor se adaptem as necessidades dos deficientes visuais.

Index Terms — deficientes visuais educação a distância, interfaces, recomendações.

INTRODUÇÃO

O olho humano é considerado um órgão sensório fotorreceptor, que percebe a luz, as cores, as formas, os movimentos e o espaço. O olho humano é opticamente equivalente a uma máquina fotográfica comum, sendo constituído basicamente de um sistema de lentes, um sistema de diafragma variável e uma retina que corresponde a um filme a cores.

O olho humano tem características especiais como um sistema automático de focalização que permite ver, por exemplo, objetos a 25 cm e logo a seguir outros a grandes distâncias, a íris, que corresponde ao diafragma controlando automaticamente a quantidade de luz que entra no olho, apresenta eficiência de operação para ver tanto em ambientes com muita luz como em outros pouco iluminados, apresenta visão angular muito grande: horizontal e vertical e a imagem de um objeto formada na retina é invertida [1].

Existem muitas causas que levam um indivíduo a obter cegueira ou visão subnormal entre elas podemos destacar as mais comuns, como: o tracoma, o glaucoma, a catarata, a miopia e o descolamento da retina.

INCLUSÃO DIGITAL

Inclusão Digital é a denominação dada aos esforços de fazer com que a maior parte possível das populações das sociedades contemporâneas – cujas estruturas e funcionamento estão sendo alteradas pelas tecnologias de informática e de comunicação possam [2]:

- Obter os conhecimentos necessários para utilizar com um mínimo de proficiência os recursos de informática e de telecomunicações existentes;
- Dispor de acesso físico regular a esses recursos.

A expressão-chave no conceito de Inclusão Digital é utilizar com um mínimo de proficiência os recursos de informática e de telecomunicações existentes. Dependendo do significado atribuído ao termo "utilizar", emergem duas visões bastante diferentes do alcance do processo de Inclusão Digital: Inclusão digital restrita e Inclusão digital ampliada.

Quando o termo "utilizar" é referido à idéia de consumidor, origina-se uma visão essencialmente passiva do que é utilizar com um mínimo de proficiência os recursos de informática e de telecomunicações existentes. Nesse caso, o conceito de inclusão digital prioriza o treinamento dos cidadãos para operar computadores e softwares aplicativos de uso comum e podemos citá-la como Inclusão digital restrita.

Na definição de inclusão digital, se o termo "utilizar" for referido à idéia de instrumentalização – de uso instrumental por um sujeito que age com objetivos autônomos – é gerada uma visão de inclusão digital que, além, dos objetivos da visão utilitarista, incorpora o fator finalidade. Temos assim uma visão de Inclusão Digital Ampliada onde o alvo estratégico é universalizar entre as populações o uso instrumental dos recursos das tecnologias de informática e de comunicação para alavancar a aprendizagem contínua e autônoma, para fomentar o exercício da cidadania, para dar voz às comunidades e setores que normalmente não têm acesso à grande mídia e para apoiar a organização e o

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adensamento da malha de relações comunicativas entre os atores da sociedade civil que constituem a esfera pública [2].
A relevância atual do tema Inclusão Digital deve-se ao quase consenso que já existe, em escala mundial, quanto à importância e a centralidade das tecnologias de informática e de comunicação na estruturação e no funcionamento de grande parte das sociedades contemporâneas.
Tanto na forma restrita quanto na forma mais ampla, a Inclusão Digital tem um papel importante no momento atual.

TIPOS DE SISTEMAS PARA DEFICIENTES VISUAIS

O conceito de sistema de interação deficiente visual-computador tem um sentido bem amplo, envolvendo hardware, software ou outros tipos de equipamentos. Diversos fatores fazem com que exista atualmente uma quantidade grande e diversificada de sistemas. Primeiramente, devido ao caráter muitas vezes particular de cada usuário deficiente visual, freqüentemente são desenvolvidos ou adaptados sistemas de maneira personalizada. Em segundo lugar, as pesquisas nesta área estão em fase praticamente inicial, com abordagens e enfoques muito variados no desenvolvimento de produtos. Somando-se a isto tudo, existe uma total falta de padronização entre os fabricantes de tais sistemas. Esse é um fator importante, uma vez que é necessário um grande esforço por parte dos deficientes visuais para se adaptar a um determinado tipo de sistema.

Pode-se classificar os sistemas de interação deficiente visual-computador em três tipos principais: os sistemas amplificadores de telas, os sistemas de saída de voz e os sistemas de saída em braille. Além destes, existem outras tecnologias, menos importantes no que diz respeito à sua adoção pelos usuários deficiente visual de computadores, que são as tecnologias de reconhecimento de voz, os "scanners" e os amplificadores de imagens [12].
O sistema de ampliação da saída de vídeo, pode ser obtido de duas maneiras. A primeira delas é por meio da conexão de um processador com caracteres maiores do que o normal, baseado em hardware. A segunda maneira é utilizar um pacote de software que irá aumentar o tamanho do que aparecer na tela.
Os sistemas de saída de voz são compostos por um sintetizador de voz, um alto-falante externo e um software para acessar o texto. Estes equipamentos são muito eficientes e pouco onerosos, estando disponíveis em grande variedade no mercado. O sintetizador de voz é um hardware, geralmente uma placa, que pode ser inserido internamente no computador ou então um dispositivo externo, ligado ao computador através da porta serial ou paralela. O software acessa o texto armazenado no computador e o envia ao sintetizador de voz, efetuando um processo padronizado de conversão, denominado TSC (Text-to-Speech Conversion) que significa, conversão de texto para fala.
Os sistemas de saída em Braille são divididos em dois grupos: o de impressoras e o de terminais de acesso em Braille. As impressoras braille seguem o mesmo conceito das impressoras de impacto comuns e podem ser ligadas ao computador através das portas paralelas ou seriais. Os terminais de acesso em braille foram criados para fornecerem uma janela móvel, codificada em braille, que pode ser deslocada sobre o texto na tela do computador. O alfabeto braille é composto de caracteres que possuem 6 pontos de código.
Enquanto os sistemas sintetizadores de voz estão bem desenvolvidos, os sistemas de reconhecimento de voz estão em um estado tecnológico muito mais primitivo. Eles permitem evitar o uso do teclado, e podem ser treinados para reconhecer centenas de comandos de um usuário em particular, mas geralmente falham, se necessitam receber comandos de mais de um usuário [12].
A conversão de textos impressos, para fins de saída em voz ou braille, exige que seja usado um sistema denominado OCR (Optical Character Recognition), que consta de um “scanner” e de um software próprio. Entretanto, a confiabilidade da tradução dos textos impressos para o meio eletrônico é muito variável, devido a fatores como tamanho, estilo, contraste, e espaçamento entre os caracteres impressos na fonte.
Outros dispositivos amplificadores de imagem disponíveis aos usuários com visão subnormal são os sistemas de circuito fechado de televisão (CCTV) que permitem a execução de tarefas guiadas visualmente, que seriam impossíveis ou improdutivas de serem executadas de outra forma. Alguns destes dispositivos podem ser interconectados com um microcomputador para obtenção de imagens da tela do mesmo [12].

CONCLUSÕES SOBRE OS DIFERENTES TIPOS DE SISTEMA E SUA APLICAÇÃO

Os sistemas de saída de voz são os mais difundidos, fato que ocorre devido, em parte, ao seu baixo custo em relação aos outros sistemas e, em parte, por poderem ser acessados por usuários com qualquer tipo de deficiência visual. Uma combinação dos sistemas de saída em braille e reconhecimento de voz aumenta ainda mais a sensação de manipulação direta e domínio sobre o aplicativo.
As características do usuário assim como o ambiente em que será utilizado devem ser observados para que se possa optar pelo sistema mais adequado.

ENSINO A DISTÂNCIA

Ensino a distância pode ser definido como a família de métodos instrucionais onde as ações dos professores são executadas a parte das ações dos alunos, incluindo aquelas situações continuadas que podem ser feitas na presença dos estudantes. Porém, a comunicação entre o professor e o aluno deve ser facilitada por meios impressos, eletrônicos, mecânicos ou outros [14].

Educação/ensino a distância (*Fernunterricht*) é um método racional de partilhar conhecimento, habilidades e atitudes, através da aplicação da divisão do trabalho e de princípios organizacionais, tanto quanto pelo uso extensivo de meios de comunicação, especialmente para o propósito de reproduzir materiais técnicos de alta qualidade, os quais tornam possível instruir um grande número de estudantes ao mesmo tempo, enquanto esses materiais durarem. É uma forma industrializada de ensinar e aprender [16].

Os conceitos acima apresentam elementos centrais que podem ser resumidos da seguinte forma [14]:

- separação física entre professor e aluno, que a distingue do ensino presencial;
- influência da organização educacional (planejamento, sistematização, plano, organização dirigida etc.), que a diferencia da educação individual;
- utilização de meios técnicos de comunicação para unir o professor ao aluno e transmitir os conteúdos educativos;
- previsão de uma comunicação de mão dupla, onde o estudante se beneficia de um diálogo e da possibilidade de iniciativas de dupla via;
- possibilidade de encontros ocasionais com propósitos didáticos e de socialização.

A EaD, no sentido fundamental da expressão, é o ensino que ocorre quando o ensinante e o aprendente estão separados (no tempo ou no espaço). No sentido que a expressão assume hoje, enfatiza-se mais a distância no espaço e se propõe que ela seja contornada através do uso de tecnologias de telecomunicação e de transmissão de dados, voz e imagens (incluindo dinâmicas, isto é, televisão ou vídeo). Não é preciso ressaltar que todas essas tecnologias, hoje, convergem para o computador [17].

DESENVOLVIMENTO DE CURSO A DISTÂNCIA

Em sua grande maioria os cursos desenvolvidos resumem-se em componentes que convertem o material didático em curso a distância. O curso deve ser planejado e estruturado pelo docente seguindo propostas compostas por descrições gerais, objetivos, métodos de ensino, métodos de avaliação do estudante, plano de estudo, período, objetivos específicos, público alvo, conteúdo e programação [18]. Impõe-se no entanto neste ponto o conflito inerente ao direcionamento de um curso para a comunidade de deficientes visuais oferecidos na World Wide Web (www). Devem ser observados requisitos especiais relacionados às interfaces que compõem o curso para que seja possível ao deficiente o acompanhamento de um curso ministrado a distância com um mínimo de frustração e um máximo de conforto.

ACESSIBILIDADE NA INTERNET PARA DEFICIENTES VISUAIS

A Internet tem um papel fundamental a desempenhar na inclusão digital. Ela "quebra" barreiras físicas e espaciais, servindo de suporte a um grande numero de atividades possíveis de serem realizadas por portadores de deficiência visual. Os deficientes visuais, sem uma tecnologia de acesso a Internet adequada, podem ficar gravemente limitados quanto à quantidade das informações que podem acessar. Essa situação inibe, ou até mesmo impossibilita que eles utilizem por inteiro as potencialidades deste meio de comunicação. A maior parte dos softwares para acesso dos deficientes visuais à Internet é feita em outros paises, com idioma e perfil do usuário diferente dos nossos. Isso torna inadequado o aproveitamento dos sistemas estrangeiros. O acesso a Internet para deficientes visuais baseia-se na concepção de equipamentos, softwares e conteúdos com características de acessibilidade [11].

Acessibilidade significa facilidade de interação, aproximação. No contexto computacional, a acessibilidade está associada a ações que tem como objetivo tornar os computadores mais acessíveis a todos os usuários.
Na Internet, a acessibilidade caracteriza-se pela flexibilidade da informação e interação tornando possível sua utilização por pessoas com necessidades especiais, bem como a utilização em diferentes ambientes e situações através de vários equipamentos ou navegadores.
Os principais problemas encontrados pelos deficientes visuais são [11]:

- Dificuldades em obter informações apresentadas visualmente;
- Interagir usando um dispositivo diferente do teclado;
- Distinguir rapidamente os links em um documento;
- Navegar através de conceitos espaciais;
- Distinguir entre outros sons uma voz produzida por síntese.

ORIENTAÇÕES PARA A CONCEPÇÃO DE INTERFACES ACESSÍVEIS AOS DEFICIENTES VISUAIS

Para auxiliar os desenvolvedores de paginas da Web o W3C (World Wide Web Consortium), organismo responsável pela elaboração de padrões mundiais para a Web, publicou em 5 de Maio de 1999 o primeiro documento: "Web Content Accessibility Guidelines". Este documento tem como objetivo auxiliar e encorajar o desenvolvimento de páginas acessíveis a portadores de deficiência, indicando não só regras gerais como formas ideais de implementação.
As principais regras para o desenvolvimento de páginas serão descritos a seguir de forma genérica [11]:
1. Deve-se utilizar padrões para que qualquer indivíduo de qualquer parte do mundo tenha possibilidade de criar páginas que são acessíveis universalmente aos diferentes tipos de usuários, independente do tipo de software, hardware e limitação que possua permitindo a interoperabilidade.

2. As páginas devem sempre prover mecanismos para gerar um texto alternativo quando um elemento não puder ser exibido e devem assegurar que todos os elementos do site são acessíveis via teclado.

3. Deve-se utilizar navegação consistente e clara, além de colocar informação clara no topo dos cabeçalhos, parágrafos, listas, etc.

4. Outras facilidades importantes são mecanismos para "congelar" as informações que aparecem em movimento. De forma ao sintetizador de voz poder transformá-las em áudio.

5. Ao invés de destacar alguma informação importante através de cores ou outra forma de formatação utilizando-se elementos visuais deve-se, indicar através de palavras sua importância no contexto da apresentação.

6. Deve-se criar uma ordem lógica para os links apresentados, facilitando a navegação. Fornecer links para a página inicial em todas as páginas e garantir que os links textuais são formados por palavras ou sentenças compreensíveis fora do texto.

7. Sempre que se usar elementos gráficos como botões, utilizar texto com a mesma função para facilitar a interação por dispositivos não gráficos e via teclado.

8. Deve-se testar a acessibilidade em diversos browsers, incluindo os browsers com capacidade de sintetizar voz e com os leitores de tela e validar com ferramentas de validação.

CONCLUSÕES

Já existe, hoje, uma preocupação por parte dos fabricantes de fazer as modificações necessárias em sistemas de IHC, para aumentar a acessibilidade de produtos a indivíduos que apresentem limitações no sentido da visão. Além de quase não onerar o custo final dos mesmos, estes produtos passariam a ser acessíveis a um número maior de pessoas que em várias situações encontram-se na periferia da utilização de novas tecnologias.

A observação de recomendações e orientações por parte de desenvolvedores de sítios utilizados em um ambiente de aprendizado computacional contribui de forma sensível para que ocorra uma utilização mais eficiente dos recursos oferecidos de forma confortável evitando frustrações e a exclusão digital de portadores de deficiências visuais neste ambiente tão cooperativo oferecido por meio da Internet.

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DESENVOLVIMENTO DE SIMULAÇÕES PARA O APRENDIZADO EM CURSOS NA WEB

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Resumo — *Nos últimos anos, a aplicação das tecnologias de informação à educação vem crescendo bastante. Nesse contexto, surgiu o grupo WEL (Web Engineering for Learning), cujo objetivo é o desenvolvimento de conteúdos digitais baseados na Web, para algumas disciplinas da área de computação. Vinculado a esse grupo, existem alguns sub-projetos: conteúdo, simulação, simulação 3D, avaliação eletrônica e interpretadores de algoritmos. Este trabalho, em específico, foca a criação de simulações visuais para o acompanhamento no aprendizado dos conteúdos desenvolvidos.*

Palavras-Chave — *Simulação, WEL, Educação a Distância.*

INTRODUÇÃO

Desde a década de 1990, a área de educação vem sendo fortalecida pelo desenvolvimento de outras áreas, uma delas é a Computação. Foi a partir daí que surgiu a informática na educação, um nicho que vem crescendo cada vez mais, seja através do desenvolvimento de novos dispositivos de hardware, seja no desenvolvimento de novos sistemas de software.

Pensar em informática na educação não é simplesmente destacar elementos computacionais. Existe uma série de fatores pedagógicos envolvidos nesse processo, e que precisam ser considerados. Estes últimos são os elementos que irão realmente contribuir com o fator "motivação" embutido em um sistema computacional, além do processo de desenvolvimento do raciocínio, do conhecimento e aprendizagem.

Juntamente com a Informática na Educação, podemos falar da Educação a Distância (EaD). Na Educação a Distância, o objetivo é acompanhar o processo de ensino-aprendizagem entre pessoas dispersas espacialmente. São vários os grupos de pesquisa que vem trabalhando nesta linha, entre eles o Nead [32] e Nied [33].

Em específico, no Nead (Núcleo de Educação a Distância da UNICSUL) existe o grupo WEL (Web Engineering for Learning), que trabalha no desenvolvimento de conteúdos digitais baseados na Web para algumas disciplinas básicas da área de computação, em especial aquelas que se apresentam com maior dificuldade para o aprendizado, entre elas; Algoritmos, Estrutura de Dados, Física Aplicada e Laboratório de Linguagens de Programação.

Para a criação de conteúdos digitais nessas áreas, o desenvolvimento de simulações é importante para o acompanhamento do aprendizado. As simulações podem envolver vídeos, animações e imagens em movimento. Segundo Byrne [9], a animação permite uma visualização concreta de conceitos abstratos. Para ele, os fenômenos conceituais e abstratos são notoriamente difíceis para o entendimento de estudantes e as animações ajudam na concretização desses conceitos.

Educadores constantemente estão buscando novos caminhos para prover instrução, facilitar o aprendizado e prender a atenção de seus estudantes. O poder dos computadores para armazenar grandes quantidades de informação e para simular ambientes e condições que seriam, em outro caso, não disponíveis, faz das animações uma boa possibilidade [9].

Enquanto visualizações estáticas podem prover pessoas com a essência de como alguma coisa ocorre, é colocada, ou constituída; as animações se mostram mais bem habilitadas para explicar um processo dinâmico. Animações devem apoiar estudantes em construir um modelo mental de vários processos, tal como, o movimento de componentes de um sistema mecânico [9]. Vários estudos sugerem que modelos mentais ajudam os estudantes à, mais precisamente, prever o comportamento dos vários processos ou sistemas [22].

É notório o quanto uma representação visual pode trazer de contribuição ao ensino: "uma imagem pode dizer mais que mil palavras". Quem ainda não se deparou com a seguinte situação: precisar ler um texto imenso e ao se deparar com uma imagem, dirigir a visão diretamente para ela. Uma imagem ou animação tem informação "comprimida" ou "embutida", que pode ser de fácil compreensão. Para obter a mesma informação utilizando textos, poderíamos perder mais tempo. Imagens e/ou animações representam recursos importantes, mas devem ser utilizadas de forma correta e moderada [38].

Neste trabalho, estaremos destacando, entre outras coisas, alguns trabalhos desenvolvidos na área em questão, considerações para a construção de simulações em ambientes educacionais, além de ilustrações de estudos de

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caso realizados pelo grupo WEL para a disciplina de Algoritmos e Estrutura de Dados.

REFERENCIAL TEÓRICO

A visão tradicional de ensino, em que o professor exerce o papel ativo de possuidor de todo o conhecimento, e o aluno o papel passivo de receptor, está se transformando rapidamente, devido ao surgimento de novas tecnologias. O novo modelo é centrado no aluno, no qual ele passa a ter um papel muito mais ativo e autônomo na busca do aprendizado e do conhecimento.

A educação a distância baseada em computadores é uma das tecnologias educacionais que está envolvida nesta evolução, pois devolve a iniciativa do aprendizado ao aluno, e possibilita o progresso individualizado. Com a internet, tem surgido novos paradigmas de intercâmbio de informação a distância, e suas surpreendentes possibilidades estão resgatando a imaginação e interesse de educadores dispersos pelo mundo, levando-os a repensar a natureza do ensino e da aprendizagem [10].

Como boa parte de professores e/ou pesquisadores precisa realizar uma aula prática, são universais as dificuldades em se conseguir material, equipamentos e pessoal técnico especializado para montagem de laboratórios e de um programa de aulas práticas, seja pelos altos custos de aquisição e manutenção, seja pelo domínio técnico do manejo de equipamentos. Além disso, a dificuldade para locomoção dos alunos para participação de cursos em instituições de ensino distantes de suas casas tem frustrado os seus objetivos com relação ao aprendizado.

Para tentar resolver parte desses problemas e com o intuito de facilitar e aprimorar o aprendizado, vários pesquisadores estão observando a relevância da utilização de simulações [10].

O vídeo *Sorting Out Sorting*, apresentado no SIGGRAPH'81, é geralmente aceito como o início do campo de animação de algoritmos [1]. Ele mostra visões dos dados sendo ordenados por diferentes algoritmos para ajudar estudantes a entender como os algoritmos trabalham. Desde então, muitos sistemas de animação de algoritmos foram desenvolvidos [6, 7, 8, 17, 30, 35, 40] e estão largamente disponíveis.

Vários estudos tem examinado a eficiência da Web como uma ferramenta de estudo em termos das opções que ela oferece, entre elas, as ilustrações animadas e aplicações multimídia em geral [3, 29, 36, 37] e no caso especial em Ciência da Computação [2, 4, 5, 9, 11, 16, 28, 31].

Para a análise da efetividade de ilustrações animadas baseadas em Web, como uma ferramenta para prover aprendizado, muitos estudos tem demonstrado sucesso em tópicos básicos da computação como programação, estrutura de dados e algoritmos [2, 4, 11], além disso, tópicos avançados como algoritmos paralelos [31], protocolos de comunicação, algoritmos distribuídos [28] e compiladores [16].

Byrne et al. [9] focam o uso de animação para ajudar no ensino de programação e para auxiliar estudantes no entendimento de como os algoritmos trabalham. Segundo os autores, esse é o processo chamado de animação de algoritmos [6] e é uma instância particular de visualização de software [34], ao qual é o uso de imagens, gráficos e animação para ilustrar algoritmos de computador, programas e processos.

A tese de doutorado de Lawrence [24] avalia uma variedade de algoritmos de ciência da computação introdutórios, tal como, algoritmos de ordenação e grafos, e examina a adição de animação para auxiliar no ensino. Segundo ele, o aprendizado é beneficiado pela habilidade de entender a execução de algoritmos e responder questões conceituais sobre o algoritmo.

Hansen et al. [19] encontraram significantes benefícios de aprendizado usando sistemas hipermídia que incluem animações para ensinar estudantes sobre algoritmos.

Mayer e Anderson [25, 26] e Mayer e Sims [27] concluíram que as animações ajudaram estudantes a aprender conceitos de mecânica.

Schimiguel et al. [11] ilustram um caso da aplicação de simulações para o aprendizado na disciplina de Sistemas Operacionais, vinculada a cursos de graduação na área de computação. Segundo os autores, fenômenos computacionais podem ser representados através de animações, como por exemplo, a execução de processos, o compartilhamento de recursos, entre outros.

Kobayashi [8] desenvolveu um sistema, denominado Cabri, para o acompanhamento no aprendizado de conceitos de matemática. Para ele, a matemática é muito abstrata, sendo necessário a criação de imagens e/ou animações para o seu entendimento.

Cardoso [1] descreve a aplicação de simulações para ciências biomédicas, permitindo ao estudante observar o comportamento de um determinado sistema orgânico através de um modelo do mesmo, ou seja, de uma representação matemática, gráfico ou simbólica do fenômeno.

O projeto Multiverse [3], desenvolvido no Institute for Computer Based Learning da Heriot-Watt University, fornece um ambiente de software para facilitar e encorajar o uso de simulações em educação e pesquisa. Além deste, vinculado ao mesmo Instituto, existe o projeto Inside, para integrar simulações em educação distribuída.

O grande número de trabalhos mostra a importância que está sendo dada para o desenvolvimento de simulações para conteúdos digitais baseados na Web. Na próxima seção, estaremos focando a efetividade de simulação para o ensino.

Eficiência da Simulação no Ensino

As simulações têm se apresentado como ferramentas de aprendizagem muito efetivas, ainda que os professores tenham sido lentos para explorarem este claro potencial. Segundo Cardoso [1], em estudos comparando programas de simulações com laboratórios tradicionais demonstrou-se que, embora a aquisição de conhecimento por ambos os grupos tenha sido a mesma, os estudantes tiveram uma atitude mais positiva na utilização em programas deste tipo, e que o custo de laboratórios convencionais baseados nesta abordagem foi cinco vez maior.

Gurka e Citrin [18], com base em estudos e experimentos, identificaram sete fatores a serem considerados no estudo de benefícios pedagógicos de animações: (i) flexibilidade no uso do sistema de animação, (ii) disponibilidade do sistema de animação, (iii) treinamento no uso do sistema de animação, (iv) complexidade envolvida, (v) qualidade da animação, incluindo design gráfico, (vi) como, onde e quando a animação é usada e (vii) diferenças individuais entre estudantes.

Entre as vantagens no uso de simulações, podem-se destacar [10]:

- O software de simulação pode permitir a visualização gráfica e a mudança de parâmetros e variáveis que não seriam possíveis em um experimento convencional;
- O professor pode propor experimentos, roteiros, perguntas; que o aluno irá realizar, responder, escrever relatórios experimentais, entre outros;
- A utilização do programa de simulação pelo aluno pode gerar uma autodocumentação, escores de acertos; que são utilizadas localmente ou enviadas pela Internet e possibilitam ao professor avaliar as táticas de aprendizado, além do desempenho do aluno;
- A simulação pode incluir vínculos de hipertexto para o acesso a material didático em forma digital, além de outros sites web e recursos que permitam o aprofundamento do aluno de acordo com seu grau de interesse;
- As simulações podem ser usadas facilmente nas fases de aprendizagem e avaliação da aprendizagem.

Entre algumas desvantagens das simulações, podemos citar [10]:

- Os modelos podem representar apenas uma parte da função de um elemento, conceito ou componente, sendo desconectados dos seus aspectos integrativos;
- O contato com experimentações reais é perdido, podendo dar idéias incompletas ou imprecisas a respeito de um fenômeno.

Essas desvantagens podem ser eliminadas a medida que as simulações progridem para o entendimento e modelagem dos fenômenos que elas descrevem. Outras podem ser resolvidas pelo próprio desenvolvimento da tecnologia. O professor deve ter uma visão clara de quais aulas podem ser efetivamente substituídas por ambientes com simulações e quais não podem, ou ainda, se as duas formas de ensino podem ser aplicadas paralelamente.

Com o advento de simulações na Internet e na WWW (World Wide Web), e com a possibilidade de usar módulos executáveis em páginas web (applets desenvolvidos na linguagem Java), vários grupos passaram a fazer uso de simulações. Em Kobayashi [8], existe um repositório de simulações no formato de applets para o ensino de matemática.

A integração de Web e Java representa um avanço tecnológico que habilita uma nova aproximação para modelagem de simulações, que torna possível o desenvolvimento de ambientes baseados em Web para criação de modelos colaborativos, além de documentação baseada em multimídia, tal como análise investigativa de modelos [20].

Na próxima seção, ilustraremos um estudo de caso para uma animação desenvolvida pelo grupo WEL na disciplina de algoritmos e estrutura de dados.

ESTUDO DE CASO

O estudo de caso que estaremos ilustrando está relacionado a um dos tópicos da disciplina de Algoritmos e Estrutura de Dados: busca em árvores binárias [12, 13, 14, 15]. Essas árvores tem por característica básica a ordenação e, sobre elas, a realização de várias atividades, como, por exemplo, busca (consulta ou caminhamento), inclusão e exclusão de nós. Cada nó possui um item de dado e dois apontamentos, um para seu filho do lado esquerdo e outro para seu filho do lado direito.

No processo de busca em árvoves binárias pode ser realizado de três formas:

- InOrder: primeiro é visitado o nó pai (ou raiz), depois o nó filho esquerdo e por fim o nó filho direito;
- PréOrder: primeiro é visitado o nó filho esquerdo, depois o nó pai e por último o nó filho direito;
- PósOrder: primeiro é visitado o nó filho direito, depois o nó filho esquerdo e por último o nó pai.

Cada um desses três métodos foi implementado nas formas recursiva e não recursiva. No exemplo das figuras 1 e 2, ilustramos uma árvore para um caminhamento PréOrder Recursivo, onde, a cada vez que o aluno pressionar o botão "Executar Passo a Passo" (localizado na parte central inferior de ambas as figuras), será realizado um novo passo no processo.

Quando um nó é visitado, sua cor é modificada de branco para preto. Além disso, nas figuras 1 e 2, observa-se a existência de uma pilha onde cada caminhamento pendente é inserido. Posteriormente, é necessário visitar esse caminho, a partir do momento que o algoritmo começa a "retornar" em sua execução, retirando, dessa forma, os elementos da pilha.

Na parte inferior esquerda de ambas as figuras, existe um campo onde o resultado do caminhamento é constantemente atualizado. Juntamente com a ilustração da árvore, foi representado o algoritmo que realiza o caminhamento e, a cada vez que o aluno pressionar o botão "Executar Passo a Passo", além dele poder estar visualizando o resultado do caminhamento na ilustração da árvore, ainda poderá verificar como seria a execução do algoritmo, simultaneamente. As simulações ilustradas nas figuras foram criadas utilizando-se as linguagens Html e JavaScript.

No início da execução do algoritmo, é verificado se a raiz é nula (NULL). Como isso não acontece, pois a raiz é o nó "A", ela é visitada, passando da cor branca para preto, conforme pode ser verificado na Figura 1.

Depois disso, é realizado um caminhamento para o nó filho esquerdo de "A", e esse caminhamento é inserido na pilha (PréOrder: A→Esquerdo), pois posteriormente será necessário caminhar para o nó filho direito de "A". Na seqüência, é verificado se a nova raiz (nó "B") é nula; e como isso não ocorre, o nó é visitado, modificando sua cor de branco para preto (Figura 2).

A execução continua, e um nó filho direito somente será visitado quando for encontrado nulo (NULL) em algum nó filho esquerdo. Quando isso ocorrer, será retirado um dos elementos da pilha de execução, que indicava um caminhamento PréOrder-Esquerdo para algum nó.

CONTRIBUIÇÕES E CONCLUSÕES

O interesse pela área de educação a distância vêm aumentando de forma significativa, devido as possibilidades trazidas por ela, como é o caso da não obrigatoriedade presencial em um mesmo espaço físico para a realização do curso.

O desenvolvimento de conteúdos digitais baseados na Web envolve vários fatores; além de elementos computacionais, devem ser considerados aspectos pedagógicos relacionados ao aprendizado.

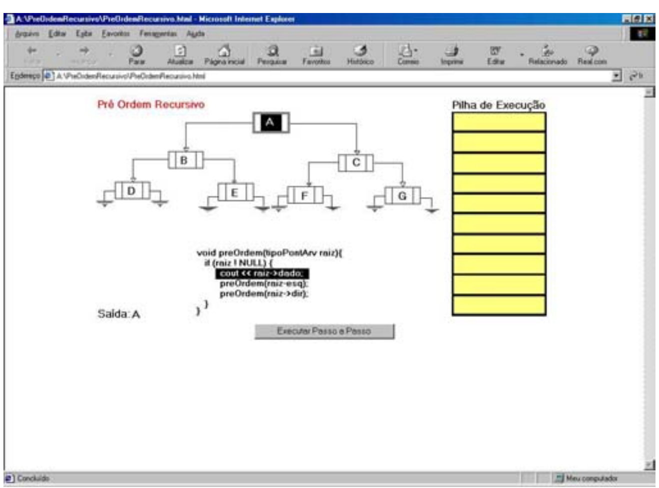

FIGURA. 1
VISITANDO O NÓ RAIZ "A" EM UMA ÁRVORE DE BUSCA BINÁRIA (PRÉORDER RECURSIVO).

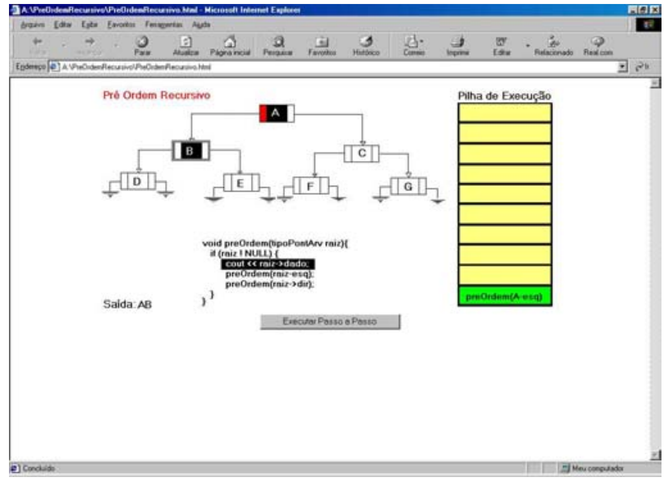

FIGURA. 2
VISITANDO O NÓ FILHO ESQUERDO DE "A" (NÓ "B") EM UMA ÁRVORE DE BUSCA BINÁRIA (PRÉORDER RECURSIVO).

Um dos pontos a serem considerados é a criação de simulações para esses conteúdos pedagógicos. Através deles, temos um ganho significativo no processo de aquisição de conhecimento e formulação do raciocínio lógico. Além de motivar a interatividade com o ambiente, uma simulação pode trazer vantagens com relação ao custo de equipamentos e laboratórios.

Esperamos, com este trabalho, ter focado a contribuição dada por uma simulação ao processo de aprendizagem, influenciando para uma adaptação em sua forma de pensar, raciocinar e interagir com um ambiente computacional.

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Definição de Premissas para o ReDesign do Website Institucional do Colégio Santa Marcelina São Paulo

Silvana Cristina Alves[1], Juliano Schimiguel[2]

Resumo *– Nos últimos dois anos, o departamento de informática educacional do Colégio Santa Marcelina São Paulo, vem estudando e desenvolvendo um projeto que tem como objetivo principal tornar o Site Institucional uma ferramenta de comunicação efetiva e eficaz para troca de informações entre os usuários que fazem parte da comunidade educativa, bem como, apresentar ao usuário externo a proposta pedagógica e a infra-estrutura do Colégio. Este trabalho tratará, especificamente, do ReDesign do WebSite atual, propondo que a comunidade educativa possa participar das decisões, de forma a interagir na dinâmica das informações que serão apresentadas a todos os usuários.*

Palavras-Chave – ReDesign, WebSite, Ferramenta de Comunicação, Colégio Santa Marcelina São Paulo

Abstract *– In last two years, the educational informatic department of Santa Marcelina São Paulo College, comes studying and developing a project that has as main objective, to become the Institutional Site a communication tool accomplishes and efficient for exchange of information between the users who are part of the educative community, as well as, to present to the external user the pedagogical proposal and the infrastructure of the College. This work will treat specifically, of the ReDesign of the current WebSite, considering that the educative community can participate of the decisions, to interact in the dynamics of the information that will be presented to all the users.*

Index-Terms – ReDesign, WebSite, Tool Communication, Santa Marcelina São Paulo College

INTRODUÇÃO

Desde 1996, quando foi implantado o departamento de informática educacional do Colégio Santa Marcelina São Paulo, observou-se que a Internet poderia ser tratado como um meio de comunicação e interação para apresentação de atividades e projetos desenvolvidos pelos professores, explorando este meio para trocas de informações com toda a comunidade educativa.

No início de 1997, surge a primeira proposta em desenvolver o Site Institucional, onde os alunos da 2ª série do Ensino Médio ficariam responsáveis pela criação e manutenção do Site.

O Site começou a ser construído nas aulas de informática educacional, uma vez por semana, onde os alunos tiveram como ferramenta principal o *Browser Netscape Gold* para a elaboração de toda a estrutura, sendo estes alunos, supervisionados durante as aulas pelos professores de informática.

Surgiu, em agosto de 1997, o primeiro Site do Colégio Santa Marcelina São Paulo. Esta primeira versão ficou no ar durante um ano e meio, onde alguns alunos que haviam participado da sua criação ficaram responsáveis pela manutenção e atualização do Site. Esta versão não teve participação da comunidade, sendo que sua atualização deu-se de modo precário.

O Site tinha como característica principal: "mostrar a história do Colégio", sem possibilitar a interação com a comunidade educativa, não atingindo assim as expectativas da direção.

Em 1999, foi chamado um profissional especializado na construção de WebSites - o "Web Designer" - para reestruturar os aspectos visuais do Site, tornando-o mais atrativo. Este profissional, após algumas reuniões com a direção do Colégio, apresentou a nova estrutura, que foi aprovada.

Verifique, na Figura 1, a página principal atual do WebSite do Colégio, trazendo como referência o logotipo do colégio e uma mensagem bíblica.

Para dar continuidade à navegação ao WebSite, o usuário é convidado a clicar na ilustração das duas meninas (Figura 1), para ter acesso ao menu principal. A segunda página do WebSite esta estruturada conforme a Figura 2.

É através desta segunda página (Figura 2) que o usuário poderá encontrar as informações desejadas, utilizando os subitens do menu principal.

O WebSite atual tem como pontos principais: (i) Estrutura do WebSite, desenvolvida totalmente em Flash, (ii) Manutenção, feita pelo estagiário que precisou estudar o Flash em curto espaço de tempo, (iii) Conteúdo de responsabilidade das coordenações de áreas que, uma vez por mês, passariam estas informações para o estagiário. Este novo design mostrou-se mais eficaz, fazendo que os alunos navegassem mais facilmente pelo WebSite.

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FIGURA. 1
PÁGINA INICIAL (HOME-PAGE) DO SITE INSTITUCIONAL DO COLÉGIO SANTA MARCELINA SÃO PAULO

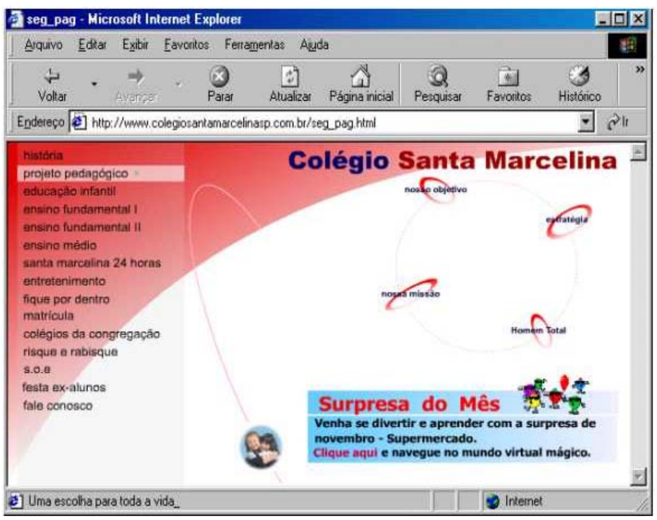

FIGURA. 2
SEGUNDA PÁGINA (COM ITENS DE MENU) DO SITE INSTITUCIONAL DO COLÉGIO SANTA MARCELINA SÃO PAULO

Os coordenadores de áreas decidiram por fixar a data 27 de cada mês para que os professores entregassem as atividades para serem colocadas no ar, sendo que, o departamento de informática educacional tinha até o dia 05 do mês subseqüente para disponibilizar estas informações. As coordenações de áreas são divididas pelos seguintes departamentos: Educação Infantil, Ensino Fundamental Nível I, História, Geografia, Ciências, Matemática, Física, Química, Língua Portuguesa, Língua Inglesa, Educação Física e Biologia.

Muitos desses departamentos não entregavam os seus materiais (atividades, imagens, fotografias, etc) para a coordenação no prazo estabelecido, dificultando assim o andamento do cronograma do departamento de informática educacional, fora às cobranças de alunos, que gostariam de visualizar em casa com seus pais estas atividades.

Atualmente, estamos com o WebSite que foi projetado em 1999, sendo que, nestes últimos dois anos, o mesmo passou por pequenas modificações, perdendo suas características iniciais.

No momento atual, destacamos os seguintes pontos: (i) Proposta Pedagógica do Colégio, (ii) Site elaborado por profissional da área, (iii) Manutenção feita pelos estagiários com orientação da coordenadora de informática, (iv) A comunidade participa na manutenção, fornecendo as atividades, projetos, informativos, comunicados e todas as informações que julgarem necessários para serem disponibilizados, (v) Livro de visitas, (vi) Acesso a outros WebSites da congregação.

Neste ano tivemos entre janeiro a outubro, 43.545 acessos ao WebSite, gerando uma média de 4354 acessos ao mês, para uma população estudantil de 1906 alunos, que dá uma média de dois acessos por aluno.

ATIVIDADES A SEREM DESENVOLVIDAS

Para o ano de 2003, pretendemos reformular o WebSite atual, pois colhemos durante os dois últimos anos muitas observações, críticas dos professores e sugestões dos alunos.

Estamos propondo uma estrutura que trará como benefícios:

1. Facilidade na navegação por parte do usuário, através das seções subdivididas por segmentos, são eles:

a) Educação Infantil – nesta seção iremos incluir os seguintes subitens: (i) Projeto do Ano Letivo, suas características e objetivos principais, (ii) Atividades realizadas, (iii) Passeios, etc;

b) Ensino Fundamental Nível I – nesta seção iremos incluir os seguintes subitens: (i) projetos de cada série (1^a a 4^a séries), (ii) Momento de Descontração, iremos disponibilizar as imagens que serão tiradas diariamente pelas dependências do Colégio, (iii) Atividades realizadas, (iv) Passeios, (v) A palavra é sua; aqui os alunos irão divulgar seus textos, poesias, uma mensagem para toda a comunidade, etc;

c) Ensino Fundamental Nível II – será também subdividido nas séries, tendo como principais itens: (i) Projetos, (ii) Atividades Realizadas, (iii) Passeios, (iv) Texto off-line, aqui os alunos poderão sugerir o texto semanal que será disponibilizado para a comunidade, etc;

d) Ensino Médio – (i) Projetos do Ano Letivo, (ii) Atividades realizadas, (iii) Vestibular, aqui dicas sobre vestibulares, (iv) Nosso Espaço, onde os alunos poderão colocar mensagens, recadinhos e fotografias, (v) Provão, aqui estaremos disponibilizando aos alunos os calendários dos provões e seus gabaritos, etc.

2. Criação de seções solicitadas pela comunidade educativa e que no WebSite atual não foram disponibilizadas, tais como:

a) Pastoral – divulgar os trabalhos realizados pelos alunos, pais, professores e funcionários, voltados para as crianças da creche, doentes do hospital e os idosos em asilos, etc;

b) DAD (Departamento de Apoio Disciplinar) e SOE (Setor de Orientação Educacional);

c) Fale Conosco (por departamentos): aqui deixaremos o coordenador de cada área responsável por abrir os e-mails do seu departamento, tornando assim a comunicação mais fácil para a tomada de decisões;

d) Álbum de Fotografias;

e) Recreio On-Line (tirar fotos no momento do intervalo de cada segmento e disponibilizar no WebSite);

f) Espaço para Ex-Alunos;

g) Eventos do Mês;

h) Mensagem para a comunidade diariamente;

3. Programação diversificada (linguagem HTML [6], DHTML [9], Banco de Dados, Flash [7]) e outros recursos que forem necessários;

4. Imagens tridimensionais (para dar visão da infra-estrutura do Colégio, principalmente aos usuários que entrarem no WebSite pela primeira vez). A visualização 3D permite ao usuário a sensação de imersão, ou seja, é como se o usuário estivesse participando do ambiente [8].

Hoje, com os avanços tecnológicos, podemos dispor de várias ferramentas para a elaboração de um WebSite e vários meios para disponilizá-lo na Internet. Estaremos utilizando recursos conhecidos pela Equipe de Informática Educacional, bem como, recursos que serão apresentados pelos profissionais que farão parte do projeto.

Não podemos deixar de explicitar que, para que este projeto possa dar continuidade, traçamos algumas metas de gerenciamento[1] para o WebSite, são elas:

a) Levantamento de necessidades e expectativas com a Direção e Coordenação (quais serão os objetivos do Site);

b) Elaboração de uma pesquisa com os alunos sobre o que eles gostariam de encontrar no WebSite do Colégio;

c) Qual será o principal *slogan* do WebSite? (neste caso, qual a mensagem que melhor descreverá o nosso Colégio) – vale ressaltar aqui que poderemos trocar este *slogan* de tempos em tempos, com a participação efetiva dos alunos, que ficarão responsáveis pela criação desses *slogans*;

d) Verificação, através de outros WebSites Institucionais, o que o nosso WebSite deverá ter como sendo o diferencial em relação a eles;

e) Levantamento das tecnologias que serão utilizadas, para que a equipe de informática possa estar preparada, por exemplo, para a tarefa de manutenção;

f) Como as informações do WebSite serão atualizadas:

- Diariamente;
- Semanalmente;
- Mensalmente.

g) Quem aprovará o projeto? (Direção, Coordenação, Professores, Alunos, Pais e Funcionários);

h) Qual o tempo que o Colégio dará à equipe para a construção no novo WebSite? (três meses)

i) Qual o provedor que estaremos utilizando para a hospedagem do WebSite? (o provedor que nos fornecer um acesso rápido);

j) Qual o orçamento para a construção do mesmo?

CONTRIBUIÇÕES

Tornar o WebSite mais atrativo para os nossos usuários, onde as informações disponibilizadas no WebSite, estejam vinculadas com a proposta pedagógica do Colégio e, ao mesmo tempo, conectadas à nova visão de comunicação on-line, que é a Internet.

A idéia é que os pais possam comunicar-se com a escola do seu filho quando necessário, sem ter que estar presente fisicamente na mesma; e que possam estar informados quando esta presença é importante.

Pretende-se divulgar os trabalhos realizados em sala de aula, para os alunos e professores, que em muitas ocasiões ficam restritos ao espaço que os mesmos estão inseridos, que é a sala de aula. Neste contexto, também poderemos compartilhar trabalhos nos diversos segmentos: Educação Infantil, Ensino Fundamental Nível I, Ensino Fundamental Nível II e Ensino Médio. Essas informações também poderão ser compartilhadas com a comunidade em geral e permitir a troca de experiências com outros colégios e segmentos de trabalho.

Com estas características, pretendemos fazer com que o WebSite seja um referencial atrativo para o colégio. Nossa pretensão é aumentar em 30% o número de acessos ao WebSite em 2003; sendo que, para a população estudantil, pretende-se chegar a uma média de 50%, passando de dois acessos por aluno ao mês para 4 acessos por aluno ao mês.

Para que se tenha uma idéia de 01 de Janeiro de 2002 a 31 de Outubro de 2002, foram gerados 43.545, sendo que a média por mês durante os dez meses foi de 4354 acessos.

CONCLUSÕES

Esperamos que este trabalho possa mostrar o caminho percorrido pelo colégio até o momento atual, identificando que, durante os seis anos de informática educacional, o WebSite do Colégio foi reestruturado apenas duas vezes e que este dado possa trazer para as pessoas envolvidas no novo projeto, algumas reflexões e discussões sobre qual será a nova postura mediante aos caminhos que serão adotados para a construção do novo WebSite; pois, cada dia mais a comunicação on-line faz-se necessária também dentro do ambiente educacional.

Conforme obtenção de métricas de qualidade para o design de interfaces em WebSites [2, 3, 4, 5], observamos que os colégios estão aprimorando cada vez mais a sua comunicação on-line com os usuários.

Este trabalho terá como principal objetivo propor o ReDesign do WebSite, através da participação efetiva de toda a comunidade educativa, sendo que; sem este trabalho em conjunto, correremos o risco de não atingir os nossos propósitos iniciais, que é "Transformar o WebSite em um instrumento de comunicação para a Comunidade".

É o contexto da escola, a prática dos professores, e a presença dos alunos, pais e funcionários que determinarão o que deverá ser abordado no WebSite; pretendemos assim, desenvolver um processo de formação [10] através de oficinas para que estes usuários possam ter condições de interagir com o WebSite e Comunidade Educativa, enriquecendo a prática pedagógica que a escola se propõe.

Atrelado a isto, temos o desenvolvimento de um Design que traga inovação na forma de apresentação dos conteúdos, onde o mesmo possa contribuir harmoniosamente os conteúdos gráficos (fotografias, imagens, etc) com os conteúdos de texto, além de uma navegação fácil e dinâmica; pois temos observado também em outros WebSites institucionais, a dificuldade em unir dentro de um mesmo espaço visual estes dois conteúdos.

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UM AMBIENTE PARA APRENDIZAGEM COOPERATIVA DE ENGENHARIA DE REQUISITOS ORIENTADO A PROJETOS

Denise Franzotti Togneri[1], Silvana Rossy de Brito[2], Ricardo de Almeida Falbo[3], Orivaldo de Lira Tavares[4] e Crediné Silva de Menezes[5]

***Resumo -** Este artigo discute as principais dificuldades e necessidades enfrentadas no processo de ensino-aprendizagem de Engenharia de Requisitos e propõe uma abordagem baseada na pedagogia de projetos para apoiar esse processo. Apresenta. um ambiente para aprendizagem cooperativa de engenharia de requisitos baseado na abordagem de projetos de aprendizagem.*

Palavras-Chave - Engenharia de software, engenharia de requisitos, pedagogia de projetos, ambiente cooperativo.

I. INTRODUÇÃO

A Engenharia de Software foi criada em resposta a problemas enfrentados no desenvolvimento de software e tem estado em crescente progresso, produzindo novas metodologias, paradigmas e ferramentas. Dentre suas várias atividades, uma das que apresentam maiores problemas quando feita de forma inadequada é a Engenharia de Requisitos [7].

A Engenharia de Requisitos de Software é uma atividade que engloba a descoberta, documentação e manutenção do conjunto de requisitos de um sistema de software [22].

Objetivando produzir software de qualidade e eliminar mitos relativos à forma de atuação do engenheiro de software, a disciplina de Engenharia de Software e, em particular, a Engenharia de Requisitos possui grande destaque no currículo dos cursos de Ciência da Computação.

Dentre as possibilidades pedagógicas utilizadas para auxiliar a aprendizagem de Engenharia de Requisitos, a Pedagogia de Projetos destaca-se por valorizar a cooperação e a colaboração entre os desenvolvedores de um projeto mas, para isso, necessita de apoio automatizado adequado.

Este artigo apresenta um ambiente cooperativo orientado a projetos para apoio à aprendizagem de Engenharia de Requisitos, discutindo suas principais dificuldades e necessidades e apresentando o processo de aprendizagem no contexto da pedagogia de projetos. Está estruturado da seguinte forma: a seção 2 aborda o ensino-aprendizagem da Engenharia de Requisitos; a seção 3 discute a abordagem de projetos na engenharia de requisitos; a seção 4 apresenta um ambiente para aprendizagem cooperativa de Engenharia de Requisitos Orientado a Projetos e finalmente na seção 5 são apresentadas as conclusões deste trabalho.

II. ENSINO-APRENDIZAGEM DA ENGENHARIA DE REQUISITOS

Atualmente, apesar do progresso da tecnologia de informação, produtos de software de baixa qualidade têm sido entregues com freqüência. Tem-se observado que a complexidade dos problemas sendo resolvidos por software tem crescido mais rapidamente que a habilidade de desenvolvê-los e mantê-los [16]. A despeito de várias décadas de esforço, o desenvolvimento dos sistemas de software caracteriza-se mais como uma arte do que uma ciência, sendo dominado por suposições, princípios heurísticos e diretrizes vagas, ao invés de princípios definidos formalmente e técnicas bem definidas [17].

Muitos observadores da indústria de software, já na década de 70, caracterizavam os problemas associados ao desenvolvimento de software como uma "crise" [18]. As investigações determinaram que esses problemas, normalmente, não têm uma causa única, mas as deficiências nos requisitos dos sistemas contribuem fortemente para o problema [5]. Para muitos desenvolvedores de sistemas de software complexos e grandes, os requisitos são o maior problema da Engenharia de Software. Nenhuma outra atividade do processo de desenvolvimento é tão difícil de executar ou tão desastrosa em seus resultados, quando feita de forma inadequada [7].

Com objetivo apoiar a solução desses problemas através de uma melhor formação do Engenheiro de Software, o ensino da Engenharia de Requisitos tem sido cada vez mais valorizado em muitos cursos de graduação e pós-graduação em Computação e em Sistemas de Informação. No entanto, a Engenharia de Requisitos tem sido abordada no contexto

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de disciplinas denominadas Engenharia de Software [3], passando, em algumas instituições de ensino, a compor uma disciplina nos programas desses cursos, possibilitando um espaço mais adequado para as discussões pertinentes à área [12].

Segundo Martins [12], apesar de diversos indicativos apontarem que os alunos reconhecem a relevância da Engenharia de Requisitos em suas atividades profissionais, esses indicativos também revelam dificuldades na aplicabilidade da mesma. Além disso, os indicadores relativos à preferência dos aprendizes pelos assuntos abordados na disciplina revelaram uma concentração maior nos temas referentes a elicitação, análise e documentação do que a validação e gerenciamento de requisitos.

Dentre as possíveis causas apontadas para a questão das preferências dos aprendizes nos temas de elicitação, análise e documentação estão [12]:

- há um maior número de pesquisas e artigos publicados sobre elicitação, análise e documentação de requisitos do que validação e gerência de requisitos;
- a validação e a gerência de requisitos são atividades que requerem um considerável esforço dos envolvidos, cujos resultados nem sempre são perceptíveis de forma tão direta como os da elicitação, análise e documentação de requisitos.

As causas apontadas remetem a uma abordagem pedagógica centrada em conteúdos, em detrimento daquelas que valorizam a construção do conhecimento através de construções (artefatos) de discussão, colaboração e cooperação [19].

Adicionalmente, os aprendizes devem compreender que a Engenharia de Requisitos apresenta diversos problemas [4] [9] [29] e é uma tarefa não trivial, iterativa, que envolve intensa comunicação humana e cooperação. Para auxiliar nessa compreensão, é fundamental envolver os aprendizes nas atividades de construção, de forma que, através da experimentação, possam realizar reflexões sobre as falhas que ocorrem no processo de engenharia de requisitos. Essas reflexões podem remeter às seguintes questões:

- essas falhas podem ser atribuídas, em parte, à dificuldade da equipe de desenvolvimento em trabalhar de forma cooperativa, uma vez que, em geral, os engenheiros de software não se preocupam em compartilhar informações e interagir, além de visualizarem a cooperação como um mal necessário [21];
- Os problemas decorrentes da falta de cooperação tendem a se agravar à medida que o número de profissionais envolvidos no processo de software aumenta [11];
- o apoio dos computadores às atividades cooperativas pode auxiliar na solução de alguns desses problemas [27].

Uma abordagem pedagógica que valoriza essas reflexões, as atividades de construção e a experimentação é a Pedagogia de Projetos. Ela pode favorecer o envolvimento do aprendiz no processo de ensino-aprendizagem da Engenharia de Requisitos, através da aprendizagem significativa, promovendo a cooperação e a colaboração entre os participantes desse processo.

III. A ABORDAGEM DE PROJETOS NA ENGENHARIA DE REQUISITOS

Segundo Draves [6], a maior utilidade de um ambiente de aprendizagem cooperativa não é o seu aparato tecnológico e sim o papel de facilitar as interações entre aprendizes e mediadores, e entre os aprendizes. Nesse sentido, estabelecer recursos para que o ambiente melhore o grau de interatividade e envolvimento de seus participantes parece o caminho para aumentar a efetividade dos ambientes de ensino-aprendizagem e promover o crescimento de comunidades de construção de conhecimento [2]. Para alcançar o grau de interatividade e envolvimento necessários, devem ser consideradas tanto as questões relativas ao modelo pedagógico adotado, quanto à necessidade de ferramentas que apóiem o mediador nas suas atividades de acompanhamento.

Na concepção da pedagogia de projetos, os alunos são distribuídos em grupos, cabendo a cada grupo investigar e construir conhecimento sobre um tema. A escolha do tema é norteada pela curiosidade visando com isso tornar a aprendizagem mais significativa possível [24].

Nessa abordagem, os projetos se constituem em planos de trabalho e conjunto de atividades que podem tornar o processo de aprendizagem mais dinâmico, significativo e interessante para o aprendiz, deixando de existir a imposição dos conteúdos de maneira autoritária. A partir da escolha de um tema, o aprendiz realiza pesquisas, investiga, registra dados, formula hipóteses, analisa, aplica e avalia o artefato construído [2]. A aprendizagem é significativa uma vez que a definição de um tema para o projeto pressupõe que o aprendiz possui algum conhecimento prévio sobre o tema proposto, levando em consideração que este se encontra dentro de seu foco de interesse.

Nessa abordagem, não há professor no sentido clássico do termo. Ao invés disso, cada projeto conta com um, ou mais, mediadores. O envolvimento dos aprendizes é fundamental, sendo uma característica chave do trabalho de projetos. Além disso, a responsabilidade e a autonomia dos aprendizes são essenciais: os aprendizes são responsáveis pelo trabalho e pelas escolhas ao longo do desenvolvimento do projeto [24].

Grégoire & Laferrière [8] defendem a idéia de que um projeto será bem sucedido se a participação dos aprendizes e sua contribuição ao tema tiverem sido importantes para o grupo de maneira geral. Isso acontece se os artefatos de um pequeno grupo de aprendizes atraírem o interesse de outros, permitindo que esses outros expandam ou refinem o seu próprio processo de aprendizagem. Os artefatos são produtos produzidos ou consumidos nas diversas atividades durante a construção do projeto [28].

Em um projeto, a responsabilidade e a autonomia dos aprendizes são essenciais. Os aprendizes são co-responsáveis pelo trabalho e pelas escolhas realizadas ao longo do desenvolvimento do projeto. Em geral, essas escolhas são realizadas em equipe, motivo pelo qual a cooperação está também quase sempre associada ao trabalho de projetos. A cooperação é necessária uma vez que o desenvolvimento de um projeto envolve complexidade e resolução de problemas. O objetivo central do projeto constitui um problema que exige o planejamento e a execução de uma ou mais atividades para sua resolução. A execução dessas atividades acontece em fases, conforme sugerem Menezes et al. [13]: identificação do problema, observação e mineração, coleta de dados, análise, síntese, formalização e validação.

No contexto da educação orientada a projetos, as ferramentas de apoio devem prever um meio de comunicação multidirecional eficiente entre seus participantes (mediadores, aprendizes e colaboradores), de forma a substituir a interação pessoal entre eles por uma ação sistemática e conjunta de diversos recursos didáticos, proporcionando um aprendizado independente e flexível aos estudantes. Ao contrário de uma sala de aula, não é necessário que todos os aprendizes estejam realizando as mesmas tarefas, ou em um mesmo ponto em relação ao conteúdo e objetivos do curso. Dessa maneira, seria inadequado insistir na prática de longas aulas de exposição de temas e na hierarquia de papéis de mediadores e aprendizes [24].

No contexto do ensino-aprendizagem da Engenharia de Requisitos, a Pedagogia de Projetos pode auxiliar os aprendizes a compreender a problemática envolvida nas diversas atividades que compõem o processo de Engenharia de Requisitos.

Ainda que diferentes projetos requeiram processos com características específicas para contemplar suas peculiaridades, é possível estabelecer um conjunto de atividades básicas que deve ser considerado em qualquer definição de processo de Engenharia de Requisitos. Existem vários conjuntos de atividades propostos para o processo [1] [9] [10] [15] [22] [25]. Tomando por base a proposta feita por Kotonya & Sommerville [9], de maneira geral, o processo de Engenharia de Requisitos é composto de elicitação de requisitos, análise e negociação de requisitos, documentação, validação e gerência de requisitos.

Não há limites bem definidos entre as atividades propostas; na prática elas são intercaladas e existe um alto grau de iteração e feedback entre elas.

Nos projetos de aprendizagem da Engenharia de Requisitos, o processo de aprendizagem [13] é executado até que um grau de aceitabilidade, definido pelo grupo e pelo mediador, seja alcançado ou que a pressão do cronograma do grupo estabeleça a transição para a próxima fase (Projeto do Software ou apresentação dos resultados da Engenharia de Requisitos para os demais grupos).

No entanto, para suportar a pedagogia de projetos, é imprescindível a utilização adequada de tecnologias que auxiliem o trabalho cooperativo entre os participantes do processo. Sendo assim, um ambiente de aprendizagem orientada a projetos deve fornecer suporte às questões relativas à interatividade, cooperação, colaboração e mediação, além de facilitar a construção dos artefatos do projeto [2].

IV. Um Ambiente para Aprendizagem Cooperativa de Engenharia de Requisitos Orientado a Projetos

Um ambiente de aprendizagem orientada a projeto deve permitir o acesso às ferramentas necessárias para o desenvolvimento de seu trabalho e para suportar as fases do projeto. Além disso, é fundamental que se promova a interação entre os participantes do grupo e entre eles e o mediador.

A necessidade da interação na aprendizagem baseada em projetos também é observada pela estreita relação dessa abordagem pedagógica com a aprendizagem cooperativa. Nos últimos anos, a pesquisa em Aprendizagem Cooperativa Apoiada por Computador (CSCL - *Computer-Supported Cooperative Learning*) deu origem a diversos ambientes que apóiam os processos de aprendizagem promovidos através de esforços colaborativos. A aprendizagem cooperativa é uma técnica com a qual os estudantes se ajudam nos processos de aprendizagem, atuando como parceiros entre si e com o mediador, e visando adquirir conhecimento sobre um dado objeto [20].

No contexto da educação orientada a projetos, as ferramentas de suporte ao processo de aprendizagem devem prever um meio de comunicação multidirecional eficiente entre seus participantes (mediadores, aprendizes e colaboradores), de forma a substituir a interação pessoal entre eles por uma ação sistemática e conjunta de diversos recursos didáticos, proporcionando um aprendizado independente e flexível aos estudantes. Ao contrário de uma sala de aula, não é necessário que todos os aprendizes estejam realizando as mesmas tarefas, ou em um mesmo ponto em relação ao conteúdo e objetivos do curso. Dessa maneira, seria inadequado insistir na prática de longas aulas de exposição de temas e na hierarquia de papéis de mediadores e aprendizes [23].

A CRETA – Uma Ferramenta de apoio à Engenharia de Requisitos Cooperativa pode ser utilizada para apoiar os aprendizes e mediadores, que podem assumir diversos papéis relativos ao desenvolvimento de sistemas, tais como gerentes de conhecimento, engenheiros de requisitos, especialistas de domínio, usuários, gerentes de projeto e patrocinadores [26].

Nesse contexto, CRETA provê mecanismos para compartilhamento e distribuição de informações, facilita a comunicação, a coordenação e cooperação entre os participantes, bem como a percepção e a memória organizacional.

O conhecimento sobre padrões a serem adotados, paradigma, processo, modelos de ciclo de vida, atividades e artefatos, dentre outros, é cadastrado pelo grupo, enquanto exercendo o papel de gerente de conhecimento. O projeto a ser desenvolvido é cadastrado, seu processo é definido pelo grupo, com apoio do mediador e os responsáveis por cada atividade são alocados.

Os participantes fazem uso de ferramentas cooperativas disponíveis, tais como agendas eletrônicas, correio e compromissos eletrônicos, listas de discussão, reuniões virtuais síncronas (chat) e assíncronas (fórum), para promover a comunicação, a cooperação e a interação. Documentos e protótipos para avaliação podem ser disponibilizados, utilizando-se mecanismos da ferramenta. Os diversos artefatos, produzidos pelo grupo, em cada atividade, tais como planos de entrevistas, atas de reuniões diversas e documentos de requisitos podem ser cadastrados, de modo a promover seu registro, compartilhamento, validação e gerência. A arquitetura definida para a ferramenta é composta por cinco componentes [27]: Conhecimento de Processo, Recursos e Padrões, Definição do Processo, Engenharia de Requisitos, Trabalho Cooperativo e Acompanhamento de Projeto. A implementação da arquitetura proposta foi baseada na Web, de forma a possibilitar que os participantes possam estar geograficamente dispersos. Foram utilizadas a tecnologia JSP – *JavaServer Pages* e a linguagem Java 2 da Sun.

A figura 1 apresenta a página principal de CRETA, que exibe os compromissos e correios não lidos, as atividades agendadas para a data corrente e a agenda particular do participante. A partir dessa página tem-se acesso às funcionalidades disponíveis em CRETA.

Na estruturação do projeto de aprendizagem, o planejamento é definido como sendo o momento em que os aprendizes definem o problema (tema) e estabelecem os primeiros procedimentos necessários para desenvolvimento de uma solução.

Ainda que diferentes projetos requeiram processos com características específicas para contemplar suas peculiaridades, é possível estabelecer um conjunto de atividades básicas que deve ser considerado em qualquer definição de processo de Engenharia de Requisitos. Esse processo não deve ser imposto pelo mediador e sim discutido e acordado pelos aprendizes.

Depois de planejado o processo, os aprendizes, na etapa de montagem e execução, iniciam o processo de investigação propriamente dito, realizando entrevistas e reuniões, síncronas e assíncronas, presenciais ou virtuais, pesquisando na Internet, em livros e em outras mídias, coletando informações em sites específicos, participando de listas de discussões, consultando virtualmente especialistas no assunto, elaborando e aplicando questionários, etc.

FIGURA 1
PÁGINA PRINCIPAL DE CRETA

À medida que as informações vão sendo levantadas, elas são formalizadas, compartilhadas, analisadas e negociadas.

A seguir, inicia-se a depuração, que é uma etapa de auto-avaliação e autocrítica, em que os ajustes poderão ocorrer. Nesse momento, o grupo deverá avaliar os artefatos construídos e supostamente acabados para refletir criticamente sobre eles e alterá-los, se julgar necessário. Essa etapa dá oportunidade ao aprendiz de olhar analiticamente seu projeto, buscando a melhoria e a qualidade do resultado final.

Na etapa de apresentação, a criação e depuração do projeto já foram realizadas e os aprendizes podem expor, apresentar e/ou disponibilizar seu produto para a comunidade (mediadores, outros grupos, observadores e colaboradores). Nessa etapa, os mediadores podem também estar realizando a avaliação, não só dos artefatos gerados, mas principalmente, de tudo o que foi aprendido durante o desenvolvimento do projeto.

A etapa de avaliação e crítica tem como finalidade a análise e reflexão sobre o projeto e sobre o processo de desenvolvimento, questionando sua qualidade e apresentando soluções de melhoria para projetos subseqüentes. Segundo Nogueira [14], considerando-se apenas as etapas de utilização dos recursos tecnológicos na elaboração de um produto, o projeto poderia ter sido concluído na etapa anterior (apresentação). Entretanto, o objetivo não é apenas o produto final, mas principalmente, todo o aspecto pedagógico envolvido na metodologia de projetos, justificando a necessidade de mais essa etapa, na qual o aprendiz poderá verificar, analisar e aceitar possíveis "erros".

V. CONCLUSÕES

A ferramenta CRETA, apesar de ter sido desenvolvida, inicialmente, para apoiar a Engenharia de Requisitos Cooperativa [26], pode ser aplicada para auxiliar no processo de aprendizagem, no contexto da Pedagogia de Projetos. Ela favorece a comunicação, as diversas modalidades de interação, a coordenação, a cooperação e a colaboração. Permite o registro e compartilhamento dos diversos artefatos gerados, coletivamente, durante o desenvolvimento de um projeto, que poderão servir como um repositório de conhecimento, a ser utilizado por outros grupos.

A partir da utilização dessa ferramenta, pretende-se aprimorar os requisitos já levantados por Tavares et al. [24], relativos ao acompanhamento dos projetos pelos mediadores, de forma a fornecer registros que permitam potencializar suas atividades de mediação.

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CURSO TÉCNICO EM ELETRO-ELETRÔNICA: UMA PROPOSTA INOVADORA EM CURRÍCULO POR COMPETÊNCIAS PARA A EDUCAÇÃO PROFISSIONALIZANTE

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Resumo — *As transformações no mundo globalizado pedem um profissional formado em curto espaço de tempo, flexível, crítico e capaz de mobilizar os seus diversos saberes diante de um ambiente de natureza dinâmica e complexa. Em resposta a esta nova demanda social, o Instituto Centro de Ensino Tecnológico (CENTEC) está criando o curso Técnico em Eletro-eletrônica. Este plano de curso busca uma política de ensino de qualidade, visando o desenvolvimento de alunos como pessoas integrais, na ampliação de seus conhecimentos; capacitando para a autonomia, a autocrítica e para uma praxis efetiva de mudança do contexto sociocultural e econômico vivido. Para efetivar estes objetivos partimos para uma proposta inovadora de organização curricular e metodologia de ensino, adequada à democratização do saber: currículo modular e baseado em projetos. O presente trabalho visa apresentar um breviário do curso e realizar algumas considerações teóricas a respeito.*

Palavras-chave — Currículo por Competências, Eletro-eletrônica, Ensino Baseado em Projetos.

INTRODUÇÃO

As transformações no mundo globalizado vêm ocorrendo em ciclos com períodos cada vez menores e envolvendo um número elevado de elementos interdependentes. Este processo propicia o surgimento de um ambiente de natureza dinâmica e complexa, com alto nível de incerteza. Neste contexto, a evolução tecnológica de forma ampla e, mais particularmente, a evolução da informação associada ao desenvolvimento do conhecimento, vem sendo apontada na literatura como elementos fundamentais dessas mudanças.

A escolha por um Curso Técnico em Eletro-eletrônica deve-se, *apriori*, à possibilidade de ampliação do uso dos laboratórios do Curso de Tecnologia em Eletromecânica no período noturno. Desta forma, estaremos otimizando os investimentos realizados pela Instituição. Um outro fator imperante, nesta tomada de decisão, é o reconhecimento que a revolução tecnológica da atualidade é permeada em todos os seus aspectos e nuances pelo uso sistemático da eletricidade e da eletrônica.

O projeto de Curso Técnico em Eletro-eletrônica, a ser desenvolvido pelo Instituto Centro de Ensino Tecnológico – CENTEC, Ceará, busca aproveitar de forma integrada as condições de desenvolvimento e transformações sócio-econômicas e culturais por que passam as regiões do Vale do Jaguaribe, Vale do Acaraú e Vale do Cariri, neste momento, propiciando além da educação profissional de nível técnico, o atendimento à demanda do mercado de trabalho regional.

Em conseqüência, as empresas instaladas nos Pólos Industriais do Ceará, além de transferirem tecnologias, indispensáveis ao desenvolvimento regional, vão colaborar com o CENTEC, na formação de profissionais de nível técnico que atendam às suas necessidades básicas.

Neste contexto, o CENTEC com o presente Curso Técnico de Eletro-eletrônica, primeiro de uma série de outros, se propõe a desenvolver as competências necessárias ao atendimento às empresas instaladas e àquelas que virão a se instalar, contribuindo para o desenvolvimento do potencial humano e profissional da região que se transforma de uma economia fortemente agrícola numa economia significativamente industrial, integrando os recursos humanos locais, no atendimento da demanda do mercado de trabalho.

Pretendemos também, atender as expectativas das empresas implantadas nos Pólos Industriais do Ceará no sentido de gerar oportunidades de melhoria educacional e de condições de profissionalização para os seus funcionários, como conhecimentos e habilidades específicas, propiciando-lhes a qualificação necessária, garantindo-lhe a manutenção no mercado de trabalho bem como o desenvolvimento de habilidades voltadas para o progresso individual e regional.

PRESSUPOSTOS TEÓRICOS

O termo competência tem sua origem no latim competere (cum-com, pete-buscar) que queria dizer correr com alguém,

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ter a mesma meta, buscar com. Não é à toa que o lema do Barão de Coubertin, criador das Olimpíadas da era Moderna, era: “o importante não é vencer. O importante é competir”. Em outras palavras, o importante é ter o mesmo objetivo.

Com o passar dos séculos, o termo passou a designar o ponto de partida, e não mais o ponto de chegada de uma corrida, ou seja, o conceito tornou-se o de disputar com, lutar por, rivalizar desde o começo. Mas por que esta reviravolta? Quando se está com um único objeto, ou alguém em vistas e duas pessoas estão desejosas por ele, então o caráter excludente vem à tona: se um consegue o objeto, a pessoa, o outro não o terá. Em um mundo capitalista essa noção de posse é essencial, fundamental, o senso comum: o que se quer é concorrer, competir, disputar com o adversário, para conseguir um lugar ao sol.

Mas como retomar ao conceito original? O saber, o conhecimento, pode ser um retorno ao conceito original. Quando se busca o saber, busca-se o sabor das coisas (ambas tem o mesmo radical latino), e nada dá mais sabor do que buscar com outro.

Mas no contexto escolar, o que vem a ser competências? Segundo o MEC competências são “a capacidade de mobilizar, articular e colocar em ação valores, conhecimentos e habilidades necessários para o desempenho eficiente e eficaz de atividades requeridas para o trabalho” [1].

Nos anos noventa a abordagem por competências resultou em total rearranjo dos sistemas educacionais em países como Bélgica, Canadá e França. Mais recentemente estão sendo implantado currículos sob esta óptica no Brasil (e também na Suíça) desde a instituição das diretrizes curriculares para o ensino técnico (1999), como disposto pela Lei de Diretrizes e Bases da Educação (LDB) de 1996.

A abordagem por competências surgiu da sociologia do trabalho, da pesquisas ergonômicas feitas para um desempenho eficaz e móbil no trabalho realizadas na França [5]. Desta forma, a competência surge como a capacidade de transpor o trabalho prescrito, cotidiano. Diante de uma situação nova e complexa, o trabalhador é obrigado a mobilizar saberes para resolvê-la. É o trabalho real e concreto em contraposição velada ao trabalho prescrito, rígido, normalizado e, portanto, artificial, imposto.

Em um mundo globalizado, em que os avanços tecnológicos são rápidos e efêmeros, não se pode, segundo Perrenoud, “... reduzir o mundo econômico à exploração máxima de uma força de trabalho pouco qualificada já não faz sentido hoje, ainda que o capitalismo descrito por Marx subsista em uma parte do planeta [3]”. Assim, o trabalhador passa a ser visto pela empresa como algo que deve ser flexível, inteligente, perspicaz, imaginativo, tenha entusiasmo, caso se queira uma produtividade eficiente e eficaz. As empresas passam a se interessar por uma pessoa competente no sentido explicitado mais acima. No entanto, elas não fazem isso, é claro, por humanismo, mas por cálculo. Segundo Perrenoud, “o interesse pelas competências insere-se em um contexto de concorrência e de busca de produtividade[3]”. Alem disso, pessoas competentes *a priori*, podem ser descartadas mais facilmente, uma vez que, sendo inteligentes e criativas, podem encontrar mais facilmente novos empregos.

Diante desta necessidade econômica das empresas as escolas não podem mais desenvolver trabalhadores imediatamente adaptados a um posto de trabalho; definidos e com bom desempenho em seu posto. Eles perderiam logo seus postos para outros mais competentes.

No entanto, Perrenoud adverte: “por isso, é importante examinar os currículos muito de perto, para compreender que tipo de seres humanos eles pretendem formar. Seria fácil opor a autonomia ao conformismo, o espírito crítico à obediência cega. As comparações são mais delicadas quando se trata de distinguir uma ‘verdadeira’ autonomia de uma autonomia a serviço da cultura empresarial, um ‘verdadeiro’ espírito crítico de um espírito crítico enquadrado, excluindo de seu campo certos valores e certas práticas [3]”.

Segundo a Proposta do MEC de Metodologia de Planejamento de Currículos por Competências – Cursos Técnicos, o novo paradigma muda o foco do trabalho escolar: de transmissão de conteúdos, para construção de competências. Assim, tem-se em mãos um novo projeto de escola, que pressupõem o aluno como agente do processo: faz perguntas, pesquisa, descobre, cria, aprende; o currículo é considerado como meio para guiar a prática pedagógica; o foco passa a ser a aprendizagem, não mais o ensino.

Nesse sentido deve-se construir competências desde a escola. Aqui, competência significa ações e operações mentais que, associadas a conhecimentos e experiências, geram habilidades (saber-fazer).

Para constituir competências, a estratégia utilizada é a ação desencadeada por desafios, projetos, problemas propostos pelo professor e por este monitorado e assessorado. Esses problemas, projetos são a característica de um currículo dirigido por competências. Podem ser reais ou simulados, formando um conjunto que desencadeia ações resolutivas, tais como as de pesquisa e estudo de conteúdos ou de bases tecnológicas capazes de propiciar ao aluno uma base teórica para a resolução do problema proposto. Neste sentido, a resolução do projeto, do problema passa a ser o foco do aluno, e o saber o meio para isso, tornando-se contextualizado.

A estratégia de solução de problemas, então, capacita os alunos a aprender a aprender, de questionar e ir buscar respostas, de construir autonomia, tornando-os competentes para diante de problemas do cotidiano do processo produtivo de forma rotineira ou inusitada, tomar decisões acertadas.

Organização Curricular

O curso de técnico em eletroeletrônica do CENTEC tem sua organização curricular baseada em uma estrutura por módulos de projetos. A definição dessa estrutura contou com a participação de uma comissão de professores nas áreas afins de cada unidade descentralizada do Instituto CENTEC.

Baseado nessa proposta pode-se assumir, juntamente com a introdução das diretrizes curriculares, *"que* os *currículos não são fins, mas coloca-se* a *serviço do desenvolvimento de competências, sendo ess*as *caracterizadas pela capacidade de, através de esquemas mentais ou de funções operatórias, mobilizar, articular* e *colocar em* ação *valores, conhecimentos e habilidades".* Isto *"significa, necessariamente, adotar uma prática pedagógica que propicie, essencialmente, o exercício contínuo e contextualizado desses processos de mobilização, articulação e aplicação".*

O plano de curso de técnico em eletroeletrônica do CENTEC tem uma organização curricular centrada em projetos, onde são previstos, basicamente, quatro projetos. Cada um deles permite o desenvolvimento de um ou mais produtos a serem entregues no final do módulo correspondente. Os projetos são os responsáveis pelo desenvolvimento das competências mais complexas. Além disso, os projetos articulam Oficinas destinadas ao desenvolvimento de competências mais específicas e nelas focadas, sendo estas competências componentes das mais complexas, atribuídas aos projetos. As oficinas são também instrumentais no desenvolvimento dos projetos e uma mesma Oficina pode estar a serviço de vários deles. O presente plano de curso tem uma organização curricular em espiral e em rede.

Módulo I - Nivelamento

O Módulo I - Nivelamento consiste na identificação do perfil de entrada dos participantes quanto aos conhecimentos básicos no sentido de garantir, de forma igualitária, um ótimo desempenho nos módulos subseqüentes.

Através deste nivelamento busca-se capacitar o participante com conhecimentos básicos indispensáveis para seu desempenho em módulos posteriores em matemática, eletricidade e magnetismo, e informática; possibilitar ao aluno conhecimentos sobre a estrutura, funcionamento e importância do Curso Técnico em Eletro–eletrônica no âmbito do CENTEC, mostrar as perspectivas do curso no contexto regional, áreas de trabalho, necessidades do mercado etc.

Vale ressaltar que o nivelamento não possui terminalidade, nem haverá certificação, posto seu caráter ser meramente de equiparação dos participantes do curso. As disciplinas consideradas necessárias ocorrerão após o processo seletivo, perfazendo 240 horas, e seguirão a seguinte ordem de sequenciamento:

Primeiro momento: Matemática Aplicada (60 horas); Eletricidade e Magnetismo (45 horas) e Introdução a Eletro-eletrônica (15 horas).

Segundo momento: Informática Básica (45 horas) e Análise de Circuitos (75 horas).

Os workshops, descritos em tópico adiante, complementarão as 300 horas do módulo I, serão ministrados ao longo do módulo.

Módulos com Terminalidade (de II a V)

A partir do Módulo I, todos os módulos são terminais e conduzem a uma certificação de nível técnico. As ações educativas compreendidas pelos módulos terminais são articuladas por projetos e estão relacionados diretamente com a formação técnica objetivada pelo módulo correspondente.

Os projetos destinam-se a desafiar o participante e a problematizar o corpo de saberes em construção. Estão no rumo da contextualização do saber, favorecendo o aumento da complexidade do conhecimento e a incorporação das competências pelo aluno. Esses projetos serão relacionados com situações reais.

Cada projeto articula as ações educativas envolvidas em um módulo terminal correspondente. Esses projetos terão um ou mais produtos específicos e estarão destinados ao desenvolvimento das competências necessárias para o desempenho eficaz do profissional a ser qualificado em nível técnico. São as atividades realizadas nas Oficinas, disciplinas, workshops que contribuirão para a realização dos diversos produtos a serem entregues no final de cada módulo.

Neste Plano de Curso estão especificadas, em tópico posterior, as ações educativas (oficinas, ciclo de pesquisas, workshops) que são articuladas pelos projetos, bem como o próprio projeto e os produtos específicos que deverão ser apresentados no final dos módulos correspondentes.

Os quatros módulos com terminalidade perfazem um total de 1200 horas. O Módulo II articula projetos em instalações elétricas prediais, com um total de 300 horas; o Módulo III em instalações elétricas industriais, com 300 horas; o Módulo IV em sistemas eletrônicos analógicos, com 300 horas; o Módulo V em sistemas eletrônicos digitais, com 300 horas;

Após a conclusão de cada módulo, com aproveitamento suficiente, será concedido ao aluno Certificado de Qualificação e Aperfeiçoamento que lhe permitirá integrar-se à força de trabalho no âmbito das atribuições e competências que o referido módulo lhe concede, bem como obter créditos para a conclusão do Curso Técnico em Eletro–eletrônica (Módulos II, III, IV e V). Desse modo, a organização curricular em módulos se consubstanciará num itinerário de níveis cada vez mais elevados de competência para o trabalho possibilitando:

- Um contínuo processo de qualificação, especialização e aperfeiçoamento profissional;
- Atendimento às necessidades do mercado através da formação contínua de mão-de-obra;
- Formação permanente, capaz de oferecer diversas e reiteradas oportunidades de realização individual e coletiva;
- Suprir a carência regional por cursos desta natureza.

Etapas do Curso

Módulo I – Nivelamento:

Ações Educativas	Modalidade	Duração
✓ Matemática Aplicada.	Disciplina	60 horas
✓ Eletricidade e Magnetismo.	Disciplina	45 horas
✓ Informática Aplicada.	Disciplina	45 horas
✓ Análise de Circuitos.	Disciplina	75 horas
✓ Introdução à Eletro-Eletrônica.	Workshop	15 horas
✓ Relações Interpessoais, Ética e Cidadania.	Workshop	30 horas
✓ Segurança, saúde e meio ambiente.	Workshop	30 horas
Duração Total		**300 horas**

Módulo II - Instalações Elétricas Prediais

Projeto	Ações Educativas	Modalidade	Duração
Instalações Elétricas Prediais	✓ Produtos: Projetos residenciais (casa, apartamento, etc).	Projeto	90 horas
	✓ Desenho Técnico e Elétrico.	Oficina	60 horas
	✓ Luminotécnica.	Oficina	30 horas
	✓ Dimensionamento de Materiais Elétricos.	Oficina	45 horas
	✓ Máquinas Elétricas de Baixa Potência.	Oficina	45 horas
	✓ Instrumentação Elétrica.	Oficina	30 horas
Duração Total			**300 horas**

Módulo III - Instalações Elétricas Industriais

Projeto	Ações Educativas	Modalidade	Duração
Instalações E. Industriais.	✓ Produtos específicos: Projeto de uma indústria	Projeto	90 horas
	✓ Motores Elétricos.	Oficina	75 horas
	✓ Transformadores.	Oficina	45 horas
	✓ Acionamentos Elétricos.	Oficina	60 horas
	✓ Manutenção Elétrica.	Oficina	30 horas
Duração Total			**300 horas**

Módulo IV - Sistemas Eletrônicos Analógicos

Projeto	Ações Educativas	Modalidade	Duração
Sistemas E. Analógicos.	✓ Produtos específicos: ▪ Fonte de Alimentação ▪ Amplificador de Sinais ▪ Filtros Ativos ▪ Osciladores ▪ Circuitos de Acionamento ▪ Retificadores Controlados ▪ Conversor D/A	Projeto	90 horas
	✓ Semicondutores.	Oficina	90 horas
	✓ Eletrônica Industrial.	Oficina	60 horas
	✓ Circuitos Integrados.	Oficina	30 horas
	✓ Manutenção Eletrônica.	Oficina	30 horas
Duração Total			**300 horas**

Módulo V - Sistemas Eletrônicos Digitais

Projeto	Ações Educativas	Modalidade	Duração
Sistemas E. Digitais	✓ Produtos específicos: ▪ Semáforo eletrônico ▪ ULA e Memória de 4 bits ▪ Contador de Passagem ▪ Divisor de Freqüência ▪ Relógio Digital ▪ Termômetro Digital ▪ Acionamento de Motor de Passo ▪ Acionamento de LCD ▪ Acionamento de D7S multiplexado ▪ Medidor de Freqüência ▪ PWM para Motor CC ▪ Medidor de RPM	Projeto	90 horas
	✓ Circuitos Combinacionais.	Oficina	60 horas
	✓ Circuitos Seqüenciais.	Oficina	60 horas
	✓ Microcontroladores	Oficina	60 horas
	✓ Manutenção em Eletrônica Digital.	Oficina	30 horas
Duração Total			**300 horas**

Em cada módulo a ordem de desenvolvimento das Ações Educativas ficará a critério de cada unidade, em função das necessidades da clientela e exigências do andamento dos projetos, e da seqüência lógica e psicológica do conhecimento. Os produtos específicos, de cada módulo, terão uma duração de 90 horas ao longo de todo o módulo.

Indicações Metodológicas

O enorme volume de conhecimento científico e as diversas mudanças efêmeras no campo tecnológico criam novas exigências para a educação profissional. Estas devem se basear na formação de um nível de pensamento mais condizente com esta nova realidade. O ensino tradicional, com seus métodos expositivos e com práticas concretas arbitrárias, não satisfaz essas demandas da produção e à constante revolução científica-tecnológica da atualidade.

A educação profissional deve garantir esta formação epistêmica, em que o aluno alcance a realidade, e a interprete de maneira científica e teórica. Desta forma, o aluno será capaz de pensar *independentemente* e de *forma criativa*, modificando ativamente o mundo circundante.

As estratégias pedagógicas adotadas para o desenvolvimento do curso deverão concretizar uma metodologia de contextualização do conhecimento, bidirecional, baseada na troca e no diálogo entre educador e educando, essencial a um processo efetivamente interativo.

As estratégias de aprendizagem deverão abranger a resolução de problemas e o desenvolvimento de projetos. Estes projetos devem conter a(s) essência(s) do saber tecnológico capaz de despertar no estudante novos conhecimentos. Além disso, o professor deve estar a par destas formas gerais e essenciais deste saber. Deve-se garantir a união do abstrato e do concreto: enquanto o professor planeja suas aulas por meio destas “formas gerais essenciais”, os alunos as exploram através da implementação dos projetos, buscando a superação das diversas nuances meramente empíricas e sensoriais, e as dificuldades inerentes na resolução dos problemas propostos. O uso de modelos gerais, e o seu desenrolar, com suas ampliações pelas inclusões das descobertas dos alunos, possibilita a inter-relação e o desenvolvimento do abstrato com o concreto: enquanto o concreto é sintetizado pelas formas abstratas, o abstrato é enriquecido pelo concreto, pois nada se manifesta sem o abstrato [6].

Estas estratégias devem ser flexíveis, propiciando o aproveitamento dos saberes individuais e permitindo o acompanhamento das mudanças e do equilíbrio dinâmico do mundo do trabalho.

Conclusão

A problemática de um trabalhador polivalente não é nova. Embora Perrenoud associe o Capitalismo da era de Marx e o atual, como coisas distintas, vale lembrar o que o próprio Marx dizia sobre o assunto há 150 anos atrás: "o verdadeiro significado que o ensino recebeu entre os economistas filantrópicos é este: treinar cada operário no maior número possível de ramos do trabalho, de modo que, se por introdução de novas máquinas ou por mudanças na divisão do trabalho, ele vier a ser expulso de um ofício, possa mais facilmente achar colocação em outro". Além disso, "a grande industria, com suas próprias catástrofes, faz com que o reconhecimento das variações do trabalho, e daí, da maior versatilidade possível do operário (...) se torne uma questão de vida ou morte [2]". Pode-se concluir daí, que o capitalismo atual nada mais é que uma evolução histórica do da época de Marx, e este previu acertadamente os acontecimentos atuais. A abordagem por competências vai de encontro ao exposto mais acima, surgindo da sociologia do trabalho e da ergonomia francesa.

Perrenoud em suas palestras e artigos tem sido o principal divulgador desta teorização. No entanto, ele mesmo tem notado a ambigüidade, notada por Marx, na implantação de uma escola voltada para as competências. Muitas dúvidas, possíveis desvios são por ele analisados, na tentativa de levar as escolas e professores ao caminho correto pela escolha em se trabalhar por competências.

Deve-se ter em mente, segundo ele, que: as competências não substituem o saber, na verdade ele é a base da competência. No entanto, não se deve confundir um e outro, competência é mobilizar saberes, não um saber a mais. Além disso, também é aprendida. Contudo, não se pode privilegiar o saber em detrimento à competência, o que seria retornar ao método tradicional.

Outro ponto é o perigo dos textos não serem nada mais do que textos... "Pode-se ter um programa magnífico, mas cuja realização plena diz respeito apenas a uma minoria no seio de cada geração. Na maior parte dos sistemas educativos, as finalidades da escola e as intenções subentendidas nos currículos são bastante honrosas. O ponto fraco é a enorme desigualdade em sua realização, em primeiro lugar na interpretação que se faz e que determina o 'currículo real', depois, e, sobretudo, nas aprendizagens efetivas dos alunos [3]". Além disso, ainda em relação aos Currículos, as competências a privilegiar não podem ser "aquelas que mobilizam fortemente os saberes escolares e disciplinares tradicionais", segundo aqueles "que querem que nada mude, salvo as aparências. Se os programas prevêem o estudo da lei de Ohm, eles proporão acrescentar um verbo de ação ('saber servir-se conscientemente da lei de Ohm') para definir uma competência. Para ir além do passe de mágica, é indispensável explorar as relações entre competências e programas escolares atuais [4]".

O CENTEC, sendo uma instituição de ensino recente, não possui certos vícios das instituições mais antigas. Neste aspecto, soube muito bem direcionar as atividades necessárias para a confecção de um currículo por competências de uma forma responsável e dentro do estabelecido, não somente pelos ditames do MEC, mas, sobretudo, pelos olhares atentos de seus colaboradores. Sem esta iniciativa, estaríamos, como adverte Perrenoud, apenas escrevendo textos.

Deve-se ressaltar, ainda mais, que as disposições do MEC são uma coisa, e a filosofia de Perrenoud e seus colaboradores outra. Isso pode ser notado pela tentativa do MEC em prescrever as competências de cada setor produtivo, de considerar as competências como mero saber-fazer eficaz e eficiente. A abordagem por competências é muito mais que saber-fazer, é mobilizar saberes e está além de construir verbos prescritivos para competências e outros para habilidades. Não há em Perrenoud nenhuma alusão a esta distinção. O que ele busca é uso eficaz dos saberes escolares de uma forma transgressiva, para além de prescrições, restrições e do senso comum, voltado para o trabalho real. No entanto, o uso de solução de problemas e uso de projetos é sugerido por Perrenoud como requisitos para se trabalhar com competências.

O Curso Técnico em Eletro-eletrônico está em sintonia com a abordagem original. Espera-se com ele, capacitar os seus alunos para a transgressão do cotidiano, buscando resolver problemas inusitados, enfim, construir competências. O currículo por competências permite isso. Primeiro: sendo modular, se tem terminalidade. Segundo: sendo baseado em projetos, não se tem o saber pelo saber, mas oficinas orientadas ao projeto, o que permitirá ao aluno contextualizar as bases tecnológicas apresentadas. Terceiro: as oficinas podem ser ministradas de acordo com a necessidade dos produtos de cada etapa modular. Assim, não se sobrecarrega o aluno com informações de 4 a 6 disciplinas de uma vez, como ocorre nos currículos tradicionais.

Atenta a estes pormenores, a equipe de elaboradores teve o cuidado para não criar meros arranjos de disciplinas, ensacá-las em um módulo, reescrever unidades em verbos apropriados para agradar ao MEC. Estava-se preocupado com aqueles que ingressarão futuramente no curso. De forma responsável, não se buscou o caminho mais fácil, mas se comprometer, não com um mero cliente em potencial, mas com um futuro cidadão digno de seus direitos e consciente de sua força emancipatória. O CENTEC nos permitiu essa aventura.

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TRADITIONAL TEACHING METHOD: CRITICISM AND PERSPECTIVE OF A NEW PATTERN FOR THE TEACHING OF ENGINEERING

Allan Kelvin Mendes de Sales[1]

Abstract — *The traditional method of teaching is, no doubt, the most used among university teachers. Practically, the whole educational system of the nation adopts it, except for pre-school institutions and some schools that teach the fundamental level, the so called "constructive" method. Expository classes, explanations of formulae, sequential tests, condensation of knowledge into disciplines, and laboratories in which measurement and observation are overvalued may be considered characteristic of this traditional method. This paper analyzes the possible sources that originated the traditional teaching method, exposes part of the most common criticism about it, and presents a new perspective trying to modify it, based on the scientific theories of Vygotsky, Leontiev, and Davydov.*

Key words: Activity Theory, Teaching of Engineering, and New Pattern.

INTRODUCTION

An overwhelming amount of literature deals with the "crises of education" or with the underlying philosophies about the subject [1].

The specific literature we investigated nevertheless is silent about the scientific treatment of the process that involves teaching-and-learning at the universities.

The traditional method is, no doubt, the most widely used in Brazilian Universities. Almost all the educational system adopts it, except for pre-school and some basic level schools, which adopt the "constructive" method. Expository classes, explanation of formulae, transposition of sequential tests, condensation of knowledge into disciplines, and laboratories in which measurement and observation are overvalued may be considered characteristics of this hegemonic method in Brazilian schools.

In the next segment we analyze the source of origin of the traditional method. Next, we show the commonest criticisms to it and, then, we present a new perspective for change, based on the scientific theories of Vygotsky, Leontiev, and Davydov.

TRADITIONAL TEACHING METHOD SOURCES

In [2], Saviani presents three theses about the teaching process in 1st Degree Schools. One of these theses states that the traditional method has its origins and was studied by means of the Herbatian pedagogic methodology, that is, "in the expository method, which we all know and have been exposed to it, and many are still being exposed, the theoretical matrix is found in Herbart's five formal steps".

Note that in [5] the author, writing about "the traditional approach to the teaching process (not about the traditional method) states that this approach is not implicit or explicitly based in empirically validated theories, but in an educational practice and in its transmission through the years", since it presents in its genesis several theoretical tendencies, both scientific or philosophic about man, the world, the school, etc.

In other texts we may find that the method, not the approach, really comes from generalization or, in other words, from Herbart's steps hegemony and in the so-called formal disciplines [13]. In Brazil, elements from other scientific theories and ideological standpoints were added to this method, especially North-American behaviorism and technicism. This can be inferred by the context in which changes in Brazilian education were carried on at the time of the political dictatorship begun in 1964, as presented in the famous Rudolf Atcon report [4]. From what has been exposed, we may consider the origin of traditional pedagogy as Herbatian.

MOST IMPORTANT CRITICISMS

The traditional teaching is multi-faceted and may be criticized from several standpoints.

Criticisms are always based on its concrete characteristics, and the pre-supposed theoretical and/or philosophical and/or scientific ideas that would justify this didactic attitude.

From the concrete characteristics, we may outline some of the most important: several students seated on desks (depending on the teaching level, we will have a number between 15 and 60!) before a single person who relates the lessons, the contents, and the subject. A moment to clarify doubts and answer questions. Then, homework or some kind of example. A test. The process is now repeated with new contents. These are the main characteristics of the so-called academic school. In some other types of schools (technical, universities) we add a laboratory and several technical experiments to consolidate what has been taught. Tied to this panorama are implicit different viewpoints of the world, the student, the learning process, and we cannot, at this point, homogenize existing ideologies: each teacher will develop them along his school practice.

Once the picture of traditional teaching is characterized we may now look for the presuppositions of this caricature.

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Johann Friedrich Herbart (1776-1841) was an eminent German philosopher and a skilled teacher. He was the first to develop a learning psychology to justify the "clean slate" theory (derived from Locke's empiricism) by mid XIX century. His psychology was metaphysical and speculative and was based in his own teaching experiences. Therefore it was not an experimental psychology yet. In his view, psychology should be introspective. The four stages of Herbart's method were: clarity, association, system, and method, which his American followers extended to five [9]. These stages were looked upon as a general learning method. The so-called Herbart's formal steps that originated the fundamental teaching are the following: *preparation, presentation, assimilation/comparison, abstraction, generalization, and application [3].*

These steps, if watched attentively, are nothing else than Bacon's scientific method: observation, generalization, confirmation, which are also the reasoning inductive method.

The similarities with traditional teaching do not end here. The renowned class-plans that teachers used to create have their origins in it. Today, not used any more, they were replaced by the emendations.

The practices arising out of this approach required total discipline and attention from the part of the students to the topics presented by the teacher who, on his side, should follow in detail the steps outlined in his lesson-plan, etc. This discipline, focused on total attention, justified the punishment methods so far imposed or, at least, provided subsidies to them. According to Herbart himself the teacher is supposed to disguise any debate from the part of the students by means of an undisturbed disapproval and "wait till fatigue takes care of them" [9]. Needless to say that other disciplinary techniques such as the palmer were considered more efficient to calm down and impose attention from the part of the rowdy and heedless students. The passiveness of the students arises as a result of Herbart's metaphysical philosophic conception in which active are the ideas, not the persons.

Philosophic Presuppositions

The philosophy underlying this method is Locke's sensory empiricism but without a materialist, objective, character. Whereas, according to Locke, learning comes from the interaction of sensory experience with the environment, and this shapes the minds of the persons, who are morally neutral and passive in terms of action, to Herbart everything happens in the heads of the students. It is a world of ideas, perceptions. The ideas, however, have autonomous activity; they live by themselves. Afterwards, Kant, Hegel, and others, being replaced by objective empiricism, criticized these ideas.

Power Structure

Until now, we live a "Herbatian" culture. The palmer was replaced by more subtle tactics of punishment. The established knowledge provides "ex-catedra" supremacy, and this improves discipline, dismissing the use of power. The use of negative points, second-chance tests (generally more difficult), the exclusion/repetition of the "rebel", "problematic" students, permeate the school structure and end up by taming the student, hegemonically producing "docile and submissive bodies" [8].

It is, above all, an excluding and discriminating process: while the "good" students receive the prize of promotion, the "bad" students will repeat, repeat, and repeat... there is no interest in their recovery and reinsertion. If the student does not learn, it is not the teacher's fault! The evaluation is based only on his behavior and on the tests. The student, having no alternatives, memorizes, cheats; what really matters are the grades, to pass easily in all disciplines, knowledge being something secondary in this homeopathic sadism [7].

That is the watch and punish procedure that Foucault and Tragtenberg indict [8]. The school structure, with its roll-calls and ringing of bells, remind us of the of control of the labor forces and the prisoners in jail.

Behaviorism – Technicism

This metaphysics was, little by little, replaced by objectivism and technicism. This happened with the help of behaviorism that proclaimed a programmed instruction, the teacher being a mere extension of the technique and of the teaching instruments. This psychological current admonished the stimuli presented by traditional teaching were presented in a way too slow to provide a reinforcement contingency. The stimuli were based more in negative (punishment) than in positive (prizes) reinforcements. Although behaviorism criticizes traditional teaching methods in some aspects, the ones about reinforcement contingency, it has amalgamated itself so strongly to traditional methods that it is hard to say where is one and where is the other. This is because it has just modified the use of the "stimuli", besides upholding the use of prizes and/or punishments, and the repetition of exercises (memorization) to avoid the *extinction* of an answer. However, behaviorism did not attain itself to other important aspects such as the student's epistemology. Well, for behaviorists only what can be measured and seen matters. Conscience is a black box and so, left to the rats...

The New School

The objective empiricism was readily replaced by pragmatism, forming what was called progressive pedagogy of the New School, its most important exponent being John Dewey. For Dewey, what was important was the learning experience. He criticized Herbart because he took into account everything that was important in education except the essential – "a vital energy searching for an opportunity to effectively exercise" [9]. This way, the central focus is now the student and his actions; not the teacher and the content.

Considering Herbart's teachings, we may find five steps in open contradiction with Dewey [3], very widespread today by what we came to call a learning process based on problems: activity, problem, data, hypothesis, experimentation. Observing this scheme attentively, we will notice a parallelism with the hypothetical-deductive method. While Herbart used the inductive method, the New School and its followers opposed it to the hypothetical-deductive one, being confirmed by contemporary philosophic tendencies such as in the case of the "Viena Circle", and of Karl Popper, among others.

Other Pedagogies

Saviani tries a synthesis of these two educational tendencies, proposing a "content pedagogy", the steps of this synthetic method being: "syncretic" social practice, problematization, instrumentalization, catharsis, and "synthetic" social practice [3].

The scientific method would be the one proposed by Marx in his "Introduction to the Criticism of Political Economy"

In his work he upholds some points of Herbart's method and severely criticizes the progressive pedagogy. However, he sins when he considers progressive pedagogy a pseudo-science because it appeared, as well as traditional pedagogy, from personal experiments of their mentors. And, although both are based in different methods of logical analysis, both of them may be considered scientific, even deserving mutual criticism.

Paulo Freire is another great educator that used to criticize the traditional method on account of its bureaucratization, its insistence in mechanical memorization. He called it "bank teaching" because what mattered was the building up of knowledge, its authoritarianism (the center is the teacher), its micro-reproduction of social dominance. He opposed it with the Pedagogy of the Oppressed, that aimed to produce liberty, not by means of an overwhelming amount of reading, but by reading the world by the oppressed viewpoint, in a horizontal dialogue, consequently democratic, between teacher and student.

There are other pedagogies that could be dealt with: by competence, nowadays a colloquialism in the building up of curricula, Ausubel's meaningful apprenticeship, the ideas of J. Bruner, the field-gestalt theory, etc., but they will not be discussed here.

Piaget's Epistemology

Piaget's epistemology may be one of the most consistent criticisms to the traditional method. Nowadays it is one of the most used in grade school.

Today it is hard to find someone who calls himself traditional in pre-school (even in a worldwide sense). Owing to the lack of space in this paper, we will not consider its details, stressing only its main criticism: the school uses very poorly the spontaneous character (in Piaget's concept) of the children's thoughts, totally forgetting its episteme, and how much it could profit from the lack of equilibrium of the mental schemes already formed in a child's mind. Besides, of course, the over-valorization of the heteronomy and the lack of construction of autonomy by the part of the students [10 e11].

As one may notice, the criticisms to the traditional teaching method are innumerable and even consistent. Nevertheless, we may place a question: why, then, still today, at the very beginning of the XXI century, such an archaic method is used in Engineering courses?

A New Pattern

All the literature presented offers a consistent criticism but fail to provide the teacher with elements that may help him in his daily task. Besides that, all the theories seen so far are unsuccessful in this aspect for they are either pure philosophical speculation (Saviani, Gadotti, Tragtenberg) or emphasize either infantile education (maybe up to 16 years of age) or adult education (Piaget and Paulo Freire). It is not in vain that teachers of technical areas raise comments such as "pedagogy is for children", or "this is something for sissies" We really need an educational theory scientifically based, that may be used by teachers as a didactic guide.

Developmental Education

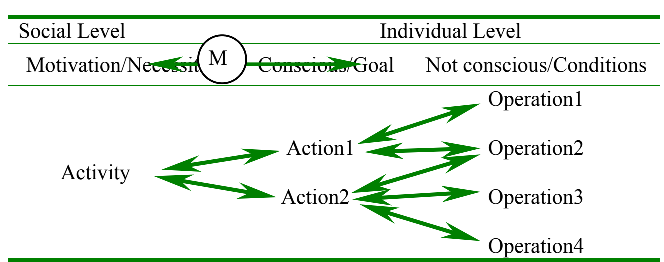
Developmental Education (DE) originated in old USSR, as an outcome of the historic-cultural theory presented by Vygotsky, Leontiev and Luria, later developed in its theoretical aspects by Davydow, Galperin, Elkonin, Lompscher, Chaiklin, Engeström, among others. The philosophic pressupositions of this theory return to Hegel, Marx, and Engels.

The term DE reflects the basic idea presented by Vygotsky that "adequately organized learning turns out into development" [12, 15]. Reference [16] presents briefly some theoretical concepts proposed by Vygotsky and Davydow.

The main concept of this theory comprises learning activity. It arose from the concretion of the general concept of activity made clear by the Activity Theory (TA) (Table I)

TABLE I

STRUCTURE OF ACTIVITY, BASED IN LEONTIEV.



(M): mediation

Still, it is worth taking into account that the concept of Activity has a different meaning for the Russians in relation to the Latin language. It is a lot more than a specific action;

it is a group of actions aimed at the satisfaction of a social necessity and so it may never be looked upon as something individual. It is also a unit in the analysis involving action-emotion-cognition.

The so-called developing education, then, is fundamentally based on the structure of what is known as learning activity. Beyond the relation between activity-motivation, action-purpose, operation-condition, other aspects are taken into account such as the use of psychic instruments of mediation (formation of scientific-theoretical concepts), confining of the action, zone of proximal development (ZPD) and analysis of the discipline [14].

This theory shows itself, then, as something that may be used beyond youth, in spite of the learning activity not being the main activity of the students in this period, and, most probably allowing the teacher to move inside the entangled curricular grid of the engineering course [15].

In this approach, the teaching aim is to give birth to a theoretical thought about reality in the student's minds, expanding a merely empirical thought (to distinguish between the one and the other, see [6] and [16]). If the exposure method is empirical the level of thought of the students will be the same, that is, he will be unable to associate what he learns and the surrounding world.

The main strategy for an educational process to produce development is considered in this theory as an ascending from to abstract to the concrete, typical of Marx's dialectic method; that is, to develop an essential relationship that characterizes an area of knowledge and find out how this relationship appears in several problems. This strategy is oriented towards the conscious and systematic formation of the student's own activity. Besides this and according to Lompscher, "it is important to consider that motivation only arises from activity; it cannot be transferred to the students. This implies the fact that didactics is something that must be oriented towards the actions of the subject that prove necessary to master the contents and the psychic control of the action". In other words, we should pay attention to the unit activity-object-concept and perform a logical and psychological study of the object of the area being studied [14].

Another important point is the analysis of the previous mental conditions of the students. To bear in mind the inter-relationship between internal-external, and ZPD.

Well, if we look upon traditional teaching of Engineering we will see that it tries to transmit something essential by means of concrete examples (i.e. overemphasis measurements of concrete cases without essential inter-relations in the labs). As the student has no psychic tool to adequately manipulate these examples, he remains in the surface, in the outer aspects of the phenomenon (empirical thought). Thus, the students will not be able to make out the differences between the essential characteristics (of content) and the general, or specific ones (formal) [6].

Expository classes and the use of several examples end up, then, overloading the students memory and they do not have a mediating element (psychic tool) to act as a link to the several objects of study and act as an anchor for memorization. This mediating element cannot, however, be formed haphazardly [14]. It is necessary to analyze the discipline, to study the hierarchy of concepts in order to find the one that permeates all the objects of study.

To explain the subject, the teacher must, then, start his work by means of this initial essential relation (ER). This will be gradually enriched and discovered by the students in the handling of the objects/phenomena (O1, F1, etc) being studied, in the transformation of the representative models (Mod.) flowing from this manipulation and by the study of their intrinsic properties (Pro.). The highest point of this activity will be the use of essential abstraction in several problems that will be presented, developing a theoretical thought (Figure 1).

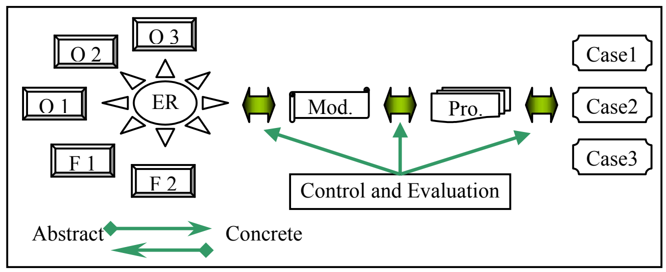


FIGURE. 1
STRUCTURE OF LEARNING ACTIVITIES AND THEIR TYPICAL ACTIONS

Reference [15] shows how to use this analysis of discipline to find the essential generalization (scientific-theoretical concept). This concept many times is something simple and trivial, but fundamental to the organization of the learning activities. It will be the lost link between the sensory aspect and the intrinsic essence among the objects and/or phenomena being studied.

After the previous study of the essential relation, or relations, the teacher should study the necessary actions for the *full* and *independent* development of his students.

We may point out the following as typical actions concerning the learning activity [6]:

- Motivation: the students should learn to evaluate their present way of action, which proves insufficient to solve a new class of problems. This is the moment when the learning activity goals appear.
- Modeling: building up of a model that will settle the essential relation in a material, graphic or literal form, by means of the transformation of the conditions of the proposed material situation.
- Analysis/Synthesis: a study of the intrinsic properties of the relation raised before, which happens by means of the transformation of the models that have been built.
- Expanding: application of the essential relation to the solution of specific problems.
- Auto-regulation: control of the preceding actions, both by the students and by the teacher.

- Evaluation: we confirm the internalization and the independent use of the essential abstraction in new problems.

CONCLUSION

Young teachers, especially those from engineering and technological areas, suffer from being totally unprepared in what concerns the origins and ways of teaching. The way they were taught, they teach. Some head for "alternative methods", try to conform their classes to a context, etc. Somehow, even though these tactics prove necessary, they are insufficient for an effective teaching.

Besides that, the teachers of a technological area, may come in contact with pedagogic theories in didactics courses but these will be presented empirically. Thus, many will feel the necessity to change their teaching techniques but will be unable to do it.

Dewey, Saviani, Gadotti, Tragtenberg and Paulo Freire, all of them educational philosophers, have different opinions about the pedagogical momentum. Even though their personal experiments may have contributed a lot for the development of teaching methods, they lack a scientific-theoretical basis to lay a foundation *specific* for engineering teachers; that is, they say a lot about "what" to change but are of little help in what concerns "how" to perform their daily activities.

Much of what has to be done may be inferred from Piaget, but that applies to pre-school teaching. Piaget, in his theory, was interested much more in developing the individual's cognitive structure performed spontaneously than in his school formation, as he himself stated: "I am a psychologist, not an educator" [11]. In spite of that, many Brazilian educators have wasted time in an inactive and unsuccessful discussion, contraposing or identifying Vigotsky and Piaget, and they would fare a lot better by studying something more up-do-date…

Yet, we may not simply blame the teacher, subdued by the lack of time, by the power structure, as we have shown above. How to remain gentle in overcrowded rooms? How to keep the students' attention? Besides, time is pressing, "time is think", in this crazy run against the clock. School subjects may be planned with excessive or insufficient hour loads, the contents may be crumbled, the knowledge fragmented. What to do if the student lacks a meaningful context: to teach this in spite of it, or step over the student's ignorance? What to do if the matter has already been studied formerly? How to motivate the students?

The structure of the curricula places gaps or superimposes contents. As teachers normally act differently, how to warrant this inter-disciplinary dialogue? When will the teachers be able to discuss such matters? Time passed, the semester is coming to an end. Now the question arises: what to do with the students that were not able to follow the teacher?

DE presents itself as a new pattern for engineering. It points out the necessity to study the school subjects from a new angle, and to analyze curricula from a different standpoint, one that goes beyond formal aggregation of disciplines (pre-requisites).

It is necessary to group similar disciplines and form conceptual modules ("kernel"), We must use the innocuous existence of the school units to formalize groups of side-studies and redefine the teachers' activities as well as the students'. The educator must be educated in order to educate.

Either we dare to relearn how to teach, educate (science of the process teaching/learning and its special activity) or this picture will emphasize the exclusion of the critical knowledge of the world even more.

Paraphrasing Marx, it is necessary not to thing the educational action in different manners; what matters here is to transform it. Paraphrasing Lenin, without a revolutionary theory, we will not have a revolutionary didactics. The DE is a prospective towards that…

ACKNOWLEDGMENTS

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POTENCIALIZANDO AS FRONTEIRAS DA DISCIPLINA METODOLOGIA DO ENSINO SUPERIOR COM O APOIO DA TECNOLOGIA – RELATO DE UMA EXPERIÊNCIA PRÁTICA DIFERENTE EM UMA AULA VIRTUAL

Cláudia Batista Mélo [1] e Antônio Berto Machado [2]

Resumo **— Este trabalho apresenta uma experiência prática de uso de novas tecnologias em uma aula à distância da disciplina Metodologia do Ensino Superior, realizada no período letivo 2002.2, com alunos da Pós-graduação em Computação da UFCG. O professor, doutor em Educação, apesar de possuir alguma prática em Informática, não tinha qualquer experiência em EAD e em chats. Embora existam diversos ambientes virtuais de aprendizagem, essa experiência se passou em uma sala de bate-papo comum, com estrutura pedagógica inadequada. Contudo, ficou demonstrado que esta prática pedagógica motiva troca de experiências (alunos conhecedores da tecnologia utilizada e professor com domínio do conteúdo ministrado), funciona como repositório de conteúdo (possibilita o acesso à discussão a alunos ausentes na aula) e favorece um ambiente de aprendizagem colaborativo (construção coletiva de novos conceitos). Dessa forma, comprovamos as potencialidades dessa inovação metodológica, onde professor e alunos interagem no ensino e na aprendizagem, mediados por novas tecnologias de ensino.**

Palavras chave **— Educação a Distância, Internet na Educação, Metodologia do Ensino Superior, Novas Tecnologias Educacionais.**

INTRODUÇÃO

Já não mais convém a discussão da utilização ou não de novas tecnologias no sistema educacional, mais especificamente o computador, nem a questão do custo serve mais como argumento para justificar a sua não utilização, a realidade é que ele está cada vez mais dentro e fora da escola. Isso ocorre devido principalmente ao aparecimento dos microcomputadores, que aliam baixo custo, grande disponibilidade no mercado, simplicidade de operação, manutenção e programação, aos sofisticados recursos para aplicações educacionais, tais como imagens, animações, efeitos sonoros, portfolios eletrônicos de ensino, entre outros [4].

Agora, a questão é saber como ficam melhor distribuídos os papéis d@ educad@r e do computador no processo educacional. O tema precisa ser tratado da forma mais ampla e integrada, não se tratando apenas do uso ou não da máquina, mas também de todo o gerenciamento da informação e do aprendizado.

Este trabalho apresenta um relato de uma experiência prática diferente em uma aula virtual da disciplina Metodologia do Ensino Superior, realizada no período letivo 2002.2, com alunos da Pós-graduação em Engenharias e Computação da Universidade Federal de Campina Grande, na qual os alunos tinham total domínio da tecnologia e o professor do conteúdo.

A EXPERIÊNCIA

A vivência dessa aula virtual teve as seguintes motivações:

a) há algum tempo pensávamos em realizar uma experiência inovadora nas aulas de Metodologia do Ensino Superior – MES, de forma que envolvesse o uso de novas tecnologias;

b) a oportunidade de estar ministrando a referida disciplina para uma turma constituída, em sua maioria, por estudantes do Curso de Pós-graduação em Informática;

c) a provocação desencadeada pelo texto “Da voz à tela, a nova linguagem docente” [1].

Como a disciplina MES destina-se a discentes de Pós-Graduação, os quais, em sua maioria, têm intimidade com o mundo da informática e o acesso facilitado a terminais de micro conectados na rede, acreditamos ser possível ousar inventar e viver uma aula diferente dos modos convencionais, onde @ docente fala e @s alun@s simplesmente escutam, numa atitude de passividade, em relação ao conhecimento apresentado. Com esse intuito, a oportunidade de estar trabalhando com uma turma, cuja maioria era alun@s do Curso de Informática, favoreceu para que avançássemos da intenção à ação.

O fato de contar com um grupo de alun@s que dominava a tecnologia informacional, propiciou a condições necessárias à operacionalização da idéia. O círculo motivacional foi completado com as argumentações

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apresentadas por Abreu [1], em defesa da transformação da sala de aula em um espaço de construção do conhecimento, tendo por base a participação interativa dos sujeitos envolvidos no processo de ensino e de aprendizagem, tomando como elemento mediador a linguagem audiovisual, enquanto potencializadora das novas interações entre discentes e docentes.

Planejamento, Execução e Avaliação

Como a Educação a Distância (EAD) deixou de ser inovação e a cada dia surgem novos projetos envolvendo a tecnologia disponível em cada momento, sabemos que atualmente existem diversos ambientes virtuais de aprendizagem disponíveis na Internet e de livre acesso para quem quiser fazer suas experiências de EAD. Entretanto, nossa experiência se passou em uma sala de bate-papo comum, sem a menor estrutura pedagógica.

Coletivamente, docente e discentes, resolvemos concretizar a idéia da aula virtual. Decidimos que aproveitaríamos o espaço de tempo destinado à reposição de uma aula, a qual estava prevista para ser realizada em um sábado, à tarde. Definido a data e o horário, estabelecemos que os participantes da aula deveriam ler, previamente, o texto de "Da voz à tela, a nova linguagem docente". Esse texto foi escolhido por apresentar a necessidade de se transformar a sala de aula em um espaço de construção do conhecimento, tendo como suporte o uso de novas linguagens e tecnologias.

Ficou a cargo do docente todo o planejamento da atividade durante a aula virtual. Para @s alunos ficou a responsabilidade da execução. E em conjunto, professor e alunos fizeram a avaliação da experiência.

O grupo de alun@s da informática ficou encarregado de preparar o ambiente onde seria realizada a aula. Acessando à rede, abriu uma sala de bate-papo, espaço no qual, reuniram-se discentes e docente, na data e horário marcados. O objetivo maior era discutir o conteúdo do texto proposto, a partir dos vários locais físicos onde se encontravam os participantes da aula, tendo como suporte a rede. Isso propiciou a reunião em um espaço virtual (sala de bate-papo) de pessoas distribuídas em diversos espaços geográficos, além de garantir as condições para uma comunicação sincronizada.

Por não dominarmos a tecnologia da informática e sermos inexperientes quanto a esse tipo de ferramenta, enfrentamos algumas dificuldades, entre as quais destacamos:

a) a falta de um ordenamento para apresentação das idéias produzidas pelo grupo envolvido. Isso provocou um acúmulo de textos enviados, simultaneamente, dificultando o processo interacional. À medida que os textos eram remetidos em grande volume, não havia tempo suficiente para construção de posicionamentos individuais dos sujeitos participantes, frente aos textos enviados;

b) a não realização da leitura prévia do texto proposto, por participantes da aula. O fato de não ter lido o texto, contribuiu para que discentes participassem de forma opinativa, cujo posicionamento situou-se no nível do senso comum. Embora reconheçamos a importância do conhecimento de senso comum, esse tipo de posicionamento pouco contribuiu para o aprofundamento do conteúdo sugerido;

c) decorrida a primeira hora de aula, diante da reclamação apresentada por alguns sujeitos envolvidos na experiência, resolvemos propor um ordenamento, de forma que contribuísse minimamente para organização da discussão. Nesse sentido, levantamos aspectos fundamentais tratados no texto estudado e solicitamos que cada participante construísse e expusesse o seu posicionamento. Isso facilitou o processo interacional, contribuindo para o aprofundamento do conhecimento apresentado. À medida que as atenções se voltavam para um aspecto destacado, as pessoas tinham uma fração de tempo maior para pensar e construir um posicionamento através de textos mais elaborados, contribuindo para ressignificar, individual e coletivamente, o conhecimento objeto da discussão, com vistas a uma apropriação mais significativa.

A avaliação foi feita presencialmente sob a forma de um debate na qual professor e alun@s chegaram as seguintes conclusões:

a) a tecnologia utilizada não é o fator mais importante no processo de EAD: com criatividade e responsabilidade, ferramentas diversas podem ser utilizadas e apresentarem bons resultados, mesmo que não tenham sido desenvolvidas com finalidades educacionais;

b) o planejamento é o responsável pelo sucesso da experiência: o processo unido aos objetivos que se deseja alcançar são muito mais importantes do que as ferramentas utilizadas;

c) flexibilidade: apesar da grande importância do planejamento, precisamos destacar que o esforço não é válido se não há interesse por parte da turma, então, cabe ao professor a tarefa de motivar os alun@s;

d) troca de experiência: aulas virtuais podem ser vistas como tendo um grande potencial para troca de experiências, no nosso caso constatamos que além do conteúdo objeto da aula o fato d@s alun@s terem um maior domínio da tecnologia que o professor fez com que @s alun@s tivessem uma grande atuação durante a aula virtual;

e) formação de um ambiente de aprendizagem colaborativo: a medida que o conteúdo era abordado pelo professor, cada alun@ dava o seu ponto de vista e muitas vezes, de acordo com as abordagens dadas pel@s colegas e pelo professor, chega a mudar de opinião em um curto espaço de tempo;

f) inversão de papéis e comportamento entre alun@s: alun@s tímid@s nas aulas presenciais se mostraram totalmente desinibidos durante a aula virtual e alun@s que freqüentemente são bastante atuantes nas aulas presenciais muitas vezes pareciam que estavam apenas acompanhando as discussões e faziam poucas iterações;

g) dependência da tecnologia: alguns alun@s não conseguiram participar da aula pois tiveram problemas como falta de energia, não conseguiam se conectar a Internet naquele momento, etc.;

h) flexibilidade no que diz respeito a localização geográfica dos alunos: muitos dos alunos puderam participar da aula mesmo estando em suas cidades de origem, já que a aula se deu numa tarde de sábado;

i) repositório de conteúdo: para os alunos que por alguma razão não participaram da aula, foi gerado um documento com mais de 80 (oitenta páginas) que ficou disponível para estudos.

RESULTADOS

A realização dessa aula virtual, nos proporcionou algumas indagações:

a) por que no ensino superior, o corpo docente ainda apresenta uma série de resistência com relação a utilização de novas tecnologias no exercício da prática docente, mesmo quando essa nova tecnologia é acessível e encontra-se disponibilizada no âmbito da instituição?

b) essa resistência seria decorrente da falta de domínio dessas novas ferramentas, ou por receio do corpo docente em perder o seu controle sobre os conhecimentos a serem produzidos e apropriados pelos sujeitos envolvidos, minando as relações de poder entre docente e discentes?

Concordamos com a afirmação de que os "indivíduos suportam cada vez menos acompanhar cursos uniformes ou rígidos que não correspondem às suas reais necessidades e à especificidade de seus trajetos de vida" [2]. Isso aponta para a necessidade de uma dinamização do processo de ensinar e de aprender, o que implica ressignificar os próprios conceitos estruturantes da prática docente, tais como: conhecimento, aprendizagem, aula, sala de aula, conteúdo, metodologia, docência, docente, discente, relação docente-discente. Em outras palavras, isso nos remete a uma reflexão do currículo enquanto campo articulador da prática docente, bem como das políticas curriculares enquanto mecanismos de controle do conhecimento, sua produção, disseminação e apropriação, no atual contexto científico, cultural, social e econômico.

Nessa perspectiva, estamos intimados a construir um novo discurso que contribua para estruturação de uma nova prática docente. Para tal, faz-se necessário que tomemos como referência uma pedagogia "que favoreça, ao mesmo tempo, os aprendizados personalizados e o aprendizado cooperativo em rede" [2]. Dessa forma, a docência também tem que ser ressignificada e @ docente "vê-se chamado a tornar-se um animador da inteligência coletiva de seus grupos de alunos, em vez de um dispensador direto de conhecimentos [2].

No entanto, vale ressaltar que, como demonstrei em outro trabalho [3], a construção dessa nova docência e dos novos sujeitos docentes ocorrerá no processo de confronto com os modelos existentes, não para substitui-los, mas para disputarem uma visibilidade hegemônica.

CONCLUSÕES E COMENTÁRIOS FINAIS

Contudo, ficou demonstrado que esta prática pedagógica motiva troca de experiências (alun@s conhecedores da tecnologia utilizada e professor com domínio do conteúdo ministrado), funciona como repositório de conteúdo (possibilita o acesso à discussão a alunos ausentes na aula) e favorece um ambiente de aprendizagem colaborativo (construção coletiva de novos conceitos). Dessa forma, comprovamos as potencialidades dessa inovação metodológica, onde professor e alun@s interagem no ensino e na aprendizagem, mediados por novas tecnologias de ensino.

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A INCLUSÃO DE SURDOS NO ENSINO DE ENGENHARIA: UMA PROPOSTA COM APOIO DAS NOVAS TECNOLOGIAS

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Abstract — *O trabalho discute junto aos educadores dos cursos de engenharia a inclusão do aluno surdo, com apoio computacional. Segundo a lei Darcy Ribeiro, o aluno portador de necessidades especiais deve prioritariamente permanecer na rede regular de ensino. A Lei de Diretrizes e Bases também se refere à importância da preparação para o trabalho. Desta forma, discutimos e defendemos a inclusão de surdos na engenharia. Para tanto, é necessário um projeto político pedagógico em que educadores possam discutir, junto aos alunos surdos, sobre as propostas para a educação de surdos. Propomos as novas tecnologias como apoio a essa interação professor-aluno. Num discurso moderno, constata-se que a escola é, por excelência, heterogênea, que deve ser tratada como uma perspectiva de celebração das diferenças, respeitando a heterogeneidade, os direitos de cidadão e preparando-se para esse novo desafio, que é a inclusão dos alunos com deficiência auditiva, no ensino de engenharia.*

Index Terms — *Ensino de surdos, Ensino apoiado computacionalmente, Novas tecnologias de ensino.*

INTRODUÇÃO

A intenção primeira deste trabalho é trazer ao debate algumas questões sobre a inclusão de surdos na universidade, sobretudo, no curso de engenharia. Para que essas questões fiquem bem situadas, dispomos de duas orientações básicas que vêm sendo discutidas por educadores de diferentes níveis escolares, tanto na educação básica quanto na educação superior. Definimos como eixo temático os seguintes pontos: a inclusão de surdos e a visão do educador para enfrentar esse novo desafio no curso superior, na era digital.

Essas duas vertentes têm sido alvo de inúmeras discussões em congressos nacionais e internacionais, seminários, imprensa e demais órgãos integrados à educação. Para entender o porquê dessa chama acesa de discussão, precisamos fazer uma busca sobre a história da educação especial no Brasil e concluir que a polêmica da inclusão se amplia nos últimos anos, respaldada pela lei de Diretrizes e Bases da Educação Nacional [1]. O documento da lei gera polêmica pelo desafio de incluir o aluno com necessidades especiais na rede regular de ensino. Baseados na lei, apoiamos a inclusão de aluno portador de deficiência auditiva no curso de engenharia.

Essa inserção determina um novo caráter da discussão que diz respeito à formação do educador e à adaptação curricular. Neste momento, questionamos: estará o professor preparado para esse novo desafio? É preciso adaptar o currículo aos alunos com necessidades especiais? O processo de avaliação dos cursos de engenharia está adaptado para essa clientela especial?

Por outro lado, o caráter utilitário da educação superior, enfatizado na profissionalização, não pode ser deixado de lado. Contudo, a universidade tem também outras funções que contribuem com o cidadão, no tocante à formação do caráter, à formação ética, à criatividade e ao exercício da capacidade crítica.

Uma proposta feita neste estudo é a alternativa do uso do computador como apoio à educação de surdos. A informática educativa tem sido utilizada por alunos surdos em diferentes níveis. Várias escolas do país já adotaram esse recurso, com êxito na aprendizagem. A contribuição da máquina é visível, visto que a maior dificuldade do surdo é a comunicação.

Para contribuir com a reflexão dos educadores sobre a proposta da inclusão de surdos no curso, foi feita uma pesquisa com educadores do ensino de engenharia, cujo resultado apresentaremos mais adiante.

Diante do exposto, este trabalho vem discutir junto aos educadores do ensino de engenharia a inclusão do surdo com apoio computacional. Na próxima seção, abordamos a política de inclusão do surdo na escola, a formação do currículo e o educador do novo milênio**.** Na seção seguinte, as novas propostas para a inclusão de surdos com apoio computacional são aparesentadas. Na última seção, disctimos os resultados de uma pesquisa feita por nós, com educadores de engenharia, sobre a inclusão de surdos no curso de engenharia e apresentamos as conclusões do trabalho.

A POLÍTICA DE INCLUSÃO DE SURDOS: O PROJETO PEDAGÓGICO E A EDUCAÇÃO SUPERIOR

Ao discutir este tema, visualiza-se como foco principal a instituição de ensino superior em geral. Referimo-nos à escola, a qual há de considerar o fracasso que ela apresenta ao longo de sua história, num processo

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seletivo, contribuindo com o desenvolvimento das diferenças, na sociedade capitalista. A educação de surdos está dentro deste contexto discriminatório que em nada favorece a clientela. Vislumbrando as teorias da educação, citaremos a distinção entre a concepção crítico-reprodutivista e a crítico não-reprodutivista, apontadas por Saviani [2]: "Segundo a concepção crítico-reprodutivista o aparente fracasso é, na verdade, o êxito da escola; aquilo que se julga ser uma disfunção é, antes, a função própria da escola. Com efeito, sendo um instrumento de reprodução das relações de produção, a escola na sociedade capitalista, necessariamente, reproduz a dominação e exploração. Daí, seu caráter segregador e marginalizador. Daí sua natureza seletiva".(p.34). "(...) uma teoria crítica (que não seja reprodutivista) só poderá ser formulada do ponto de vista dos interesses dominados". (p.35).

Conforme exposto acima, podemos concluir que a teoria reprodutivista serve como estratégia política aos interesses de produção da classe dominante, na sociedade capitalista. Já a crítica não-reprodutivista focaliza uma saída para um funcionamento condizente com os interesses dos dominados.

Neste contexto, são relevantes os questionamentos sobre a educação de surdo feito por Fernandes [3]: "Quando o surdo teve voz? Quando se dispuseram a ouvi-lo, quer seja através do português, quer através de sua língua natural, a (Libras) Língua Brasileira de Sinais?" (p.15). Skliar [4] completa a questão, perguntando: "Quais são os mecanismos de participação da comunidade surda no processo educativo?" (p.18). Desta forma, observamos que é primordial uma reflexão sobre a participação dos envolvidos no processo, educadores e educandos, na construção de uma escola democrática que sirva aos interesses do povo, diminuindo o fracasso e a exclusão social. Para concluir a questão, citaremos dois autores: Weiss [5] quando ressalta: "É fundamental que a escola reflita sobre o papel do sujeito que aprende" (p.18) e Demo [6], ao definir o papel da instituição de ensino: "A escola - que não faz milagres - pode fungir papel estratégico como instrumento público de equalização de oportunidades, à medida que se torna espaço privilegiado popular, universalizante, para concepção e exercício de cidadania". (p.81).

Quanto ao aspecto político-pedagógico, ressaltamos a importância da elaboração de projetos sérios e comprometidos com a educação de surdos, priorizando recursos humanos especializados, bem como recursos materiais para o desenvolvimento integral do educando, respeitando o cotidiano de um sujeito surdo, conforme define Skliar [4]: "A pedagogia para surdos se constrói, implícita ou explicitamente, a partir das oposições normalidade/ anormalidade, saúde/ patologia, ouvinte/ surdo, maioria/ minoria, oralidade/ gestualidade" (p.9).

Desta forma, a viabilidade desta investigação ocorre a partir de um envolvimento com o sujeito-surdo respeitando as oposições e apontando novas perspectivas para o desenvolvimento profissional, num olhar antropológico, cultural e tecnológico.

Ressaltamos que a política educacional deve levar em consideração a importância da educação especial. Esta abordagem é apontada por Skliar [4], quando diz que: "A educação especial é um subproduto da educação, cujos componentes ideológicos, políticos, teóricos são, no geral, discriminatórios, descontínuos e anacrônicos, conduzindo a uma prática permanente de exclusão e inclusão" (p.15).

É evidente que a educação de surdos não deve ser incorporada a essa educação que ora inclui ora exclui. Segundo Skliar [4], para que haja uma proposta significativa de educação de surdos é necessário "Um nível de reflexão acerca das potencialidades educacionais dos surdos que possa gerar a idéia de um consenso pedagógico". (p.15).

Paralelamente, temos também a construção do currículo que não pode ser elaborado numa visão homogênea, sem respeitar a diversidade do sujeito. Um outro aspecto discutível é a integração do currículo ao poder, formando cidadãos subordinados à vontade dos privilegiados do conhecimento gerando o binômio saber/poder.

Sob o aspecto legal, a Lei de Diretrizes e Bases da Educação (LDB) privilegia o aluno portador de necessidades especiais nos artigos 58º, 59º, e 60º. O enfoque principal da lei sobre essa clientela especial é a inclusão social desse grupo em classes regulares. Um outro ponto relevante é a flexibilidade do texto em possibilitar o uso da informática educativa, como apoio ao aluno com necessidades especiais, no processo de aprendizagem, uma vez que o artigo tem o seguinte texto: "currículos, métodos, técnicas, recursos educativos e organização específicos para atender às necessidades especiais". art. 59º. Nestes termos, podemos aproveitar também a idéia de avaliação. Demo [7] diz ser a lei de grande importância para a educação especial, que mesmo não falando diretamente em avaliação, é evidente que está incluída nessa atividade educativa "de extremo esmero qualitativo o processo avaliativo". (p.44)

Ainda citando a LDB, destacamos a flexibilização em nível de processo. Para Bordas [8], "A educação passa a beneficiar-se com o fim da obrigatoriedade da organização departamental e dos currículos mínimos que se constituíam em verdadeiras camisas de força para as instituições de ensino superior". (p.29). Deste modo, podemos constatar a importância de uma política inclusiva, com apoio de especialistas em surdez, integrados aos profissionais do curso de engenharia, a fim de atender a clientela especial.

Podemos observar, portanto, que o processo de inclusão do aluno com necessidades especiais é discussão de muitos especialistas em educação. Entretanto, a escola inclusiva ainda está muita fora do alcance da sonhada escola para todos, pois há divergências entre implicações pedagógicas e escolares no contexto inclusivista. Segundo Mendes [9] "A adoção da filosofia de inclusão vem sendo defendida como um potencial de demanda por políticas educacionais mais afetivas.(p.79), contudo o educador ainda se sente despreparado para esse momento de inclusão.

Quanto à atividade docente, é necessário considerar que a complexidade da sala de aula é um processo contínuo e de múltiplas variáveis em interação. Conforme Mizukami [10], tal complexidade é "caracterizada por sua multidimensionalidade, simultaneidade de eventos, imprevisibilidade, imediaticidade e unicidade." (p.55). O educador vive o momento de exigência progressiva sobre a formação continuada, e está cada vez mais sobrecarregado de trabalho e com menos tempo para se dedicar à atividade docente.

Para finalizar, é importante esclarecer que o surdo pode estar incluído em turmas de alunos ouvintes, desde que o curso de engenharia seja de seu interesse e que haja esforço pessoal e coletivo, para que a integração seja efetivada. Esse processo só será possível se houver uma política educacional de inclusão, bem como um processo de abertura no mercado de trabalho que não limite às possibilidades de ascensão profissional, excluindo o surdo. Para concluir, destacamos Coelho [11], quando diz que "a formação de profissional deve ser aberta, inserida numa formação mais ampla, crítica, rigorosa voltada para o culto do raciocínio, da autonomia, da criatividade, da comunicação e da capacidade de identificar problemas e produzir alternativas para superá-los. (p.9).

NOVAS PROPOSTAS PARA A INCLUSÃO DE SURDOS COM APOIO COMPUTACIONAL

O ser humano vive um momento de grandes transformações. Um novo espaço de comunicação e uma revolução informacional nos despertam para um projeto pedagógico menos individual e mais coletivo. Devemos usufruir o lado positivo desta nova era. Há abertura política, econômica, cultural e humana. Entretanto, é preciso ter discernimento, para perceber que nem tudo que é feito com as redes é bom.

Estar ao lado da cibercultura é, conseqüentemente, visualizar claramente o abismo entre os excluídos e os bem nascidos., quando se avaliam as oportunidades de acesso e de filtragem da informação. Entretanto, mesmo nem sempre absorvida plenamente pelo conjunto da população, a tecnologia vem avançando a cada década. O telefone, por exemplo, gera fortuna, mas é útil à comunicação humana, inclusive a dos surdos.

A cibercultura é um processo globalizador, o qual incomoda aos afortunados que percebem a ameaça que esse avanço pode causar, ou seja, a informação ao alcance de todos, independente de raça, sexo, classe social e necessidades especiais. É evidente o crescimento de viagens espaciais, biologia molecular, telecomunicações, enfim, do dilúvio informacional, que ao que tudo indica, jamais cessará. Só para exemplificar essa questão, podemos citar as mensagens universais que podem ser lidas por qualquer grupo social, que tenha acesso a leitura, via internet. Enfim, as mensagens universais antes restritas, atualmente são abertas a qualquer cidadão. Basta ter discernimento e acesso tecnológico para usufruir dessas tão consagradas mensagens.

Pesquisadores e estudiosos em informática educativa já constataram que a apropriação da máquina como uma ferramenta de apoio à educação, aliada à produção do conhecimento humano, pode gerar grandes resultados. O ideal seria propiciar a democratização social do uso das novas tecnologias, a fim de que todos pudessem ter acesso.

A engenharia, em particular, oferece um palco especial para o desenvolvimento do ensino apoiado computacionalmente. Com o computador sendo, ao mesmo tempo, ferramenta essencial e objetivo de pesquisa e desenvolvimento, o aluno de engenharia integra facilmente a informática educativa no seu processo de aprendizado, potencializando enormemente os seus efeitos. Assim, o aluno surdo que chega a uma faculdade de engenharia pode também se benificiar destas características específicas da área, compartilhando, sem dificuldades maiores, com o aluno ouvinte as perspectivas de aprendizado que as novas metodologias de ensino propiciam.

Recentemente, vários congressos nacionais e internacionais vêm discutindo o uso das novas tecnologias na educação. O Congresso Brasileiro de Educação Superior a Distância [12], organizado pela Cederj e Unirede, discutiu a importância da educação a distância e o novo perfil profissional, diante das novas tecnologias, para a formação profissional no ensino superior. O 1º Congresso Internacional de Tecnologia e Educação [13] apresentou pesquisas desenvolvidas em torno da tecnologia educacional e da importância desses recursos para o ensino-aprendizagem.

Não podemos deixar de citar o V Congresso de Informática Educativa [14], que apresentou vários trabalhos sobre Educação Especial e Informática Educativa, contribuindo com educadores que se deparam com o novo momento de inclusão do aluno com necessidades especiais na rede regular de ensino. Neste contexto, destacamos o trabalho apresentado por Oliveira e Bohadana [15], que reflete sobre o projeto pedagógico, quando aponta que o apoio computacional é importante, uma vez que "o aluno surdo vive mergulhado num mundo tecnológico e a instituição precisa aproveitar essa oportunidade para a produção do conhecimento". O XXIX Congresso Brasileiro do Ensino de Engenharia [16] apresentou trabalhos sobre Ensino de Engenharia com apoio computacional. O congresso discutiu o novo perfil profissional aliado às novas tecnologias. Ressaltamos a comunicação apresentada por Oliveira e Seixas [17], que enfatiza o novo perfil profissional, na seguinte afirmação "O maior desafio pedagógico está na mudança de atitude do educador e das instituições em relação às novas tecnologias".(p. 382). O III Congresso Ibero-americano de Informática Educativa Especial [18] apresentou pesquisas e experiências sobre a utilização das tecnologias da informação e comunicação para contribuir com portadores de necessidades especiais.

Nos tempos atuais, as novas tecnologias são importantes para os portadores de necessidades especiais. Sem dúvida, a informática nos permite conhecer um futuro mais próximo. A hipermídia permite auxílio auditivo, facilitando a vida do surdo. Através da Informática Educativa, observamos vários fatores de auxílio dessa ferramenta na educação especial.

RESULTADO DO ESTUDO E CONSIDERAÇÕES FINAIS

Desenvolveu-se uma pesquisa qualitativa, cujo objetivo primordial era incitar e contribuir com a discussão sobre a inclusão de surdos no curso de engenharia, tendo como ferramenta de apoio a informática educativa. Um curto questionário foi desenvolvido para a pesquisa e aplicado preliminarmente no Departamento de Engenharia Eletrônica e de Computação da Universidade Federal do Rio de Janeiro (UFRJ), como protótipo de uma pesquisa de grande cobertura que se pretende efetuar em diferentes habilitações de engenharia e diferentes universidades públicas e privadas. Os questionários foram respondidos voluntariamente por docentes da instituição. A seguir, descrevemos os resultados preliminares, de uma amostra constituída por 10 professores, os apontam uma reflexão positiva a respeito da inclusão de surdos no curso.

Foram feitas cinco perguntas aos docentes, direcionadas à inclusão de surdos no ensino de engenharia:

- Questão A: tempo de atividade docente no curso de engenharia. Os educadores participantes trabalham na universidade em tempo integral. O mais novo participante tem 1 ano e o mais antigo, 24 anos de tempo acadêmico.
- Questão B: A escola de engenharia e a preparação para inclusão de alunos surdos. A maioria respondeu que a escola não está preparada para esse desafio, mas precisa romper barreiras para desenvolver o processo de inclusão.
- Questão C: O projeto político pedagógico da escola de engenharia e a inclusão de aluno surdo. Os participantes desconhecem qualquer proposta de inclusão feita pela instituição.
- Questão D: O educador e a prática docente com aluno surdo. A totalidade dos participantes nunca trabalhou com surdo em sala de aula, ou, pelo menos, nunca percebeu a presença de alunos surdos.
- Questão E: A informática educativa como auxílio na aprendizagem de surdos no curso de engenharia. Os participantes da pesquisa acreditam ser a informática educativa um recurso de grande importância para auxiliar os alunos surdos no curso de engenharia.

A seguir, destacamos a opinião de dois participantes sobre a seguinte questão:

A escola de engenharia deve fazer um esforço para incluir o surdo tendo como recurso o apoio computacional?

- "A escola deve realizar esforços não somente para deficientes auditivos, como também para outros portadores de deficiências. O computador é uma ferramenta que facilita a troca de experiências, aprendizado e comunicação".
- "A escola deve auxiliar um aluno surdo que entre através de vestibular normal. Não se deve facilitar a entrada de surdos pelo fato de ser deficiente".

As conclusões preliminares da investigação nos estimulam a continuar com a pesquisa, uma vez que percebemos o interesse dos educadores em contribuir com a inclusão de surdos no curso de engenharia. Entretanto, a escola precisa incluir os alunos com necessidades especiais em seu projeto político pedagógico e preparar os educadores, através da educação continuada, para que possam atender a esses alunos, com credibilidade e atitude de cooperação, deixando, para o século passado, o caráter discriminatório, o qual vivemos mergulhados ao longo da história da educação especial.

Para finalizar este estudo, concluímos que o apoio computacional pode contribuir com o rompimento de barreiras físicas e sociais. Entretanto, para romper tais barreiras, é urgente propor mudanças no currículo do curso de engenharia, a fim de aproximar o surdo à tecnologia da informação, orientar o educador para o processo pedagógico, dentro da nova proposta curricular tecnológica e refletir sobre os desafios pedagógicos, que a complexidade da sala de aula moderna gera no cotidiano e na interação professor-aluno. Para que esta proposta tenha êxito, precisamos divulgá-la. Desta forma, estaremos contribuindo com o processo de inclusão do surdo no curso de engenharia.

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ORIENTACIÓN NO LINEAL EN CURSOS A DISTANCIA

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Resumen *— Este trabajo presenta una propuesta de mecanismos de orientación, navegación y evaluación no lineales en cursos a distancia, basados en la definición y las relaciones entre los objetivos del curso, proyectados previamente con una herramienta computacional que funciona utilizando la teoría de las reglas de producción. Se demuestra la utilización de este módulo, que forma parte de un sistema para la organización y administración de cursos Web, con posibilidades para la inscripción, evaluación, cooperación, orientación remota de los alumnos y que estará preparado para, a partir de las definiciones y estrategias establecidas por los profesores orientadores del curso, generar todo el contenido necesario para la manipulación de datos y el código que será ejecutado en el espacio del servidor de páginas Web.*

Índice de términos — Educación a distancia, evaluación remota, Internet, reglas de producción, sistemas expertos.

INTRODUCCIÓN

Son diversas las propuestas y experiencias publicadas sobre la necesidad de construir ambientes realmente interactivos y que faciliten la necesaria colaboración [1,4,5] entre los participantes de un curso, asignatura o cualquier otra forma de enseñanza a distancia.

El tema del presente artículo, está relacionado con las posibilidades de presentación de contenidos, siguiendo otras estrategias no lineales, como complemento de la lectura lineal, tradicional y necesaria, que aparece acompañada, normalmente, por un índice de uno o varios niveles de acceso. Otra experiencia interesante de navegación no lineal, por agrupación conceptual, fue descrita en [2].

El principio utilizado en este trabajo para las sugerencias de presentación de contenidos, estará vinculado con el "aprovechamiento" previo de un alumno en específico y la experiencia descrita por el profesor para acompañar un estudio satisfactorio de la materia. En otras palabras, las evaluaciones interactivas del alumno y las sugerencias que parten del conocimiento del profesor, podrán guiar o sugerir al alumno otras formas de consultar/acceder el curso y concentrar su atención en sus puntos débiles o ausentes.

SISTEMA UNIVRT

El sistema UniVrt es una experiencia que viene siendo desarrollada en la Universidade Cruzeiro do Sul, de São Paulo, desde el año 1999. Dentro de los objetivos propuestos para esta investigación, se destaca el empeño en pesquisar y desarrollar metodologías y herramientas computacionales, orientadas a la enseñanza a distancia que permitan vincular las líneas de pesquisa, la docencia y el trabajo científico estudiantil de la Universidad.

El módulo de profesor del sistema UniVrt, le permite preparar un curso para la Web, con herramientas básicas de proyecto, que generarán, finalmente, todo el material necesario para que ese curso funcione activamente en Internet (Figura 1).

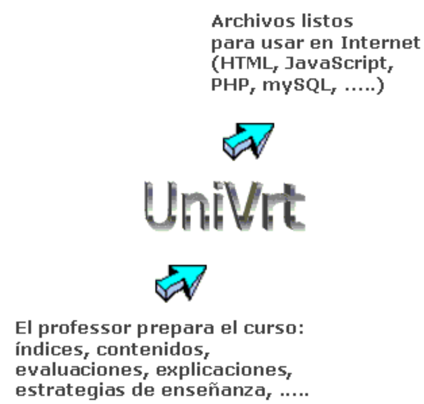

FIGURA 1
EL SISTEMA UNIVRT.

Organización de Contenidos

Un objetivo primario del sistema UniVrt es permitir la organización de los contenidos de un curso, facilitando la creación de un índice de tópicos o epígrafes y todos los vínculos o enlaces necesarios para la navegación por los diferentes niveles de este índice o para la presentación secuencial de la materia.

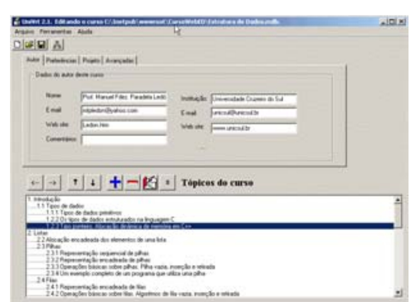

FIGURA 2
ORGANIZACIÓN DE CONTENIDOS.

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La Figura 2 muestra un ejemplo de la pantalla de organización de contenidos. Los epígrafes del curso pueden ser organizados en la forma más conveniente y podrá ser atribuido el nivel adecuado para cada tópico. Se trata de un editor general de los tópicos o epígrafes del curso a distancia en proyecto y las posibilidades de edición incluyen la organización, las evaluaciones propuestas, los vínculos con los documentos externos y otros elementos.

Evaluaciones

La interacción del alumno será un elemento básico para poder orientarlo en futuras consultas del curso. En UniVrt, quedará a criterio del profesor cómo utilizar las evaluaciones individuales de los alumnos pero, en principio, deberá ser un elemento activo estimulador de la participación, comunicación y la presencia del alumno, sin objetivos coercitivos o de punición.

Con el clásico mecanismo de identificador y contraseña, el sistema "en ejecución", registrará la presencia del alumno, su participación, sus evaluaciones, su entrada en la sala de colaboración, el número de accesos y otros datos.

Pero el principal objetivo de la evaluación voluntaria, será la orientación futura al alumno, como será comentado en las próximas secciones.

La Figura 3 muestra la ventana de definición de las evaluaciones.

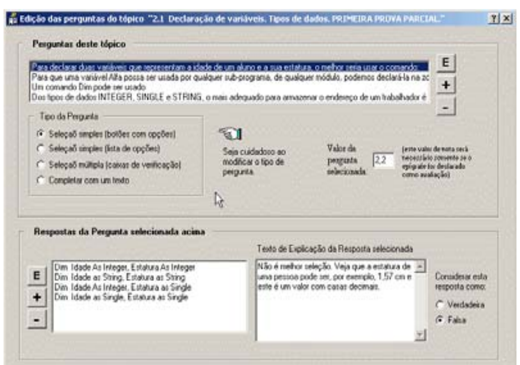

FIGURA 3
EDITOR DE PREGUNTAS O EVALUACIONES.

Observemos, que existen dos clasificaciones de "preguntas":

- Pregunta con retorno y explicación inmediata, sin objetivo de control.
- Pregunta declarada por el profesor como "evaluación" del curso o asignatura.

Las primeras, permiten simular una interacción alumno-profesor en tiempo real, con una explicación adecuada del profesor ante cada respuesta positiva o negativa del estudiante.

El segundo tipo de pregunta será controlada por el sistema, guardando la nota de la evaluación, la fecha, hora y otras informaciones dentro del banco de datos en el servidor Web.

En el cuadro izquierdo superior de selección (vea la Figura 3), el profesor decidirá el formato de la pregunta, que en la versión actual puede ser alguno de los siguientes:

- Selección simple con opciones
- Selección simple con lista de opciones
- Selección múltiple (check-box)
- Completar texto

El resultado de la elaboración de preguntas, será la generación de código HTML/JavaScript/PHP con un formato visual adecuado. Vea los dos ejemplos mostrados en la Figura 4.

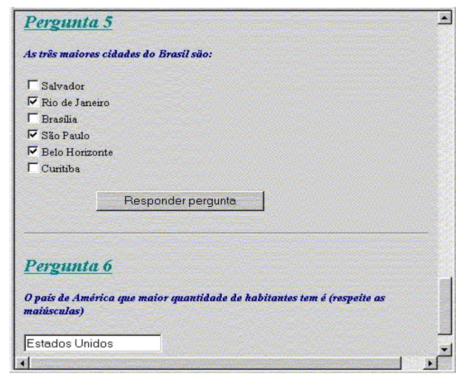

FIGURA 4
DOS EJEMPLOS DE PREGUNTAS EN UNIVRT.

La nota de cada pregunta y la evaluación total de un epígrafe serán decididas por el profesor en esta etapa de proyecto.

Editor de Reglas de Producción

La utilización de reglas de producción [3,6] es el mecanismo de representación de conocimiento utilizado en UniVrt para proyectar la navegación no lineal dentro del curso. Este mecanismo está estrechamente vinculado con las evaluaciones de los epígrafes y la experiencia de los profesores para la presentación y "asimilación" de los contenidos del curso por parte de los alumnos.

La utilización de las reglas de producción en el sistema UniVrt, puede ser dividida en dos etapas. La primera etapa está relacionada con el proyecto de las estrategias de navegación/evaluación, mediante la definición de las estructuras adecuadas de reglas de producción y la segunda etapa será la ejecución de las reglas, utilizando las informaciones específicas del alumno que se encuentra navegando en las páginas del curso.

El sistema permite la construcción de reglas de producción mediante la utilización de operandos (identificadores de epígrafes y objetivos parciales o finales del curso), operadores (conjunción, disyunción, agrupación) y factores de certeza (porcentajes).

La Figura 5 presenta la ventana inicial de manipulación de reglas. Las tablas superiores permiten ver y modificar los identificadores definidos para cada epígrafe y objetivo del curso y la lista inferior muestra las reglas definidas.

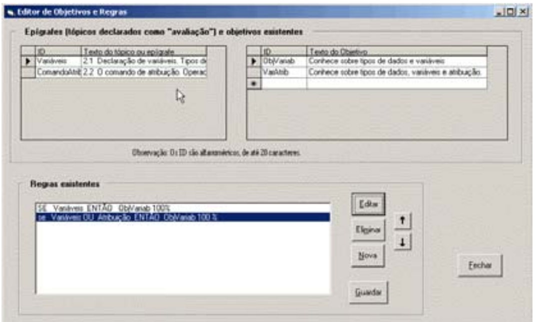

FIGURA 5
MANIPULACIÓN DE OBJETIVOS Y REGLAS.

Como fue mencionado antes, una regla de producción estará compuesta por operandos, operadores y un factor de certeza, con la estructura clásicas de premisas y conclusión. Otro formulario permite la edición individual de cada regla de producción (Figura 6), facilitando la selección de los operadores e identificadores de epígrafes y objetivos posibles.

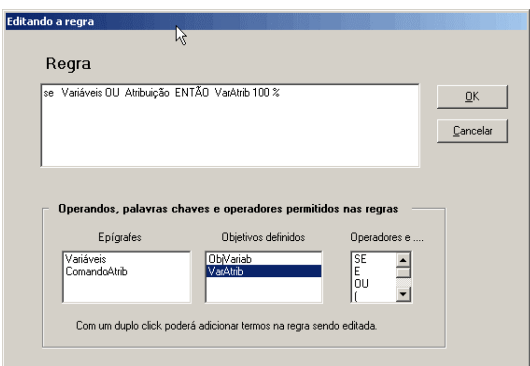

FIGURA 6
EDITOR DE REGLAS DE PRODUCCIÓN.

Las reglas de producción utilizan una sintaxis simple de palabras claves y operadores básicos. Por ejemplo, las reglas que definen el conocimiento de sentencias para ciclos en determinada lenguaje de programación, podrían ser:

SI DoWhile O DoLoopWhile
ENTONCES ConoceCicloWhile (90%)
.....
SI ConoceCicloWhile Y ConoceCicloFor
ENTONCES ConoceCiclos (100%)

Los identificadores DoWhile y DoLoopWhile representarían epígrafes, que tomarán valor dependiendo de las respuestas interactivas del alumno y los identificadores ConoceCicloFor, ConoceCicloWhile, ConoceCiclos, pueden ser objetivos parciales o finales definidos por el profesor.

Para el procesamiento de las reglas de producción, el sistema contiene un pequeño compilador, con las etapas de análisis sintáctico, análisis semántico y generación de código en notación postfija en la etapa de proyecto y un evaluador de expresiones en la etapa de ejecución, en lógica codificada para ser ejecutada en el servidor de páginas Web.

NAVEGACIÓN NO LINEAL ORIENTADA

El complemento de este pequeño sistema experto [3] embutido en el sistema UniVrt, se encuentra dentro del módulo en tiempo de ejecución, un motor de inferencia que permite evaluar las reglas de producción definidas durante la etapa de proyecto, a partir de los valores de los identificadores de entrada, que están relacionados con epígrafes y objetivos del curso, los primeros esperando por las respuestas de un alumno en específico.

Una posibilidad de forma simple de salida del módulo de evaluación/ orientación/explicación, será un reporte que, a partir de un enlace *¿Qué debo estudiar ahora?*, mostrará las informaciones necesarias, con enlaces activos para páginas específicas. Por ejemplo:

Para llegar a la conclusión "Conoce los comandos para ciclos en Visual Basic.NET", usted deberá estudiar y responder satisfactoriamente las preguntas de los epígrafes:

2.1 La sentencia Do-While para ciclos con control en el inicio de la repetición.

O

2.2 La sentencia Do-Loop-While para ciclos con control en el final de la repetición.

Y

2.3 La sentencia For en Visual Basic.NET.

Para la evaluación de los términos de una regla de producción, el sistema permitirá decidir entre dos métodos para operar con los niveles de certeza. Dependiendo del valor final de certeza calculado en la conclusión de una regla, ésta será considerada como verdadera o falsa.

Resulta interesante insistir nuevamente en que este mecanismo propuesto e implementado en el sistema UniVrt, podría ser utilizado como criterio de evaluación individual de los alumnos participantes en el curso, lo que quedaría completamente a criterio del profesor. Las preguntas de un epígrafe (sin límites de cantidades, ni tipos), con los valores de "nota" establecidos por el profesor, conformarían una prueba parcial de la asignatura o curso a distancia.

CONCLUSIONES

En este artículo, fue presentada una propuesta de mecanismos de orientación y navegación no lineales en un curso a distancia, basados en la definición de relaciones entre los epígrafes y objetivos del mismo, proyectadas utilizando reglas de producción que acompañan la participación del alumno en el curso.

Este módulo, forma parte de un sistema para la organización y administración de cursos para Internet, con posibilidades para la inscripción, evaluación, cooperación y orientación remota de los alumnos.

El sistema permite, a partir de las definiciones y estrategias establecidas por los profesores orientadores del curso, generar todo el contenido necesario para la manipulación de datos y la creación del código que será ejecutado en el espacio del servidor de páginas Web.

La investigación de otras formas didácticas de presentación de contenidos en cursos a distancia, de la cual este trabajo es un ejemplo, deberá ser, en nuestra opinión, una línea de pesquisa técnica y pedagógica bastante abordada, por su importancia docente en los tiempos actuales.

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INTERAÇÃO UNIVERSIDADE-EMPRESAS MEDIANTE ESTÁGIOS CURRICULARES

Benedito Antonio Luciano[1] *e Talvanes Meneses Oliveira*[2]

Resumo — *Nos últimos anos, tem-se intensificado a aproximação entre as instituições universitárias e os setores industriais e de serviços. Esta aproximação tem ocorrido de diversas formas, dentre outras: oferta de cursos, treinamento para capacitação, educação continuada, serviços de consultoria e extensão universitária. Neste contexto, a interação universidade-empresas mediante a realização de estágios curriculares por parte de alunos dos cursos de graduação se apresenta como uma oportunidade adicional de aproximação, com reflexos positivos para ambas as partes, preservando identidades, propiciando parcerias e superando antigas dicotomias e preconceitos infundados. Neste artigo, em particular, são relatadas as experiências adquiridas com os estágios curriculares desenvolvidos no âmbito do curso de graduação em Engenharia Elétrica da Universidade Federal de Campina Grande, desde a implementação do seu primeiro Programa de Estágio, em 1973.*

Palavras-chaves — Universidade-empresas, Estágio curricular, Ensino de engenharia.

INTRODUÇÃO

Uma das primeiras experiências de programas de Interação Universidade-Empresa ocorreu no *Suderland Tecnical College*, na Inglaterra, em 1903. Naquele programa, as indústrias participavam permitindo aos estudantes a realização de estágios em suas dependências.

Nos Estados Unidos, essa experiência teve início em 1906, no curso de engenharia da Universidade de *Cicinnati*, onde eram alternados períodos de estudos na universidade com períodos de estágios em atividades correlatas nas empresas locais. Essa experiência recebeu o nome de Educação Cooperativa ("*Coperative Education*"), e na Inglaterra foi denominada de Curso Sanduíche ("*Sandwich Course*").

No Brasil, a primeira iniciativa dessa natureza se deu no Instituto Tecnológico da Aeronáutica – ITA, em São José dos Campos, São Paulo, local onde foram realizados os estudos iniciais para o desenvolvimento de um "Plano de Cooperação com a Indústria" na área de engenharia.

Já nas Instituições de Ensino Superior da rede federal, o início do Programa Cooperativo ocorreu a partir do Primeiro Plano Nacional de Desenvolvimento, com o Plano Setorial de Educação e Cultura, incluindo o Projeto 16 – Integração Escola/Empresa/Governo. A execução desse Projeto foi realizada com a participação do Instituto Euvaldo Lodi – IEL, formalizado mediante convênios firmados com o Ministério de Educação e Cultura – MEC.

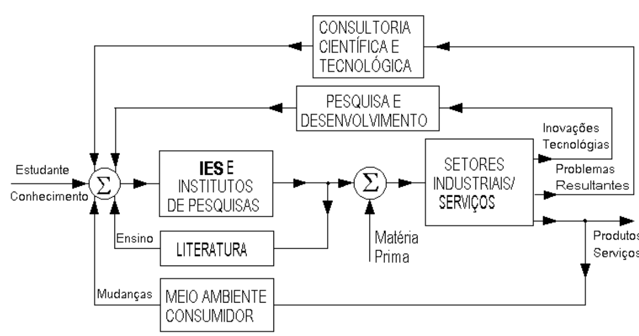
Neste trabalho são apresentadas uma cronologia e as principais ações desenvolvidas no âmbito do Programa Estágio Curricular do Curso de Engenharia Elétrica do CCT da Universidade Federal de Campina Grande - UFCG, a partir do ano de 1973.

A IMPORTÂNCIA DO ESTÁGIO

A aproximação entre ciência e tecnologia é atribuída a Roger Bacon (séc. XIII), segundo o qual essa aproximação se fazia necessária para que a primeira não permanecesse estéril, porque afastada da realidade, e a segunda ineficiente, porque empírica e desprovida de um corpo de doutrina [1].

O conhecimento científico é dominado, armazenado, organizado e gerado, quase que em sua totalidade nas universidades e nos institutos de pesquisas científicas.

A necessidade de interação surge quando os setores industriais e de serviços necessitam absorver uma tecnologia nova para eles, ou quando o setor científico produz inovações tecnológicas com vistas às aplicações práticas. Um diagrama deste fluxo interativo é apresentado na figura 1, com destaque para os elementos de entrada e saída.



A universidade dispõe dos conhecimentos científicos e

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tecnológicos necessários, nas diversas áreas de conhecimento, por meio de um corpo docente capaz de orientar as atividades dos centros empresariais de pesquisa e desenvolvimento [2].

As potencialidades universitárias apresentam-se nas mais diversas formas, e dependem, basicamente, do nível de instrução que propiciam, da capacidade do seu corpo docente, do regime de dedicação do seu corpo técnico e de sua capacidade física instalada.

A ação comunitária dessas potencialidades é basicamente associada a convênios firmados com entidades públicas e privadas, os quais abrangem atividades de serviços técnicos, prestação de serviços científicos, serviços de extensão cultural, bem como outras atividades artísticas e culturais. Neste contexto inserem-se os estágios como uma das modalidades de interação universidade-empresa [3].

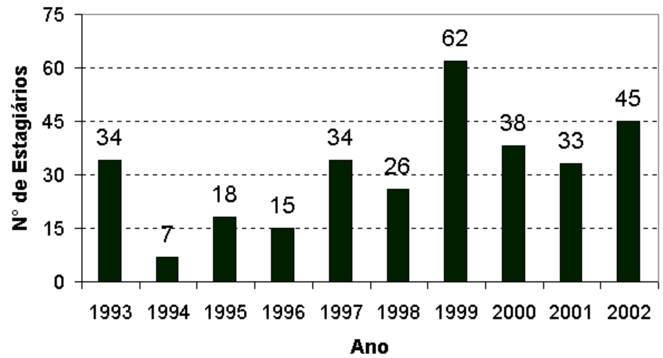
CRONOLOGIA

Em 1972, três centros universitários foram escolhidos para a experiência-piloto de implantação do Curso Integrado, denominação que foi dada no Brasil à Educação Cooperativa: o Centro de Ciências e Tecnologia da Universidade Federal de São Carlos, no Departamento de Engenharia de Materiais; o Centro de Tecnologia da Universidade Federal de Santa Catarina, no Departamento de Engenharia Mecânica; e o Centro de Ciências e Tecnologia - CCT da Universidade Federal da Paraíba - UFPB, no Departamento de Engenharia Elétrica - DEE. Neste último, o Programa de Estágio foi implantado em 1973 [4].

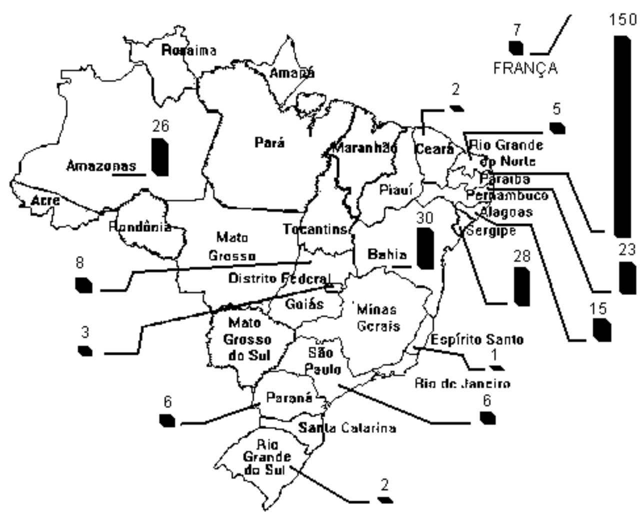
Em 1992, num trabalho publicado no COBENGE'92 [5], foi apresentado, sob forma de tabela, um levantamento dos estágios realizados por alunos dos cursos de graduação em engenharia elétrica da UFPB (atual UFCG), listando os nomes das empresas, por estado, e o respectivo número de alunos que nelas estagiaram. O período coberto pelo referido levantamento foi de 1973 a 1992, contabilizando um total de 94 empresas, 19 estados e Distrito Federal e 544 estágios realizados. Desse total, 173 (31,8%) alunos realizam estágios no próprio estado da Paraíba e 127 (23,3%) realizaram estágios no estado da Bahia, 70 deles na Companhia Hidrelétrica do São Francisco – CHESF. Com relação ao estado da Paraíba, as empresas que mais ofertaram estágios foram a TELPA (19%), a SAELPA (12,7%) e a CELB (11%).

No ano 2000, a secretaria da coordenação de estágios do curso de graduação em engenharia elétrica (CCT/UFPB) realizou um novo levantamento da oferta de estágios cobrindo o período de 1997 a 2000, verificando a oferta de estágios em dois novos estados: Goiás e Rio Grande do Sul Em relação ao total de estágios realizados no período supra citado, os estados que mais ofertaram estágios foram os seguintes: Paraíba (28,28%), Sergipe (15,15%) e Amazonas (12,62%) [6].

Na figura 2 é apresentado um novo levantamento dos estágios curriculares envolvendo o último decênio (1993 a 2002), com destaque para a distribuição de estágios por ano e por estado da federação, distrito federal e no exterior.



a)



b)

FIGURA. 2

ESTÁGIOS CURRICULARES NO DECÊNIO 1993-2002 NO CURSO DE ENGENHARIA ELÉTRICA DO CCT/UFCG: *a)* DISTRIBUIÇÃO POR ANO; *b)* DISTRIBUIÇÃO POR ESTADO.

De acordo com este levantamento, ocorreu um aumento do número de estagiários no último decênio, contabilizando um total de 312 estágios (média de 31,2 estágios/ano) e 87 empresas, sendo cinco destas localizadas na França (Renault, EDF, Alston, Mastra e BIC). Por outro observa-se que o estado da Paraíba aumentou o número de vagas de estágios ofertados, com índice de 48,08%, seguido por 9,62% da Bahia, 8,97% de Sergipe e de 8,33% do Amazonas.

CENÁRIO ATUAL

Na estrutura curricular do curso de graduação em engenharia elétrica da UFCG o estágio é considerado como uma disciplina obrigatória. Atualmente, o estágio pode ser enquadrado numa das duas categorias: estágio supervisionado ou estágio integrado. O estágio supervisionado pode ser realizado pelo aluno em tempo parcial, cursando simultaneamente outras disciplinas. O estágio integrado, por outro lado, é realizado de modo que o aluno permaneça em tempo integral na empresa. Em ambos os casos, o estagiário dispõe de um supervisor designado pela empresa e professor orientador designado pela instituição de ensino.

Os alunos do curso de graduação em engenharia elétrica têm uma formação com perfil mais generalista do que especialista, entretanto, o aluno pode escolher, como aprofundamento de estudos, pelo menos uma das quatro ênfases do curso: controle e automação; eletrônica; eletrotécnica e telecomunicações.

ASPECTOS OPERACIONAIS

Em termos institucionais a coordenadoria de estágio do curso de graduação em engenharia elétrica está a cargo de um professor designado pela chefia de departamento e de uma secretária.

Ao coordenador de estágio cabem as seguintes atribuições: cadastramento de empresas; regulamentação interna dos estágios; levantamento de vagas; seleção e distribuição de vagas; designar os professores orientadores; operar a estrutura de estágio; realizar reuniões prévias com estagiários e orientadores; encaminhar credenciamento de empresas e realimentar o processo curricular.

Ao professor orientador, no âmbito da universidade, cabe: Apreciar o programa de estágio; orientar o estágio; propor o credenciamento de campos de estágios e avaliar o estágio.

Ao supervisor do estágio na empresa cabe: elaborar a proposta da programação do estágio; supervisionar e treinar o estagiário; controlar a freqüência e avaliar o estágio.

Na atual estrutura curricular os alunos devem estagiar no penúltimo ou último período do curso, em tempo parcial ou integral.

VISÃO DA UNIVERSIDADE VERSUS VISÃO DA EMPRESA

Baseados na experiência, acumulada ao longo desses trinta anos, pode-se afirmar que a interação universidade-empresa, mediante estágio, ainda é cercada de conflitos em termos de entendimento, particularmente no que se refere aos papeis da universidade e das empresas na formação do futuro engenheiro.

Pelo lado da universidade o entendimento é que o estágio deve ser conduzido a partir de um plano de atividades criteriosamente definidas, com vistas à formação sistêmica do futuro engenheiro, o que pressupõe um processo complementar, que supere a equívoca dicotomia entre teoria e prática, estabelecendo a conciliação entre elas.

Por outro lado, o entendimento da empresa é que o estágio é uma oportunidade de adaptação do estudante ao ambiente da empresa, às suas necessidades específicas, ajustando-se, desse modo, ao já existente, de forma passiva. Adicionalmente, em alguns casos, o estágio de estudantes de engenharia pode significar redução de custos com treinamento de profissionais recém-formados, ou a utilização de mão de obra qualificada para realizar tarefas aquém da formação acadêmica desses estudantes.

Entende-se que a interação universidade-empresa, mediante estágios curriculares, deve ser precedida de uma política bem definida, a partir de ampla discussão entre as partes, tendo como mediadores os órgãos representativos dos segmentos acadêmicos e empresariais.

Entende-se também que o processo interativo é dinâmico, sendo a oferta de estágio susceptível às mudanças na política econômica, sobretudo aquelas que implicam em retração ou expansão nos setores industriais ou de serviços.

AGRADECIMENTOS

A Rosilda Maria Costa, secretária da Coordenadoria de Estágios do Curso de Graduação em Engenharia Elétrica – CCT/UFCG, pelo sistemático trabalho de atualização das informações referentes à interação universidade-empresas mediante estágio curricular.

CONCLUSÕES

Neste artigo foram relatadas as experiências adquiridas com os estágios curriculares desenvolvidos no âmbito do curso de graduação em Engenharia Elétrica da Universidade Federal de Campina Grande, desde a implementação do seu primeiro Programa de Estágio, em 1973.

A realização do estágio materializou a interação universidade-empresa, com reflexos positivos para as partes envolvidas, preservando identidades e abrindo novas perspectivas de parcerias para outras iniciativas conjuntas.

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CARACTERIZAÇÃO DE CURSOS HIPERMÍDIA ADAPTATIVOS

Raul dos Santos Gonçalves Barbeiro [1], *Clovis Torres Fernandes* [2] *e Luciano Vieira Dutra* [3]

Resumo — *Cursos Hipermídia ou CHs são sistemas que integram características de Sistemas de Treinamento por Computador e Sistemas Hipermídia, enquanto Sistemas Hipermídia Adaptativos ou SHAs são sistemas que integram características de Sistemas Hipermídia e Sistemas de Tutoria Inteligente. Esses novos tipos de sistemas ajudam a promover um alto nível de envolvimento do aprendiz com o conteúdo instrucional. Contudo, eles têm limitações. Por exemplo, um aprendiz estudando através de um CH será exposto ao mesmo material instrucional apresentado a outro aprendiz, enquanto um aprendiz estudando através de um SHA não será usualmente exposto a uma apresentação didática do material instrucional. Este trabalho apresenta uma caracterização e arquitetura dos assim chamados Cursos Hipermídia Adaptativos ou CHAs, que integram características de CHs e SHAs, de forma a apresentar o material instrucional de forma didática, pedagógica e adaptada para cada aprendiz. Um CHA é para ser empregado em atividades de aprendizagem a distância via Internet.*

Palavras-chave — *Cursos, Hipermídia, Adaptativos, Inteligente.*

CONTEXTO DA PESQUISA

A Internet rompeu barreiras que limitavam o acesso ao conhecimento, informação e aprendizagem. As ferramentas e aplicações tradicionais voltadas ao aprendiz, como pesquisa, consulta bibliográfica, apostilas e cópias de transparências de aulas, compartilham, agora, espaço com cursos completos de ensino a distância.

As salas de aulas virtuais passaram a ser empregadas por instituições de ensino como complemento ao ensino tradicional e também como forma de expandir os projetos educacionais. As atividades de aprendizagem realizadas na Internet fazem uso principalmente de aplicações hipermídia. Neste caso, o que se faz normalmente é transpor os cursos tradicionais para essa nova forma tecnológica, usualmente sem o emprego de modelos e metodologias pedagógicas apropriadas [1].

As modificações que aconteceram nos sistemas de aprendizagem assistida por computador, causadas pela evolução dos sistemas de aprendizagem tradicionais, representaram um avanço em direção ao que um aprendiz pode esperar de um sistema computacional para facilitar a aprendizagem. A integração das características dos sistemas de Aprendizagem Baseada em Computador e dos Sistemas Hipermídia nos Cursos Hipermídia e dos Sistemas Hipermídia e Sistemas de Tutoria Inteligente nos Sistemas Hipermídia Adaptativos produziu sistemas com características que facilitam a aprendizagem.

Este trabalho apresenta uma caracterização de Curso Hipermídia Adaptativo ou CHA e uma proposta de arquitetura para um CHA.

O trabalho possui a seguinte organização: primeiro apresentam-se sistemas tradicionais de aprendizagem e sua evolução, que constituem novas formas de aprendizagem; depois se apresenta uma caracterização para CHAs e discorre-se sobre a arquitetura proposta para um CHA.

SISTEMAS DE APRENDIZAGEM TRADICIONAIS

Nesta seção serão apresentados três tipos de sistemas de aprendizagem tradicionais [2]: Sistema de Aprendizagem Baseada em Computador ou CBL (acrônimo do correspondente em inglês: *Computer-Based Learning*), Sistema Hipermídia ou HS (acrônimo para *Hypermedia System*) e Sistema de Tutoria Inteligente ou ITS (acrônimo para *Intelligent Tutoring System*). Tais sistemas são considerados tradicionais porque atualmente dispõe-se de pesquisas em número tal que as suas bases já se encontram definidas.

Sistema de Aprendizagem Baseada em Computador

Sistemas de Aprendizagem Baseada em Computador têm sido a forma de ensino por computador empregada com maior ênfase atualmente [2]. Esses sistemas computacionais de aprendizagem são comumente descritos como CAI, acrônimo para *Computer-Aided Instruction* (Instrução Auxiliada por Computador), ou CBT, acrônimo para *Computer-Based Training* (Treinamento Baseado em Computador).

Independente da distinção que possa ser feita entre um termo ou outro, os sistemas de aprendizagem do tipo CBL são programas que funcionam como receptáculos organizados estaticamente para incorporar tanto o domínio do assunto, quanto o conhecimento pedagógico dos professores especialistas [3].

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Os CBLs convencionais são caracterizados por sua estrutura relativamente inflexível e pelo uso de várias formas de apresentação da informação, como vídeo e áudio. Além disso, a estrutura dos CBLs é predeterminada precisamente pelos autores. Um CBL é diferente de um sistema de auxílio online, help em inglês, pois estes são normalmente direcionados para determinada aplicação, ao passo que os CBLs são materiais independentes [4].

Apesar de se encontrar algumas variações quanto à arquitetura dos sistemas de aprendizagem baseada em computador, existem três componentes que podem ser considerados básicos para esses sistemas. São eles o conteúdo, a interface gráfica com o usuário ou GUI (acrônimo para *Graphical User Interface*) e as funcionalidades do sistema [5], conforme ilustra a Figura 1.

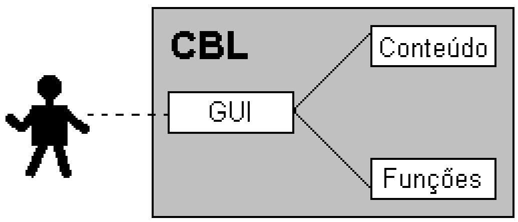

FIGURA 1
ARQUITETURA DE UM CBL.

A interface gráfica com o usuário, ou apenas interface com o usuário, é a responsável pela interação do aprendiz com o sistema. O conteúdo usualmente compreende uma estrutura linear de material instrucional. As funcionalidades são as possibilidades do aprendiz ir para frente ou voltar na estrutura linear, além de receber realimentação sobre respostas a exercícios realizados [6].

Sistema Hipermídia

Os termos hipermídia e hipertexto têm sido freqüentemente utilizados como sinônimos. Embora hipertexto sugira que toda a informação esteja na forma de texto puro, a maioria dos sistemas hipertexto permite o uso de informação em outras formas, como gráficos, som, animação ou vídeo. Pode-se usar a palavra hipertexto hoje em dia com o significado mais completo de hipermídia [7].

Sistema Hipermídia é um ambiente que facilita a criação e manipulação de uma aplicação hipermídia. Uma aplicação hipermídia pressupõe a existência de um sistema hipermídia que forneça os recursos para se realizar a autoria, a apresentação e a navegação. Dessa forma, uma aplicação hipermídia será construída criando-se uma hiperbase, um conjunto de estruturas de acesso e uma interface com o usuário [8]. A Figura 2 apresenta a arquitetura de um Sistema Hipermídia.

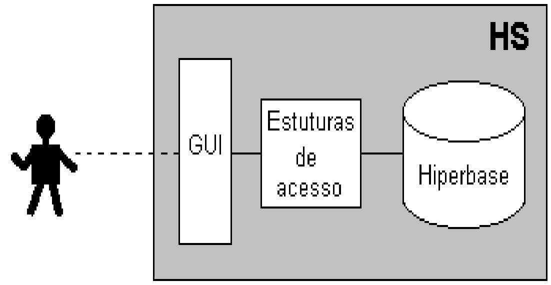

FIGURA 2
ARQUITETURA DE UM HS.

Teoricamente pode-se definir um sistema hipermídia em uma estrutura contendo três níveis [9]:

- Nível de apresentação: interface com o usuário
- Nível Hypertext Abstract Machine (HAM): nós de informação e links
- Nível de banco de dados: armazenamento, compartilhamento dos dados e acesso à rede

O nível de banco de dados está na base do modelo de três níveis, sendo responsável por todos os assuntos tradicionalmente relacionados com armazenagem de informação que não são necessariamente relacionados com hipermídia. Independente da forma como a informação é armazenada, deve ser possível recuperar um bloco específico em um curto espaço de tempo.

Além disso, o nível de banco de dados deve lidar com os assuntos relacionados com acesso múltiplo de usuários, segurança, *backup* etc. Normalmente é responsabilidade desse nível fazer cumprir os controles de acesso definidos nos níveis mais altos da arquitetura.

O nível HAM situa-se entre os níveis de banco de dados e o nível de apresentação. Neste nível central o sistema hipermídia define cada nó de informação, seus links e os respectivos relacionamentos entre eles. O HAM possui conhecimento na forma de nós e links e conhece quais atributos estão associados a cada nó e link. Um exemplo de atributo associado a um nó pode ser o atributo “responsável” que especifica quem é responsável pela criação do nó e possui autorização para atualizá-lo. Outro exemplo de atributo pode ser o “número de versão” do nó.

A interface com o usuário trata da apresentação da informação, incluindo aspectos como quais comandos devem ser disponibilizados para o aprendiz, como exibir nós e links, e apresentação de diagramas. Um exemplo do que pode ser tratado na interface com o usuário em um Sistema Hipermídia é controlar se o aprendiz pode efetuar entrada de valores ou se isso só pode ocorrer no modo de autoria. Os aspectos tratados no nível de apresentação devem refletir a estrutura adotada no HAM.

Para o desenvolvimento de aplicações hipermídia pode-se fazer uso de vários modelos para estruturar a informação. Dentre esses modelos, pode-se citar o Hypermedia Design

Model ou HDM [10], Mapeamento de Informação ou MI [11] e DAPHNE [12].

Sistema de Tutoria Inteligente

Sistemas de Tutoria Inteligente (ITS) utilizam alguma forma de inteligência para a tarefa de instruir com base em computadores. Existem dois lugares chave para inserir inteligência em um ITS. Um é no conhecimento que o sistema tem sobre o domínio do assunto. O outro é nos princípios através dos quais ele efetua a tutoria e nos métodos pelos quais aplica esses princípios [13].

Um ITS é um programa de computador que auxilia de forma inteligente o aprendiz a aprender determinado assunto. Não existe uma definição aceita sobre o que significa favorecer a aprendizagem de forma inteligente. Entretanto, uma característica compartilhada por muitos ITSs é que eles inferem um modelo do entendimento atual do aprendiz sobre o assunto e usam esse modelo individual para adaptar a apresentação didática do conteúdo às necessidades do aprendiz [14].

Com base nos itens descritos acima, pode-se definir os ITSs como sendo programas de computador destinados a auxiliar o processo de aprendizagem, utilizando técnicas e métodos de Inteligência Artificial (AI) para representar o conhecimento e para conduzir a interação com o estudante. Esses sistemas têm por característica possibilitar um maior controle, pelo programa, sobre a forma como está sendo realizado o aprendizado [15].

Os módulos componentes da arquitetura de um ITS, ilustrada pela Figura 3, apresentam as seguintes funções [15]:

- Interface com o usuário - Componente do ITS responsável por realizar a interação com o aprendiz.
- Módulo Tutorial - Responsável por planejar e gerenciar a interação com o aprendiz.
- Modelo do Estudante - Responsável por capacitar o sistema a fornecer uma individualização da aprendizagem.
- Módulo do Especialista ou Domínio - Compreende o conhecimento do especialista.

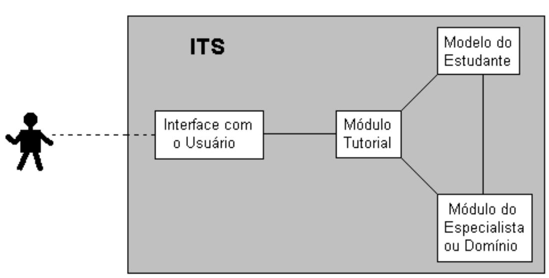

FIGURA 3
ARQUITETURA DE UM ITS.

EVOLUÇÃO DOS SISTEMAS DE APRENDIZAGEM TRADICIONAIS

Os sistemas de aprendizagem tradicionais foram aperfeiçoados, vindo a constituir novas formas de facilitar a aprendizagem. Esses sistemas foram integrados, conforme ilustrado na Figura 4, formando estruturas que apresentam características próprias. Por exemplo, Cursos Hipermídia ou CH são sistemas que integram características de CBLs e HSs, enquanto Sistemas Hipermídia Adaptativos ou SHAs são sistemas que integram características de HSs e ITSs. Esses novos tipos de sistemas, descritos em seguida, ajudam a promover um alto nível de envolvimento do aprendiz com o conteúdo didático [8].

Curso Hipermídia

Um Curso Hipermídia é um curso realizado por computador que utiliza a tecnologia hipermídia, cujo objetivo é facilitar o desenvolvimento de novas estruturas de conhecimento por parte do aprendiz [9].

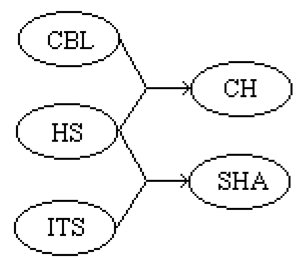

FIGURA 4
EVOLUÇÃO DOS SISTEMAS TRADICIONAIS.

Esse tipo de curso apresenta, assim, a informação de forma didática e pedagógica sobre determinado assunto. O CH fornece orientação ao aprendiz, embutida nas seqüências de informação definidas ou roteiros, e nos mecanismos de navegação empregados [8].

Os roteiros são definidos com base na aplicação hipermídia armazenada num banco de dados, que é chamada de hiperbase. Além da referência aos nós da hiperbase, os roteiros incorporam nós adicionais que ajudam na apresentação didática do material instrucional. Os roteiros não são lineares como nos CBLs por causa dos links hipermídia, embora nem todos os links da hiperbase sejam ativados no nível dos roteiros. Isto constitui o grau de liberdade de navegação, associado a cada nó do roteiro [1]-[15].

Um ambiente de aprendizagem deve prover uma boa orientação para o aprendiz, de modo a facilitar a obtenção dos objetivos pretendidos pelo autor do curso. É importante ter-se um balanço entre o controle do autor e o grau de liberdade oferecido ao aprendiz [1]-[8]-[15].

Enquanto os sistemas inteligentes têm sido criticados pela forma como efetuam a tutoria e o modo como empregam os modelos especialistas do domínio do conhecimento, os cursos hipermídia sofrem pela falta de uma estrutura ou auxílio especialista ao longo da seqüência instrucional [16]. Como decorrência, isto pode ocasionar a sensação de desorientação no aprendiz, ou de "perdido no hiperespaço" [20].

A expressão "perdido no hiperespaço" refere-se a um problema de desorientação que ocorre quando se utilizam até mesmo aplicações hipermídia relativamente pequenas, educacionais ou não. Esse problema consiste na combinação dos dois subproblemas seguintes [21]:

- Uma vez que se encontre algum material instrucional interessante, o leitor acredita ser melhor lê-lo cuidadosamente de imediato, porque pensa na eventualidade de não o encontrar novamente;
- Ao se navegar numa aplicação hipermídia, fica-se confuso sobre o local atual de navegação, não se sabendo, momentaneamente, porque se chegou nesse ponto, nem para onde se deslocar, uma vez que se perdeu o foco que deve nortear uma navegação.

Para reduzir os problemas relacionados à estrutura dos cursos hipermídia, utilizam-se modelos para desenvolver os cursos hipermídia. Encontram-se na literatura vários modelos e metodologias que podem ser empregadas [1]-[8]. Independente do modelo ou metodologia empregada, a construção de cursos hipermídia pode compreender as seguintes etapas, adaptadas de [1]-[8]:

- Pré-autoria: planejamento da hiperbase e dos roteiros
- Autoria: implementação da hiperbase e dos roteiros
- Infra-estrutura de apresentação e navegação

Sistema Hipermídia Adaptativo

Sistemas Hipermídia Adaptativos têm sido projetados e desenvolvidos em reconhecimento à necessidade de fornecer algum grau de apoio aos aprendizes durante a navegação. Um Sistema Hipermídia Adaptativo busca fornecer uma solução para o problema de desorientação causado pela navegação em sistemas hipermídia e a necessidade de acomodar usuários com interesses variados. Isso é conseguido através da capacidade de buscar e filtrar a informação mais relevante para as necessidades do usuário, seus objetivos e interesses [17].

SHAs são todos os sistemas hipermídia que reflitam algumas características do usuário em um modelo de usuário e aplique esse modelo para adaptar vários aspectos visíveis do sistema para o usuário [17].

Em um SHA pode-se adaptar o conteúdo da página hipermídia e os links de uma página, incluindo páginas de índice e mapas, para as páginas relacionadas. Distinguem-se essas duas técnicas de adaptação chamando a primeira de apresentação adaptativa, ou adaptação ao nível do conteúdo, e a segunda de suporte para a navegação adaptativa, ou adaptação ao nível dos links [18].

CARACTERIZAÇÃO DE CURSOS HIPERMÍDIA ADAPTATIVOS

Um aspecto que deve ser observado nos sistemas resultantes da evolução dos sistemas tradicionais, é que a integração resultante se apresenta com características marcantes de um ou outro sistema. Olhando um sistema filho, pode-se dizer de qual sistema pai ele herdou mais fortemente uma característica.

Os Sistemas Hipermídia Adaptativos possuem forte influência dos Sistemas de Tutoria Inteligente, no sentido em que buscam uma solução que está centrada em um modelo de usuário. Esse modelo procura representar o "estado cognitivo" do usuário e através desse modelo o sistema procura se adaptar ao mesmo. Já os Cursos Hipermídia demonstram forte influência dos sistemas de Aprendizagem Baseada em Computador, representada pela incorporação de aspectos pedagógicos no curso [1]-[8]-[19].

Buscando incorporar aos Cursos Hipermídia e aos Sistemas Hipermídia Adaptativos novos mecanismos para facilitar a aprendizagem, esses dois sistemas de aprendizagem foram integrados, gerando os assim chamados Cursos Hipermídia Adaptativos. Esses cursos irão apresentar maior ou menor grau de facilitação da aprendizagem em função das características incorporadas dos sistemas pai.

Curso Hipermídia Adaptativo

Os cursos hipermídia adaptativos ou CHAs incorporam características dos cursos hipermídia e dos sistemas hipermídia adaptativos. Um curso hipermídia adaptativo é um curso hipermídia que utiliza a tecnologia dos sistemas hipermídia adaptativos para fornecer uma informação sobre determinado assunto de forma didática, pedagógica e adaptada para cada aprendiz que realize o curso. A Figura 5 representa a integração dos CHs e SHAs, formando os CHAs.

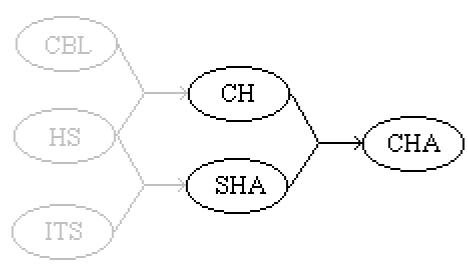

FIGURA 5
EVOLUÇÃO DOS CHS E SHAS.

Um CHA facilita o desenvolvimento de novas estruturas de conhecimento por parte do aprendiz, através da aplicação de um modelo de usuário que reflita no curso características do aprendiz, adaptando vários aspectos do sistema ao usuário.

Com isso, no CHA emprega-se uma característica herdada dos SHAs que pode resolver o problema dos cursos que são realizados por diferentes classes de aprendizes. Os aprendizes podem apresentar grande divergência quanto aos seus objetivos, suas experiências e seus conhecimentos sobre os assuntos abordados num dado curso. Contudo o CHA irá tratar essas diferenças de modo único e voltado para cada aprendiz [20].

Ao se preparar um CHA, estar-se-á fornecendo um curso que deverá atender os objetivos específicos de cada aprendiz, adequando o conteúdo do curso para as necessidades, experiências e conhecimento do mesmo durante todo o transcorrer do curso. Isso é obtido através do uso de modelos de usuário, que fornecem as informações necessárias para que o CHA possa adequar-se ao aprendiz.

Outro aspecto, herdado dos CHs e SHAs, é que um CHA evita a sensação de "perdido no hiperespaço" do aprendiz [20].

Quanto à questão de encontrar material instrucional de interesse, num CHA o aprendiz não precisa se preocupar com isso, pois ele deverá ter acesso, por definição, somente a documentos que sejam de seu interesse.

A questão da navegação em um CHA é realizada como se fosse uma via de mão única e sem retornos. Caso o sistema do CHA detecte, num dado ponto, que o aprendiz requer algum conhecimento prévio, este será apresentado na interação imediatamente a seguir do aprendiz com o sistema. Uma interação é representada pelo ato do aprendiz solicitar ao CHA a apresentação de algum material instrucional. Isso deve ser feito de forma transparente para o aprendiz, de modo que o aprendizado não seja prejudicado.

A Figura 6 representa duas interações do aprendiz com o curso: i e i+1. Antes da interação i, o CHA seleciona qual material instrucional será exibido para o aprendiz e em que ordem, no caso o item 2. Após a interação i, antes de o aprendiz realizar a interação i+1, o CHA recalcula, com base em seu desempenho na interação i, o material instrucional que será apresentado ao aprendiz na interação i+1, no caso o item 3. Percebe-se que não apenas o próximo material instrucional é alterado (item 3 em vez do item 5 da interação i): toda uma possível seqüência é recalculada.

Essa é uma característica que remonta aos ITSs, uma vez que um CHA efetua um maior controle sobre a forma como está sendo realizado o aprendizado. O aprendiz comanda o sistema para prosseguir, mas é o CHA quem diz para onde ele pode ir ou o que ele pode ter acesso.

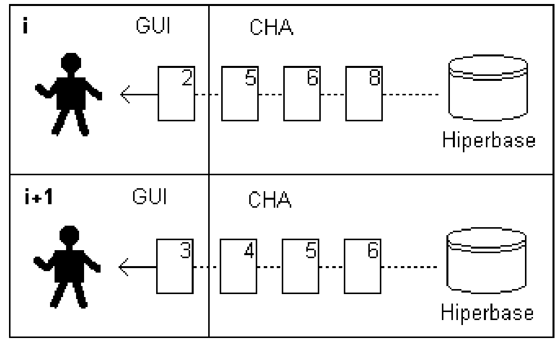

FIGURA 6
INTERAÇÕES DO APRENDIZ.

ARQUITETURA PROPOSTA DE UM CHA

A caracterização dos CHA, nos leva à seguinte proposta para uma arquitetura de um Curso Hipermídia Adaptativo, com os seguintes elementos:

- Servidor CHA – Implementa a lógica do curso, integrando as informações dos demais elementos constituintes do CHA.
- Roteiro-base – Melhor seqüência para percorrer o material instrucional do curso, definida por especialistas.
- Modelo do Aprendiz – Módulo que permite extrair informações do usuário, visando adaptar o curso ao mesmo.
- Módulo Avaliador – Efetua o controle de desempenho do aprendiz.
- Hiperbase – Aplicação hipermídia armazenada em um meio persistente ou banco de dados.
- Interface com o aprendiz – Interface de acesso ao material instrucional do curso.

A Figura 7 apresenta a arquitetura conceitual proposta para um CHA e a Figura 8 seguinte representa a arquitetura para um CHA quando realizado na WWW em um ambiente cliente-servidor.

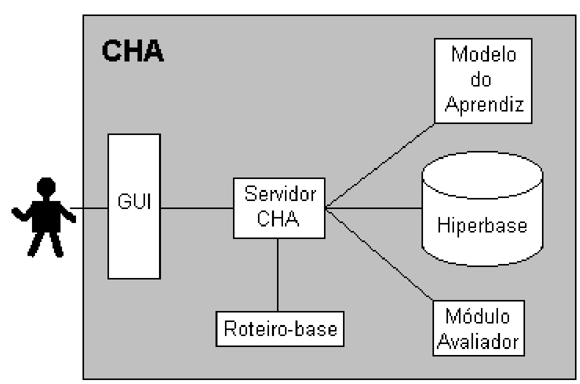

FIGURA 7
ARQUITETURA DE UM CHA.

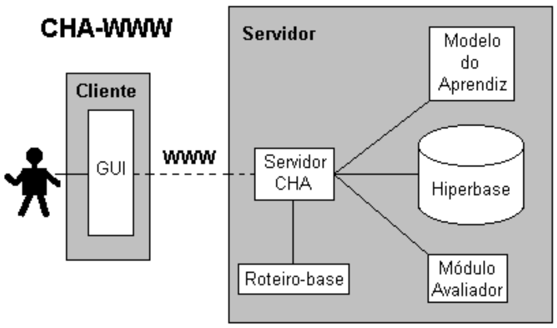

FIGURA 8
ARQUITETURA DE UM CHA PARA A WWW.

Servidor CHA

Este módulo implementa a lógica do curso, integrando as informações dos demais elementos constituintes do CHA. Este módulo é responsável pelo planejamento e gerência da interação com o aprendiz. Neste módulo estão integradas as estratégias de aprendizagem, ou conjunto de ações que serão executadas visando atingir os objetivos de aprendizagem definidos pelo autor do curso.

As informações sobre o aprendiz, obtidas do Modelo do Aprendiz, e o desempenho do aprendiz, obtido do Módulo Avaliador, integradas com o Roteiro-base capacitam o Servidor CHA a selecionar na Hiperbase o material didático adequado que será apresentado ao aprendiz. Este módulo representa o chamado Módulo Tutorial dos ITSs.

Roteiro-base

Neste módulo está presente o roteiro de referência que o CHA irá utilizar para definir o material instrucional a ser apresentado ao aprendiz. Este módulo representa o modelo de roteiro utilizado nos CHs, onde para cada nó é oferecida uma lista de opções alternativas que o aprendiz pode seguir.

O modelo de roteiros dos CHs atua como um roteiro-base, pois para um CHA os roteiros devem ser adaptativos e este tipo de roteiro será alcançado quando as informações do Roteiro-base forem integradas com as informações dos demais módulos.

Hiperbase

O conjunto de material instrucional da hiperbase deve ser projetado de modo que possa atender os diferentes aprendizes que deverão realizar o curso. As informações presentes na hiperbase devem conter material relevante a cada aprendiz, de outra forma ela poderá atender somente uma pequena parcela de aprendizes.

Roteiro-base, Servidor CHA e Hiperbase, em conjunto, representam o Módulo do Especialista dos ITSs, que contém os fatos e regras de um determinado domínio que será apresentado ao aprendiz.

Módulo Avaliador

É responsável por efetuar o controle de desempenho do aprendiz. A avaliação é um aspecto essencial em toda aprendizagem. Ela é utilizada com os seguintes propósitos [21]:

- Determinar o que um aprendiz conhece ou não conhece.
- Ordenar os aprendizes em função de seu desempenho.
- Decidir o que deve ser empregado na apresentação do material instrucional.
- Atribuir notas aos aprendizes.
- Admitir um aprendiz no próximo nível de um curso.

A avaliação pode ser um questionário informal ou um exame formal, monitorado, em grupo ou individual. Na arquitetura do CHA proposto, o Módulo Avaliador assume duas funções principais:

- Determinar o desempenho do aprendiz no curso, visando definir qual o melhor nível de informação para apresentar ao aprendiz, dentre os níveis suportados pela hiperbase.
- Selecionar quais conceitos ele deve ver, e serão apresentados ao aprendiz, e quais conceitos ele não precisa ver, e não serão apresentados ao mesmo.

Modelo do Aprendiz

Módulo que permite extrair informações do usuário, visando adaptar o curso ao mesmo através da representação do estado atual de conhecimento do aprendiz sobre o assunto do curso. Esse módulo realiza a tarefa de reunir informações que sejam consideradas relevantes sobre um aprendiz individual que podem ser utilizadas para adaptar o curso ao aprendiz.

Os módulos Avaliador e Modelo do Aprendiz representam o chamado Modelo do Estudante dos ITSs que é responsável pela capacidade de individualização da aprendizagem nesses sistemas.

Interface com o Aprendiz

Este módulo realiza a apresentação ao aprendiz do material instrucional selecionado pelo Servidor CHA. Este módulo deve possuir suporte aos vários tipos de arquivos presentes na hiperbase, tais como texto, som e vídeo. A interface com o aprendiz deve possuir os seguintes recursos [15]:

- Capacidade de personalização pelo aprendiz
- Apresentação de dados em diversos formatos e meios
- Facilidade de uso, minimizando o número de ações necessárias para uma comunicação efetiva entre aprendiz e sistema.

- Interatividade e apresentação de informações sobre o estado atual do sistema, como no caso de se estar aguardando o resultado de um processamento.
- Reconhecimento de erros involuntários e monitoração contínua das ações do aprendiz
- Respostas rápidas, dentro dos limites impostos pelo meio físico empregado no curso

Comparação Entre CH, SHA E CHA

Através das características dos CHs e SHAs, apresentadas anteriormente, e pela caracterização dos CHAs, pode-se observar que esses sistemas apresentam grande potencial para seu emprego na aprendizagem. Esses sistemas de aprendizagem apresentam características que podem ser contrastantes e devem ser apresentadas para que, quando da realização de um curso, possa escolher-se o sistema que melhor atenda as necessidades do autor.

Para realizar uma comparação entre esses sistemas de aprendizagem, foram adotados os critérios utilizados por Santos, conforme apresentados na Tabela 1 [15].

TABELA 1
COMPARAÇÃO ENTRE SISTEMAS DE APRENDIZAGEM.

Critérios x Tipos de Sistema	CHs	SHAs	CHAs
Grau de liberdade	Alto	Variável	Variável
Estilo de aprendizagem	Informal	Formal	Formal
Modelagem do domínio	Implícita	Explícita	Explícita
Métodos de ensino	Não	Sim	Sim
Modelagem do usuário	Não	Sim	Sim
Iniciativa na interação	Flexível	Mista	Mista
Responsabilidade	Usuário	Sistema	Mista
Sobrecarga cognitiva	Sim	Eventualmente	Eventualmente
Complexidade de criação	Variável	Alta	Variável
Ferramentas	Muitas	Poucas	Poucas

O item "grau de liberdade" indica quanto o aprendiz é livre para determinar o rumo do curso. Esse item serve para medir o grau de controle do sistema sobre o aprendiz. Pode ser baixo, médio, alto ou variável.

O item "estilo de aprendizagem" indica o formato da aprendizagem que é empregado pelo sistema, podendo ser formal, informal ou variado.

O item "modelagem do domínio" indica se o sistema possui um Modelo de Domínio do conhecimento, podendo ser explícito ou implícito.

O item "métodos de ensino" indica se o sistema é capaz ou não de incorporar diferentes métodos de ensino. A característica de poder possuir vários métodos de ensino é muito importante para o aprendizado, possibilitando variar de método em função do desempenho do aprendiz.

O item "modelagem do usuário" indica se o sistema possui uma forma explícita para modelar o aprendiz. Isso indica a possibilidade de adaptar o curso ou não ao aprendiz.

O item "iniciativa na interação" indica qual tipo de iniciativa é utilizada durante a realização do curso pelo aprendiz. Pode ser rígida, mista ou flexível.

O item "responsabilidade" indica se a responsabilidade maior sobre o andamento do curso está a cargo do aprendiz ou do sistema.

O item "sobrecarga cognitiva" indica se o sistema pode, por suas características, causar sobrecarga cognitiva ao aprendiz. Pode ser sim, eventualmente ou não.

O item "complexidade de criação" indica o grau de exigências predefinidas, especificações rígidas e dificuldade de alterações, expansões e manutenção do curso. Pode ser baixa, média, alta ou variável.

O item "ferramentas" indica a disponibilidade de ferramentas auxiliares para a criação de um curso. Nesse item efetuou-se uma análise de modo a englobar todas as fases de criação de um curso. Em especial, no tocante à modelagem conceitual, os sistemas que envolvem modelagem de usuário não dispõem de ferramentas para essa tarefa.

Independente de qualquer análise que possa ser feita entre CHs, SHAs e CHAs, os dois primeiros apresentam uma característica que os distinguem dos CHAs e justifica o desenvolvimento deste trabalho de pesquisa. CHs e SHAs possuem metodologias de desenvolvimento que norteiam os autores para extrair, de cada sistema de aprendizagem, as suas melhores características.

Quanto ao item "responsabilidade", enquanto num SHA a responsabilidade pelo andamento do curso está a cargo do sistema, num CHA está a cargo tanto do sistema quanto do aprendiz, que explicitamente pode influenciar os passos que ele deve seguir.

Quanto ao item "métodos de ensino", embora tanto um SHA quanto um CHA incluam métodos pedagógicos na condução do curso, CHAs adicionam material didático adicional ao proveniente da hiperbase, apresentando-o de forma bastante viva e diversificada. Em contraste, um SHA apresenta apenas e tão somente o material instrucional oriundo da hiperbase.

CONCLUSÕES

Os Cursos Hipermídia Adaptativos representam uma área relativamente nova de pesquisa e um número limitado de modelos ou sistemas foi implementado visando à melhoria do grau de aprendizagem do aprendiz.

O potencial dos Cursos Hipermídia Adaptativos para a aprendizagem a distância é imenso e deve ser explorado de modo a obter todo o potencial disponível nas redes de computadores atuais e, em especial, a Internet. A tecnologia de Cursos Hipermídia Adaptativos está sendo empregada no desenvolvimento de vários cursos via Internet.

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MEJORÍA EN CALIDAD DE LA ENSEÑANZA DE INGENIERÍA: TRANSFORMACIÓN DE CONPORTAMIENTO ENTRE DOCENTE Y DISCENTE

Katia Tannous [1]

Resumen—La propuesta de ese trabajo es presentar una nueva visión de la calidad de la enseñanza de ingeniería en lo que corresponde a la relación entre profesor y alumno. La investigación fue realizada en curso de postgrado IQ100-Transferencia de la Cantidad de Movimiento ofrecida en la Facultad de Ingeniería Química de la Unicamp. La transformación del hábito y conportamiento en las actitudes en la clase puede generar una mejoría significativa en la enseñanza-aprendizaje. El abordaje constructivista proporcionó la construcción de un software con interfaz gráfica, subdividido en dos partes: abordaje teórico y abordaje matemático. En el abordaje teórico, fueran elaborados los contenidos discutidos y debatidos en clase, a saber: tensiones en los fluidos, deformaciones y ecuaciones constitutivas, ecuaciones de conservación de la cantidad de movimiento, soluciones de la ecuación de Navier-Stokes, teoría de la capa límite y flujo turbulento. En el abordaje matemático (solución analítica y numérica) fueron elaborados dos ejercícios prácticos, respectivos al flujo en ductos circulares y concéntricos, con objetivo de la determinación del perfil de velocidades en estado estacionario y transiente.

Palabras-clave: enseñanza-aprendizaje, metodología de enseñanza, tecnología orientada a objetos

INTRODUCCIÓN

La civilización dentro de la cual hemos vivido en ese último siglo es fuertemente influenciada por los parámetros de la racionalidad y por lo que se imagina ser lo mejor del rigor científico. Nos orgullamos de ese tipo de cultura objetiva, racional y científica, sin la cual, no había sido posible construir la modernidad, ni tendríamos el extraordinário progreso y tecnológico de que disfrutamos. Pero, si el paradigma de la racionalidad técnica fue útil y necesario para orientar el conocimiento y los caminos de la humanidad hasta hoy, ahora, ciertamente el se choca con las nuevas realidades y con las exigencias de los nuevos tiempos[1].

Parte de la crisis que presenciamos es fruto de una relación no satisfactoria entre una situación vivida y un modelo de respuestas que ya no atiende a esa situación. Por eso, toda crisis es benéfica, pues ella nos obliga a una introspección de la cual resulta una revisión interior y la adopción de nuevos comportamientos.

Percibimos que el mundo alrededor está cambiando de forma bastante acelerada y la educación sigue asentada en el paradigma dominante que refuerza una enseñanza fragmentada y conservadora que tiene como foco central la reproducción del conocimiento por el aprendiz, incluso utilizando avanzados instrumentos tecnológicos. Sabemos que no se cambia un paradigma educacional dominante sólo poniendo un nuevo ropaje, camuflando viejas teorías, poniendo pantallas en las clases, si el alumno continúa en la posición de mero expectador, de simple receptor, presenciador y copiador [2].

La ciencia moderna nos legó un conocimiento funcional del mundo que amplió extraordinariamente nuestras perspectivas de supervivencia. Hoy no se trata tanto de supervivir, sino de saber vivir. En esa perspectiva, el proceso de construcción, de (des)construcción o de (re)construcción del conocimiento – presencial y/o a distancia – apunta para el ultrapasaje de la visión compartimentalizada, disciplinar, aislada, objetiva, científica con base en los princípios defendidos por [1]. Todo conocimiento es local y total; todo conocimiento es autoconocimiento, todo conocimiento científico-natural es científico-social y visa constituirse en senso común.

En las propuestas pedagógicas y opciones metodológicas emergentes, el uso de las nuevas tecnologías de la información y de la comunicación no aseguran la inovación educacional, pues el salto transformador depende de la forma como los instrumentos tecnológicos son utilizados para superar la reproducción del conocimiento y contribuir a la producción de un saber significativo y contextualizado, para el desarollo de competencias, habilidades y actitudes imprescidibles a la construcción de una vida y un mundo mejor para todos [3]-[4].

La mediación pedagógica en la Educación a Distância-EAD, que enfatiza el proceso de producción de conocimiento, involucra los suportes mediadores - tecnológicos o no - los procedimientos interactivos y las relaciones que envuelven profesor/alumno/conocimiento.

Para concretizar la interactividad, [4]-[5]-[6], el profesor propone para sus alumnos el conocimiento, no la transmición. En clase, él es más que instructor, entrenador, compañero, consejero, guía, facilitador, y colaborador. El es formulador de problemas, provocador de situaciones,

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arquitecto de trayectos, movilizador das inteligencias múltiplas [7] y colectivas en la experiéncia del conocimiento. El disponibiliza estados potenciales del conocimiento de modo que el alumno experimente la creación del conocimiento cuando participa, interfiere, cambia. Por su vez, el alummo deja de la recepción pasiva em la cual oye, mira, copia y presta cuentas para que se envuelva con la proposición del profesor [8]-[9].

Adémas, la interactividad contribuye para sostener, en nuestro tiempo, que educar significa preparar para la participación ciudadana, y que esta puede ser experimentada en la clase (informatizada o no), a distancia o presencial, no más centrada en la separación de emisión y recepción. Por lo demás, la imaginación creadora del profesor está demasiado solictada delante del desafío de educar en la era de las informaciones, en la era digital [5].

Con esa visión, propuestas de técnicas y metodologías de enseñanza de forma interactiva, colaborativa y constructiva fueron presentadas em estos últimos años asociando enseñanza presencial y a distancia en cursos de graduación y postgrado en la Facultad de Ingeniería Química de la Unicamp [10-13].

MOTIVACIÓN Y OBJETIVOS

Ese trabajo forma parte de un proyecto que está siendo desarollado en el Departamento de Termofluidodinámica de la Facultad de Ingeniería Química de la Unicamp, tiendo como objetivo general el desarollo de un ambiente computacional de enseñanza-aprendizaje interactivo.

El alto nivel de multi-disciplinaridad de este proyecto exige la construcción de un prototipo para demonstrar la eficacia de ideas y tecnologías. El ambiente que se quiere desarollar posee de entre otros componientes, interfaces gráficas interactivas, comportamiento en tiempo real y arquitectura distribuida. Para satisfazer esos requisitos se recae en el domínio de la tecnología orientada a objetos.

La disciplina de postgrado elegida para el prototipo es IQ100-Transferencia de la Cantidad de Movimiento. Por tratarse de un contenido complejo para los alumnos de las ingenierías, pues involuera conocimientos fundamentales de matemática, física y fenómenos de transporte, y principalmente por las diferenciadas potencialidades de los alumnos, viniendo de diferentes escuelas nacionales y estranjeras, gran parte del tiempo disponible en clase es gasto con la transmisión de los fundamentos y conceptos del curso.

La dificultad de los aprendices está en, por ejemplo, modelar las condiciones de contorno o reconocer el caracter tridimensional del flujo o aún convalidar los resultados del análisis. Se sabe que la simulación tende a ser más motivadora que las actividades de aprendizaje tradicionales, pues siendo interactiva, estimula al aprendiz a exploración en un gran número de hipótesis. La facilidad de poder variar los parámetros y visualizar inmediatamente las consecuencías de esas variaciones, se convierte en una verdadera ampliación de aprendizaje.

La primera fase de ese trabajo es analisar cualitativamente y cuantitativamente (aplicación de contenido) la interatividad profesor/alumno y alumno/alumno en la construcción del conocimiento. Las herramientas de la Web fueron utilizadas para auxiliar en el desarollo del trabajo.

ORGANIZACIÓN DEL CURSO

Dos ambientes fueron utilizados conjuntamente en la disciplina: *WebCT (Web Course Tools)* y *Delphi.*

Estructura del Curso en Ambiente de Educación a Distancia

La disciplina fue reformulada y adaptada en el software *WebCT* como herramienta didáctica. A pesar del curso ser presencial, la utilización del software *WebCT* permite el acceso previo al contenido ministrado en clase, promoviendo mayor interactividad entre los participantes.

El contenido programático del curso IQ100 aborda la descripción del movimiento, conservación de masa en flujos, tensiones en los fluidos, deformaciones y ecuaciones constitutivas, ecuaciones de la conservación de cuantidade de movimiento, soluciones de ecuación de Navier-Stokes, teoría de la capa límite y flujo turbulento.

La presentación del curso virtualmente tuvo los siguientes accesos (www.ead.unicamp.br:8900):

- Informaciones generales del curso: informaciones del profesor, objetivos, requisitos mínimos, libros-textos
- Calendario de orientación del curso dinámico
- Contenido del curso en forma de textos didácticos y complementares en respuestas a los cuestionamientos de los alumnos
- Trabajos en grupos
- Biblioteca virtual contiendo *links* de busca
- Herramientas de comunicación (e-mail y foro de discusiones)
- Notas de evaluaciones

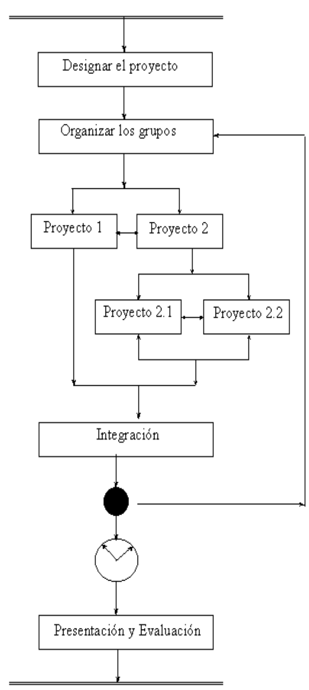
La utilización del software permitió al profesor el acompañamiento virtual de los alumnos a través de las informaciones estadísticas de la frecuencia de acceso, de la adquisición de las herramientas de comunicación y utilización de los sitios de busca para la realización de los trabajos en grupos, siendo esos disponibles para todos los participantes.

Estructura del Curso en Ambiente Orientado a Objetos

La técnica de aprendizaje adoptada fue apoyada en la realización de proyectos asociados en grupos de trabajo, evidenciando habilidades técnicas/científicas ejercitando habilidades de colaboración y comunicación entre lo profesor y alumno, y principalmente entre los alumnos.

Para el desarollo del ambiente orientado a objetos *(Learning Object)*, los alumnos fueron divididos en três largos grupos de acuerdo con la formación básica de cada uno. A pesar de uniformidad curricular de las escuelas de ingeniería química (nacionales y estranjeras), la potencialidad de los alumnos son distinctas. El modelo adoptado, sucede la sugerencia de [14], como se puede ver en la figura 1.

Esa propuesta de trabajo promovió una dinamización en curso, a través de la definición del proyecto, organización de los grupos, adaptación de los alumnos en cada proyectos inicialmente eligidos, integración de los grupos y los contenidos estructurados, atualización constante del trabajo, entrega del proyecto final y evaluación a través de la defensa del proyecto por un integrante de cada grupo.

<table>
<tr><th>Secuencia</th><th>Descripción</th></tr>
<tr><td>
</td><td>El profesor específica el proyecto.

El profesor ayuda a los alumnos en la organización de los grupos y designa para cada uno, parte del proyecto. Cada grupo proyecta su parte y integra a las otras, de los demás grupos. Un grupo es responsable por la integración total del proyecto.

El ciclo del proyecto se repite varias veces.

Término final de elaboración del proyecto.

Los alumnos presentan el proyecto final y el profesor evalua.</td></tr>
</table>

FIGURA 1
MODELO DE APRENDIZAJE ADOPTADO

RESULTADOS Y DISCUSIONES

Desarollo del Ambiente Orientado a Objetos

El ambiente orientado a objeto (*software*) fue desarollado en Delphi 6.0, denominado Momentun 1.0, donde fue subdividido en dos partes, un abordaje teórico y otra matemático.

En el abordaje teórico (Figura 2) fueron presentados conceptos de la transferencia de la cuantidade de movimiento en formato de textos sin animación, posibilitando la lectura de la teoría del curso de forma sistemática y concisa.

En el abordaje matemático fue desarollado y presentado la solución analítica (Figura 3) y numérica (Figura 4) de dos problemas envolviendo flujo en ductos circular y ortogonal en espacio anular. El objetivo de los ejercicios es la determinación del perfil de velocidad de un fluido escurriendo en ductos horizontal y vertical, en estado estacionario y transiente. En la solución numérica, el usuario puede introducir las propiedades del fluido (viscosidad, densidad), dados de la tubería (diámetro, comprimiento) y dados de operación (variación de presion y tiempo) y aclarar rapidamente el perfil de velocidad conjuntamente a los dos problemas.

CONSIDERACIONES FINALES

Esa experiencia nos permitió identificar y compreender la eficiencia de una técnica de enseñanza a partir del desarollo de actividades en ambientes virtuales de aprendizaje, siendo estos ambientes de EAD y ambientes orientados a objetos.

La tecnología implementada en el desarollo del ambiente orientado a objetos permitió que se hiciera un mejor control del proceso de aprendizaje desarrollado por los grupos de trabajo. Los resultados obtenidos nos señalan indícios de que el modelo adoptado privilegió la regularidad y consistência de aprendizaje a través de los desempeños demonstrados.

Los aspectos de motivación y interactividad, observados durante el curso, apuntan en la dirección del acceso facilitado al contenido del curso, facilidad en la comunicación entre profesor-alumnos, y alumno-alumno, así como la construcción del conocimiento individual y en grupo.

Entonces, se cree que el aprendizaje colaborativo constructivista es una buena alternativa para crear interacción entre profesor y alumno, transcendiendo la simple transmisión de informaciones.

Con eso, se buscará dar continuidad a ese trabajo, con otras grupos, proyectando nuevas formas de presentación de contenido y formación de nuevos ejemplos prácticos.

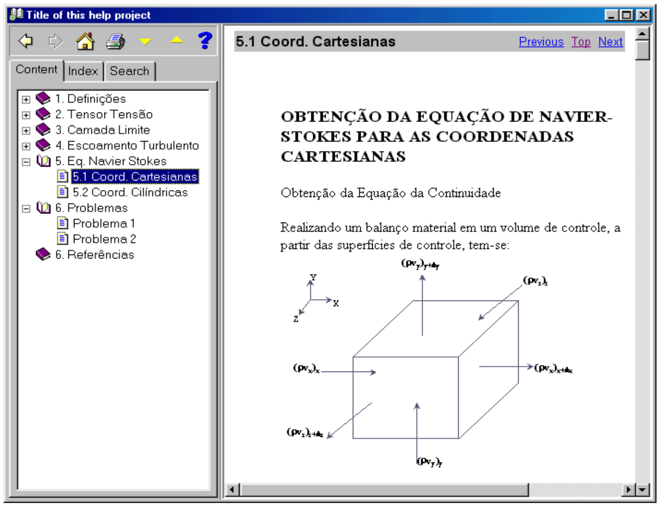


FIGURA 2
ABORDAJE TEÓRICO

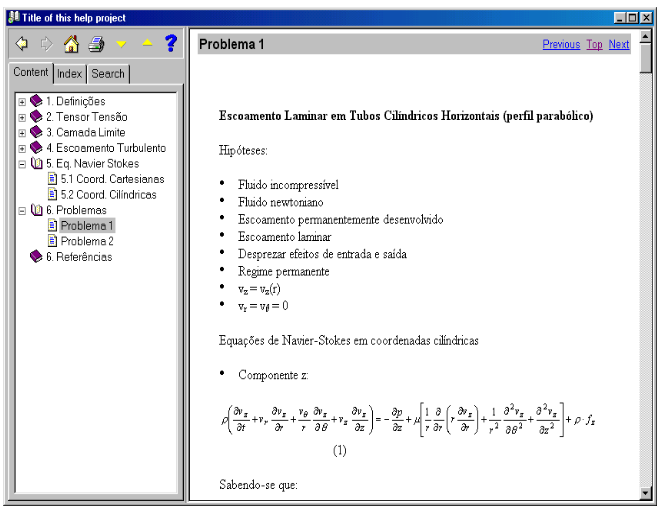


FIGURA 3
ABORDAJE MATEMÁTICO - SOLUCIÓN ANALÍTICA

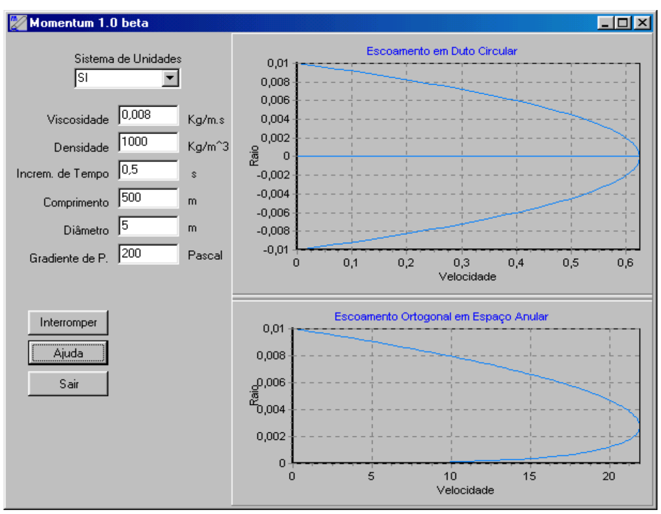


FIGURA 4
ABORDAJE MATENÁTICO-SOLUCIÓN NUMÉRICA

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O “PROFESSOR.COM”: O ALUNO E A MÁQUINA

Eloísa Vecchiato[1] *e Aldo Bizzocchi*[2]

Resumo *— O presente trabalho pretende revelar, à luz dos pressupostos teóricos de Jung, que o processo de ensino-aprendizagem estabelecido entre alunos e professores mediados pela Internet e/ou computador só é possível priorizando-se a compreensão do homem (seja ele professor ou aluno) enquanto ser cognitivo e da máquina enquanto meio no processo de aquisição e fundamentação de novos conhecimentos. Todos os seres humanos percebem e julgam informações, usando para isso quatro funções cognitivas: sensação, intuição (processos de percepção), pensamento e sentimento (processos de julgamento). Partindo desse pressuposto, pretende-se evidenciar quais aspectos humanos devem ser levados em consideração no momento em que um professor de exatas se depara com diferentes perfis de alunos, que se comportam de maneiras diferentes diante de um mesmo conhecimento.*

Palavras-chave — Comunicação interpessoal, intrapessoal e grupal, estilos cognitivos de aprendizagem, ensino da computação.

TRAFEGANDO ENTRE A SOCIOLOGIA, A FILOSOFIA E A PSICOLOGIA PARA EXPLICAR O CONCEITO DE CONHECIMENTO

“O conhecimento mantido sob controle restrito dos especialistas está escapando ao controle e atingindo cidadãos comuns. Da mesma forma, dentro das principais empresas, os empregados estão conseguindo acesso ao conhecimento que antes era monopolizado pela direção. E, à medida que o conhecimento é redistribuído o mesmo acontece, também, como o poder nele baseado”. [1]

Com a Revolução Industrial, camponeses passaram a operar em “chão de fábricas” subordinados a patrões, literais detentores de riqueza. Esse posicionamento gerou mudanças no conceito de família; o patriarca saiu de cena e alguns papéis exercidos pela família transferiram-se para a Educação. Novas elites surgiram e os pilares estruturais da sociedade tornaram-se outros, assumindo novas dimensões; o trabalho braçal deu lugar ao trabalho intelectual, e o poder deslocou-se por meio de três canais: violência, riqueza e conhecimento.

“Tal como máquinas-ferramentas […] a força, a riqueza ou o conhecimento, se usados de forma adequada podem dar ao indivíduo o comando de muitas outras e mais variadas formas de poder.” [2]

“O conhecimento é a mais democrática fonte de poder.” [3] É uma fonte inacabável: quanto mais se usa, mais se gera de forma contínua e ascendente. Pode ser usado simultaneamente por várias pessoas; gera pensamentos novos, riqueza, soluções, conceitos, direcionamentos, estratégias, ciência.

Como se Constrói o Conhecimento?

Apoiando-se na filosofia moderna para introduzir um conceito de construção do conhecimento proposto nesse trabalho, temos em linhas gerais três correntes filosóficas: o Racionalismo, o Empirismo e o Interacionismo.

- Racionalismo: representado por René Descartes, valoriza a razão como fonte de conhecimento. É a versão do idealismo grego de Platão, onde o mundo das idéias era o mundo real e o real não passava de representações do mundo das idéias. O sujeito deposita no objeto um conhecimento prévio que traz consigo.
- Empirismo: segundo John Locke, o conhecimento é resultado da experiência externa produzida pela sensação e a razão é um segundo ato na constituição interna que dá forma ao que foi captado pelos sentidos. Valoriza a experiência e a prática como fontes de conhecimento. O conhecimento parte do objeto que o sujeito recebe passivamente por meio do sistema sensorial.
- Interacionismo: acabando de vez com o reducionismo provocado pelas duas correntes filosóficas citadas anteriormente, o Interacionismo considera de forma equilibrada a participação de sujeito e objeto na constituição do conhecimento.

O conhecimento depende de julgamento (reflexão, entendimento) para se constituir, e juízo é característica inerente ao ser humano, oriundo dos estímulos provocados pelo espaço que ele habita, segundo sua concepção de “bom” ou “mau”. Assim, o ser humano é único em sua capacidade de construir e mudar o conhecimento, por meio da sua interação com o objeto e seu juízo de valor. Máquinas não julgam, portanto não constroem conhecimento.

O homem que interage com a máquina de maneira constante e talvez até desordenada reinventa esta máquina, que por sua vez fornece novos subsídios para que ele julgue/perceba novamente as transformações decorridas das ações diretas dele sobre o objeto em questão. Com isso, a tecnologia vem aos poucos querendo tornar a máquina um “ser” capaz de transmitir informação. Isso ela já é desde sua existência. O professor, como ser pensante, representante do conhecimento e disposto a compartilhá-lo de maneira a gerar

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mais, deve fugir do modelo "homem-máquina", beneficiando-se dos seus aspectos de juízo e percepção.

Agora, transformar um sistema computacional em tutor humano é, além de um grande desafio para várias áreas do conhecimento, um esforço louvável. Sob o ponto de vista das aplicações informáticas, os Sistemas de Inteligência Artificial (SIAs) são excelentes meios na transmissão de conhecimento, pela sua capacidade classificatória e de seriação de informações. Do outro lado, há o aluno-aprendiz, que não apresenta condições satisfatórias de ser modelado, seriado e classificado de forma cognitiva presumida para interagir de maneira única com os SIAs. Ao tentar reduzir a construção do conhecimento a um mero processo de transmissão de informações, estamos reduzindo o ser humano ao recipiente proposto pela corrente filosófica do empirismo.

O poder que advém do conhecimento permite um olhar totalizante, o entendimento da diversidade dentro da unidade e vice-versa. O movimento da interação provoca mudanças nas estruturas biológicas, sociais e emocionais dos indivíduos. Ao tentar explicar como um indivíduo conhece e/ou aprende, Jean Piaget não distanciou o "eu" do "meio" no momento em que se adquire um novo conhecimento, sem classificá-los como prioritários, bons ou ruins, mas sim complementares entre si. "A proposta de Piaget consiste em afirmar que o organismo assimila o meio e que existe uma reação do meio sobre a estrutura do organismo." [4] Sendo assim, o homem é o único ser capaz de ser sujeito e objeto ao mesmo tempo. Da mesma forma que modifica o meio, é modificado por ele.

UMA DEFINIÇÃO PARA O HOMEM E O MEIO NA QUESTÃO DA APRENDIZAGEM DAS CIÊNCIAS EXATAS

Numa interação do "eu", representando o homem em sua condição de aluno e/ou professor, e o "meio", representando a máquina e o uso da Internet e da comunicação virtual para se adquirir conhecimento, as ciências exatas que fazem uso contínuo desses meios possibilitam o *aparecimento do "professor.com"*, no sentido de interação das novas tecnologias com o homem que ensina, mas que também aprende, numa proporção interminável.

A tecnologia avança de forma rápida a ponto de não conseguir atingir as etapas da compreensão humana, devido a fatores externos ao homem (economia, religião, política, etc.) que não avançam com a mesma velocidade. Esses fatores externos atravancam a contemporaneidade dos fatos tecnológicos, restringindo-os a poucas pessoas ou atrasando o "relógio" da existência de determinados fatos tecnológicos à maioria da população.

No papel múltiplo de homem, meio e representante da ciência, o "professor.com" precisa deter o maior número possível de informações de maneira rápida e ininterrupta para dar continuidade ao processo de ensino-aprendizagem que mais se aproxime da realidade vivida por seus alunos naquele momento. É uma verdadeira corrida contra o tempo, num meio que se transforma, à medida que o homem se movimenta. Além disso, é importante que ele entenda como ocorre o processo de apreensão do conhecimento na sua totalidade, diminuindo o tempo gasto para transmiti-lo.

Para entrar nessa questão, vale ressaltar que a teoria sugerida é a dos estilos cognitivos frente a quatro enfoques inerentes ao que chamamos de "professor.com", para assim elucidar quais aspectos os professores de exatas devem considerar quando estiverem ensinando seus alunos.

QUATRO ASPECTOS DO "PROFESSOR.COM"

Levando em consideração que o professor como ser humano é capaz de alterar um ambiente e sofrer alterações provocadas por esse mesmo ambiente, elucidamos o "professor.com" sob quatro aspectos que podem influenciar diretamente sua forma de ensinar:

- Professor.COMercial: muitos alunos procuram os cursos de exatas levando em consideração o aspecto mercadológico e financeiro das profissões associadas. O "professor.COMercial" precisa entender que, como profissional, também é responsável pelo funcionamento da engrenagem do mercado, que necessita de mão-de-obra qualificada para o exercício de determinadas funções. Se ele quiser continuar sendo um profissional da área da educação para a tecnologia, precisa doutrinar o aluno para uma prática profissional que requer mudanças. Isso quer dizer que o professor tem papel primordial na escolha de determinados alunos que, apesar de não terem perfil para tal carreira, viram nela uma possibilidade de crescimento. As carreiras mudam conforme a necessidade do mercado e a necessidade atual é voltada para o mercado da informação, da tecnologia, do "@". O mesmo vale para o professor de cursos livres de informática, que representa o saber de uma área que cada vez mais se apropria de um mercado sem fim, abarcando uma grande parcela da população que depende do uso dos computadores para exercitar suas tarefas cotidianas.
- Professor.COMunicação: para ser um bom professor, é preciso ser um bom comunicador. Nas áreas de exatas, além da já conhecida comunicação homem-máquina, existe a comunicação homem-homem e máquina-homem. É preciso estabelecer um diálogo formal com a máquina, por meio de uma linguagem de programação ou um simples clicar do mouse. É preciso dominar várias línguas (a maioria dos programas usa a língua inglesa como padrão, sem falar nas linguagens de programação, que de certa forma estabelecem uma comunicação do homem para com a máquina) e saber relacionar-se de forma a criar um clima de parceria entre educadores e educandos. Ter inteligência emocional e saber o verdadeiro significado de relações inter e intrapessoais.

- Professor.COMplemento: o professor complemento é aquele que vê na ausência de determinados aspectos do processo de aprendizagem uma oportunidade para a compensação, não mudando as formas como a realidade se perfaz, apenas conduzindo-a. Ele é capaz de completar o aluno onde ele apresentar deficiência. Tem a percepção de que não é o todo no que diz respeito ao conhecimento, mas sim parte dele. Soma qualidades ao invés de subtrair. Percebe-se como um indivíduo que somado a outros cresce em sua proporção. A engrenagem que falta para o mecanismo funcionar, mas que tem perfeita noção de que a máquina não funciona sem a engrenagem anterior. Entende a diversidade na unidade.
- Professor.COMpleto: um professor completo é um ser humano completo: aquele a quem nada falta, pois, usando o conceito anterior, consegue perceber que seus alunos o tornam completo. Aquele que faz uso de todas as suas capacidades e potencialidades, comportando-se de várias formas diante de um mesmo conhecimento, de forma que não seja somente um instrutor, mas sim um professor. Instruir é intermediar a transmissão de um conhecimento, ensinar é propor a constituição de um sujeito que constrói seu próprio significado. Ser completo não é necessariamente ser perfeito, mas é sentir-se completo com a presença do outro, com potencialidades, dificuldades, defeitos. Entender a unidade na diversidade.

O "PROFESSOR.COM": SUAS PERCEPÇÕES E SEUS JULGAMENTOS

Como único ser que consegue estabelecer uma posição sincrônica de sujeito e objeto frente ao conhecimento, o homem deve ter em mente de que o processo de aquisição de conhecimento não ocorre de maneira unilateral, ou seja, só recebendo estímulos e não os gerando. O professor de exatas precisa compreender que ele, enquanto sujeito, e seus alunos, também enquanto sujeitos, possuem formas diferentes de receber estímulos e gerá-los. Precisa entender que, por mais lógica que seja uma teoria, há alunos que se perguntam o porquê de aprender aquilo e daquela forma, necessitando de razões diferenciadas. Isso não significa incapacidade de compreender, mas sim a forma natural como esses alunos compreendem um conteúdo.

Teoria dos Estilos Cognitivos

Presentes em qualquer ser humano, os estilos cognitivos se referem aos processos que o homem utiliza para adquirir e processar o conhecimento. Essas formas partem basicamente de dois canais: percepção e julgamento. Esses dois canais participam ativamente da interação sujeito-objeto, dando forma a um tipo psicológico, que une uma função perceptiva e uma função de julgamento.

Carl Gustav Jung descreve tipo psicológico como caracterização de indivíduos conforme interesses, preferências e habilidades. Dentro de cada canal existe aquilo que Jung chamou de função. Existem as funções para perceber e para julgar uma informação. Essas funções estão divididas em:

Funções de percepção:

- *Sensação*: relativa ao sistema sensorial;
- *Intuição*: relativa aos significados não captados pela lógica ou pela sensação.

Funções de juízo:

- *Pensamento*: relativa à lógica;
- *Sentimento*: relativa aos valores pessoais.

Todos os seres humanos possuem as quatro funções, só que, ao longo da vida, existe a predominância de uma delas devida ao seu uso constante, que é influenciado pelo meio. A essa função predominante Jung chamou de f*unção principal*. As outras funções até existem, porém se mantêm inativas, a menos que instigadas com certa freqüência. Foram denominadas de *função auxiliar* (segunda mais usada) e *função inferior*, que corresponde à função oposta à função principal. Exemplo: se a função principal de um indivíduo é o pensamento, a função inferior é o sentimento, pois pertencem ao mesmo canal, que é o julgamento.

Jung afirmou que é impossível desenvolver as quatro funções de maneira simultânea, pois as situações sociais farão com que o sujeito "escolha" aquela que mais lhe traga conforto perante as exigências do meio.

A referência [4] tenta traçar um paralelo entre os tipos psicológicos e a escolha profissional relacionada à Polícia Militar do Estado de São Paulo, chegando à conclusão de que a maioria dos policiais possuía um perfil predominante, no qual a sensação e o pensamento eram as funções mais ativas, criando um estereótipo que influenciava diretamente o relacionamento desses policiais com a comunidade e também exercia influências sobre a escolha profissional de aspirantes à carreira militar que se identificaram de alguma forma com a corporação.

Existem organizações que utilizam testes para identificar e montar uma equipe que trabalhe em prol de um objetivo comum sem muito conflito. Para muitas empresas, conflito entre funcionários causa perda de tempo e conseqüentemente queda na produtividade. Temos como exemplos o teste de MBTI (Myers-Briggs Type Indicator) e o QUATI (Questionário de Avaliação Tipológica).

Na intenção de montar equipes com funções psicológicas equivalentes, podemos deduzir que, se o grupo perdurar, jamais haverá estímulos gerados por possíveis conflitos que façam o grupo desenvolver a capacidade de resolver determinados problemas. Ou seja, todos pensarão e agirão da mesma forma, causando uma diminuição de tempo nos prazos estabelecidos e também uma sincronia nas formas de adquirir e manipular conhecimento, melhorando a produtividade. Por outro lado a produtividade se sobrepõe ao homem.

Numa situação de aula de exatas, espera-se que tanto alunos quanto professores usem muito mais a lógica (função pensamento) para compreender determinados fenômenos e estabelecer um diálogo formal com eles. Espera-se, mas nem sempre é o que ocorre. A grande questão é como aprender ciências exatas sem fazer uso somente da lógica. Alunos de exatas que têm como função principal o sentimento ou a intuição também podem aprender de maneira eficaz, pois essas funções são determinantes na forma como apreendem o conhecimento, independente de ser um conhecimento lógico ou não.

Usar da lógica constantemente no ensino e considerar que ela é a única forma de o indivíduo apreender cálculos, equações, algoritmos é negligenciar o desenvolvimento completo, causando:

- um baixo aproveitamento das múltiplas inteligências do indivíduo; ele só estará preparado para provar, testar e avaliar à luz da razão, deixando de lado valores pessoais e morais em nome do que é racionalmente aceito;
- desequilíbrio das estruturas cognitivas que necessitam de outros estímulos para funcionar adequadamente promovendo a equilibração dos aspectos comportamentais humanos;
- uma valorização extrema do ser pensante e conseqüentemente uma desvalorização do ser como sujeito completo que pensa/age/sente/cria (não necessariamente nessa ordem);
- a eterna dissociação da boa convivência entre *humies* e *techies* [6];
- a incompreensão da *Educação para o Século XXI* proposta pela Unesco.

Se a intenção da educação não deve ser de forma alguma classificatória, como trabalhar com esses aspectos?

- As pessoas recebem diretamente a influência do meio para balizarem suas atitudes. Portanto, se o meio representado pela figura do professor for um meio multidirecional, a possibilidade de essas pessoas trafegarem pelas suas quatro funções cognitivas será bem maior.
- O professor tem um tipo psicológico definido, tendendo a aproximar alunos com tipo psicológico semelhante ao seu e chamar os alunos que mais se afastam dessa predominância de "alunos difíceis". Na prática didática, o "professor.com", deve deixar seu tipo psicológico "camuflado", tentando compreender que seus "alunos difíceis" não passam de pessoas com um tipo psicológico diferente do seu, mas com uma mesma capacidade para aprender.
- Devemos levar em consideração que, numa sala de aula com área de conhecimento definida, a possibilidade de termos tipos psicológicos semelhantes é considerável. Se a maioria predominante for compatível com o tipo psicológico do professor, a minoria não concluirá de forma satisfatória o processo de aprendizagem, pois a forma como o professor se comunica é aceita pela maioria, mas não pela totalidade.

A grande preocupação dos professores enquanto representantes diretos de uma área específica do conhecimento é: como ensinar de maneira equivalente sem que haja deficiências?

Para um grupo específico de professores, o ato de aprender é puramente mecânico; os números fazem o acerto das hipóteses levantadas. Caso fossem indagados sobre como ocorreu a própria aprendizagem, tentariam achar uma resposta lógica para o processo. O difícil é convencer que, apesar de envolverem o aspecto emocional, os estilos cognitivos são extremamente lógicos no sentido de explicar como se dá parte do processo de aprendizagem.

Aplicado à tecnologia, isso fica ainda mais evidente frente às perguntas, respostas e inquisições feitas por alunos de cursos universitários de Computação e também por professores de informática. Por meio de algumas palavras ou colocações usadas com mais freqüência por esses indivíduos, identificamos e criamos uma classificação segundo os tipos psicológicos. Essas expressões ditas com freqüência acabam por caracterizar o professor e/ou o aluno dentro da função psicológica que ele mais usa:

- perguntas e inquisições com expressões como "sinto", "se eu fosse você", "eu acho", "concordo", "não sei como começar" revelam uma maneira de interação com o meio baseada no sentimento do indivíduo. Fala carregada de sentimento em relação às atitudes alheias são características de pessoas-sentimento;
- perguntas e inquisições que contenham "li numa revista"; "segundo o autor…", "as pesquisas mostram…", "vou lhe ser franco", "deixa que eu faço", "mas por que…", "isso está errado" revelam um perfil de pessoa racional, que se baseia em processos anteriores fundamentados de maneira lógica. Fala carregada de tom lógico, impositivo e constante é característica de pessoas racionais;
- perguntas e inquisições com expressões como "vi", "ouvi dizer", "deixa eu ver" (já inclinando-se para pegar o objeto em questão), "passa pra cá", "isso não é pra já", "onde?" revelam uma maneira sensorial de aprender, baseada no que o indivíduo consegue captar através do sistema sensorial. Pessoas mais práticas e de ações rápidas também pertencem a essa categoria;
- perguntas ou inquisições com expressões como "muito tempo atrás", "minha mãe disse", "amanhã…"; "Já sei!", "percebi que…", "não é bem assim" revelam perfis de pessoas que aprendem por intermédio de significados não apreendidos de forma presente, mas que dão significado a atuações futuras; pessoas que planejam muito antes de agir são classificadas nessa categoria.

Com base nessa classificação, observamos o comportamento de 12 instrutores de informática submetidos a treinamento e alcançamos os seguintes resultados:

- dos 12 professores envolvidos, seis possuíam tendências a ter como função principal a intuição, cinco deles o pensamento, um a sensação e nenhum o sentimento (o que caracteriza o estereótipo profissional do uso da lógica nas ciências exatas);
- um dos que apresentaram tendências intuitivas confirmou que tinha sérios problemas de relacionamento com um dos instrutores que apresentaram a tendência a ter como função principal o pensamento (funções opostas);
- os cinco instrutores classificados como "pensamento" tacharam como alunos difíceis pessoas que perguntam demais e fazem questão de estabelecer relação do que estão aprendendo com fatos passados e futuros. Já um instrutor com tendência intuitiva disse que esse aluno era o melhor para ele trabalhar.

Apesar de a amostragem ser pequena, um teste de avaliação tipológica revelou que as tendências classificadas se aplicaram a dez indivíduos envolvidos.

Tornando-se um "Professor.Com"

Tomando como base a crescente necessidade da utilização do computador para o desenvolvimento de várias atividades, como agregar no processo de ensino-aprendizagem diferentes tipos psicológicos frente a uma área de conhecimento na qual todos têm interesse, movidos pelas tendências mercadológicas?

O "professor.com" novamente tem papel primordial. Deve ser capaz de classificar ao menos de forma superficial seus alunos dentro de um tipo psicológico, deixando de lado sua subjetividade. A partir do momento que o "eu" der lugar ao professor, ele conseguirá atrair para si todos os alunos de forma efetiva na aprendizagem e será capaz de criar uma maneira que lhe permita trafegar pelas quatro funções.

Na sociedade da informação, ainda mais na área de exatas, quanto mais formos capazes de exprimir ou mesmo captar um novo conhecimento de maneira ampla e não fragmentada, mais conseguiremos colocar em prática os preceitos da *Educação para o Século XXI* proposta pela UNESCO e que se enquadra perfeitamente na idéia deste trabalho:

- *Aprender a ser*: global, inteiro, desenvolvendo-se em todas as partes;
- *Aprender a fazer*: de nada adianta teoria sem conceitos e sem o "fazer". Usando das sensações podemos trabalhar esse item de forma ampla;
- *Aprender a aprender*: como professor e como aluno aprendemos da mesma forma? Para aprender é preciso haver correlação do item a ser aprendido com a realidade vivida;
- *Aprender a viver juntos*: buscar na diversidade uma forma congruente de troca de informações. Estar juntos apesar da distância. Complementar e completar o outro na busca pelo conhecimento;
- *Aprender a sentir*: humanização. Consciência de que o ser humano é um ser completo e de que, apesar de ter um tipo psicológico predominante, precisa ser trabalhado e compreendido na sua totalidade, para que o ensino de exatas não seja algo puramente mecânico, mas seja a porta de comunicação entre a linguagem humana e a linguagem de máquina, utilizadas pelo professor que, além de ser "pontocom", é completo e complemento de si mesmo.

Não se pode voltar aos tempos remotos de escola, classificando os alunos em A, B ou C, de acordo com a forma como aprendem e com seus estilos cognitivos. A valorização do racional existe, porém por trás do racional existe o humano. Os educadores da área de exatas precisam ter a consciência de que aquele aluno que se sente incompreendido, na realidade, é um aluno com estilo cognitivo diferente do dos demais, que precisa ser tão estimulado quando os outros, e, principalmente, que a realidade de uma sala de aula de exatas revela o meio e, como tal, as profissões a elas relacionadas trazem para si pessoas nem sempre com perfil ideal para tal posicionamento no mercado. De fato, com o grande desenvolvimento das tecnologias da informação, tem havido um crescimento constante da demanda nos cursos técnicos e superiores ligados à informática. Graças a atrativos como expansão crescente do mercado de trabalho, que afasta o risco de desemprego, e a alta remuneração dos profissionais de computação na maioria das empresas, muitos alunos de cursos como Sistemas de Informação, Ciência da Computação, Engenharia de Computação, Engenharia de Telecomunicações e mesmo de cursos livres ou técnico-profissionalizantes de informática não apresentam real vocação ou aptidão para o ramo, tendo escolhido essas carreiras motivados muito mais por fatores extrínsecos do que intrínsecos. A abordagem cognitiva por parte dos professores universitários e instrutores da área pode auxiliar a contornar possíveis dificuldades que tais alunos apresentam quando submetidos a um enfoque didático tradicional. Enfim, usar a psicologia e encontrar razões didáticas e sociais para o ensino de exatas.

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Ambiente de aprendizagem adaptável conforme as preferências do aprendiz

Eliane Pozzebon, Jorge Muniz Barreto

Resumo *- Apresentamos um ambiente de aprendizagem dos conceitos básicos de neurofisiologia, adaptável conforme as preferências do aprendiz. Trabalho desenvolvido por membros da equipe do projeto ICEM (Inteligência computacional no ensino com multimídia) da Universidade Federal de Santa Catarina, para que facilite um aprendizado individualizado.*

Palavras Chaves: ensino com computador, hipermídia adaptativa.

INTRODUÇÃO

A utilização do ensino via computador com abordagens da IA (Inteligência Artificial) pode ser uma forma de diversificar os instrumentos de apoio do ambiente atendendo às necessidades pedagógicas e tecnológicas em questão. Um ponto central de sistemas de ensino considerados inteligentes para suporte ao aprendizado é sua adaptação às experiências requisitadas pelos aprendizes.

A hipermídia permite relacionar os assuntos de muitas maneiras, onde os aprendizes também podem visualizar suas experiências. Existem numerosos problemas nestes sistemas, que, todavia, tem sido reduzidos utilizando um modelo teórico de hipermídia baseado na Teoria dos Autômatos, denominado hipertômato [1] [2].

Um percurso desenvolvido pelo aprendiz pode identificar seu comportamento. Dessa maneira, elaboramos um questionário onde o aprendiz responderá questões para identificar suas preferências e adaptar o ambiente de ensino para que facilite um aprendizado individualizado.

Dependendo das características dos softwares estes podem ser classificados como [8] [9]: tutoriais, exercitação, investigação, simulação e jogos.

- Tutoriais: apresentam conceitos e instruções. Geralmente possuem baixa interatividade;
- Exercitação: repete e reforça conceitos já vistos anteriormente;
- Investigação: Através deste tipo de programa o aluno localiza informações a respeito de assuntos diversos. Como exemplo desta classe pode-se citar as enciclopédias;
- Simulação: O aluno é fomentado a tomar decisões a partir de resultados obtidos num modelo artificial que reproduz uma situação real. Estes softwares também são utilizados para antecipar os resultados de determinados experimentos que na vida real inspiram perigo, impossibilidade de execução, inconveniência e alto custo. Como exemplo de sua aplicação de Engenharia Civil, quando os alunos simulam falhas em estruturas. Isto seria impossível no mundo real.
- Jogos : O aluno participa de uma atividade organizada por um sistema de regras que definem a perda ou o ganho.

ADAPTAÇÃO CONFORME AS PREFERÊNCIAS

Os modelos produzidos por IA têm potencial para representarem um grande meio de comunicação de conhecimento, porque apresentam uma capacidade dinâmica de modelagem cognitiva, facilitando as decisões educacionais à medida que o estudante utiliza o sistema [13]. Dentro desta perspectiva, o processo de aprendizagem pode ser concebido como o mapeamento do conhecimento do tema a ser ensinado para a estrutura de conhecimento do estudante.

Neste tutorial o percurso é definido conforme as preferências do aprendiz. Dessa maneira, elaboramos um questionário para identificar e modelar o tutorial através de regras, conforme tela do protótipo apresentada na figura 1.

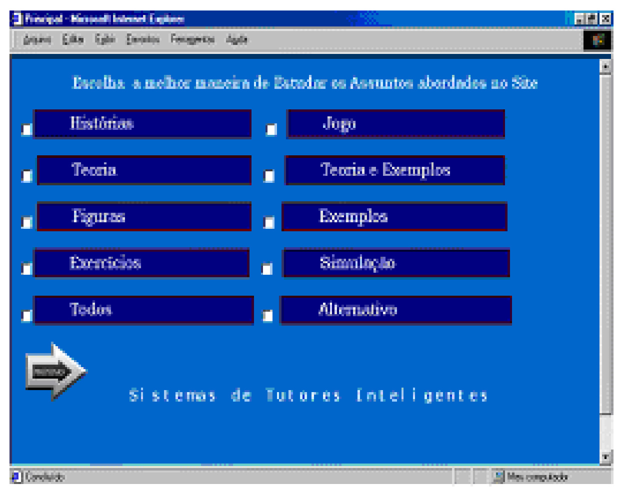

Figura 1. Tela com regras para adaptação do ambiente

Assim conhecendo-se as preferências do aluno pode-se adaptar o sistema para que facilite a aprendizagem e promova um aprendizado individualizado com a construção dos conhecimentos.

Na figura 2, as preferências do aprendiz são classificadas na base de conhecimento, através das perguntas. E a adaptação do ambiente utiliza regras conforme a resposta do questionário, por exemplo : gosta de aprender com simulação.

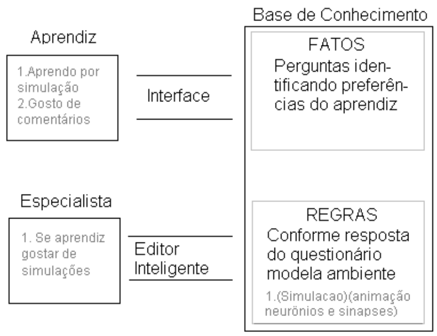

Figura 2. Adaptação do ambiente conforme preferências do aprendiz

MODELAGEM DE HIPERTEXTO COMO AUTÔMATO

Um modelo teórico de hipertexto precisa de três conceitos a serem incorporados: o nó da informação, a ligação entre os nós e os nós de simultaneidade [11] apud [10].

Um autômato pode ser considerado como uma particularização de um sistema dinâmico que varia com o tempo. Em um sistema dinâmico é descrito o mecanismo de como ele trabalha (internamente), especificando como o conjunto dos estados varia com o tempo. Tal descrição é suficiente para gerar uma definição comportamental, conforme proposto por Almeida e Barreto [1].

Um sistema computacional, denominado hipertexto, pode ser convenientemente definido como autômato (ou máquina), que é descrito abstratamente como uma sextupla:

$A_t = \{ U, Y, X, x_0, \lambda, \eta \}$

Onde:

U é um conjunto finito de entradas,

Y é um conjunto finito de saídas,

X é um conjunto de estados,

$X_0 \in X$ é o estado inicial,

$\lambda: U \times X \rightarrow X$ é a função de próximo estado ou função de transição,

$\eta: U \times X \rightarrow Y$ é a função de próxima saída.

Se a cada nó de informação é associado, por exemplo, com uma janela na tela do computador (uma forma possível de entrada), então um conjunto de janelas na tela caracteriza um estado x do hipertexto .

DESCRIÇÃO DO AMBIENTE DE APRENDIZAGEM

O protótipo para ensino consiste de quatro blocos funcionais, que são: Apresentação, Célula Biológica, Neurônio e Sistema Nervoso.

Inicialmente foi definida a estrutura do bloco de apresentação que consiste de duas molduras: uma contendo a tela principal do protótipo e outra um mapa de navegação. Isto permite ao usuário selecionar o assunto de seu interesse.

Um segundo bloco apresenta informações sobre a célula biológica, sua definição, classificação e composição. Faz parte deste bloco a página que aborda os assuntos sobre organelas.

O neurônio é mostrado no terceiro bloco instruindo o aluno sobre sua função e principais partes. Pertencem a este bloco, as páginas do impulso nervoso e da sinapse.

O quarto e último bloco apresenta informações sobre o sistema nervoso distribuídas em quatro páginas: sistema nervoso, sistema nervoso central, sistema nervoso periférico e sistema nervoso autônomo.

Estes blocos podem conter um ou mais nós de informações conectados a outros documentos do mesmo bloco ou a blocos distintos. A figura 3 mostra um modelo hipertômato.

O modelo hipertômato permite a visualização de todos os nós (estados) do sistema e das ligações (transições de estado) que poderão ocorrer quando da navegação do usuário no sistema. A grande vantagem da concepção do sistema através desta modelagem é a garantia de que todos os estados do ambiente sejam alcançáveis, ou seja, muitos dos problemas de navegação (perda do usuário no espaço de informações, páginas não encontradas) e que na maioria das vezes dependem dos aspectos construtivos dos sistemas podem ser evitados.

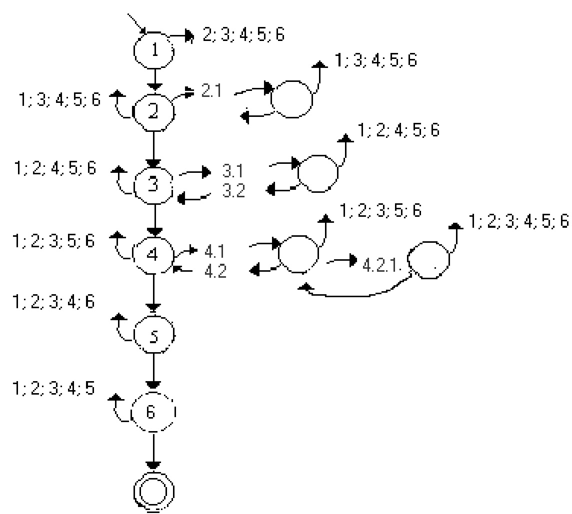

FIGURA 3: Exemplo do grafo de implementação do protótipo como hipertômato [11]

Em relação à Figura acima, tem-se que o usuário inicia a navegação do sistema tipo "espinha dorsal" no nó 1 (estado inicial) onde são realizados a apresentação do mesmo com recursos na Web internos e externos. Em seguida, o mesmo poderá seguir o percurso no nó 2 que contém os tópicos de apresentação da célula biológica. Deste, poderá percorrer o nó 3 que trata o neurônio e a seguir vai para o nó 4 do sistema nervoso.

Nota-se que os nós possuem retorno e conexões para outros nós (nós de detalhamento). A partir do nó quatro ele poderá percorrer o nó 5 que apresenta o mapa do site. Finalmente o usuário atinge o nó 6 (estado final) e sai do sistema.

A esta modelagem segue-se a implementação com a ferramenta de autoria levando em consideração os paradigmas educacionais.

IMPLEMENTAÇÃO

O protótipo implementado exibe a teoria a respeito da anatomia e fisiologia do sistema nervoso, bem como imagens, animações e vídeo que representam os tópicos estudados.

O protótipo foi desenvolvido em linguagem HTML (*Hypertext Markup Language*), JavaScript e enriquecido com algumas animações desenvolvidas em um editor de imagens.

O conteúdo apresentado está dividido em nodos, sendo que cada um deles apresenta de forma bem definida o assunto a ser estudado. Isto possibilita que os mesmos sejam alterados e modificados com facilidade dependendo do estilo e necessidade de cada professor.

FIGURA 4: Tela inicial do protótipo

A tela inicial do documento está representada na figura43 e o ambiente de aprendizagem é apresentado através das seguintes partes:

- Célula Biológica:

Este tópico apresenta ao aluno informações a respeito da constituição, funcionamento e classificação das células (figura 5). Suas principais partes como, citoplasma, organelas e núcleo, são descritas. Também apresenta figura esquemática das estruturas que a compõem e da membrana que a envolve.

Esta parte do sistema possui uma ligação com outro nodo que descreve as organelas que se encontram mergulhadas no citoplasma da célula. Este contém ilustrações e animação representando as estruturas estudadas.

FIGURA 5: Exemplo de aprendizagem com figura e texto da Célula Biológica.

- Neurônio:

Esta seção apresenta as principais partes do neurônio e suas funções.

A próxima ilustração descreve as partes da célula nervosa. Contém ligações bidirecionais para outros dois nodos:

- Impulso Nervoso :

Explica através de textos e ilustrações como um neurônio que se encontra no estado de repouso sofre o potencial de ação.

- Sinapse :

Através de texto, ilustração e animação o leitor poderá entender como os impulsos nervosos são transmitidos de um neurônio ao outro.

- Sistema Nervoso:

Nesta parte do sistema, inicialmente faz-se uma introdução a respeito do sistema nervoso demonstrando através de ilustração a sua estrutura.

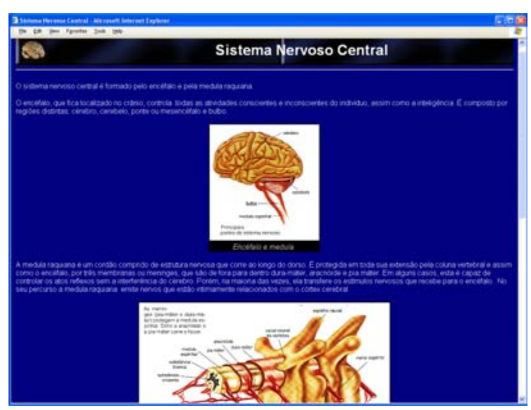

FIGURA 6: Tela do sistema nervoso central

Por motivos didáticos este sistema é dividido em dois tópicos:

a) Sistema nervoso central :

Detalha o funcionamento destacando suas principais partes, figura 5.

b) Sistema nervoso periférico :

Explica como as mensagens são transmitidas de uma parte a outra do indivíduo e quais os elementos que compõem este sistema. Este tópico possui uma ligação bidirecional para outro nodo: sistema nervoso autônomo, que descreve o funcionamento involuntário do sistema nervoso sobre os vários órgãos do corpo.

- Exercícios:

Nesta parte do sistema, inicialmente faz-se o aprendiz interagir com o tutor através de exercícios (figura 7).

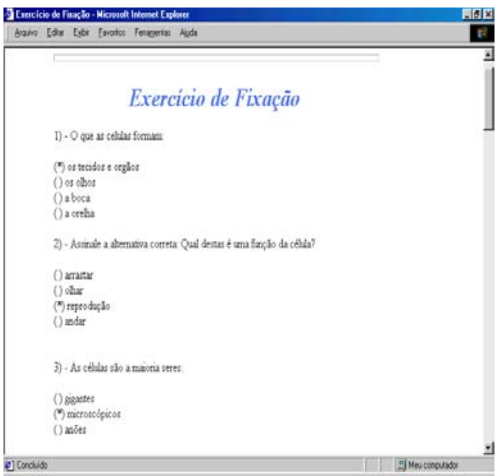

FIGURA 7: Exemplo de Exercício no ambiente

- Mapa:

A partir do mapa o usuário tem a possibilidade do usuário visualizar todos os elementos que compõem o protótipo de forma estruturada.

RESULTADOS

A fase de testes é de suma importância na elaboração de um protótipo por possibilitar a verificação de erros antes que o mesmo seja utilizado pelo usuário final.

Os testes referentes ao protótipo inicial para ensino de neurofisiologia foram efetuados com 20 alunos do curso de Informática e Biologia através da aplicação de um questionário e utilização do ambiente de ensino-aprendizagem.

Os testes revelaram que o protótipo não possui problemas funcionais, já que todas as páginas acessadas foram exibidas corretamente e de forma rápida. Quanto aos aspectos visuais, os resultados também foram favoráveis e demonstraram que a utilização de técnicas multimídia poderá tornar os ambientes de aprendizagem mais interessantes. Com relação aos textos, figuras e animações o teste demonstrou que o protótipo os apresenta de forma clara.

Alguns participantes do teste sugeriram que, para trabalhos futuros, seria interessante a inclusão de exercícios e testes, que tivessem a capacidade de fornecer os resultados do desempenho do aluno.

AGRADECIMENTO

A autora Eliane Pozzebon agradece a bolsa de mestrado da CAPES.

CONCLUSÕES

Através das pesquisas efetuadas no desenvolvimento deste trabalho, pode-se perceber que o computador pode ser utilizado como uma ferramenta no processo de ensino-aprendizagem, propiciando resultados bastante positivos e com qualidade nos ambientes adaptáveis conforme as preferencias do aprendiz.

O aluno toma conhecimento das informações e aprende a aplicá-las. Apresenta, além disso, características essenciais ao processo de aprendizagem, como prender a atenção do aluno, testar o aluno para verificar se ele entendeu os conceitos apresentados, além do aluno poder rever quantas vezes quiser um conceito mal compreendido.

A modelagem, de hipermídia como autômato, utilizada para o protótipo de ensino-aprendizagem de neurofisiologia garante que todos os estados do ambiente sejam alcançáveis [4]. Isto evita problemas como a perda do usuário no espaço de informações ou a ocorrência de páginas que não possam ser encontradas.

Quanto a perspectivas futuras poderão ser incluídas técnicas de Inteligência Artificial que no caso dos testes, por exemplo, o sistema forneça os resultados da avaliação, informações e sugestões sobre as deficiências do aluno caso seu desempenho não tenha atingido um nível desejado. O ambiente ainda poderá incorporar um banco de dados para armazenamento das informações sobre os alunos.

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ASPECTOS DA PRODUÇÃO BRASILEIRA DE WEB ARTE

Fábio Oliveira Nunes

Resumo *– Trata-se de um breve relato sobre a produção artística brasileira para a rede Internet que visa contextualizar a produção recente em arte telemática, abordar alguns trabalhos brasileiros – de diferentes tecnologias e conceitos – disponíveis atualmente na rede e propor a discussão da apropriação – estrutural e semântica – do meio em questão.*

Palavras-chave – Arte contemporânea, Arte e novas tecnologias, Internet, Web arte, Net-art.

ANTECEDENTES

As experiências artísticas utilizando-se de redes já datam de algum tempo. Muito antes do advento do computador pessoal, a arte postal – no Brasil, muito em voga nos anos 60 – foi um movimento transnacional, muitas vezes paralelo ao circuito oficial das artes, onde os artistas trocavam imagens por meio do correio tradicional. Estabelecem-se intercâmbios de imagens e delineia-se a produção de trabalhos artísticos coletivos com participantes fisicamente distantes.

Com os avanços tecnológicos no campo dos satélites e das transmissões eletromagnéticas, surge um novo elemento para a produção de experimentações artísticas: o instantâneo. Agora, torna-se possível estabelecer novos vínculos e intercâmbios imagéticos com possibilidades sincrônicas, uso do tempo real como parte inerente ao trabalho artístico e o alcance fisicamente distante. Assim, começam as primeiras experiências artísticas utilizando-se de artefatos eletroeletrônicos como a televisão de varredura lenta (Slow Scan TV), o telefone, o fax, e as redes de computadores que de início eram estabelecidas somente para eventos determinados e logo a seguir, desfeitas. Com o início do uso comercial da Internet, as estruturas – redes físicas e conexão de espaços – para as experimentações artísticas em rede computacionais, antes estabelecidas para eventos pontuais, deixam de ser unicamente efêmeras.

ARTES NA REDE INTERNET E WEB ARTE

Os espaços que levam a insígnia "artes" na Internet, de um modo geral, encontram-se em dois grupos distintos. A rede mundial pode ser utilizada como meio de divulgação de trabalhos que existem independentemente da rede – pinturas, esculturas, vídeos – e que utilizam códigos e técnicas inerentes aos meios a que pertencem, apresentando-se na rede sob a forma de fotografias, espaços em terceira dimensão simulando galerias de arte e vídeos em *streaming*[1].

Porém, o que nos interessa aqui são trabalhos artísticos que existem dentro das especificidades do meio, questionando suas práticas, utilizando suas capacidades de alcance/tempo real, proporcionando mundos virtuais ou desenvolvendo espaços com tecnologias específicas para a Internet, enfim, realizando trabalhos que desde a sua concepção, voltam-se para a sua existência através da rede. Para estes trabalhos, surgiram vários termos como *ciber-art*, *net-art* e web arte. Gilbertto PRADO[2] define:

> *Sites de realização de eventos e trabalhos na rede: (...) nos dois grupos que se seguem elas* (as redes) *intervêm mais como 'obra'. Essa participação pode ser compartilhada diretamente com outros ou ser desencadeada a partir de dispositivos particularmente desenvolvidos e direcionados para esses eventos. Por esta classificação, não queremos dizer que os artistas sejam definidos por uma única forma de trabalhar como sua característica exclusiva. As diferentes aproximações artísticas de produção em rede não se excluem, elas são algumas vezes complementares e geralmente concomitantes.*
> *a) Dispositivo: É uma estrutura em rede estendida em diferentes locais, onde o espectador e/ou artista agem – sem estar em contato com outras pessoas – diretamente sobre o dispositivo, para iniciar uma ação. O trabalho artístico se estabelece com o desencadear da ação que é proposta pelo artista, conceptor da 'obra' e que se inicia com a participação do espectador.*
> *(...)*
> *b) Interface de contato e partilha: Trata-se também de formações efêmeras de redes, mas nas quais os trabalhos existem somente e graças a diferentes participantes em locais diversos. Não é somente a noção de fronteira que é quebrada, mas também o desejo de estar 'em relação' com outros. As redes nesse caso são utilizadas sobretudo com a intenção de um trabalho coletivo e partilhado.*

PARTICULARIDADES DA WEB ARTE

A produção em web arte está necessariamente ligada ao campo de significações que a rede Internet suscita e também as especificidades técnicas e conceituais que nela se inserem. Primeiramente, esta produção é calcada na efemeridade tecnológica – onde há um permanente caráter de atualização – e em determinados casos, no caráter perecível da informação. O fluxo informacional disponível no universo telemático proporciona um envelhecimento muitas vezes precoce.

Enquanto meio de expressão, a web arte apresenta-se com uma linguagem ainda em definição. Muito do que é produzido para a Internet parte de pressupostos oriundos de traduções/transcodificações de outros meios como a pintura, a fotografia, o cinema, o vídeo e o design impresso. Parte de um processo recorrente em diversos momentos da história da arte, onde a linguagem de um novo meio nasce a partir de nuances dos meios existentes até então.

Por outro lado, em vertente avessa, encontram-se trabalhos que entendem "o meio como mensagem" e abordam o universo do usuário em rede: os caminhos bifurcados, a navegação solitária, o receio de contaminação por vírus e as suas expectativas – velocidade de carregamento, legibilidade – diante de cada página ou espaço navegado. Esses trabalhos muitas vezes exigem um repertório extremamente específico, onde conhecer a práxis da rede proporciona outros níveis de leitura. Entre os trabalhos mais conhecidos de auto-referência na rede, está o *Jodi*[3], que originou um "estilo" de sites artísticos, onde elementos de composição de sites da Internet (botões, animações, listas de arquivos) passam a ter uma dimensão estética, compondo um mundo extremamente caótico, repetitivo, desconexo. Sobre este site, DONATI escreve:

> *Na relação homem-máquina, existe a necessidade de interfaces para que se estabeleça a comunicação, para que uma informação reconhecida pela máquina torne-se legível ao homem e transmita assim um significado. Este ir e vir de códigos, como traduções sucessivas que se sobrepõem em níveis, trabalhados pelo repertório do interpretante, é representado neste site por imagens de texto que se transformam em códigos de barra, enquanto o código de cores da linguagem HTML traduz a cor vermelha para um número binário. Este site apresenta esta intertextualidade entre códigos, mas vem reverter esta situação, na medida em que produz ruídos, "chuviscos", interferências e não efetiva a comunicação, por não alcançar o sentido esperado.*

Porém, os ruídos de comunicação não são a única forma de abordagem da metalinguagem em web arte. O site "Willkommen bei Antworten"[4], proporciona um questionamento do visitante diante da espera em frente à tela de seu computador e suas expectativas. É constituído de uma interface que se assemelha a um visor eletrônico de lanchonetes, que indica o número atual e mais abaixo, o seu número. O artista, em alemão, pede: "por favor, espere!". Já o site "Unendlich, fast..."[5] que se constitui em uma única página de fundo azul, com barras de rolagem tanto verticalmente quanto horizontalmente sem texto ou imagem – apenas pequenos traços, não estão associados a nenhum link ou ação. O visitante se depara com um imenso azul, uma página web sem qualquer tipo de informação textual ou link, em que a única ação possível é tentar procurar através das barras de rolagem, a existência de algum elemento de significação. Neste trabalho, o artista questiona o meio e a tão proclamada interatividade intrínseca a Internet.

Há ainda trabalhos que buscam a especificidade do meio através da participação e interação de visitantes entre si e/ou diretamente no trabalho proposto. São espaços (net-instalações), happenings ou eventos que podem fazer referência a algum meio de origem, distante da Internet ou serem auto-referentes e que através de dispositivos de ação em espaços remotos, *webcam*[6], *chats*[7] e ambientes multi-usuário, proporcionam uma interação em tempo real nos espaços e o contato direto entre indivíduos num universo comum.

ARTISTAS BRASILEIROS

No Brasil, podemos observar diversas linhas de trabalho que adotam a rede Internet para a realização de experimentações artísticas, utilizando-a tanto em relação a espaços externos físicos como também, sob a forma de sites artísticos e ambientes virtuais em terceira dimensão. Alguns dos trabalhos aqui citados fazem parte de eventos consagrados como a Bienal de São Paulo[8].

Em relação a espaços físicos distantes conectados – muitas vezes, espaços expositivos de instituições culturais – temos a pesquisa artística de Eduardo Kac[9], que estabeleceu a "telepresence art", utilizando câmeras e outros dispositivos em trabalhos como "Ornitorrinco in Eden" (1994), onde via rede era possível estabelecer uma colaboração compartilhada de controle de um robô por participantes anônimos, mais tarde, o artista passa a se dedicar a arte transgênica desenvolvendo trabalhos como "Gênesis"[10] (2000), apresentada no Instituto Cultural Itaú, em São Paulo. A instalação Gênesis constitui-se em uma sala de paredes escuras com uma projeção de vídeo. Na primeira parede, uma transcrição de um pequeno trecho do antigo testamento onde é possível entender uma possível "autorização" divina para as intervenções da atual engenharia genética: *"Deixe que o homem domine sobre os peixes do mar, sobre as aves do céu e sobre todos os seres vivos que se movem na terra"* (Gênesis 1, 28). Em outra parede, a transcrição do texto em inglês para o código Morse e em uma terceira, a tradução do código Morse para o código genético DNA. Cria-se aqui um gene sintético, advindo do texto bíblico. O crítico de arte Arlindo Machado[11], um dos curadores da exposição, descreve o funcionamento desta instalação:

> *O gene sintético contendo o texto bíblico é, em seguida, transformado em plasmídeo (anel de DNA extracromossômico capaz de auto-replicação) e então introjetado numa bactéria E.*

coli, que o reproduzirá às próximas gerações. As bactérias contendo o gene Genesis apresentam a propriedade de fluorescência ciã (azul esverdeado) quando expostas à radiação ultravioleta e coabitam uma placa de Petri com outra colônia de bactérias, não transformadas pelo gene Genesis e dotadas da propriedade de fluorescência amarela quando submetidas à mesma radiação ultravioleta. À medida que as bactérias vão entrando em contato umas com as outras, um processo de transferência conjugal de plasmídeos pode acontecer, produzindo as seguintes alterações cromáticas: 1) se as bactérias ciãs doarem seu plasmídeo às amarelas (ou vice-versa), teremos o surgimento de bactérias verdes; 2) se nenhuma doação acontecer, as cores individuais serão preservadas; 3) se as bactérias perderem seus respectivos plasmídeos, elas se tornam ocres.

O processo de mutação cromática das bactérias pode se dar naturalmente ou pode ser também ativado por decisão humana, por meio da radiação ultravioleta, que acelera a taxa de mutação. No espaço da galeria onde ocorre a experiência, tanto os visitantes locais como os visitantes remotos (que participam do evento pela Web) podem ativar ou desativar a radiação ultravioleta, interferindo, portanto no processo de mutação e ao mesmo tempo possibilitando visualizar o estágio atual das combinações de ciã, amarelo, verde e ocre.

A instalação Gênesis constitui-se em um evento que se utiliza a Internet para estabelecer ao visitante, um controle remoto para a interação em um espaço físico: ativar a radiação ultravioleta para mutação das bactérias. Por meio do site, o internauta irá observar o status da radiação (ligada ou desligada) e imagens em tempo real, exibindo as bactérias do espaço expositivo e suas alterações cromáticas.

Em "Mediamorphose"[12], do artista franco-brasileiro Roberto Cabot, no interior de uma instalação transmídia na 25ª Bienal de São Paulo, uma câmera de vigilância captura imagens dos visitantes do espaço expositivo – tendo ao fundo uma pintura em anamorfose – e simultaneamente as projeta em um outro ambiente, mostrando ao fundo, o que antes não era inteligível: um batalhão de soldados "em ação" em torno do visitante. As imagens capturadas são também disponibilizadas imediatamente em um site, possibilitando o acesso à imagem de todos os visitantes do espaço, organizados por dia e hora de inclusão no banco de dados. O artista aborda nossa condição como ser observado, diante de um olhar eletrônico onipresente que muitas vezes se dá distante da nossa percepção.

Uma outra utilização da Internet em relação a espaços externos físicos foi realizada por Gilbertto Prado, na net-instalação "Depois do turismo vem o colunismo"[13] (1998), no Paço das Artes em São Paulo, onde a disponibilização de imagens do espaço expositivo em tempo real na rede, mesclada por imagens de banco de dados, pautava o olhar estrangeiro e a antropofagia.

Já a utilização artística da Internet sob a forma de sites é a mais comum e caracteriza-se normalmente por ser menos efêmera quando comparada com os eventos realizados em intercâmbio com espaços físicos remotos. Alguns artistas partem para a estetização e destituição de função de elementos do universo da própria rede. Um bom exemplo disso, é o site "Lands Beyond"[14] (1997), dos artistas Thiago Boud'hors e Celso Reeks, onde elementos da interface computacional encontram-se em meio a nuances literários. No memorável "Netlung"[15] (1997), os artistas Diana Domingues, Gilbertto Prado, Suzete Venturelli e Tânia fraga, a referência ao meio está no ato simbólico de respirar na rede, propondo diversos percursos sensoriais. Em "Perspectiva Clássica"[16] (1999) de Daniel Sêda, uma ciber-colagem enaltece a leitura fragmentada e simultânea.

Uma interessante metáfora ao tempo na Internet é vista no site "Cronofogia"[17] (2002) de Kiko Goifman e Juradir Muller, onde foi criado um "relógio web". O trabalho é constituído de uma única página, com o nome do trabalho e as palavras-chave "violência, tempo, deterioração, morte" que se mantêm em ritmo contínuo de acende-apaga. Logo abaixo, apresenta-se uma imagem de carne em decomposição, que ocupa uma grande parte da janela. Mais abaixo, ainda há o incentivo para a participação do usuário através da frase "clique na imagem para disparar o relógio web". Inicialmente, adentra-se a questão da expectativa do usuário: a busca de respostas claras a suas ações. A própria palavra utilizada na frase convidativa – "disparar" – dá a idéia de algo ressonante que provavelmente se configuraria com significância. Porém, ao clicar sob a imagem, somente uma linha horizontal passa e aparentemente nada acontece. Na verdade, o relógio web foi disparado e a imagem recebeu mais um clique que diminui a sua permanência, sua sobrevivência na web. Os artistas desenvolveram um mecanismo no qual cada imagem tem sua sobrevivência definida por um número – sabido somente pelos próprios artistas – de cliques somados de todos os visitantes. Ao alcançar o número definido, a imagem é automaticamente substituída por outra, igualmente com carne em decomposição. Assim como em outros trabalhos de colaboração coletiva, é o processo coletivo que determina o tempo de existência e o momento de morte e esquecimento da imagem ali exposta. São os cliques coletivos que quando somados, formam um resultado que enquanto processo é invisível para cada elemento da coletividade.

Outros trabalhos distanciam-se da referência direta ao meio e partem para a criação de faturas híbridas como em "Literaterra"[18] (2002), de Artur Matuck, um espaço de recombinação textual e "Econ"[19] (1999) de Silvia Laurentiz, espaço virtual em terceira dimensão, onde o visitante "caminha" por palavras, estabelecendo novas maneiras de ler um poema.

Em criações de terceira dimensão – Realidade Virtual – voltadas para a rede Internet, vale destacar a pesquisa de Suzete Venturelli e Tânia Fraga[20], bem como Gilbertto Prado em "Desertesejo"[21] (2000), ambiente multiusuário onde aborda-se um universo de solidão, contemplação e ritos de passagem.

Assim, da mesma forma que a produção internacional, a multiplicidade de experimentações dos artistas brasileiros reflete paradigmas em formação, idéias que flutuam sob um mar de possibilidades e caminhos possíveis em meio a conceitos que vão emergindo diante do fazer artístico na web.

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[1]Tecnologia amplamente utilizada em arquivos multimídia (vídeo e música) via Internet, onde a exibição ocorre simultaneamente ao carregamento do arquivo.

[2] PRADO, Gilbertto. Estudo e criação dos sites de arte na rede Internet. In: Anais do IX Encontro Nacional da ANPAP – Associação Nacional dos Pesquisadores em Artes Plásticas. Volume 2. pp.296-204. São Paulo: ANPAP, 1997. Neste texto, o artista define os sites de divulgação e os sites de realização.

[3] http://www.jodi.org

[4] http://www.antworten.de

[5] http://www.thing.at/shows/ende.html

[6] Webcams são câmeras conectadas a rede Internet que disponibilizam imagens em tempo real, que, atualmente, são de baixa resolução.

[7] Designação dada às salas de bate-papo da rede Internet. Essas salas possibilitam o contato textual entre os usuários em tempo real.

[8] A mostra de web arte da 24ª Bienal pode ser vista em http://www.uol.com.br/bienal . Já a mostra de net arte da 25ª Bienal pode ser vista no endereço: http://bienalsaopaulo.terra.com.br .

[9] Registro de trabalhos realizados pelo artista estão em: http://www.ekac.org .

[10] Gênesis foi apresentada no Brasil, em agosto de 2000, no Instituto Cultural Itaú em São Paulo, permanecendo on line durante o período da exposição. Texto explicativo sobre a instalação pode ser encontrado em: http://www.itaucultural.org.br/exposicoes/trabalho_do_artista/kak/genesis00.htm .

[11] Texto disponível em http://www.itaucultural.org.br/exposicoes/trabalho_do_artista/kak/genesis00.htm .

[12] O registro do trabalho encontra-se no endereço: http://mediamorphose.org

[13] http://wawrwt.iar.unicamp.br/colunismo/colunismo.htm

[14] http://www.distopia.com/LandsBeyond/

[15] http://www.arte.unb.br/netlung/netlung.htm

[16] http://interaubis.tripod.com/navis/index.htm

[17] http://www.paleotv.com.br/cronofogia

[18] http://www.teksto.com.br

[19] http://www.pucsp.br/~cos-puc/interlab/in4/entrada.htm

[20] Um dos trabalhos das artistas, Actbolus, pode ser visto no seguinte endereço: http://www.unb.Br/vis/lvpa/actbolus/index.html

[21] http://www.itaucultural.org.br/desertesejo

A LINGUAGEM DA INTERNET E OS DIFERENCIAIS NA TRANSMISSÃO DA MENSAGEM PUBLICITÁRIA

Alessandro Marques de Oliveira[1]

[Este artigo é dedicado ao Prof. Dr. Flávio Mário de Alcântara Calazans, amigo e orientador, pelo incentivo contínuo e "nada virtual"]

RESUMO:

A LINGUAGEM DA INTERNET E OS DIFERENCIAIS NA TRANSMISSÃO DA MENSAGEM PUBLICITÁRIA

Tudo começou com a idéia de um meio seguro de transmissão de mensagens. O processo embrionário do que seria a Internet surge em meio à corrida espacial e guerra fria. Hoje, a guerra fria terminou e a corredores da competição pela conquista do espaço parecem ter cansado. Sem verbas, a NASA adia e retarda projetos, os russos idem, pois se encontram em meio a crises financeiras e novas tentativas de emancipações de alguns de seus territórios. Diante desse quadro parece que a única maneira que se têm encontrado para a sobrevivência de todos é a convênio. O embrião desenvolveu-se e nasceu a Internet. O grande número de usuários e o crescimento constante, atraiu empresas que, através do mercado publicitário, investem milhões de dólares em uma nova forma de Publicidade, a Webvertising, ou a propaganda on-line. A interatividade e a comodidade do internauta são as benefícios da Propaganda na web.

Palavras-Chave: Internet, Publicidade na Internet, Comunicações Digitais, Sociedade de rede.

1- Introdução

A Internet é o mais recente meio de comunicação de massa. Estima-se que, em 2005, o mundo terá mais de 1bilhão de internautas[2]. Este poderoso meio atrai tantas pessoas por ser prático, fácil e, principalmente, pela sua interatividade, o receptor da mensagem possui mecanismos de responder ao emissor. Isso é o que fascina o internauta, pois há um certo diálogo. Mas, além da interatividade, a Internet também possui outra característica: a comodidade, pois não depende de deslocamentos físicos para utilizar-se da web. Na web, basta que o webwriter[3] – redator que escreve textos publicitários para a Internet – receba o briefing, ou seja, a solicitação de serviço que uma uma agência de Propaganda recebe de uma empresa, através de seu departamento de marketing, formate e adapte a linguagem, através de linguagens visuais e textuais de Internet e elabore a Webvertising[4]. Esse confortável cliente on-line, pode conhecer empresas, cadastrar-se como cliente
preferencial, mandar correspondências(e-mails) e, principalmente, comprar os produtos. Mas a Internet perde e ganha com suas características e é isso que esse estudo pretende levantar, utilizando-se como **metodologia**, Levantamento Bibliográfico sobre o tema e Observação Participante de sítios de Internet, pois o pesquisador faz parte do universo pesquisado, enquanto estudioso da Internet, comunicólogo e publicitário.

2- A Internet como meio de comunicação e veículo publicitário

Em 1957, em plena guerra fria, quando os soviéticos lançaram no espaço o satélite artificial Sputnik, o mundo percebeu que o céu não era mais um lugar seguro e exclusivo e algumas nações. Era necessário criar alternativas de envio e recebimento de informação em terra firme. Mas como seria criada essa tecnologia? Na verdade, o embrião dessa tecnologia já havia sido lançada, quando o engenheiro americano Bob Taylor, teve a idéia de ligar os computadores da ARPA (Advanced Research Project Agency), entidade do Pentágono responsável pelas pesquisas espaciais. Em 1969, nasce então a ARPAnet. Em 1973, após a ARPAnet já ter criado conexões em rede entre algumas Universidades norte-americanas, ocorre a primeira conexão internacional com a Universidade de Londres.

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Da mesma forma como a ARPAnet, instituições privadas começam a investir em meios de transmissão de dados via rede. Através do Engenheiro da Xerox, Americano Bob Metcalfe, que utilizou idéias oriundas da ARPAnet, descobriu-se como conectar Computadores Pessoais em redes empresariais. A empreitada deu tão certo, que Bob criou a 3Com, empresa que desenvolveu o mecanismo Ethernet

Depois, surge a Novell, que desenvolve um sistema novo de conexões em rede que faz os computadores pessoais armazenassem dados em servidores, podendo haver compartilhamento. Depois da 3Com e Novell. Outras empresas surgem e criam-se então, várias redes independentes e fechadas de comunicação via rede.

Na década de 80, dois estudantes da Universidade de Stanford, Califórnia, Sandy Lerner e Len Bosak, conseguem passar 25km² de cabos, interligando todos os 5mil computadores de toda a Universidade que, em seus respectivos prédios, já eram conectados. Depois de saírem da Academia, entram no mercado e fundam a Cisco Systems. Em breve, todas as Universidades americanas também foram cabeadas, criando uma grande rede nacional.

Mas, somente em 1991, quando o inglês Tim Berners-Lee, um técnico em informação do Laboratório Europeu de Física em Genebra cria a *World Wide Web* (Grande Rede Mundial), começa-se a esboçar a Internet. Tim, utilizando-se do *hyper text transfer protocol*, descobre que é possível conectar outros computadores, de outras redes, transportando quaisquer informações. Para isso bastasse que essas informações estivessem armazenadas em servidores e que tivessem, um endereço eletrônico. Daí nasceram as ***http://www***. Com essa facilidade de comunicação global, a Internet ganha força e conquista o mundo.

Entre os setores que mais rapidamente se adequaram à grande rede, estão os veículos de comunicação. Jornais, revistas, emissoras de rádio e televisão rapidamente lançaram seus *sítios* (conjunto com mais de 500 páginas de internet), fazendo ou incrementando a interatividade que nunca tiveram ou que tinham discretamente, através de discretos contatos por telefone ou carta. Grandes conglomerados da Comunicação aumentaram sua força entrando na Internet e outros, de modo inverso, nasceram dela e cresceram "para fora" da grande rede, adquirindo outras empresas. Entende-se como portal, o conjunto de mais de 10mil páginas de internet, onde é possível formar comunidades virtuais, que são grupos afins de usuários da web. Assim sendo, portais como a Ameria on Line, Terra, Universo on Line por exemplo, têm diversos serviços à disposição de usuários, o que os torna grande fonte de consulta e, conseqüentemente, de procura de anunciantes, o que acaba gerando receita a esses portais, fazendo-os investir cada vez mais em novidades para o internauta (outro termo que advém do usuário já familiarizado com o computador e a operacionalização deste e das ferramentas da Internet).

Com essa possibilidade de ganhos, hoje a Internet é opção real na indústria da Propaganda. Em 1997, uma pesquisa feita pelo IAB – Internet Advertising Bureau, apresentou um estudo comparativo entre os investimentos em propaganda nos diversos meios de comunicação. Nesse estudo, o IAB demonstra que a Internet, na época com pouco mais de 5anos de existência, já abocanhava a considerável fatia de US$ 907milhões. Todo esse dinheiro e confiabilidade de retorno aplicada pelas empresas anunciantes à internet deve-se, principalmente, pelo diferencial da interatividade e comodidade. O internauta interage com a empresa, através de mecanismos de Webvertising e acaba consumindo, sem sair de casa, os produtos anunciados no portal. Para atrair a atenção do internauta de maneiras diferenciadas, são sempre criados mecanismos de divulgação das mensagens através do talento e criatividade de webdesigners e webwriters.

Podemos citar entre vários mecanismos de propagandas on-line:

–SITE: CONJUNTO DE PÁGINAS DA WEB. TEM CERCA DE 500 PÁGINAS;

–PORTAL: CONJUNTO DE SÍTIOS QUE POSSUI CERCA DE 10.000 PÁGINAS;

–MINISITE: SITE COM POUCAS MENSAGENS. FORTE APELO VISUAL;

–HOTSITE: MINISITE ESPECÍFICO DESTINADO PARA EVENTOS COM DATA DE INÍCIO E ENCERRAMENTO.

–PUSH ADVERTISING: PERGUNTA-SE AO CLIENTE O QUE ELE DESEJA. É OFERECIDO CONJUNTAMENTE COM UM ANÚNCIO, QUE PAGA O "PUSH".

–BANNER: ATÉ AGORA A "ALMA" DA PROPAGANDA ON-LINE. PEQUENA FIGURA QUE MOSTRA COMO ACESSAR DE MANEIRA RÁPIDA O ANUNCIANTE/PRODUTO.

Somando-se a verba publicitária ao preço pago pelo internauta pelo uso do portal, chega-se à receita final. Portanto, quando mais audiência, mais receita e confiabilidade possui o portal.

Essa confiabilidade é indispensável às empresas e à própria Internet para o seu crescimento enquanto

meio publicitário, principalmente porque os outros meios de comunicação ainda estão bem à frente quando o assunto é verba.
Na mesma pesquisa já citada neste texto, do IAB– Internet Advertising Bureau, demonstra que, o jornal lidera os investimentos com cerca de US$41,2 bilhões. A TV vem em segundo lugar com cerca de US$37,1bilhões seguido de perto pela Mala-direta, com US$36,9 bilhões. Comparando-se aos pouco mais de US$900 milhões, a Internet tem muito a investir, crescer, modificar-se.

3- Considerações Finais

A Publicidade na Internet, ou a Webvertising é uma realidade que progrediu e vem em constante aperfeiçoamento.
Diversas maneiras de divulgação da mensagem publicitária on-line, foram criadas especificamente para esse motivo, além de medidas de conferência e medição de audiência. Isso sinaliza e faz pensar que, os quase 1bilhão de usuários que a Internet, já em 2005 terá, muito provavelmente tornará a Webvertising um dos negócios mais lucrativos do mundo.

(2)-Projeção de usuários da Internet retirada do livro Como escrever na rede, de Leonardo Moura. Pg 14.
(3)-Termo retirado do livro Webwriting-pensando o texto para a mídia digital, de Bruno Rodrigues.
(4)- Termo retirado do livro Webwriting-pensando o texto para a mídia digital, de Bruno Rodrigues.

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ANÁLISE DAS POSSIBILIDADES PARA O USO DAS CALCULADORAS GRÁFICAS NOS CURSOS DE ENGENHARIA

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Resumo *— A sociedade atual requer um profissional que trafegue eficazmente não só em uma área específica, mas também que não se intimide com as incertezas e velocidade das transformações do mercado. Para tanto, as Instituições de Ensino Superior devem formar profissionais habilitados para os novos desafios surgidos com a tecnologia. Os cursos de Engenharia são constituídos por disciplinas básicas, de formação geral e profissionalizantes, as quais devem caracterizar o perfil do aluno que a Instituição deseja formar. As disciplinas básicas são oferecidas no início do curso e constituem o "Núcleo Comum" às Engenharias tendo a finalidade de fornecer as ferramentas matemáticas e teóricas para as disciplinas de formação geral e profissionalizantes. Este trabalho apresenta: 1) a análise dos resultados de uma pesquisa feita com professores e alunos dos cursos de Engenharia sobre o possível uso pedagógico das calculadoras gráficas em sala de aula; 2) um entrecorte do estado atual dos ensinos passivo versus ativo no grupo pesquisado; 3) uma discussão sobre as metodologias de ensino envolvendo a pedagogia e a andragogia, visto que os alunos ingressantes notam as diferentes exigências de seus comportamentos ao passarem do Ensino Médio ao Superior.*

Palavras-chave — Ensino de Engenharia, Calculadoras Graficas, Tecnologias Informáticas.

INTRODUÇÃO

Nos dias de hoje é bastante fácil observar que a tecnologia já faz parte de nossas vidas. Os bancos já disponibilizam operações e transações na internet, as notícias já se encontram on-line, os celulares já podem se conectar e com isso trocar mensagens, nossos filhos já possuem aulas de informática e com nossos alunos não seria diferente.

A sociedade atual requer um profissional de engenharia que trafegue eficazmente não só em uma área específica, mas também que não se intimide com as incertezas e velocidade das transformações do mercado de trabalho. Percebemos que o mundo contemporâneo tornou-se globalizado e altamente dependente das tecnologias, fazendo com que as pessoas necessitem cada vez mais de uma maior qualificação (tanto cultural como escolar) para ocupar uma melhor posição neste mercado. Para tanto, as Instituições de Ensino Superior devem formar profissionais habilitados para os novos desafios surgidos com a tecnologia.

Nesta perspectiva, consideramos que uma das preocupações do ensino atual da Matemática Superior seja o desenvolvimento de competências na resolução de problemas em situações da realidade e a utilização da tecnologia como elemento mediador nessa atividade.

Automaticamente, entendemos que esses alunos devem estar preparados para viver numa sociedade tecnológica racional e matemática, em que viver significa ser um elemento crítico, atuante e preparado para mudanças.

Em contrapartida, os docentes devem também estar abertos para essa realidade, de modo a conceber diferentes caminhos para gerar o conhecimento juntamente com os alunos ou, conseqüentemente, ficarão estagnados à métodos de ensino obsoletos. É neste quadro que a aprendizagem matemática passa a ter um papel relevante na formação dos jovens, se o seu ensino for adequado às exigências da sociedade atual.

Neste trabalho apresentamos, primeiramente, a análise dos resultados de uma pesquisa feita com professores e alunos dos cursos de Engenharia sobre o possível uso pedagógico das calculadoras gráficas em sala de aula; seguido de um entrecorte do estado atual dos ensinos passivo versus ativo no grupo pesquisado e, finalmente, uma discussão sobre as metodologias de ensino envolvendo a pedagogia e a andragogia, visto que os alunos ingressantes notam as diferentes exigências de seus comportamentos ao passarem do Ensino Médio ao Superior.

AS CALCULADORAS GRÁFICAS

Neste artigo utilizamos uma das Tecnologias Informáticas (TI´s) presentes no Ensino Superior, as calculadoras gráficas. Essas são superiores às calculadoras científicas, pois possuem além de inúmeras funções adicionais (como por exemplo, as funções estatísticas) a propriedade de confeccionar diversos tipos de gráficos a partir de funções ou tabela de dados, ambos inseridos pelo aluno.

A calculadora gráfica é um instrumento portátil que pode dar ao aluno a possibilidade de recolher, trabalhar e trocar dados com professores e colegas dentro e fora da sala de aula, não só nas atividades de Matemática, mas também em aulas de Física, Química, Biologia e disciplinas afins de cada currículo.

Aproveitamos para ressaltar que esses instrumentos não são novos, ou seja, as calculadoras gráficas foram lançadas há vários anos e, até hoje, muitos alunos e professores ainda

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não resgataram o potencial pedagógico que esses instrumentos podem oferecer.

Neste artigo utilizamos as calculadoras gráficas HP 48 série G pois, durante a observação, percebemos que a maioria dos alunos possuía esse modelo de instrumento.

METODOLOGIA

Como metodologia utilizamos a abordagem qualitativa sabendo que nessa perspectiva o "pesquisador colhe informações, examina cada caso separadamente e tenta construir um quadro geral [de uma dada] situação. É um exercício de ir juntando as peças, como num quebra-cabeça, até o entendimento global do problema" [1]. A seguir, apresentamos os procedimentos metodológicos para a coleta de dados relativos aos professores e alunos, respectivamente.

Com os Professores

Para a coleta de dados com esses participantes, nos valemos do uso de questionários contendo perguntas de múltipla escolha e também perguntas abertas. Essa técnica tem as vantagens de atingir um maior número de pessoas e a facilidade de registro das respostas enviadas [1].

Na análise dos dados procuramos identificar categorias, tendências, padrões, de modo a classificar os dados que havíamos recolhido [2]. Assim, analisando os questionários recebidos, percebemos que muitos eram os argumentos que surgiam em relação ao uso da calculadora gráfica em sala de aula, os quais receberão mais detalhes na seção Uso das Calculadoras Gráficas.

Com os Alunos

Com esses participantes utilizamos como técnica de coleta de dados a observação participante não-estruturada, como afirma Alves-Mazzotti e Gewandsznajder [2], "[é] a qual os comportamentos a serem observados não são predeterminados, eles são observados e relatados da forma que ocorrem, visando descrever e compreender o que está ocorrendo numa dada situação". Esses autores [2] ainda afirmam que "nesta observação, o pesquisador se torna parte da situação observada, interagindo por longos períodos com os sujeitos".

A observação teve um caráter natural, pois os pesquisadores – autores deste artigo – pertenciam à mesma comunidade que o grupo investigado [3], ou seja, durante o ano letivo de 2002, os pesquisadores foram os docentes dos sujeitos observados.

De maneira a aumentar a confiabilidade dos dados coletados, foram também distribuídos questionários aos docentes (de um modo geral) dos sujeitos da pesquisa. Esse segundo procedimento nos ajudou na triangulação que "tem por objetivo abranger a máxima amplitude na descrição, explicação e compreensão do objeto de estudo" [4], no nosso caso o uso da calculadora gráfica pelos alunos.

Na seção Uso das Calculadoras Gráficas serão apresentados mais detalhes sobre as categorias estabelecidas para os alunos.

USO DAS CALCULADORAS GRÁFICAS

Ao longo dos anos ministrando disciplinas de Cálculo Diferencial e Integral e de Física Geral e Experimental nos cursos de Engenharia, pudemos perceber os diferentes usos que os docentes normalmente fazem das TI´s, mais especificamente, das calculadoras gráficas.

Inicialmente tínhamos o foco centrado no aluno, porém, durante o caminhar desta pesquisa, resolvemos observar também os professores. Assim sendo, primeiramente, vamos ressaltar alguns pontos importantes em relação ao comportamento dos professores diante do uso da calculadora gráfica e, posteriormente, nos centraremos no comportamento dos alunos.

Pelos Professores

Após a análise dos dados pudemos agrupar e, em conseqüência, classificar os argumentos em três categorias distintas: 1) os professores que não utilizam a calculadora gráfica em sala de aula; 2) os professores que não as utilizam nas aulas, porém permitem que os alunos as portem nas provas e 3) os professores que aderem ativamente a sua utilização em sala de aula.

Na primeira categoria, o argumento denominado de ordem técnica para o não uso da calculadora gráfica foi uma possível heterogeneidade de modelos e marcas existentes na sala de aula, implicando que o professor dominasse os diferentes equipamentos. As dificuldades listadas a seguir também foram citadas pelos docentes quanto ao uso da calculadora gráfica: a complexidade no modo de operação, as dificuldades na programação, a exigência que o aluno domine alguns tipos de algoritmos característicos de algumas disciplinas, além dos docentes se auto-julgarem com poucas habilidades no uso desse instrumento e a falta de tempo para se dedicarem ao seu uso pedagógico em suas respectivas disciplinas. Um ponto notável dessa categoria foi a preocupação quanto às conseqüências do processo de aprendizagem com o apoio da tecnologia, numa avaliação final decisiva para a vida do estudante. Esse argumento foi rapidamente refutado, uma vez que em 1996 (para os cursos de Engenharia Civil) e 1998 (para os cursos de Engenharia Elétrica) foram instituídos os exames nacionais (ENC) nos quais é permitido ao aluno o uso de calculadoras, inclusive as gráficas.

No segundo grupo, encontramos o argumento que titula essa categoria, justificado quando olhamos a necessidade do docente em modificar os exercícios de modo que os alunos não fiquem dependentes dessa tecnologia, nem sintam impossibilitados de a utilizarem. Com isso advém o sub-uso das calculadoras gráficas, ou seja, elas são empregadas como calculadoras científicas e, por esse motivo, são permitidas em provas. Desse modo, a calculadora toma um forte apelo de instrumento de conferência de cálculos algébricos, inicialmente para o professor e posteriormente para o aluno.

Na terceira categoria, na qual nos incluímos, estão os docentes que aderem ao uso das TI´s em sala de aula. Exemplos deste uso estão apresentados em diversos trabalhos [5, 6, 7, 8, 9 e 10]. Alguns docentes afirmam que a incorporação da calculadora gráfica em sala pode ser feita num período de 20 minutos da aula, deixando que os alunos trabalhem em grupos orientados pelo professor.

Pelos Alunos

Nos dias de hoje, a calculadora gráfica tornou-se um instrumento de trabalho muito útil aos estudantes, porém devido ao quadro que apresentamos na seção anterior, poucos são os professores que estão posicionados na visão proposta pela terceira categoria. Em contrapartida, muitos são ainda os professores que estão na categoria 1 e em menor quantidade na categoria 2.

Assim, analisando as observações feitas e os questionários recebidos, buscamos identificar categorias e tendências de modo a compreender os dados que havíamos recolhido. Como resultado da análise desses dados percebemos que os alunos – embora diferentes uns dos outros – estabeleceram critérios para recorrer ao uso da calculadora.

Dentro desses critérios identificamos quatro categorias, a saber: 1) alunos que utilizam a calculadora gráfica para qualquer cálculo, mesmo que esse cálculo seja elementar; 2) alunos que possuem dificuldades quando necessitam fazer uma confrontação entre o resultado obtido com o lápis e papel e o resultado mostrado na calculadora gráfica; 3) alunos com um conhecimento deficiente na manipulação da calculadora conduzindo, em geral, a erros de interpretação dos resultados gráficos e 4) o uso da calculadora gráfica fora da sala de aula.

Na primeira categoria, observamos o uso imaturo da calculadora gráfica por parte do aluno e uma negligência por parte do professor. Muitas vezes esse aluno sabe que sua calculadora possui funções gráficas, mais é incapaz de as conhecer ou ter interesse por essas possibilidades. Notamos neste tipo de aluno uma grande importância ao tempo dispendido ao estudo gerando uma acomodação para com o ato de pensar.

A principal característica que nomeia a segunda categoria se faz presente nos alunos que possuem algumas dificuldades ao confrontarem os resultados obtidos com o lápis e papel com resultados mostrados na calculadora gráfica. Apoiados na observação percebemos que, nesses casos, a dúvida normalmente permanece, pois faltam aos alunos tanto domínio quanto conhecimento da matemática envolvida numa questão determinada.

Para ilustrar essa categoria, tomemos o exemplo a seguir, quando é necessário o valor da integral:

$$\int_1^x \frac{1}{x}\,dx \qquad (1)$$

que é facilmente resolvida utilizando uma tabela de integração donde temos: ln |x| - ln |1| = ln |x| - 0 = ln |x|.

O aluno que opta em utilizar a calculadora gráfica, primeiramente insere a função a ser integrada, a variável de integração, os limites inferior e superior e o tipo de resultado desejado (simbólico ou numérico) obtendo a resposta, que está apresentada na Figura 1.

FIGURA 1
A) INSERÇÃO DA FUNÇÃO, B) RESULTADO DA INTEGRAÇÃO.

Neste caso em específico, os alunos não sabem interpretar a resposta fornecida pela calculadora, ou seja, não possuem conhecimentos matemáticos para tal confrontação. Note que na pilha 1, a calculadora fornece o resultado e o aluno deverá substituir os limites de integração para obter a resposta final desejada.

Na terceira categoria, classificamos os alunos que possuem um conhecimento deficiente em relação a manipulação da calculadora gráfica conduzindo, em geral, a erros de interpretação dos resultados gráficos apresentados. Novamente através da observação realizada, apresentamos a seguir um exemplo na disciplina que ministramos.

Um exemplo de aplicação é quando solicitamos aos alunos a construção de gráficos oriundos da aplicação da Transformada de Laplace [11] onde em um circuito elétrico são pedidas a carga e a corrente, às quais são calculadas através dessa transformação. Os alunos deverão construir os gráficos da: $q(t) = e^{-2t}.sen16t$ e $i(t) = -2e^{-2t}.sen16t + 16e^{-2t}.cos16t$, respectivamente, de modo a obter, através do gráfico, o valor máximo da carga e da corrente num instante t de tempo.

Primeiramente, os alunos devem inserir a função, nomear a variável independente e pressionar a tecla DRAW para plotar o gráfico, como mostrado na Figura 2.

FIGURA 2
A) INSERÇÃO DA FUNÇÃO, B) GRÁFICO DA CARGA.

Contudo, devemos notar que a janela de visualização acima não é a mais adequada para o gráfico dessa função, pois esta apresenta os valores ‘default’ para H-VIEW e V-VIEW. Dessa forma, para obtermos o valor máximo da carga, precisamos re-ajustar essa janela e re-desenhar o gráfico, como mostrado na Figura 3.

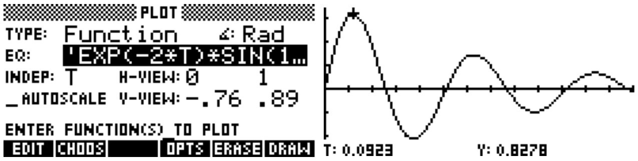

FIGURA 3
A) INSERÇÃO DA FUNÇÃO, DEFINIÇÃO DA JANELA DE VISUALIZAÇÃO, B) GRÁFICO DA CARGA.

Para obter a corrente, o aluno deverá derivar a carga no tempo, cuja resposta gráfica está apresentada na Figura 4.

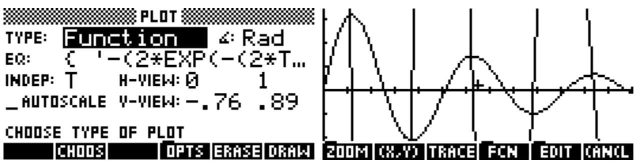

FIGURA 4
A) DEFINIÇÃO DA JANELA DE VISUALIZAÇÃO, B) GRÁFICO DA CARGA E DA CORRENTE.

Neste caso, percebemos que uma conseqüência da má visualização poderá gerar distorções na aquisição de conceitos.

Uma categoria que emergiu da pesquisa realizada, mais precisamente das observações, foi a categoria quatro. Nesta, notamos que os alunos utilizam amplamente a calculadora gráfica fora da sala de aula. Esse instrumento se faz presente nos momentos de monitoria ou estudos em grupo, onde notamos que a aprendizagem ocorre entre os alunos de uma maneira informal, a medida que um aluno ensina o outro uma nova dica de programação e este agora aprende um comando novo para o cálculo de alguma tarefa matemática.

Além disso, nesta categoria, notamos uma organização entre os alunos para realização de cursos (fora do período de aula) para os alunos menos experientes no uso da calculadora gráfica. Observamos também, que há uma troca entre os pares de: programas, jogos e aplicativos para as diversas disciplinas de seus cursos utilizando tais calculadoras [12].

CONSIDERAÇÕES FINAIS

As considerações finais foram divididas primeiramente aos professores e posteriormente aos alunos. Após isso, seqüencializamos apreciações, de um modo geral, em relação à inserção das tecnologias informáticas no ensino tecendo um paralelo entre o ensino passivo versus ativo, nos valendo da pedagogia auxiliada pela andragogia quando lidamos com o ensino universitário.

Para os Professores

Esse trabalho mostra que, mesmo os professores classificados na primeira categoria, acreditam que as Instituições de Ensino Superior devam fornecer um curso ou treinamento para ampliar o uso desses instrumentos dentro e fora da sala de aula.

Os argumentos presentes na segunda categoria são bem próximos da anterior. Contudo, esses docentes se auto-denominam um pouco mais flexíveis ao uso das TI´s, pois apesar de não as incorporá-las nas suas aulas, permitem que os alunos as utilizem nas avaliações.

Na terceira categoria, os docentes enfatizam que as atividades com calculadoras gráficas possuem o potencial de integrar os alunos entre si, bem como alunos e professor. Neste contexto, esses instrumentos, possuem fundamental importância na formulação de hipóteses, verificação de resultados e desenvolvimento do espírito crítico do aluno. Neste caso, o professor deve adaptar suas práticas e suas provas de acordo com a abordagem a ser feita na sala de aula.

Todos esses comportamentos desafiadores decorrentes da integração das TI´s ao ambiente educacional impõem mudanças estruturais à ação docente e às formas de ensinar.

O novo papel do professor será o de validar mais do que anunciar a informação. Em todas as categorias os docentes relatam que a calculadora gráfica poderia ser utilizada, a princípio, em todas as disciplinas do "núcleo comum" do currículo de Engenharia, destacando-se as disciplinas: Cálculo Diferencial e Integral, Geometria Analítica, Cálculo Numérico, Estatística, Física Geral e Experimental, Mecânica Geral, Mecânica dos Fluídos, Circuitos Elétricos e Eletromagnetismo.

Para os Alunos

Com relação aos alunos, os resultados levaram-nos a estabelecer dois grupos: 1) os que recorrem quase sistematicamente à calculadora gráfica, confiando completamente nos resultados que esta fornece, com objetivo de tentarem resolver todos os problemas propostos e 2) os que preferem usar o papel e lápis na resolução dos exercícios, usando raramente a calculadora gráfica, pois manifestaram maior confiança nos seus raciocínios e cálculos.

No primeiro grupo havia alunos que manipulavam bem a calculadora gráfica e outros não, porém esses últimos legitimavam o uso do instrumento, mesmo esse não lhes fornecendo respostas consistentes.

No segundo grupo, notamos que muitos alunos não se interessavam por aprender a trabalhar com as calculadoras gráficas, pois só recorriam a ela para cálculos mais complexos ou para a confirmação de gráficos que foram previamente esboçados a mão. Temos, então, um entrelaçamento dos dados vindos dos alunos e dos professores. Como justificativa, para essa convergência, acreditamos que o comportamento desses alunos seja um reflexo da conduta dos docentes. Neste momento, cabe um alerta que o docente deve ter consciência que a sua opção pela adoção (ou não) das Tecnologias Informáticas poderá influenciar o comportamento e atitude dos alunos no uso de quaisquer tecnologias em sua vida profissional.

Constatamos também, nesta pesquisa, que o emprego das calculadoras gráficas pelos alunos se faz com maior freqüência nas: operações elementares, funções matemáticas e construção de gráficos. A opção pela programação é bastante utilizada por poucos alunos de modo a confeccionar programas que lhes auxiliem durante as aulas ou nas provas.

A Pedagogia auxiliada pela Andragogia

Alguns professores, em sua prática, se apóiam na Pedagogia, que "é a arte e a ciência de ensinar crianças, tendo como preocupação a formação e o desenvolvimento do homem na sua totalidade" [13]. Baseado nessa premissa, percebemos que os professores ensinam aos graduandos, apoiados em métodos da educação para crianças. Em outras palavras, uma educação baseada em disciplinas e regras, enquanto os indivíduos mais maduros desejam uma educação centrada na solução de problemas, de modo a prepará-los para as dificuldades que irão enfrentar ao longo de sua carreira.

É nesse ínterim que a Andragogia "arte e a ciência de ajudar o adulto a aprender baseando-se em pressupostos acerca das diferenças entre crianças e adultos, onde os últimos são considerados aprendizes" [13], tem sua contribuição na formação desses estudantes.

Nos cursos de engenharia temos como aprendizes, indivíduos que estão em transição entre a adolescência e a maturidade. Esses autores [13] afirmam que o estudante universitário é impactado ao ingressar na Universidade, por se deparar com um mundo onde o comportamento adulto é predominante. Então temos o paradigma: se por um lado ele já pode ser considerado adulto, por outro não tem muita experiência acumulada, o que sugere a aplicação dos princípios da Pedagogia e da Andragogia de forma consorciada.

Um outro fato que reforça o elo Pedagogia-Andragogia é que a maioria das turmas em nível universitário são compostas por calouros (que vêm de um ensino médio baseado na pedagogia) e por alunos mais velhos (que tiveram um longo intervalo de tempo entre o ensino médio e o universitário dedicando-se, na maioria dos casos, ao trabalho) que já possuem muitas experiências intelectuais e de vida acumuladas.

Como Bazzo e Pereira [14], alertamos da necessidade em conhecer os alunos com quem vamos trabalhar. Isso deve ser uma premissa básica para empreendermos um ensino que resulte em uma aprendizagem transformadora. Os autores [14] afirmam que, se entendermos um pouco melhor o contexto com o qual estamos trabalhando, é possível lutar por um ensino que privilegie a formação de cidadãos criativos, críticos e esclarecidos.

Além de o docente conhecer o aluno, acreditamos que as Tecnologias Informáticas podem ter um papel fundamental na formação desse indivíduo. Desta forma, as TI´s são vistas como agentes transformadores da dinâmica da sala de aula. Como relatado anteriormente com os docentes que incorporaram as TI´s em sua prática, percebemos uma transformação de um ensino passivo para um ensino ativo, onde neste último as TI´s são as mediadoras das atividades ocorridas em aula.

Alertamos que somente a introdução das TI´s na prática do docente, não garantem essa transformação no ensino. Para que possamos realizar essas mudanças é preciso que o docente saiba lidar crítica e pedagogicamente com as TI´s.

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EDLIB: UMA BIBLIOTECA DIGITAL MULTIMÍDIA PARA O APOIO EDUCACIONAL

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Resumo *— Atualmente, no desenvolvimento completo de sistemas para o apoio educacional se faz necessário incorporar uma biblioteca digital. Entretanto, um dado assunto deve ser avaliado através de diferentes mídias tais como textos, vídeos, áudios e imagens. Desse modo, é necessário prover uma biblioteca digital que lide com esses diferentes tipos de mídia. Nos últimos anos, a abundância de dados multimídia que têm sido gerados aliado à larga aceitação da Internet como a infraestrutura para publicar esses dados tem motivado pesquisas no campo das bibliotecas digitais multimídia. Esse artigo apresenta uma biblioteca digital multimídia chamada EDLib (Educational Digital Library – Biblioteca Digital Educacional). O projeto EDLib é baseado em uma arquitetura de n camadas e manipula dados multimídia como objetos de primeira classe. Esta arquitetura distribuída provê escalibilidade e otimiza o armazenamento balanceado.*

Palavras-chave — bibliotecas digitais, multimídia, educação, sistemas para web

1. INTRODUÇÃO

Pesquisas em informática na educação vêm evoluindo rapidamente nos últimos anos com modelos e ferramentas para suportar o ensino a distância. No entanto, para se ter uma universidade virtual completa, faz-se necessário não apenas ferramentas de autoria, apresentação e representação de conteúdo educacional, mas também um repositório tal como uma biblioteca digital no qual o aluno pode realizar buscas sobre tais conteúdos educacionais. A área de pesquisa Bibliotecas Digitais vem se consolidando em todo mundo como um elemento indispensável na cadeia de informação que visa implantar a sociedade da informação [1,2]. Destarte, a integração de tais bibliotecas em ambientes de educação a distância constitui-se numa importante área de pesquisa.

Muito já se tem evoluído na área de bibliotecas digitais textuais, inclusive com padrões já amplamente utilizados para representação textual tais como: TEI (http://www.tei-c.org/). Outros domínios específicos tais como aplicações espaciais e museus têm também seus padrões de metadados definidos e largamente usados como por exemplo o ISO/TC11 Geographic Information/Geomatics. Necessita-se, pois, desenvolver tais bibliotecas num contexto mais amplo, envolvendo não apenas os diferentes tipos de mídia como também diferentes domínios. Isto caracteriza uma biblioteca digital de quarta geração que provê acesso a conteúdo digital distribuído na Internet [3].

O principal diferencial desta pesquisa com relação aos trabalhos correlatos deve-se ao fato de integrar numa biblioteca digital dados multimídia como objetos de primeira classe. Isto é, textos, sons, vídeo e imagens serão armazenados e consultados de acordo com a peculiaridade de cada mídia. Por exemplo, full-text retrieval para textos, content-based retrieval para imagens e vídeo [4].

Neste artigo, apresentamos a EDLib – Educational Digital Library, que é uma biblioteca digital multimídia para fins educacionais. EDLib é baseada numa arquitetura distribuída em n camadas e disponibilizada na Web. A EDLib mantém os requisitos básicos de armazenamento, recuperação e visualização de dados multimídia distribuídos na Web.

O restante deste artigo é organizado da seguinte forma: a seção 2 apresenta alguns dos principais requisitos envolvidos na área de bibliotecas digitais; a seção 3 discorre sobre aspectos de projeto da biblioteca EDLib; a seção 4 apresenta exemplos de uso da biblioteca; finalmente, a seção 5 conclui o artigo e aponta futuros trabalhos a serem realizados.

2. BIBLIOTECAS DIGITAIS: REQUISITOS BÁSICOS

As bibliotecas digitais caracterizam-se pelo tipo de recursos armazenados em suas coleções, pelos padrões de metadados utilizados para descrever tais coleções e pelos serviços que são providos tais como cobrança, segurança e recuperação da informação.

Nas primeiras gerações das bibliotecas digitais, o acervo era restrito a documentos do tipo texto. Em uma biblioteca digital de última geração, ao pesquisar, por exemplo, por "staphilococcus aureus" é possível recuperar não apenas artigos ou livros que abordam o assunto, mas também, imagens de microscópio da bactéria e até mesmo vídeos educativos mostrando uma aula sobre o assunto, desde que disponibilizados nas coleções. As bibliotecas digitais desta geração são chamadas bibliotecas digitais multimídia.

Outro aspecto importante das bibliotecas digitais é o uso de metadados para a descrição dos recursos. Os metadados permitem que, através de uma única consulta, diversos tipos

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de conteúdos digitais sejam recuperados, uma vez que todos os conteúdos, independente de mídia, são descritos em termos de metadados. Além do que, a utilização de padrões de metadados é peça fundamental para a interoperabilidade entre bibliotecas digitais. Historicamente, os padrões mais usados nas bibliotecas eram os da família MARC[5]. Com o advento da Internet e a necessidade da descrição semântica dos recursos nela disponibilizados foi proposto o padrão Dublin Core[6].

Com relação às técnicas de recuperação da informação utilizadas pelas bibliotecas digitais multimídia destacam-se:

Recuperação baseada em atributos de metadados: aplica-se a qualquer recurso multimídia. As consultas são realizadas em termos dos metadados que descrevem os recursos. Exemplo: o autor de um documento, a data de criação, o título do documento, etc.

Recuperação baseada em conteúdo (content-based retrieval): aplica-se a imagens e vídeos. As consultas são realizadas em termos de determinadas características dos dados tais como histograma de cores, textura e forma dos objetos que compõem uma dada imagem ou videoframe. Exemplo: recupere fotografias de aves semelhantes a uma dada imagem.

Recuperação textual. As palavras dos textos são indexadas. As consultas são realizadas utilizando uma linguagem baseada em palavras ou radicais de palavras com o auxílio de operadores lógicos. Exemplo: recupere os textos que contêm a palavra "diabetes".

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3. EDLIB

Bibliotecas digitais podem ser usadas para armazenar dados de diversos domínios. Estes dados são agrupados em coleções que contêm os dados em formato digital. No campo da educação, por exemplo, poderemos ter uma biblioteca digital específica para uma determinada área de conhecimento como medicina; ou uma biblioteca mais genérica com coleções sobre diversas áreas de conhecimento. O projeto EDLib incorpora estas duas características e o bibliotecário decide como ele deseja organizar os dados em diversas coleções. A seguir daremos um exemplo de uso da EDLib para apoio ao ensino à medicina, com uma coleção sobre Zoologia.

Coleção de Zoologia

Uma biblioteca digital, como a tradicional, pode ser organizada em coleções. Portanto, vamos ilustrar esta aplicação com a criação de uma coleção sobre a área de Zoologia onde podem ser encontrados aulas em formato de texto e vídeo sobre espécies em extinção; fotografias destas espécies; no caso de aves, poderíamos ter o canto destas aves representadas como áudio. Toda esta informação servirá para apoiar o ensino em aulas de Zoologia em que, por exemplo, aves em extinções seja discutido. Na seção 4 mostraremos algumas consultas com estes tipos de dados.

Projeto da EDlib

A EDLib foi desenvolvida usando um processo iterativo e incremental usando notação UML [7]. A EDLib possui quatro camadas: o software para navegação na web (cliente); páginas de apresentação (HTML e JSP); lógica da aplicação, encapsulada em JavaBeans e Java Servlets; banco de dados objeto-relacional com as extensões para tratar com dados multimídia. A figura 1 mostra o projeto arquitetural da EdLib.

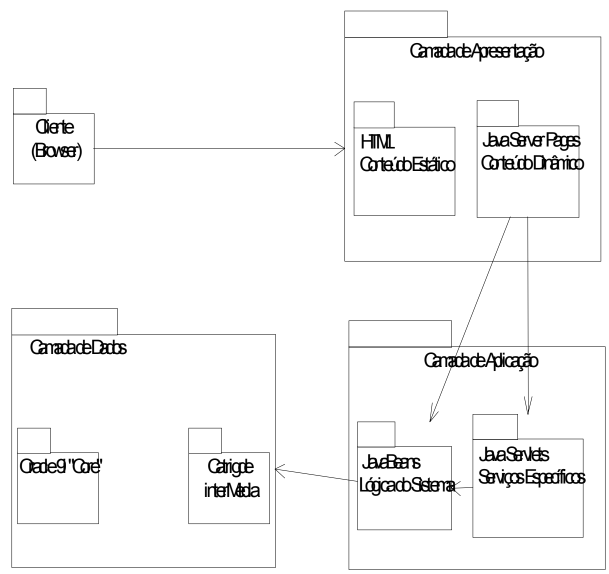

FIGURA 1 ARQUITETURA DA EDLIB

As quatro camadas da arquitetura compreendem:

- Camada do Cliente: Nesta camada, são usados os navegadores para Web, como o Internet Explorer e o Netscape Navigator, que têm a função de apenas exibir as páginas que são geradas pela camada de apresentação.
- Camada de Apresentação: esta camada apresenta a página index.jsp quando o usuário acessa o site da EDLib, contém as páginas de apresentação estática, através de HTML, e dinâmica através de JSP.
- Camada de Aplicação: nesta camada estão os JavaBeans, responsáveis por processar as consultas realizadas nas páginas JSP; e Servlets, que preparam aos dados para serem expostos nas páginas JSP.
- Camada de Dados: nesta camada a EDLib guarda os metadados e dados armazenados na biblioteca digital. Estes dados são modelados em três camadas e utilizam-

se bibliotecas específicas do SGBD para suporte à consultas multimída em textos, imagens, vídeo e áudio.

Modelo de Dados da EDLib

O modelo de dados da EDLib contempla três níveis. A figura 2 mostra este modelo usando um diagrama de classes em UML.

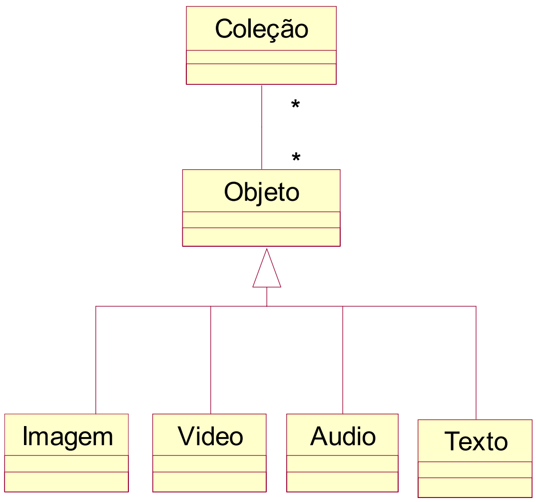

FIGURA 2: MODELO DE DADOS EDLIB

De acordo com a figura 2 temos as seguintes classes:

- Coleção: nesta classe temos informações sobre o título, descrição, responsável e data de criação;
- Objeto: nesta classe armazenamos os metadados que são genéricos a qualquer tipo de dado seja ele imagem, vídeo, áudio ou texto. Estes atributos são: título, descrição, temas (palavras-chave), criador, e data de criação;
- Imagem: esta classe contém os atributos herdados de Objeto mais os atributos específicos a uma imagem tais como: tamanho (em bytes), numX e numY (número de pixels nas coordenadas x e y, respectivamente);
- Video: esta classe contém os atributos herdados de Objeto mais os atributos específicos a um vídeo tais como: tamanho em bytes, duração do vídeo em horas, minutos e segundos, bitRate (velocidade em bits/seg), frameRate (quantidade de quadros por segundo);
- Audio: esta classe contém os atributos herdados de Objeto mais os atributos específicos a um áudio tais como: tamanho em bytes, número de samples/seg, número do canal associado ao áudio, duração do áudio em horas, minutos e segundos;
- Texto: esta classe contém os atributos herdados de Objeto mais os atributos específicos a um texto tais como: língua em que o texto foi escrito, tamanho do texto em bytes, wordCount quantidade de palavras no texto.

Além destes atributos, os metadados específicos informam qual o formato do dado. Os formatos disponíveis serão armazenados em tabelas separadas, para facilitar sua consulta. Exemplos de formatos disponíveis no Meridional incluem:

- *VideoFormat*: VHS, Hi-8, D-1;
- *VideoSTD*: pal, ntsc, secam;
- *ImageFormat*: jpeg, gif, tiff, bmp, etc;
- *TextFormat*: ascii (txt), MS word (doc), pdf, post script (ps);
- *AudioCompress*: mp3, wav, real audio (ram).

O esquema conceitual da EDLib foi mapeado para um esquema objeto-relacional do SGBD Oracle. Desta forma, fez-se uso de algumas bibliotecas (data cartridge no jargão Oracle) para o armazenamento de dados multimídia tais como interMedia e Text do Oracle 9i [8].

4. EXEMPLO DE FUNCIONAMENTO DA EDLIB

Nesta seção mostraremos alguns exemplos de interação com a EDLib. Assim que o usuário se loga na biblioteca ele obtém a interface que é mostrada na figura 3.

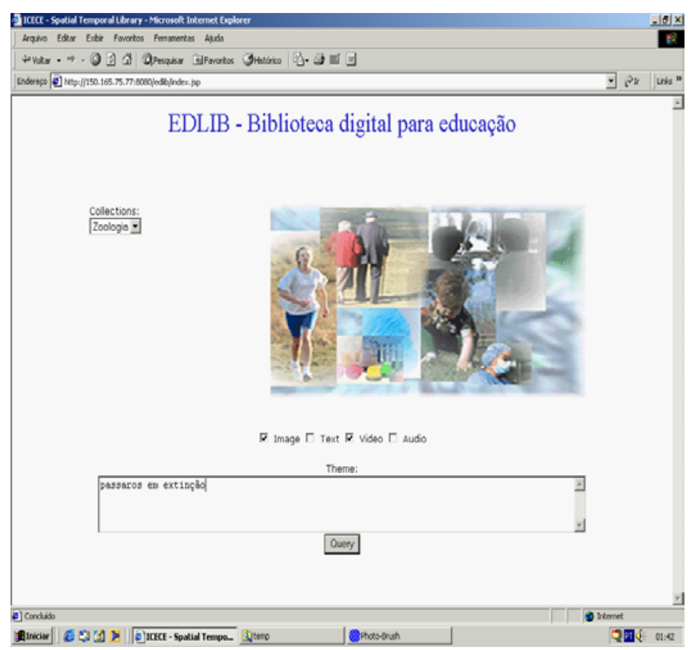

FIGURA 3 EDLIB: INTERFACE PRINCIPAL

Como pode ser visto na figura 3, o usuário pode selecionar a coleção que deseja realizar buscas. Exemplos de tais coleções incluem zoologia, computação, medicina, engenharia elétrica, engenharia civil, matemática, sociologia, dentre outras. Logo em seguida, o usuário informa, através de checkboxes, quais tipos de dados ele está interessado, podendo escolher entre vídeo, áudio, texto e imagem. Por último, o usuário informa palavras chaves que identificam o tema que se está pesquisando, por exemplo 'aves em extinção'. Após preencher estas informações o usuário submete sua consulta ao pressionar o botão query.

Em seguida, a EDLib retornará os metadados dos objetos que satisfizerem à consulta. A figura 4 mostra um exemplo de um conjunto resultado pertencente à coleção Zoologia.

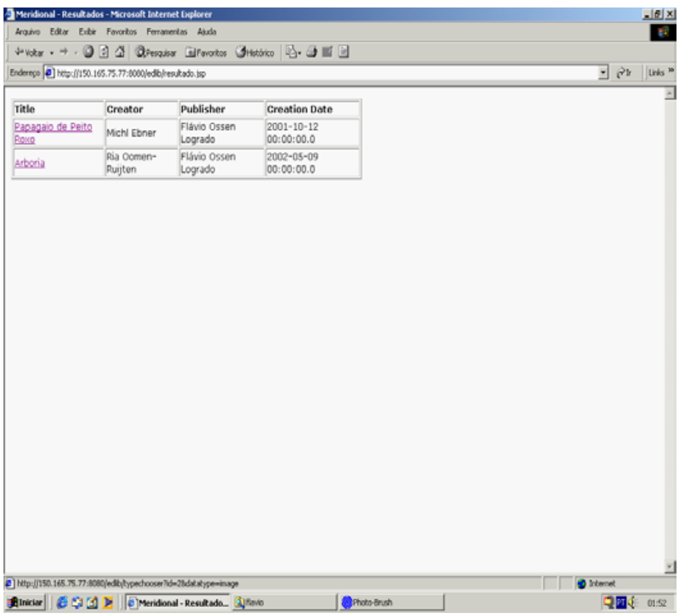

FIGURA 4 EDLIB: RESULTADO DE UMA CONSULTA

O usuário pode então, ao analisar os metadados, abrir qualquer documento multimídia, bastando para isso clicar no link contido no título de cada objeto do conjunto resultado. Estes objetos podem ser uma aula (vídeo), um livro (texto), o canto de um pássaro (áudio) ou uma fotografia de uma ave (imagem). Ao abrir um objeto e fazer a carga do objeto multimídia uma nova janela é aberta dependendo da mídia associada. As figuras 5 e 6 mostram exemplos de tais janelas.

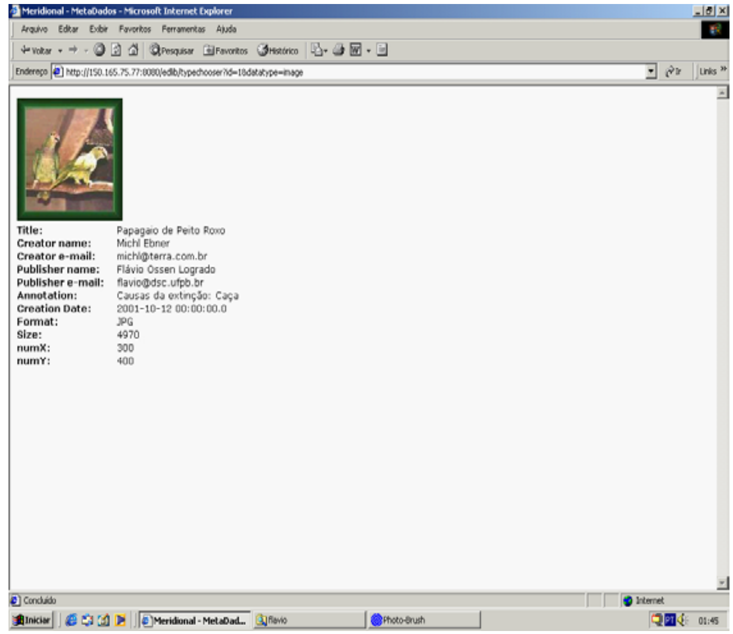

FIGURA 5 EDLIB INTERFACE DE IMAGENS

FIGURA 6 EDLIB INTERFACE DE ÁUDIO

5. CONCLUSÕES

Bibliotecas digitais completam um ambiente de educação assistida por computador. O grande volume de dados disponibilizados em diversas mídias e o sucesso da Internet como um grande repositório de dados universal tem impulsionado pesquisas na área de bibliotecas digitais. Neste artigo apresentamos uma biblioteca digital multimídia para o apoio educacional chamada EDLib. A EDLib é baseada numa aruitetura em n camadas que permite uma maior escalabilidade da solução; manipula dados multimídia tais como textos, vídeos, áudio e imagens em diferentes formatos; é desenvolvida no ambiente Java que permite a independência de plataforma de software; e implementa a persistência dos dados usando um SGBD objeto-relacional que permite estensibilidade.

Como futuros trabalhos, pretendemos migrar a camada de metadados para o padrão MPEG-7[9] e usar além de consultas estruturadas via SQL, como na versão atual da EDLib, consultas a dados semi-estruturados via XQuery[10]. A idéia é poder ter um repositório MPEG-7 no qual possamos fazer consultas diretamente sem a necessidade de transportar estes dados para um esquema Dublin Core num SGBD objeto-relacional.

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Processo Didático na Fabricação de Chips MOS para estudantes de Engenharia/UNISANTA

Djalmir Corrêa Mendes[1], *Aureo Emanuel Pasqualeto Figueiredo*[2], *Jean Louis Noullet*[3]

Introdução *— A finalidade deste trabalho é demonstrar a estratégia didática dirigida aos alunos dos cursos de graduação nas diversas habilitações em Engenharia Elétrica, de processos de tecnologia de ponta, como subsídios e meios no desenvolvimento de estudos, pesquisas, treinamento e fabricação de CIs, no âmbito da MICROELETRÔNICA.*

A base operacional é o intercâmbio franco-brasileiro entre o AIME (Atelier Interuniversitaire de Microelectronique) Toulouse/França e a UNISANTA (Universidade Santa Cecília) Santos/Brasil, que envolve além de professores/técnicos franceses e brasileiros, um grupo de alunos com o pré-requisito de conhecimento de eletrônica básica, circuitos e sistemas digitais.

O programa se desenvolve em 6 meses, de fevereiro a julho, com aulas específicas enfocando conceitos da física quântica, física do semicondutor e microeletrônica, etapa realizada na UNISANTA.

A etapa de fabricação dos chips é realizada na "salle blanche" do AIME, quando os alunos estudam um projeto segundo as normas do "Atelier", aplicando seus conhecimentos nos processos de fabricação dos Cis, em Toulouse.

Dentro dos conceitos"VLSI", quatro máscaras são, então, utilizadas, assim como o processo de auto-alinhamento de "gate". Com isso, pode-se obter transistores cujos canais são menores que 10 micra, possibilitando, desta forma, grupar cerca de 25 transistores numa área 1 milímetro quadrado. Além dos transistores, também são implementados capacitores MOS, diodos e resistores MOS, perfazendo um conjunto de dispositivos úteis na diversificação dos projetos envolvendo contadores, seqüenciadores, osciladores em anel, portas lógicas, etc .

Ao final são realizadas medições, especificações e encapsulamento dos chips como produto final.

O PROJETO

Este projeto na área da microeletrônica, fundamentalmente se baseia nos conceitos e processos para implementação de " chips " contendo transistores de canais NMOS, com portas de polisilício construídas por auto alinhamento, em prazo limitado de uma semana, na *salle blanche* (sala limpa) do AIME.

Dada a avançada tecnologia necessária à realização de um CI, são necessários equipamentos altamente sofisticados como microscópios eletrônicos, fornos de altas temperaturas, câmaras de vácuo, computadores de médio porte, micro processadores, sala de fotolitografia, sala limpa de alta assepsia e super pressionada, reator LPCVD (Low Pressure Chemical Vapour Deposition), equipamentos para teste químicos e eletrônicos a nível molecular, etc.

Assim, através do intercâmbio entre a UNISANTA e o AIME, alunos do curso de graduação de engenharia eletrônica, de telemática e de computação, tem acesso de forma diferenciada a uma tecnologia de ponta que no Brasil, raramente poderiam dispor em sua graduação.

A Universidade de Toulouse e do INSA apóiam o programa aceitando os alunos para o estágio com facilidades no acesso ao campus e restaurante universitário, material para fabricação dos "chips", indicações bibliográficas, acesso da *salle blanche* e informações sobre equipamentos, enfatizando a de segurança individual e coletiva. Destaca-se, além da cooperação prática, um sólido e amigável acompanhamento dos professores e técnicos franceses, proporcionando aos alunos brasileiros um rendimento relevante.

O AIME, segue os princípios básicos na fabricação de um chip de tecnologia MOS, de forma dirigida a torna-los instrumento de aprendizado, viabilizando a assimilação do conhecimento aplicado com alta confiabilidade. Considera-se essencial o aprendizado do processo, buscando sempre um produto final da melhor qualidade.

Por exemplo, a implementação do elemento ativo fundamental de um "CI", o transistor NMOS com porta auto-alinhada, tem suas etapas são definidas em:

1. Análise e caracterização do substrato tipo P
2. Oxidação de Mascaramento
3. Fotogravura 1: Abertura da difusão
4. Limpeza R.C.A.
5. Oxidação seca para a realização da porta
6. Depósito de polisilício dopado tipo N por LPCVD
7. Fotogravura 2: Abertura no Polisilício por plasma
Abertura química do SiO2 da Porta
8. Difusão de Fósforo na Fonte e no Dreno: Pré-deposição e Redistribuição
9. Depósito de SiO2 à baixa temperatura por LPCVD
10. Fotogravura 3: Abertura dos contatos
11. Metalização
12. Fotogravura 4: Gravação do Metal
13. Recozimento do Metal
14. Montagem/encapsulamentoe teste com micropontas
15. Teste elétrico e eletrônico

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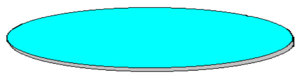
Os procedimentos específicos, são consolidados de forma a evidenciar as principais fases do processo como um todo.

1 - Análise e caracterização do substrato tipo P

Nesta etapa, a placa componente é examinada e medidas da espessura da placa e determinando a relação tensão/intensidade. São calculadas a resistividade "r" e a concentração da Dopagem Aceitadora "N_A" imposta à placa.



Observações : Placa de Silício tipo P
Espessura de 300 µm

2 - Oxidação de Mascaramento

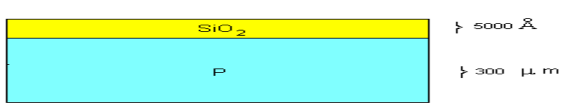
Promove-se a oxidação da plaqueta com espessura de óxido suficiente para que a camada sirva de máscara para a difusão de Fósforo na fonte e no dreno, com:

Limpeza preparatória

- Desengorduramento - Tricloroetileno, após acetona e água DI (a quente)
- Oxidação química - $H_2 SO_4 + H_2 O_2$ (1/1) 2 min. e água DI
- Ataque do Si O_2 - HF diluído, por 30 s.; rinçagem água DI; secagem c/ Nitrogênio
- Lavagem /secagem - Máquina lavadora/secadora

Oxidação Térmica em cinco etapas de forno

Nº	Temperatura	Tempo	Fluxo
01	T=800º C à1100ºC	t=25mim	N_2 = 01 l / min
02	T = 1100º C	t = 40 min	H_2 = 2,7 l / min e O_2 = 1,5 l / mn
03	T = 1100º C	t = 30 min	O_2 = 2,2 l / min
04	T = 1100º C	t = 10 min	Ar = 1,5 l / min
05	T = 800º C à 110	t=60min	N_2 = 01 l / min



" Wafer " de Silício P com o óxido de mascaramento

3 - Fotogravura 1 : Abertura da difusão

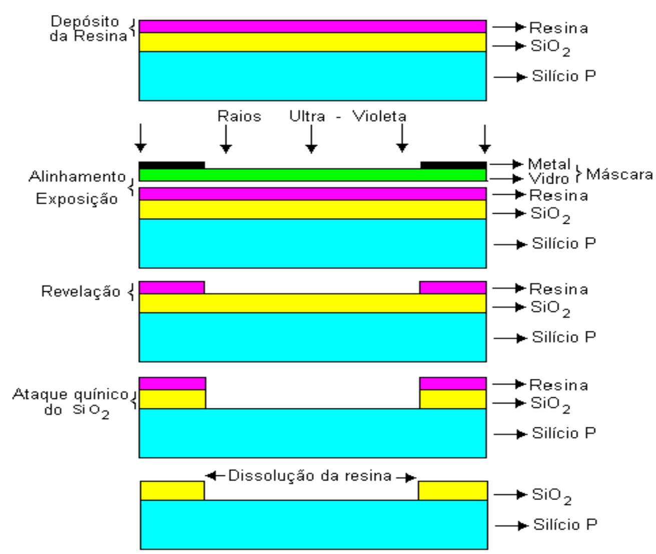
O objetivo dessa etapa é a de realizar aberturas no óxido de mascaramento nas zonas onde se pretende implementar o óxido de Porta. Nesta ocasião, será definido o rendimento do chip fabricado.

Esta etapa requer operações executadas rigorosamente dentro de padrões, e de sua precisão decorre o sucesso nos testes eletrônicos de checagem a que será submetido no final do processo.

Assim sendo, a tabela a seguir mostra os passos das operações e condições de execução.

Nº	Operações	Condições
01	Secagem	Estufa com 120 ° C por 5 min
02	Depósito da resina	Ref : 14000 – 27 Positiva / Centrífuga por 30 s
03	Primeiro recozimento	Chapa a 100 ° C por 30 s
04	Alinhamento / Insolação	Por 5 s
05	Revelação	20 ° C por 30 s
06	Gravação do Si O_2	Buffer HF conforme tempo da "placa testemunha"
07	Observações / Análises	Microscópio eletrônico
08	Dissolução da resina	Acetona e água D I
09	Limpeza	$H_2 SO_4 + H_2 O_2$

As operações enumeradas acima, também podem ser interpretadas através dos seguintes esquemas:



4 - Limpeza R.C.A.

Antes da oxidação da Porta, a presente operação tem por finalidade preparar a interface de Si/SiO2. São cinco os procedimentos:

01 - Banho A' - HF diluído por 30 s rinçagem e secagem

02 - Banho A - HNO3 fervente por 10 min rinçagem e secagem

03 - Banho A’ - HF diluído por 30 s rinçagem

04 - Banho B - NH2 OH + H O2 + H2 O por 10 min rinçagem

05 - Banho C - HCl + H2 O2 + H2 O por 05 min rinçagem e secagem.

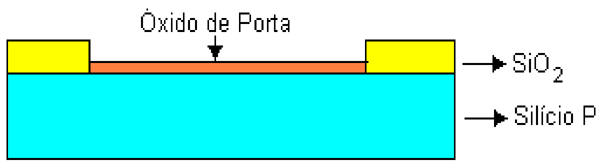
5 - Oxidação seca para a realização da Porta

Antecipando a fase do depósito de polisilício na região da Porta, uma camada bastante fina de óxido deverá ser implementada com a finalidade de estabelecer uma região própria para produção de campo elétrico. Esta operação, realizada em forno com temperatura de 1100 ° C, é dividida em dois ensaios:

1° - Com a duração de 30 minutos estimula-se um fluxo de O2 igual a 2 l/min.

2° - Com a duração de 10 minutos estimula-se um fluxo de ar igual a 2 l/min

Deve-se como norma de projeto, dar início nesta fase às especificações e caracterizações do processo. O esquema abaixo mostra a oxidação.

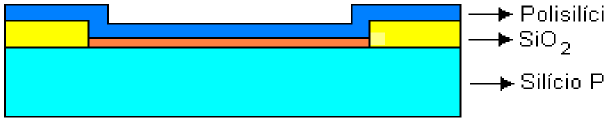


6 - Depósito de Polisilício dopado tipo N por LPCVD

Esta etapa enfoca o depósito de uma camada de Sílicio Policristalino no intuito de proteger-se o Óxido de Porta da difusão pelo processo "LPCVD" (Depósito de Vapor Químico a Baixa Pressão) e é realizada no reator "LPCVD" em três fases:

Nº	Temperatura	Tempo	Fluxo	Pressão
01	T =400 ° C à 585 ° C	t = 45 min	N_2 = 11 l / min	p= 1 Torr
02	T =585 ° C	t = 100 min	SiH_2= 50 cc/min; PH_3= 2 cc/min	p= 250m Torr
03	T =585 ° C à 400 ° C	t = 4x2 min	$N_{2\,=}$ 1 l /min:ciclos expulsão gas	p= 1 Torr

O resultado final do processo executado no reator de Depósito de Vapor Químico a Baixa pressão, pode ser resumido no esquema abaixo:



7 - Fotogravura 2 :

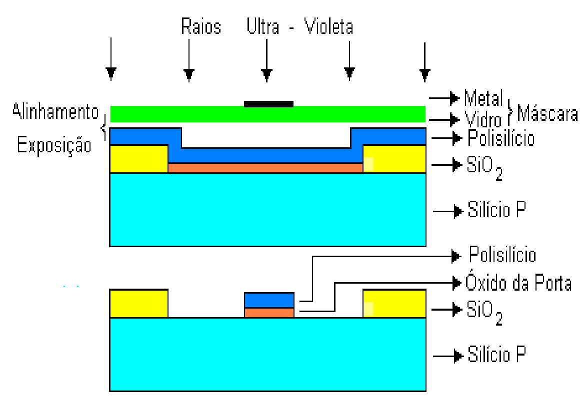
Abertura no Polisilício por plasma

Abertura química do SiO_2 da Porta

Destina-se esta etapa do processo às aberturas do polisilício e no óxido, com objetivo de difundir as regiões de dreno e fonte no "chip", buscando fixar o comprimento "L" do canal. São doze os passos a serem efetuados:

Operações	Condições
01 – Secagem	Estufa de 120 ° C por 5 min
02 – Depósito de resina	1400 – 27 Positiva (4000 r / min por 30 s)
03 – Recozimento	Chapa de 100 ° C por 60s
04 - Alinhamento / Insolução	Por 5 s
05 – Revelação	20 ° C por 45 s
06 – Observação	Microscópio
07 – Recozimento	Chapa 120 ° C por 45 s
08 – Gravação do Polisilício	Gravação iônica reativa (Fluxo SF_6 : 30cc/mn; Pressão : 0,02 m bar; Potência RF : 50 W)
09- Gravação do Si O_2	Buffer HF : Tempo conforme placa testemunha 1
10 – Observação	Microscópio
11 – Dissolução da resina	Acetona e água DI
12 – Limpeza	$H_2 SO_4 + H_2 O_2$

O produto final está representado abaixo:



08 Difusão de fósforo na fonte e no Dreno : Pré-deposição e redistribuição

Para a difusão do fósforo nas regiões do dreno e da fonte realizam-se duas tarefas definidas por pré-deposição e redistribuição. Também nesta etapa, as placas testemunhas são expostas aos fornos.

Na pré-deposição, três ciclos são observados

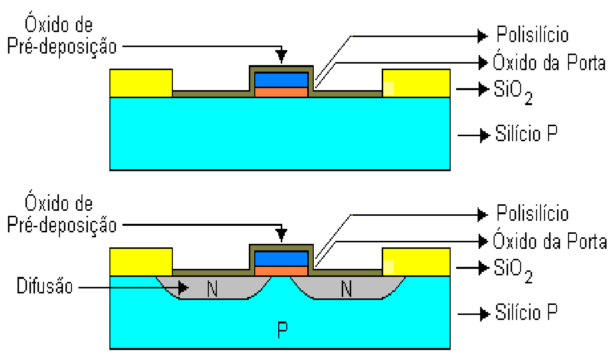
Nº	Temperatura	Tempo	Fluxo
01	T = 1050 ° C	t = 5 min	N_2 = 2 l / min

02	T = 1050 ° C	t = 5 min	N_2 = 2 l / min PO Cl_3 = 5 mg / min
03	T = 1050 ° C	t = 5 min	N_2 = 2 l / min

Na redistribuição, a tarefa é concluída num único ciclo, sendo, nesta ocasião medida a espessura do óxido de difusão pelo método da elipsometria .

Nº	Temperatura	Tempo	Fluxo
01	T = 1100 ° C	t = 10 min	N_2 = 1 l/min

Esta etapa pode ser esquematizada da seguinte forma:

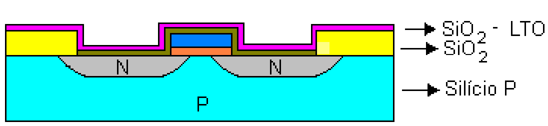


9 - Depósito de SiO_2 à baixa temperatura por LPCVD

Em seguida à difusão de fonte e de dreno, deposita-se sobre toda a placa uma camada isolante protetora de Óxido de Silício (Si O_2) a LTD (Low Temperature Oxidation) para limitar as correntes de superfície. Esta operação é realizada no forno LPCVD (Low Pressure Chemical Vapor Deposition), que também deverá conter a placa testemunha 2. As medidas da espessura e do índice de refração deste óxido pelo método da elipsometria são realizadas em duas fases sob as condições:

Nº	Temperatura	Tempo	Fluxo	Pressão
01	T = 420 ° C	t = 100 min	SiH_4 = 30cc/min ; O_2 = 60 cc/min	p = 3000 mTorr
02	T = 420º C	t = 2x2 min	N2 = 1 l/min : ciclos de vácuo e expulsão do gases	p = 1 Torr

Esta etapa pode ser representada como :

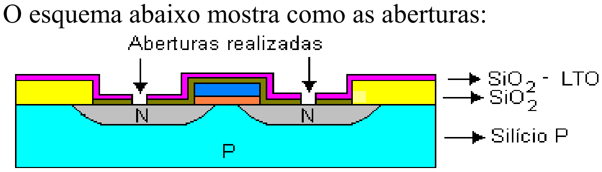


10 - Fotogravura 3 : Abertura dos contatos

A máscara de número 3, é utilizada para abrir as regiões onde serão conectados os contatos metálicos. Tal operação é realizada nas onze fases seguintes:

Operações	Condições
01 – Secagem	Estufa de 120 ° C por 5 min
02 – Depósito de aderência(HMDS)	Centriífuga com 4000 r / min por 30 s
03 – Depósito da resina	Ref 1400-27 pos Centriífuga com 4000 r/min p/30 s
04 – Recozimento	Chapa com 100 ° C por 60s
05 – Alinhamento / Insolação	Por 5 s
06 – Revelação	A 20 ° C por 30 s
07 – Observação	Microscópio
08 – Recozimento	Chapa com 120 ° C por 45 s
09 – Gravação do Si O_2	Buffer HF : Tempo conforme placa testemunha 2
10 – Observação	Microscópio
11 – Dissolução da resina	Acetona e água DI

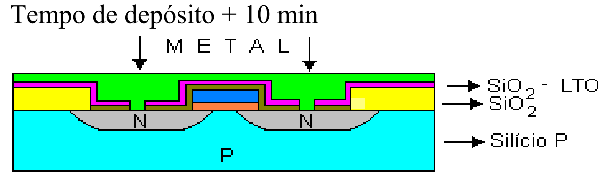
O esquema abaixo mostra como as aberturas:



11 – Metalização

A operação de *metalização* tem por finalidade depositar uma camada de cerca de 500 ηm de alumínio sobre a placa. Há dois métodos para se realizar a operação:

1°) Evaporação térmica sob vácuo
Degazagem – Temperatura por Tempo
Depósito : - Pressão antes do depósito em mbar
Pressão durante o depósito
Pressão após o depósito
2°) Pulverização catódica
Depósito: - Pressão antes do depósito = 10 - 7 mbar
Pressão durante o depósito = 2.10 – 3 mbar
Potência RF = 250
Distância alvo – substrato = 75mm
Tempo de depósito + 10 min

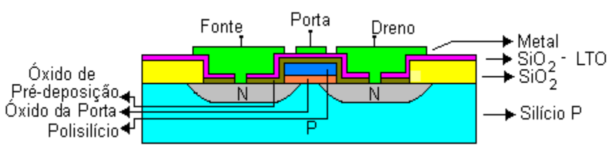


12 - Fotogravura 4 : Gravação do Metal

Nesta etapa o metal é gravado por processo químico na máscara número 4. Para isso realizam-se de 17 passos :

Nº	Operações	Condições
01	Homogeneizar a solução de ataque ao "alumínio".	Colocar a solução nos ultrasons
02	Secagem	Estufa com 120 °C p/5 min
03	Depósito da resina	Ref 1400-27 pos.Centriífuga com 4000 r/min por 30 s
04	Recozimento	Chapa com 100 ° C por 60s
05	Alinhamento / Insolação	Por 5 s
06	Revelação	A 20 ° C por 30 s
07	Observação	Microscópio
08	Recozimento	Chapa com 120 °C por 45s
09	Gravação do alumínio	Solução: (40 vol. H_3PO_4 + 7vol. HNO_3 + 7vol. H_2O) com controle visual mais 30s de ataque suplementar
10	Observação	Microscópio
11	Dissolução da resina	Acetona e água DI
12	Proteção face AV	Cera ou resina
13	Desoxidação face AR	Buffer HF (ataque SiO_2 LTO residual)
14	Gravação de polisilício face AR	Solução: (1vol. H_3PO_4 + 71vol. HNO_3 + 28vol.H_2O) controle final visual:c
15	Desoxidação face AR	Buffer HF (ataque SiO_2 na Porta ou "Gate")
16	Dissolução da cera+resina	Trichlo + acetona + água DI
17	Secagem	Máquina secadora

O modelo final do chip poderá ser representado pelo esquema abaixo.



13 - Recozimento do Metal

Nesta etapa, um novo forno será requisitado sob novas condições. Nesta operação, é medida a espessura do alumínio na placa componente com o profilômetro. As novas condições são apresentadas a seguir:

Nº	Temperatura	Tempo	Fluxo
01	T = 400 ° C	t=20min	$N_2 + H_2$ (5%) = 1 l / min

14 - Montagem/encapsulamento e teste com micropontas

Esta etapa é realizada em quatro operações:

1) Teste sob pontas – deve ser feito um mapeamento (cartografia) da placa para determinar a/as região/ões onde se situa/m os melhores componentes, para então selecioná-los .

2) Corte – a placa será cortada com microserra de corte diamantado, devidamente comandada e programada por microcomputador. .

3) Montagem – será realizada em base para soldas por eutética ouro/silício numa temperatura de 370° C.

4) Microsolda – são realizadas por ultra-som . Utiliza-se *Wedge bonding* de fio de alumínio /silício 5% com seção circular de diâmetro igual a 25μm, com o auxílio de microscópio eletrônico.

15 - Teste elétrico e eletrônico

É a tarefa final do processo. Através de medidas efetuadas sobre o desempenho do CI, poder-se-á registrar valores de corrente e capacitâncias em função da tensão, construindo os gráficos e tabelas, que por simples inspeção e análise mostrarão o grau de rendimento alcançado na implementação do "chip" .

Estas medidas podem ser classificadas em dois grupos :

1°) Medidas de corrente (I) em função da tensão (V)

Características da "I_d" em função da "V_{ds}"/"V_{gs}" de um transistor de canal longo.

Características da "I_d" em função da "V_{ds}"/"V_{ds}" de um transistor de canal longo.

Características da "I_d" em função da "V_{ds}"/"V_{gs}" de um transistor de canal curto.

Características da "I_d" em função da "V_{ds}"/ "V_{ds}" de um transistor de canal curto.

Características da "I" em função da "V".

2°) Medidas de capacitância (C) em função da tensão (V).

Características da "C" MOS em função da "V".

Conclusões

Além de transistor de canal NMOS, pode-se também implementar outros dispositivos com a metodologia inerente à microeletrônica, com por exemplo resistores NMOS , capacitores NMOS , portas lógicas, Flip-flops, etc. através de outras etapas e processos, com a mesma tecnologia. Porém, o melhor resultado é alcançar o objetivo do aprendizado, que vai incentivar os alunos na continuidade das pesquisas e servir de valioso elemento em suas carreiras.

Por esta razão, em oito anos de intercâmbio, oitenta e dois alunos já participaram do programa na França, dos quais dezessete optaram pela iniciação científica em microeletrônica e seis engenheiros recém formados, cursam mestrado no LSI (Laboratório de Sistemas Integrados) da USP - SP .

ENGENHARIA: PRÁTICA DOCENTE E FORMAÇÃO DE PROFESSORES

Danilo Pereira Pinto, Jorge Luiz do Nascimento, Júlio Cesar da Silva Portela, Maria Helena Silveira, Protásio Dutra Martins Filho e Vanderli Fava de Oliveira

Resumo - O objetivo deste trabalho é apresentar uma reflexão sobre a prática docente com vistas às mudanças que vêm ocorrendo em termos de diretrizes curriculares e projetos pedagógicos para os cursos de engenharia. Foi estruturado a partir da vivência acadêmica dos autores, da participação em eventos científicos, e da discussão da bibliografia corrente sobre a área.

Até os anos 60, o corpo docente das escolas de engenharia no Brasil era formado por renomados engenheiros, matemáticos e outros especialistas, com dedicação parcial à academia. A docência era incorporada pela repetição dos modelos dos mestres. As reformas da educação, iniciadas em 1968, estabeleceram uma nova ordem, contribuindo para sistematizar a pesquisa e estruturar os cursos de pós-graduação, modificando o perfil do engenheiro-docente, que atualmente é mestre ou doutor, com conhecimentos especializados, dividindo sua atuação entre ensino, pesquisa e extensão.

Os autores crêem ser necessário estimular a pesquisa em Educação em Engenharia como estratégia político-acadêmica visando aprimorar a formação profissional neste campo, sugerindo sua inclusão como área de pós-graduação "stricto sensu".

Sem a pretensão de esgotar o tema ou apresentar verdades absolutas e imutáveis, o que se quer é levantar questões sobre a prática docente, apontar algumas soluções já adotadas, identificar alternativas e ampliar a discussão.

Palavras-chave: Formação de professores, Professor de engenharia, Formação docente

INTRODUÇÃO

Este trabalho é resultado de uma construção coletiva. Os autores elaboraram interagindo um texto básico e cada um contribuiu com o seu pensar sobre o tema central. Todos estão vinculados a Cursos de Engenharia, sendo natural que as reflexões tenham esse foco, o que não quer dizer que em outros cursos, principalmente os da área tecnológica, os problemas sejam diferentes.

Até recentemente, a figura do professor de engenharia era a de um engenheiro com experiência técnica especializada em uma sub-área de conhecimento desta habilitação (Ex.: Engenheiro Civil especializado em Pontes), formado na prática do dia a dia, desde o início de sua atuação profissional, acompanhando um outro grande engenheiro. Com reconhecimento no mercado e com algum conhecimento no meio acadêmico, era convidado para lecionar, exercendo a docência muitas vezes por "hobby" ou por espírito altruísta. Não havia um compromisso sólido com a docência. Buscava-se a formação de novos engenheiros que iriam, apenas, ser subordinados nas empresas onde trabalhavam. A titulação acadêmica não era ponto importante para ingressar na carreira docente. Em geral, bastava ter sido bom aluno de graduação na concepção dos professores do curso e ter interesse pelo magistério. Isto levava, com freqüência, ao comprometimento da qualidade dos cursos.

O ensino nessa época funcionava através de aulas expositivas, estudos individuais e exames escritos e orais. O desempenho do aluno dependia muito mais de seu próprio esforço do que de orientação, apesar do empenho do professor estar concentrado em ampliar a clareza de suas exposições e em encadear os conteúdos explicitados em planos de curso e livros.

PUBLICAR É PRECISO

Com as reformas da educação, implantadas a partir de 1968, a organização da academia sistematizou a pesquisa e estruturou os cursos de pós-graduação no país. Muitos engenheiros, recém formados ou não, foram mandados ao exterior para realizar cursos de pós-graduação, retornando ao Brasil para implantar os nossos próprios cursos de mestrado e doutorado. Com pouca experiência na docência e na atuação técnica, chegaram pesquisadores formados, com especializações nas ciências-da-engenharia, preparados para um trabalho totalmente diferenciado em relação aos modelos anteriores. Com isso, não só, o panorama acadêmico começa a mudar, como também muda o perfil de atuação profissional dos engenheiros. Novas técnicas foram trazidas do exterior e também desenvolvidas no país. O uso do computador pessoal se dissemina grandemente na universidade junto com "pacotes-software" com soluções prontas para problemas da engenharia. Todas essas ferramentas são, em geral, mais bem manejadas pelos novos acadêmicos. A universidade inicia assim uma outra fase: agora é procurada para resolver problemas da engenharia, através de docentes-pesquisadores. A prevalência desta diretriz retarda a reflexão sobre a graduação dos engenheiros ao privilegiar a pesquisa e a busca do desenvolvimento tecnológico como atividades acadêmicas.

Com a super valorização da produção científica pelos órgãos de fomento, que exigem cada vez mais um aumento na quantidade de publicações em revistas e congressos, atrelando a isto a liberação de recursos para os projetos e programas de pós-graduação, grande parte dos docentes volta suas preocupações, quase exclusivamente, para a publicação. As universidades públicas e os sistemas oficiais de controle criam regras e sistemas de avaliação, forçando o "docente de engenharia" a ter qualificação máxima. Entretanto, pouco se considera a necessidade da formação pedagógica. Por conta disso, na maioria dos casos, ele é um profissional que dá pouca ou quase nenhuma atenção para os problemas do ensino-aprendizagem e para a evolução de sua função docente.

PREOCUPAÇÃO DE DOCENTES: CARÁTER SIGNIFICATIVO DO SABER

A seleção de conteúdos programáticos para a formulação de um projeto pedagógico de curso tem que se embasar na importância significativa para a constituição do sistema de conhecimentos imprescindíveis aos futuros profissionais. Além disso, envolver todos os participantes, que serão obrigados a aprofundar reflexões sobre os objetivos sociais da aprendizagem na formação universitária. Cada proposta vai implicar a promoção cultural, científica, social, moral, tecnológica da parcela de estudantes que nela se inscreve. Para formar cidadãos capazes de situar-se além do primarismo individualista será preciso integrar harmônica e dialeticamente o experimental, o histórico e o teórico, ao mesmo tempo que desenvolver uma forma autônoma de pesquisar, capaz de vir a produzir coletivamente as teorizações.

Os que dominam politicamente os diferentes campos de educação simulam distanciamento e neutralidade quando falam do mundo social, como se dele não se ocupassem. E os educadores são levados a interiorizar a idéia de que não são científicos, porque se envolvem em conflitos, confrontam aspirações e disputam espaços de gestão acadêmica. A universidade é um campo, talvez mais do que qualquer outro, que está voltado para sua própria reprodução pelo fato de seus componentes deterem o controle de formação e seleção.

Esta não é uma crise mais grave do que outras, é uma crise de uma ortodoxia. Voltaire fazia, às universidades européias de seu tempo, acusações tão graves quanto as atuais. Muitas crises foram favoráveis ao desenvolvimento das instituições, das ciências e das metodologias. Quem se insurge, gritando contra, são os que se beneficiam da atual estrutura. Há uma luta pelo monopólio da cientificidade e da legitimidade que não é só acadêmica.

Os filósofos, os sociólogos e todos aqueles cujo ofício é pensar o mundo desenvolvem também parte do trabalho científico ao colocar questões sobre a natureza do próprio olhar científico. Para operar uma conversão radical do olhar é preciso ter um ponto de vista teórico sobre o ponto de vista teórico e tirar conseqüências sobre o que vem sendo investigado, propondo metodologias e dispondo-se a mudar de opinião diante de argumentos melhores que os próprios.

A falsa clareza é freqüentemente o cerne do discurso dos que acham tudo normal, natural porque não querem qualquer mudança. Mantém a posição conservadora em nome do bom senso. Sabemos, entretanto, que às vezes a exposição tem que ser, por razões científicas ou políticas, tão complexa quanto o problema exige. A ciência é uma iniciação lenta, exige em geral, uma verdadeira reconversão de toda a visão de mundo.

As ciências específicas da educação, constituídas na transdisciplinaridade entre filosofia, sociologia, história, psicologia, pedagogia, análise de processos, planejamento, economia, comunicação exigem um percurso simultâneo entre teorias e práticas, sempre em re-exame, para acompanhar as mutações das sociedades e as teorizações atualizadas dos diferentes campos de conhecimento. Para isso será necessário manter a "falha", onde se gera o desejo de saber, o compromisso político-filosófico com as novas gerações e, também, concretamente, tempos de estudo em grupos de pares para a produção compartilhada. E, ainda, boa bibliografia e conexões com bibliotecas e redes de pesquisa.

É muito, mas, não é tudo. Temos de fazer de cada aluno uma razão. Fazer refletir sobre as palavras e seus sentidos, de certa forma, quase cartesianamente. Serão pessoas que se preocupam em ver claro em suas idéias, mas que, ao mesmo tempo, serão intelectuais novos porque saberão "que as coisas quer humanas, quer físicas, são de uma complexidade irredutível" e que "só podemos chegar a pensar, lentamente, progressivamente, ainda assim, imperfeitamente", como afirma Durkheim, em "*Evolution Pedagogique en France*".

O DESAFIO DOS NOVOS TEMPOS

A atual reestruturação das relações econômicas e produtivas, bem como o processo de intensificação de incorporação de tecnologias à produção, passam a exigir profissionais que dominem um conjunto cada vez mais amplo de conceitos e informações, voltados ao trabalho inter e multidisciplinar. Em segundo lugar, verifica-se uma crescente ampliação do campo de atuação dos engenheiros para as áreas gerenciais e administrativas, bem como para áreas de interface com outras ciências. Essas mudanças exigem remodelações curriculares e adaptações metodológicas para o ensino da engenharia.

Os conhecimentos, as habilidades e atitudes que vão conseguir o perfil do engenheiro moderno deverão ser incorporados num trabalho metodológico, que implique o envolvimento do aluno em práticas específicas e apropriadas à finalidade. Estas práticas devem conduzir o aluno para a pesquisa, para a análise e para a crítica dos saberes. Devem também estimulá-lo a buscar respostas ainda não encontradas e identificar novos problemas da sociedade, além de facilitar a sua participação em atividades de planejamento, de execução de projetos, de administração de pessoal e materiais, trabalhando individualmente e em equipe.

Há uma variedade de práticas de ensino a serem utilizadas, quando novos conceitos e matérias devem ser trabalhados de forma contextualizada, dentro de problemas da engenharia, antecipando o que se vai praticar na vida profissional.

Observa-se que aspectos didáticos e pedagógicos vêm adquirindo uma importância destacada na engenharia e na área tecnológica. Percebe-se que o docente do curso de engenharia vem, aos poucos, entendendo a questão pedagógica como algo intrínseco à sua atuação profissional, como se pode observar pelo aumento, quantitativo e qualitativo, em fóruns que discutem o "Ensino de Engenharia" e a "Educação em Engenharia"[14].

Para a grande maioria dos professores-engenheiros, sem formação didático pedagógica, ensinar estaria ligado a um inatismo, a ter um dom. Bastava saber, dentro da concepção vigente então, "transmitir conhecimentos". Avaliar seria preparar e aplicar uma prova, contabilizando o resultado. A qualidade do professor muitas vezes era medida pelo índice de insucesso dos alunos. O melhor professor seria aquele que conseguisse fazer seus alunos estudarem mais sua disciplina e quase sempre aquele com maior índice de reprovação. "Só resta ao professor, sem formação pedagógica, começar pela reprodução dos caminhos que fez" [16]. Em geral, procura-se reproduzir aquilo que se achou que era melhor na própria formação ou repete-se o professor pelo qual se teve mais empatia ou maior respeito, buscando alcançar o mesmo patamar.

Na educação formal, o exercício docente exige o emprego de técnicas específicas, que encaminham as atividades discentes para constituir, em relações com diferentes pessoas e fontes, seus próprios conceitos, integrando simultaneamente o novo (para ele) nas amplas teias do conhecimento historicamente acumulado. Por isso, é preciso afirmar que não há transmissão de saberes, nem aceleração de aprendizagem possível, o processo exige observação, reflexão, práticas, leituras e experimentação, entre outros, para construir o percurso educativo. Cada um tem necessidade de um certo tempo para percorrer as atividades que o levarão a apropriar-se de um tema, essa é a zona de desenvolvimento proximal ou aproximativa (Z.D.P.) de que fala Vigotsky. Nesse período se garante um direito inalienável de aprender a incluir, excluir, conectar, ordenar, distinguir, deslocar, projetar, corrigir, manipular, classificar, intercalar, identificar – operar sobre o que se quer conhecer. Não basta ouvir/anotar. Não se pode separar conteúdos das ações pedagógicas.

EXPERIÊNCIAS E SUGESTÕES

Diversas alternativas têm sido aventadas. Se for observado o número de trabalhos apresentados nos Congressos Brasileiros de Ensino de Engenharia, cujo número de participantes vem crescendo a cada ano, os congressos internacionais de Ensino de Engenharia que têm sido realizados no Brasil, verifica-se que o tema está na ordem do dia. Entretanto, ainda são ações isoladas de um ou outro professor, que por se identificar com o tema, ou por estar em função de coordenação de Curso de Graduação, descobre, se apaixona, identifica-se e procura se aprimorar na docência. Mas não há uma ação efetiva, institucionalizada, unificada que vise à mudança da prática docente nos cursos de engenharia do Brasil.

A seguir são listadas algumas experiências e sugestões que podem contribuir para mudar o cenário atual:

Estágio em docência: trata-se de uma exigência atual da CAPES para alunos de mestrado e doutorado, o que traduz um momento ímpar para começar a mudar a prática docente, através da inserção de conteúdos relacionados à didática e pedagogia, uma vez que o ingresso na carreira docente requer esta qualificação; na experimentação inicial procura-se não separar conteúdos das ações pedagógicas; professores de diferentes áreas (psicopedagogia, engenharia e pesquisa em sociologia) compartilharam a formulação da proposta inicial, para criar um traçado ético-profissional nos pós-graduandos, quanto à política de ensino superior e as práticas de aula onde virão a se exercer enquanto docentes;

Participação e promoção de eventos: os Encontros de Educação em Engenharia, as oficinas de meios educativos, os congressos nacionais e internacionais na área de ensino de engenharia, servem para mapear os campos de conhecimento sobre os quais vão incidir as preocupações docentes, contribuindo para recortar seus limites;

Estágio Probatório: na renovação dos quadros, principalmente nas IFES, prevista para 20%, com a obrigatoriedade do Estágio Probatório, há uma maneira de promover alterações significativas no perfil dos docentes, incorporando nesse período a discussão e a prática docente supervisionada, caso seja institucionalizada a obrigatoriedade de os ingressantes na carreira participarem de "cursos", oficinas ou grupos de qualificação didático-pedagógica;

Cursos de mestrado e doutorado em educação em engenharia: visando desenvolver linhas de pesquisa na área de docência, estudando, por exemplo, metodologias de ensino/aprendizagem e avaliação e outras linhas de gestão acadêmica ou para fundamentação psicopedagógica no ensino superior:

As práticas em atividades como a participação nas experiências de laboratórios abertos, sem experimentos focados, visam despertar a criatividade dos alunos, têm contribuído para a melhoria no processo de ensino/aprendizagem. Nas situações de laboratório o projeto se formula em conjunto, portanto, todos podem se sentir autores e responsáveis pela consecução dos resultados. É necessário, também, investir nas atividades em que docentes e discentes trabalhem em conjunto, buscando criar uma outra ordem de relação interpessoal. Estreitar relacionamentos, colaborar em grupos são formas de interferir diretamente no processo de ensino/aprendizagem, transformando-o. Desenvolve-se nessas situações, uma forma para conseguir estudo produtivo e não apenas reprodutivo.

A resolução CNE/CES 11/2002, publicada em 9 de abril de 2002, trouxe avanços nesta direção quando comparada com a resolução anterior (48/76 – CFE) que regia os cursos de Graduação em Engenharia, na medida em que traça um perfil de egresso que prevê, dentre outros a formação "crítica e reflexiva"... "considerando seus aspectos políticos, econômicos, sociais, ambientais e culturais, com visão ética e humanística, em atendimento às demandas da sociedade". Além disso, estabelece que "cada curso de Engenharia deve possuir um projeto pedagógico que demonstre claramente como o conjunto das atividades previstas garantirá o perfil desejado de seu egresso e o desenvolvimento das competências e habilidades esperadas. Ênfase deve ser dada à necessidade de se reduzir o tempo em sala de aula, favorecendo o trabalho individual e em grupo dos estudantes". Quando se consegue propor um projeto pedagógico que considere central o caráter significativo do saber para a época, para a sociedade, para a geração com que se interage, para o convíviio de base também afetiva, é muito mais fácil instalar condições de produção intelectual coletiva porque os objetivos sociais da aprendizagem se fazem evidentes.

Com essa nova Resolução, verifica-se que em termos de legislação, está aberta a possibilidade para criar mecanismos que flexibilizem a formação e os meios para tal, tanto em termos de conteúdos quanto de metodologias de ensino/aprendizagem. O trabalho individual e em grupo exige, para que logrem êxito, uma orientação adequada por parte do docente e um dos caminhos são os "trabalhos de síntese e integração dos conhecimentos adquiridos ao longo do curso" que também estão previstos na Resolução 11/2002. No entanto, esta resolução continua ignorando o fato de que um dos aspectos da formação do engenheiro é a docência, tanto a ligada a Instituições de Ensino quanto à de treinamento e formação que ocorre dentro do exercício profissional nas organizações de maneira geral

PÓS-GRADUAÇÃO NA FORMAÇÃO DOCENTE EM ENGENHARIA

Os desafios hoje enfrentados na gestão e planejamento do sistema educacional em Engenharia envolvem, além da organização curricular dos cursos em matérias, aos conteúdos e às articulações entre as diversas disciplinas, novos desafios como o tratamento interdisciplinar de problemas de Engenharia e a formação para atuação coletiva nestes problemas.

A perspectiva de crescente complexidade para os objetos e problemas da Engenharia no futuro mostra necessidade de investimento no planejamento da formação do Engenheiro. Esta formação profissional não mais se completa no tempo do curso de graduação, o que obriga o repensar da estrutura acadêmica atual, para incorporar uma base de sustentação que alicerce a capacitação científico-tecnológica do engenheiro continuamente, ao longo de sua vida profissional ativa. O mesmo tratamento acadêmico dispensado às "ciências da engenharia", formalizado pelos programas de formação de pesquisadores precisa ser dado à pesquisa em Metodologias Educacionais da Engenharia. Na verdade, ao se considerar a importância estratégica deste profissional para o desenvolvimento e a soberania do País, percebe-se a importância da Educação em Engenharia passar a constituir objeto de pesquisa científica formal.

A Educação em Engenharia lida com questões que têm sido, via de regra, resolvidas a partir de ações individuais e precárias. Esporádicos editais de fomento que, incentivam a busca de resultados nesse campo, sem a estabilidade necessária para manter o fôlego questionador e reformulador hoje necessários.

Reconhecendo a especificidade do tema e a dificuldade histórica em se fertilizar mutuamente os domínios acadêmicos de sustentação das engenharias e as ciências humanas, a proposta de criação de um Programa de Pós-Graduação "senso estrito" busca representar a via de superação deste desafio. É necessário que a instituição envolvida com a formação de Engenheiros desenvolva pesquisa acadêmica formal e experiências de ensino/aprendizagem no âmbito da Educação para Engenharia. Isto exige a atuação sistemática do corpo docente dos Cursos de Engenharia em projetos de pesquisa em ensino e de qualificação docente, de modo a atender o que hoje é imposto como desafio a estas instituições.

Em síntese, a estrutura elaborada pelos fóruns de discussão entre a UFRJ e UFJF para o Programa de Pós-graduação compreende uma área geral e uma área aplicada. Na geral são abordados os temas: Filosofia, Sociologia, Epstemologia, Psicologia, Pedagogia, Psicopedagogia, Metodologia de Ensino, Inclusão da Imagem Reprodutível, Metodologia de Pesquisa. Na aplicada os temas abordados são: Plíticas Educacionais e Acadêmicas, Aspectos Normativos e Interpretativos dos Sistemas Educacionais e do Exercício Profissional, Planejamento e Gestão de Sistemas educacionais, Acaliação Instituciuonal e da Aprendizagem. Formação Profissional e Organização Curricular, Analise e Produção de Meios Educatios e Metodologia de Ensino de Disciplinas de Base Ex-perimental. O programa pretende criar um fórum vivo e fértil para promover a troca de saberes e o contato interdisciplinar entre as áreas da própria engenharia, visando uma interpenetração interdisciplinar ainda não tratada na academia.

Os futuros Mestres e Doutores em Educação em Engenharia, como parte do corpo docente, contribuirão com a inovação das práticas pedagógicas, pesquisando entre outrao temas: a relação teoria-prática nas metodologias educacionais, a avaliação dos processos de apropriação do conhecimento, planejamento e elaboração de novos meios educativos, modelação experimental de fenômenos próprios das ciências e tecnologias da engenharia, determinação das invariantes específicas das matérias de formação do engenheiro, metodologias específicas do ensino à distância, além da temática afeita à gestão de sistemas de ensino de engenharia, frente às demandas de produção e desenvolvimento do país.

Talvez esses novos doutores em engenharia fertilizem a participação das discussões departamentais e dos outros órgãos ao socializarem experiências e resultados.

Entre os estudantes as inovações vêm sendo aceitas com entusiasmo como uma forma de realmente aprender a aprender. A tradição oral sempre repassa aos "novos alunos" os resultados das experiências vividas em diferentes cursos. É evidente que alunos capazes civilmente são competentes para distinguir as diversas relações pedagógicas que perpassam as propostas de trabalho dos diferentes professores. A interrelação dos conhecimentos das ciências educacionais com os saberes específicos dos engenheiros facultará rearranjos dos conteúdos, auxiliando a organizar uma visão mais abrangente da engenharia.

Na formulação do programa de pós-graduação *strictu-sensu* foi usada como base a experiência secular em método tutorial das universidades de Oxford e Cambridge, adaptando-a às condições reais do número de alunos por turma e aproveitando as novas tecnologias, como recursos educativos, atendendo à realidade do país. Além dos trabalhos em laboratório, as salas de aula se transformam em espaço de observação e orientação direta dos alunos que normalmente trabalham em grupo. A intenção inicial foi de procurar levar estudantes de pós-graduação a aplicarem, com supervisão dos professores dos cursos, em aula as metodologias embasadas especialmente na atividade dos alunos, mais do que nas "conferências" dos professores. Abrindo espaços para a constituição de hábitos de trabalho em equipe e de produção coletiva do conhecimento a ser utilizado socialmente, no desempenho das funções de profissionais de engenharia.

CONSIDERAÇÕES FINAIS

A discussão apresentada neste trabalho reflete a preocupação de um grupo de professores de duas universidades que há mais de 8 anos trabalham e refletem juntos sobre os problemas de ensino/aprendizagem nos cursos de engenharia de universidades brasileiras. Decorrem do exercício da profissão docente e do desempenho dos alunos frente aos "projetos pedagógicos" vigentes. Consideramos que estas questões devem ser tratadas de forma adequada, através de projetos específicos na área da "Educação em Engenharia". Baseados na experiência dos diversos projetos de ensino de engenharia, nas oficinas realizadas e nas atividades dos Encontros de Educação em Engenharia, promovidos em conjunto pela UFRJ, UFJF e agora pela UFF, chegamos a esta convicção. Acreditamos portanto que os problemas do ensino em engenharia poderão ser minimizados através da pesquisa científica em metodologias, projetos pedagógicos e com a contextualização socio-histórica no processo de ensino-aprendizagem.

Há sinais de que está se processando uma mudança didática e pedagógica, com pertinentes adequações ao universo da engenharia, que tem que ocupar seu espaço na bagagem de conhecimento e de formação dos professores. Ao professor de engenharia não basta mais dominar o conhecimento científico e técnico dos conteúdos, ou o funcionamento dos meios disponíveis para "ministrar" esses conteúdos. Faz-se necessário que o docente conheça e aplique métodos e técnicas de ensino/aprendizagem estruturados e consistentes que pressuponham a apropriação do conhecimento, sem o que não conseguirá contribuir para a formação de profissionais em condições de educar-se ao longo da vida e de atender às demandas da sociedade.

A formação profissional na atualidade só pode ocorrer, de maneira a atender tais demandas, a partir de metodologias que possibilitem ao aluno aprender inclusive com erros e críticas, vislumbrando um contexto de aplicações, ao invés da reprodução pura do conhecimento, que forma aplicadores de fórmulas e tabelas ou manipuladores de *softwares*, talvez exímios, mas fortes candidatos a "analfabetos tecnológicos", na medida em que suas fórmulas, tabelas e *softwares* forem se tornando ultrapassados. Isto significa, principalmente, fugir para sempre da aula meramente expositiva, que só considera importante: as transparências, o quadro-negro e os conteúdos discursivamente apresentados.

Quem justifica a atividade docente é o aluno que trabalha e aprende com entusiasmo na busca do saber e na responsabilidade compartilhada.

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AVA- UM AMBIENTE VISUAL PARA A CONSTRUÇÃO DE ALGORITMOS

Ianos Julio da Silveira Junior [1], *Ahmed Ali Abdalla Esmin* [2]

Abstract — *This paper present the development of a tool to construct algorithms by using of Flowchart. The user has many resources, like: resource to create and manipulate of flowchart by using of objects. Define variables, operations and connectivity objects. The user will be able to verify the consistency of the flowchart, by analyzing the expressions objects,, and to execute the flowcharts (algorithm) interacting with them by I/O operations. The tool was developed using the RAD Delphi and Object Orientated methodology.*

Index Terms — *Programming, Algorithms, Object Oriented, Teaching of Programming.*

INTRODUÇÃO

O ensino da lógica de programação geralmente é tratado nas primeiras fases dos cursos de informática, onde os alunos iniciantes aprendem a desenvolver o raciocino lógico para então escrever algoritmos para solução de problemas.

Estes alunos iniciantes do curso de informática geralmente encontram-se uma grande dificuldade de assimilar o conteúdo referente a disciplina de algoritmos.

O Fluxograma é uma forma gráfica muito utilizada na descrição de algoritmos, destaca-se pela abstração e o uso de objetos gráficos (figuras), o que facilita aprendizado da lógica de programação, habituando o iniciante com o formalismo de programação.

Apesar de todas essas vantagens, o Fluxograma apresenta o inconveniente dos algoritmos não poderem ser executados no computador. Dessa forma, o aluno precisa imaginar a sua execução, o que não é uma tarefa tão fácil para quem está começando.

A lógica para programação consiste em aprender a pensar na mesma seqüência em que o computador executa as tarefas, aprende-se a imaginar como as ações serão executadas partindo-se do estudo de um problema até chegar a construção de um algoritmo (solução).

Outras forma muita utilizada no ensino de algoritmos é o uso do PORTUGOL[1,2] . A grande diferencia é em relação ao Fluxograma, é o fato que contém mais detalhes o que pode dificultar o ensino dos algoritmos para os alunos incitantes.

O ALGORITMO E SUAS FORMAS DE REPRESENTAÇÃO

É uma seqüência de passos ordenados que devem ser seguidos para a realização de uma tarefa[5]. Este conceito não foi criado para satisfazer somente às necessidades da computação mas sim para a padronização do exercício de tarefas rotineiras.

As formas de representação de algoritmos tratam os problemas apenas em ível lógico, abstraindo-se de detalhes de implementação muitas vezes relacionados com alguma linguagem de programação específica. Existem formas de representação de algoritmos que possuem uma maior riqueza de detalhes e muitas vezes acabam por obscurecer a idéia principal, o algoritmo, dificultando seu entendimento.

As principais formas de representação de algoritmos, são:

- **Descrição Narrativa**: representada o algoritmo em forma de linguagem natural.
  Ex.: Troca de um pneu furado

  Afrouxar ligeiramente as porcas
  Suspender o carro
  Retirar as porcas e o pneu
  Colocar o pneu reserva
  Apertar as porcas
  Abaixar o carro
  Dar o aperto final nas porcas

- **Pseudocódigo (Portugol) :** Esta forma de representação de algoritmo é rica em detalhes, como a definição dos tipos das variáveis usadas no algoritmo e, por assemelhar-se bastante à formo em que os programas são escritos.
  Ex.: Calcular a média de duas notas.

  Algoritmo Média
  Var N1, N2, Média : **real**
  Início

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Leia N1, N2
Média ← (N1 + N2) / 2
Se Média > 7
Então
    Escreva “Aprovado”
Senão
    Escreva “Reprovado”
Fim_se
Fim.

- **Fluxograma Convencional:** É uma representação gráfica de algoritmos onde formas geométricas diferentes implicam ações (instruções, comandos) distintos. Tal propriedade facilita o entendimento das idéias contidas nos algoritmos e justifica sua popularidade..
  Ex.:

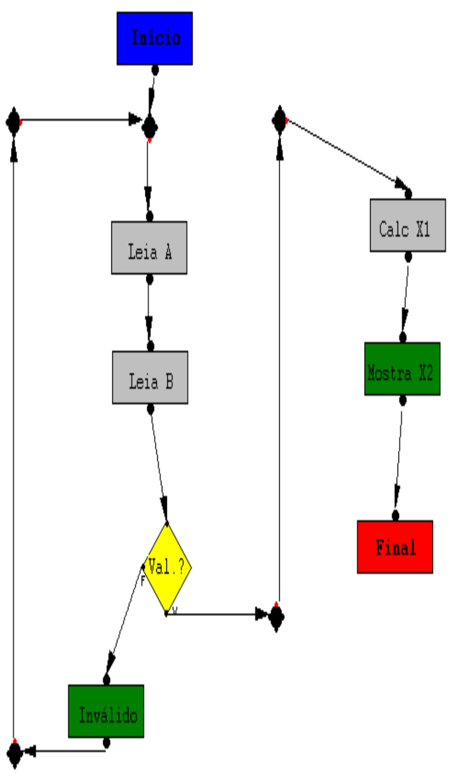


FIGURE. 1: UM EXEMPLO DE FLUXOGRAMA

O objetivo deste trabalho é apresentar um ambiente para o desenvolvimento composto por um interpretador animado, que visa auxiliar o aluno iniciante em Computação, facilitando seu aprendizado através da execução e visualização das etapas de um algoritmo estruturado em Fluxograma. Através da utilização deste ambiente, o aluno poderá implementar seus próprios algoritmos utilizando recursos gráficos.

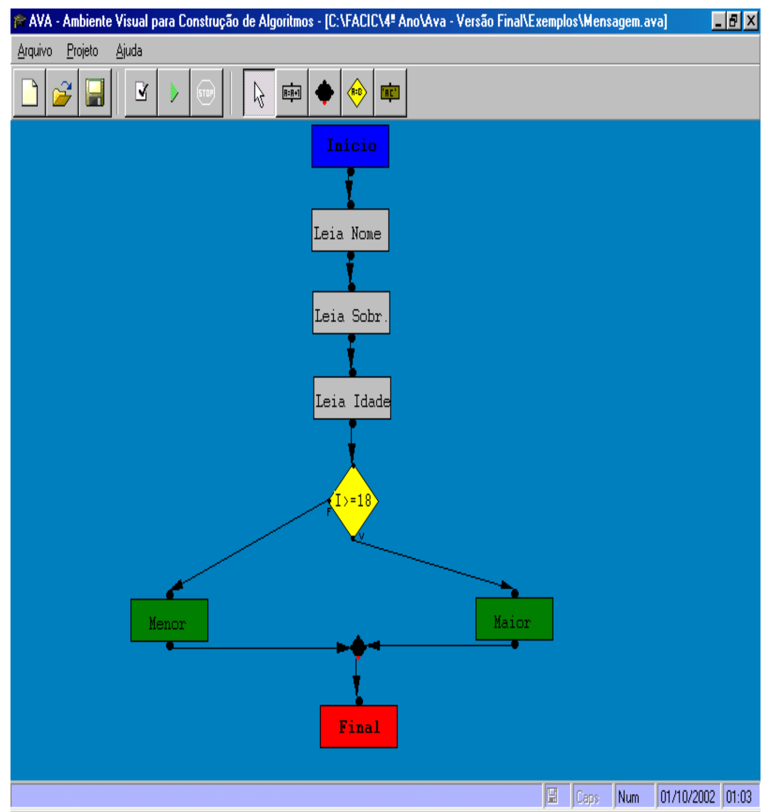
O AMBIENTE AVA

Nesta seção será apresentado o ambiente AVA – Ambiente Visual de Algoritmos

VISÃO GERAL

O AVA trás um ambiente com interface gráfica para a construção de fluxogramas [4].

Em seguida será apresentados os principais objetos utilizado para a construção e a execução dos fluxograma.



OBJETOS DO AMBIENTE

Os objetos INICIO e FINAL são criados automaticamente quando o usuário inicia um novo projeto, os demais podem ser inseridos no botão correspondente e em seguida no local onde ele será colocado (Área de Trabalho). Todos os objeto mostram suas funções quando clicados com o botão direito do mouse.

- **Objeto INÍCIO:**

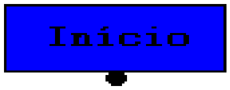


FIGURA. 3: O OBJETO INCIO

Representa o inicio do algoritmo. Quando clicado com o botão direito mostra a seguinte opção:

FIGURA. 4: O OBJETO INCIO COM AS OPÇÕES

Clique nesta opção e em seguida no objeto que receberá a sua saída. Automaticamente será feita uma ligação entre os objeto, o que representa que a seqüência durante a execução será definida desta forma. A próxima vez que este objeto for clicado com o botão direito, se tiver sido concluída a ligação, a opção mudará para "Desligar Saída" que quando acionada irá desfazer esta ligação.

- **Objeto FINAL**

FIGURE. 5: O OBJETO FINAL

Não possui nenhuma função específica, apenas representa o ponto final do fluxograma.

- ATRIBUIÇÃO

Objeto responsável por atribuir valores às variáveis declaradas. Possui as seguintes funções:

FIGURA 6 : EXEMPLO DO OBJETOS DE ATRIBUIÇÃO

FIGURA 7 : JANELA DE ATRIBUÇÃO

- **Propriedades:**

Variável: Variável a qual será atribuída o valor.
Valor: Valor que será associado à variável selecionada. Poderá ser uma expressão de acordo com o tipo da variável. Nota: se for deixado em branco significa que o valor será atribuído pelo usuário durante a execução.
Rótulo: Texto que será exibido no objeto do fluxograma.

- **Ligar Saída**

Mesma função do objeto INÍCIO.

- **Apagar**

Elimina o objeto do fluxograma. Esta função só será bem sucedida se o objeto não estiver ligado a nenhum outro objeto. Neste caso retire as ligação execute a função novamente.

- **Objeto LIGAÇÃO**

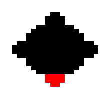


FIGURA 8: OBJETO DE LIGAÇÃO

Serve como uma ponte de ligação intermediária entre os objeto. Possui três entrada e uma saída(de vermelho). É usada quando se quer que mais de um objeto tenham o mesmo objeto de saída. Suas funções são:

- **Ligar Saída**

Mesma função do objeto INÍCIO.

- **Girar**

Muda a posição da saída girando em sentido horário.

- **Apagar**

Mesma função do objeto ATRIBUIÇÃO.

- **Objeto CONDIÇÃO**

Faz com que a execução do algoritmo possa tomar dois caminhos diferentes de acordo com a validade a condição associada ao objeto.

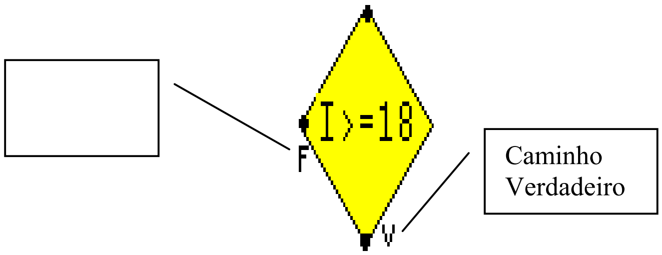


FIGURA 9 : O OBJETO CONDIÇÃO

- **Objeto MENSAGEM**

Este objeto faz com que seja mostra uma caixa com uma mensagem para o usuário durante a execução do algoritmo.

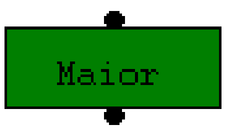


FIGURA 10 : O OBJETO PARA A SAIDA

ASISTENTES DE EXPRESSÃO

O ambiente AVA contém assistentes para ajudar o usuário a construir seus algoritmos, são:

- **Expressão Numérica**

Neste assistente, o usuário poderá montar de forma iterativa expressões numéricas usando a ADIÇÃO, SUBTRAÇÃO, MULTIPLICAÇÃO, DIVISÃO, RADICIAÇÃO, SENO e COSENO.

- **EXPRESSÃO LITERAIS**

Com este assistente o usuário poderá montar expressões literais que podem CONCATENAR com as variáveis do projeto.

FIGURA 11 ASSISTENTE DE EXPRESSÃO NUMÉRICA

- **EXPRESSÃO LÓGICA**

Este assistente é utilizado para montagem de expressões lógicas.

OPERAÇÕES DO AMBIENTE

No menu projeto existem vários opções para a realização de operações, as mais importantes são:

- **Operação EXECUTAR**

Se o fluxograma estiver consistente, ou seja, não tem nenhuma ocorrência de erro na verificação de sintaxe, o mesmo será executado animando os objetos do fluxograma. O usurário poderá ser solicitado a entrar com valores para atribuir as variáveis previamente criadas (Figura 12) permitindo que o usuário acompanhar o andamento da sua execução.

FIGURA 12 : ENTRADA DE VALORES

O andamento da execução pode ser interrompido de duas formas. A primeira seria através dos objetos de INPUT e OUTPUT apenas clicando no botão TERMINAR, ou através da opção Parar Execução do menu Projeto. A execução só irá ser concluído quando aparecer a seguinte mensagem na tela:

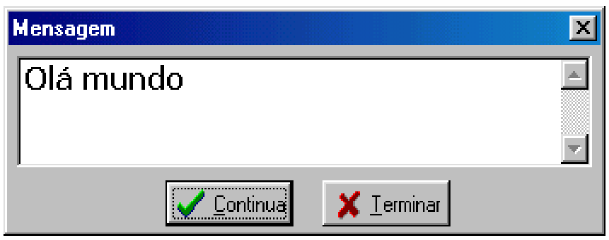


FIGURA 13 : SAIDA DOS VALORES

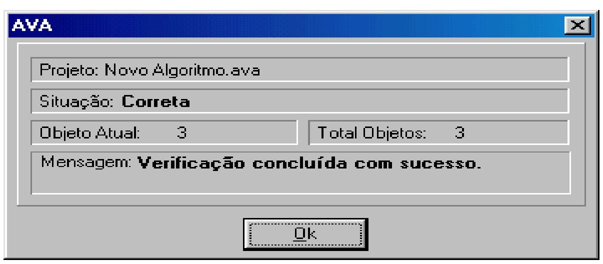


FIGURA 14 – VERIFICAÇÃO DO SINTAXE

- **Operação VERIFICAR SINTAXE**

Esta operação utilizada para a verificação da consistência dos fluxograma e todos os objetos que estão entre os objetos INICIO e FINAL. Exibe uma tela de informações sobre o andamento da verificação (Figura 14). Se houver alguma ocorrência de inconsistência, o usuário será avisado e irá parar a verificação ou caso contrario receberá uma mensagem indicando o sucesso da operação da verificação.

- **Operação PARAR EXECUÇÃO**

Esta operação é utilizada para fazer uma parada forçada na execução do fluxograma.

- **Operação LISTA VARIÁVEIS**

Esta operação lista as variáveis do projeto atual. Nesta tela (Figura 15), o usuário poderá INCLUIR, ALTERAR e APAGAR variáveis do projeto:

FIGURA 15 JANELA COM AS VARIÁVEIS

Ao incluir ou alterar variáveis, o usuário deverá preencher as informações necessárias para cadastrar uma variável (nome tipo e valor inicial).

CONCLUSÕES

A programação de computador, não é algo muito complexo de ser aprendida, no entanto, para o seu aprendizado é necessário dominar a lógica de programação. O ensino da lógica depara-se hoje com uma problemática, que é a falta de experimentar na prática o que é estudado na teoria. A falta de prática não estimula os alunos iniciantes a aprofundar no conteúdo a ser aprendido.

Visando a melhoria do ensino da lógica foi desenvolvido o AVA, que é um ambiente que auxilia na tarefa de ensinar e estudar a lógica de programação. Ele estimula o aluno a praticar e exercer o desenvolvimento de algoritmos, facilitando assim o trabalho do professor e também ajudando o aluno a ter um domínio melhor sobre o assunto.

O principal público alvo são os alunos iniciantes dos cursos de Informática, onde se espera, com a utilização desta ferramenta, um aumento no domínio do conteúdo da lógica.

Existem algumas propostas para o desenvolvimento futuro, como, transformar os fluxogramas em formato de programas em linguagem já conhecidas como o Pascal e C. A criação de subfluxogramas, o que irá trazer mais recursos para a ferramenta, permitindo ao usuário criar algoritmos mais complexos e reutilizar as rotinas prontas encaixando em novos algoritmos.

Atualmente, o AVA está sendo utilizado em caráter experimental pelo professor da matéria (Introdução à Computação), onde será avaliada a sua utilidade prática.

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COMUNIDADE VIRTUAL DE MENTORES E TUTORES DO SENAC - SP

Rita Maria L. Tarcia [1]

Abstract — *Considering that distance education is configurated as a new teaching and learning modality, the SENAC-SP Mentors and Tutors Community was created with the purpose of making conditions for teachers and professionals to develop new and specific competencies for the management of these processes in virtual enviroments. The leading principles of the Community are: virtuality, autonomy, flexibility, interdisciplinarity, communication and interaction. Many distance teaching projects have been created from present models and approaches, by means of changing experiences it is hoped to be created a space of knowledge production centered exclusively in virtuality, creating proper theories and concepts of this new modality of Education.*

Index Terms — *Pedagogical competencies specifc for distance education, pedagogical support, mentor's and tutor's role, virtual enviroment for knowledge production.*
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INTRODUÇÃO

Considerando que os processos pedagógicos em EAD são muito atuais e estão sendo estudados durante a evolução dessa modalidade de ensino, a criação de um espaço virtual para troca de experiências e construção de conhecimentos dos profissionais de diferentes áreas do saber que estão atuando em cursos a distância configura-se como um projeto inovador e importante para o desenvolvimento da pesquisa nessa área.

A missão da coordenação pedagógica da GEAD – Gerência de Educação a Distância é de desenvolver estratégias que garantam a consistência teórica e a coerência pedagógica dos cursos, a qualidade dos processos, dos produtos e da aprendizagem dos alunos, portanto, torna-se necessária a criação de estratégias centradas na formação dos profissionais que atuam diretamente com as questões pedagógicas dos cursos a distância.

Acredita-se que para a GEAD concretizar sua visão de ser reconhecida como uma instituição brasileira de e-learning especializada no segmento de Educação Profissional e Acadêmica, é mister o desenvolvimento de pesquisas e a divulgação dos saberes construídos por sua equipe.

Cabe salientar que a Comunidade de Tutores é um espaço com processos de geração e produção do conhecimento sobre Educação a distância e tal conhecimento será divulgado por meio de um portal.

O objetivo geral do projeto é criar um espaço virtual atualizado e respeitado pela comunidade acadêmica e pelo mercado profissional como centro de produção e divulgação de saberes relacionados aos processos pedagógicos de diversas experiências educacionais realizadas na modalidade a distância.

Destacam-se como objetivos específicos da Comunidade de Mentores e Tutores o desenvolvimento de competências específicas e necessárias para os processos de EAD, utilizando EAD; capacitação para o uso dos diferentes recursos tecnológicos da EAD; a comunicação entre coordenadores, mentores, tutores dos cursos oferecidos pela GEAD; a comunicação entre os profissionais que trabalham na GEAD e outros profissionais de diferentes áreas relacionadas com os cursos que atuam em diferentes instituições; a orientação pedagógica para garantia da consistência teórica e da coerência pedagógica dos cursos; a atualização de informações referentes a temas de educação, tecnologia da informação e educação a distância; a informação acerca de eventos científicos e empresariais de relevância na área de EAD e a produção de pesquisas a partir de cursos em andamento e da modelagem de novos cursos.

DESENVOLVIMENTO DO AMBIENTE

A partir de encontros presenciais com coordenadores de cursos, mentores e tutores, identificamos a falta de experiência e de conhecimentos referentes não só aos processos de ensino e de aprendizagem a distância, mas também com relação aos recursos tecnológicos vinculados a esses processos. Considerando que todos são profissionais de diferentes áreas, julgamos inadequado qualquer tipo de treinamento. A proposta era de auxiliar tais profissionais na formação de competências não só para os cursos em andamento, mas também, para a inserção nesse novo mercado de forma a agregar valor ao perfil já existente. Surge a idéia da comunidade como um Projeto de formação continuada e em exercício, cujo conhecimento seria produzido a partir da vivência dessa nova modalidade de educação. Com relação ao modelo presencial, acredita-se que todos têm um referencial construído durante sua vida escolar e acadêmica, premissa que não se aplica à modalidade a distância.

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No desenvolvimento da Comunidade de Mentores e Tutores foram considerados os seguintes aspectos:

- Virtualidade: todos os processos acontecerão exclusivamente no ambiente virtual, de modo que os profissionais possam vivenciar a aprendizagem a distância, procurando produzir seus próprios referencias para a gestão do ensino;
- Autonomia: respeitando a aprendizagem autônoma [1], a navegabilidade do ambiente permite que cada mentor/tutor procure as informações que julgar mais importantes e encontre estratégias que possibilitem a reflexão e a construção do seu próprio conhecimento, a partir de suas próprias experiências e expectativas;
- Flexibilidade: todo o conhecimento disponibilizado no ambiente possibilita a construção de novas relações e produções, a partir da hipertextualidade;
- Interdisciplinaridade: apesar da Comunidade de Mentores e Tutores ter uma característica pedagógica muito significativa, o ambiente contempla temas e discussões de diferentes áreas do conhecimento, uma vez que os aspectos pedagógicos são ferramentas para o desenvolvimento de conhecimentos em diferentes áreas do saber. Esse aspecto assume um papel motivador, uma vez que os profissionais terão oportunidade de refletir e discutir temas de sua área específica de interesse, formando grupos de discussão dentro da própria comunidade e inserindo essa temática em cursos ou situações de aprendizagem a distância.
- Dialogicidade [2]: tanto os textos quantos os recursos de interatividade valorizam e estimulam o diálogo. A comunicação é o meio pelo qual a aprendizagem se processa, portanto o mentor/tutor deve vivenciar situações dialógicas ricas por meio das quais ele identifique a possibilidade de construção do conhecimento por parte dos alunos.
- Comunicação e interatividade: esses aspectos estão diretamente relacionados com o anterior. O mentor/tutor deve reconhecer a importância dos processos de comunicação para a construção das relações tanto pessoais quanto de conhecimento. É a partir da comunicação que a interatividade é construída. *O significado das palavras é um fenômeno de pensamento apenas na medida em que o pensamento ganha corpo por meio da fala* [3], da palavra expressa nos fóruns, chats e e-mails.

Atualmente, os cursos oferecidos pela Gerência de Educação a Distância do SENAC –SP são desenvolvidos no WebCt e para estimular o conhecimento dessa ferramenta por parte dos mentores/tutores, a Comunidade Virtual também foi construída, inicialmente, dentro desse ambiente.

Para modelagem desse ambiente, decidiu-se utilizar todos os recursos disponíveis de modo a gerar a experiência e estimular sua utilização na construção dos cursos; o conteúdo foi organizado em categorias, tais como: informativa, teórica, prática, auxiliar e subsidiária.

Considerando os aspectos descritos anteriormente e a justificativa de utilização da ferramenta WebCt, passamos a descrever o processo de implantação do Projeto em questão.

IMPLANTAÇÃO DO PROJETO

A primeira fase de implantação da Comunidade Virtual aconteceu no período de dois meses, com o objetivo de teste e contou com a participação dos profissionais da própria GEAD que atuam diretamente com a questão da educação a distância e já possuem um saber elaborado ou pesquisas em andamento sobre o tema. Nessa fase foram avaliados os seguintes aspectos: construção do ambiente, organização do conteúdo, navegabilidade, recursos de interação e tecnológicos, relação entre os objetivos e os processos.

A segunda fase de implantação durou mais dois meses e contou com a participação dos funcionários do SENAC-SP que exercem a função de coordenadores de cursos a distância. Tais profissionais trouxeram contribuições de ordem prática, na medida em que avaliaram a Comunidade Virtual considerando as necessidades e dificuldades que os mentores e tutores apresentam no desenvolvimento e gestão dos cursos.

Finalmente, na terceira e última fase de implantação, o ambiente de apoio pedagógico para processos de educação a distância do SENAC-SP foi aberto para todos os profissionais que atuam direta ou indiretamente com os processos a distância, sendo esse o público alvo do projeto.

O objetivo de dividir o processo de implantação em três fases foi o de garantir a análise, a verificação e a avaliação do ambiente por grupos diferentes, de modo que ao ser aberto para todos os profissionais, que assumem o papel de mentor e de tutor, as possibilidades de identificarmos problemas tanto tecnológicos como pedagógicos fossem bastante reduzidas.

Cabe destacar que o desenvolvimento da Comunidade Virtual foi resultado da análise de inúmeros instrumentos de avaliação e situações reais de ensino e de aprendizagem. O relato dos profissionais expressava a necessidade do diálogo e do auxílio para refletir acerca das novas exigências pedagógicas e tecnológicas. É na comunidade que os mentores e tutores terão condições de desenvolver competências que possibilitem um trabalho de mediação mais qualificado e eficiente.

CONSIDERAÇÕES FINAIS

Devido ao processo de avaliação continuada da Comunidade Virtual, pudemos acompanhar a navegação dos participantes de modo a reorganizar o material informativo disponibilizado e a modelagem do ambiente.

Assim sendo, uma nova versão já está sendo desenvolvida com as algumas alterações. A comunidade deixa de ser organizada dentro do WebCt e passa a ter uma estrutura de Portal, no qual dois eixos são priorizados: um de material teórico e textos de referência e outro de informações práticas, com relatos e exemplos que contribuem com a formação profissional e criação de referenciais e balizadores do processo. Os recursos de interatividade serão mantidos, havendo espaço para os profissionais que atuam em cursos específicos possam se encontrar para trocar informações, inclusive junto com a Coordenação.

Uma inovação no ambiente é a inserção de um programa de rádio com entrevistas, relatos, música e informações sobre eventos e acontecimentos importantes relacionados com a área de educação a distância.

Respeitando o objetivo de capacitação em exercício, haverá um espaço para o mentor/tutor utilizar o WebCt de forma experimental, de modo a familiarizar-se com a ferramenta antes do início do curso.

Citamos algumas das muitas transformações pelas quais a Comunidade Virtual de Mentores e Tutores do SENAC-SP está passando, definido assim os princípios de atualização constante e de produção de conhecimento em fluxo, em movimento.[4]

Finalmente, a evolução do Projeto mostra a seriedade e o compromisso com que está sendo desenvolvido, de modo a contribuir sobremaneira com a evolução dos processos de ensino e de aprendizagem a distância, com a formação de profissionais para atuarem de maneira eficiente e com qualidade, possibilitando melhores resultados/aprendizagem por parte dos alunos. Assim sendo, este projeto possibilita o desenvolvimento de competências pedagógicas para a educação a distância, colaborando no processo individual de construção da identidade do mentor/tutor, a partir da mobilização dos saberes da experiência e da vivência de diferentes situações de aprendizagem.

Acreditamos ser esse ambiente um objeto rico de informações e dados que possibilitarão aos pesquisadores a produção de referenciais teóricos próprios da modalidade de ensino e de aprendizagem em questão, afastando-se assim da adaptação de modelos e abordagens presenciais.

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SOFTWARE EDUCACIONAL PARA DISTRIBUIDORES DE GASES E LÍQUIDOS

Fabiano A.N. Fernandes[1], Sueli Rodrigues[2], Sandro M. Pizzo[3], Marina S.Kobayasi[4] and Deovaldo Moraes Jr.[6]

Abstract *— Com o intuito de potencializar o ensino das operações unitárias, o software Distrib foi desenvolvido, trazendo cálculos e exercícios relativos ao uso de distribuidores de gases e líquidos e na qualidade da distribuição de líquidos em colunas de recheio. O software foi idealizado de forma a possuir um módulo de exercícios e um módulo de simulação. Os exercícios propostos envolvem a melhoria da eficiência dos distribuidores; suas vantagens e limitações; a variação das dimensões, configuração e variáveis operacionais. Os resultados obtidos no módulo de simulação devem ser analisados para se chegar a uma resposta, estimulando dessa forma o desenvolvimento do senso crítico nos alunos e um melhor entendimento do equipamento. A proposta do software é contribuir para o desenvolvimento da percepção da influência de cada um dos parâmetros de construção do equipamento, das variáveis de processo bem como das dimensões do equipamento na eficiência e adequação do seu uso para um determinado processo*.

Index Terms *— distribuidor de líquido, distribuidor de gás, colunas empacotadas, software.*

INTRODUÇÃO

Nos últimos três anos temos acompanhado de perto a aplicação de softwares educacionais junto aos cursos de operações unitárias e simulação de processos químicos. Estando abertos a ouvir as opiniões e críticas dos alunos quanto a aplicação destes softwares em sala de aula pudemos perceber o quanto este tipo de material é importante para os cursos. Uma das principais críticas dos alunos quanto aos cursos dados atualmente é a falta do uso de recursos computacionais, especialmente quando se trata de simulação de processos e projeto de equipamentos industriais, em especial aos equipamentos que requerem uma grande quantidade de cálculos como as colunas de destilação, trocadores de calor, extração líquido-líquido, ciclones, hidrociclones e outros equipamentos de separação gás-sólido e líquido-sólido. Devido à complexidade de operação ou mesmo à carga horária reduzida, alguns equipamentos nem sempre são detalhados no ensino de graduação, embora sejam bastante utilizados nas indústrias.

Para equipamentos complexos muitas vezes apenas um único exercício é dado ao aluno para projetar o equipamento, devido ao montante de tempo necessário para se fazer os cálculos para estes exercícios. Em muitos exercícios o aluno acaba simplesmente refazendo um modelo pronto de projeto do equipamento e desta forma passa a ser apenas um apêndice da máquina de calcular e pouco conhecimento é realmente adquirido.

Uma maior quantidade de conhecimento é adquirida pelo aluno quando um software educacional é usado, sendo que a teoria relativa ao equipamento fica mais fortalecida na mente do aluno. É claro que uma boa carga teórica deve ser dada como base para o aluno, porém esta carga pode ser centrada nos conceitos físicos do equipamento, em suas especificações mais comuns, na sua funcionalidade, aplicações e limitações, deixando que o cálculo e projeto do equipamento sejam realizados com o auxílio do software.

Do ponto de vista docente, a utilização do software pode ser uma grande fonte de informação no que concerne ao aprendizado do conteúdo teórico desenvolvido em sala de aula. Fazendo uma maior quantidade de exercícios e entregando pequenos relatórios sobre suas conclusões, muitas falhas de entendimento da teoria podem ser identificadas. Desta forma o desenvolvimento de softwares educacionais pode trazer muitos benefícios para o ensino, fazendo com que o senso crítico seja incentivado e mais conhecimento seja agregado.

DISTRIDORES DE GASES E LÍQUIDOS

Nas colunas de recheio, os distribuidores de líquidos são um dos constituintes mais importantes. Esses dispositivos são determinantes para que se consiga uma separação eficientes dos fluidos que entram no equipamento e muitos dos problemas relacionados aos processos de absorções, limpeza de gases e destilação são originários da distribuição heterogênea da fase líquida descendente.

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Já, nos leitos fluidizados, leitos de jorro e leitos borbulhantes, os distribuidores de gás também tem importância fundamental na eficiência do processo sendo responsáveis pela melhor ou pior mistura do gás e dos tamanhos das bolhas que são formadas (em sistemas gás-sólido-líquido ou gás-líquido).

Com o intuito de potencializar o ensino destas operações unitárias e suas aplicações, o software *Distrib* foi desenvolvido, trazendo cálculos e exercícios relativos ao uso de distribuidores de gases e líquidos. O software foi idealizado de forma a possuir um módulo de exercícios e um módulo de simulação. Os exercícios propostos envolvem a melhoria da eficiência do equipamento; suas vantagens e limitações; a variação das dimensões, configuração e variáveis operacionais. Os resultados obtidos no módulo de simulação devem ser analisados para se chegar a uma resposta, estimulando dessa forma o desenvolvimento do senso crítico dos alunos e um melhor entendimento do equipamento.

A utilização do software contribui para o desenvolvimento da percepção da influência de cada um dos parâmetros de construção do equipamento, das variáveis de processo bem como das dimensões do equipamento na eficiência e adequação do seu uso para um determinado processo. O software segue uma linha iterativa, com interface visual orientada a objeto de forma a simplificar ao máximo a utilização do programa pelos alunos.

EXERCÍCIOS

O módulo de exercícios contém uma série de práticas relacionados ao uso de distribuidores de gases e líquidos e distribuição de líquidos em colunas de recheio.

Nos exercícios relacionados aos distribuidores de gases e líquidos é abordado a qualidade inicial da distribuição e a influência dos parâmetros de construção deste acessório. Para as colunas de recheio são abordados exercícios relacionados com a qualidade de distribuição ao longo da coluna.

A Figura 1 mostra a tela inicial do programa. A navegação pelo software foi desenvolvida nos moldes utilizados na internet.

Para cada exercício existe um enunciado que traz toda a informação que o aluno irá necessitar para realizar o exercício. Os enunciados são apresentados em multimídia, numa interface gráfica bastante moderna, com textos claros e concisos, contendo ilustrações e tabelas acompanhando o texto. A Figura 2 apresenta a tela do enunciado de um dos exercícios do software.

Os exercícios são associados ao módulo de simulação, transferindo automaticamente partes dos dados que serão usados na simulação. Porém o aluno ainda terá bastante o que fazer para realizar e analisar os resultados.

FIGURE. 1
TELA DE APRESENTAÇÃO INICIAL.

FIGURE. 2
APRESENTAÇÃO MULTIMÍDIA DO EXERCÍCIO A SER REALIZADO PELO ALUNO.

SIMULADOR

Este módulo contém os simuladores dos distribuidores de gases e líquidos. Os simuladores foram projetados utilizando-se os principais métodos de cálculo para estes acessórios (Kunii & Levenspiel, 1991; Klemas & Bonilla, 1995; Chen, 1984; Pizzo et al., 1998). O módulo simulador abre espaço para que novos exercícios possam ser propostos pelos professores bem como para execução de projetos dos próprios alunos. No módulo simulador pode-se projetar ou estudar a performance dos distribuidores. A Figura 3 apresenta a tela de entrada de dados do software.

FIGURE. 3
TELA DE ENTRADA DE DADOS PARA SIMULAÇÃO DOS DISTRIBUIDORES DE LÍQUIDOS.

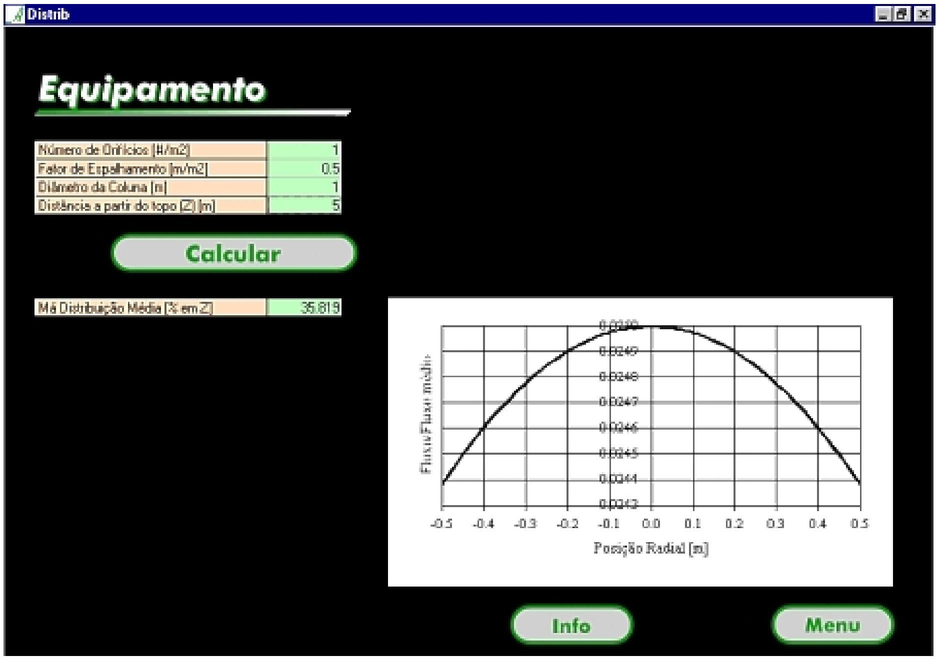

FIGURE. 4
TELA DE APRESENTAÇÃO DE RESULTADOS PARA COLUNAS EMPACOTADAS.

As entradas de dados e a apresentação dos resultados são categorizadas, de forma a apresentar de forma didática os diversos parâmetros envolvidos no cálculo do equipamento, como as variáveis de processo e de projeto. A Figura 4 mostra a tela de apresentação dos resultados.

Informações relativas ao distribuidor, às restrições operacionais podem ser acessadas num módulo de informação.

CONSIDERAÇÕES FINAIS

A introdução de um software didático no curso de engenharia traz consigo uma dinâmica diferenciada onde o aluno tem uma participação mais efetiva e menos passiva, pois terá a oportunidade de colocar o conhecimento adquirido nas aulas teóricas em prática para analisar e resolver um problema proposto, especialmente se o problema proposto for baseado num caso industrial, ou seja num caso real do ponto de vista do corpo discente. O que pudemos observar durante a aplicação de aulas computacionais é que os alunos realmente participam muito mais da aula, existe um interesse grande na aula computacional e os alunos acabam trazendo questionamentos novos sobre a teoria ou a resolução dos problemas. O uso de softwares educacionais muitas vezes extrapola os limites das aulas computacionais e muitas vezes os alunos acabam usando o software posteriormente para resolver problemas de outros cursos ou mesmo para saciar a própria curiosidade quanto á aplicações destes equipamentos em outros casos de estudo.

Independente da utilização do software, os métodos tradicionais não devem ser abandonados, e consideramos que o aluno deva realizar pelo menos um projeto ou exercício sem o uso do software de forma que ele utilize as equações e entenda o procedimento de cálculo. Caso contrário, um grave efeito colateral pode ser gerado: a formação de um “piloto de software” ao invés de um engenheiro que entenda o processo como um todo.

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CONCEPÇÃO DE UM PROJETO PEDAGÓGICO BASEADO EM CICLOS DE FORMAÇÃO

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Resumo — *Este artigo apresenta um Projeto Pedagógico que não privilegia a manifestação formal de um currículo, mas concentra-se na concepção sistêmica do curso e nas respectivas formas de organização e estruturação. É proposto a oferta do curso em Ciclos de Formação e com problemas em comum. Constam deste Projeto Pedagógico os seguintes elementos constitutivos: Contexto de Inserção, Referenciais Orientadores, Perfil do Egresso, Objetivos, Organização das Disciplinas em Ciclos de Formação, Concepção da Organização das Disciplinas, Concepção Metodológica, Concepção de Avaliação, Articulação entre Ensino, Pesquisa e Extensão. O desenvolvimento de competências/habilidades dentro dessa concepção curricular acontece de maneira contínua e gradual. O foco central de formação reflete os objetivos do curso, permeia todo o processo de formação do profissional, em diferentes níveis de complexidade. O Problema Comum é proposto para um conjunto de unidades de ensino, onde o mesmo é retomado e são identificadas as contribuições que os elementos trabalhados naquela unidade podem dar para sua solução.*

Palavras-Chave — *Projeto Político Pedagógico, Ciclos de Formação.*

INTRODUÇÃO

As mudanças educacionais exigidas pela sociedade contemporânea, assim como os ditames estabelecidos pela LDB e demais instruções do MEC e CNE acerca do ensino de graduação, indicam que profundas alterações, inclusive de ordem conceitual, deverão ser introduzidas na estrutura e organização dos currículos dos cursos de graduação.

Observando-se o modelo organizacional em que estão estruturados os atuais cursos, percebe-se que as experiências de ensino são vivenciadas isoladamente, de forma particularizada, não se constituindo em referências para o debate e a reflexão. São experiências que se perdem no isolamento das especialidades – vale dizer que o vigente modelo compartimentalizado em que se assentam os cursos está um tanto quanto ossificado diante de um tempo que exige o encontro, a convivência e a troca permanente de informações como forma de potencializar novas experiências no processo de formação.

Entre os novos componentes da reforma proposta pela atual legislação, destacam-se, sobremaneira, a *flexibilidade curricular* e a *interdisciplinaridade*. Como norteadoras de uma nova atitude acadêmica de ensinar, contemplam uma esperança de ruptura com a tradição do ensino fragmentário, mas geram, por constituírem-se, de fato, em objetivos *atitudinais* – portanto, direcionados ao *método* e não apenas ao *objeto de ensino* convencional – uma insegurança generalizada por parte da comunidade universitária.

Tal insegurança é compartilhada tanto pela parcela de interessados em promover uma efetiva mudança, como por aqueles que a rejeitam. É preciso que se compreenda que as diversas tradições que integram o mosaico dos formatos dos cursos, tanto das ciências sociais, as chamadas *humanidades*, como das ciências da natureza, as chamadas *tecnológicas, hard* ou *soft,* detêm, em seu currículo, a mesma arquitetura linear e hierarquizada centrada no *objeto,* desarticulada dos processos de aprendizagem peculiares dos sujeitos.

Historicamente a questão da *subjetividade* tem sido enfocada isoladamente como um fragmento da história do pensamento humano. Recentemente, entretanto, a partir da mútua influência dos campos da Filosofia da Educação, da História, da Antropologia, da Biologia, da Física e de suas interfaces com a Teoria dos Sistemas, com a Teoria da Auto-Organização e, especialmente, da Sociologia e das Artes, com o campo da Educação, procurou-se vencer a fragmentação do conhecimento gerada pelo paradigma cartesiano.

A partir da emergência de um novo paradigma unificador do pensamento e da ação humana, o enfoque da subjetividade passou a ser compreendido não mais como um mero objeto de estudo, mas como um componente essencial para impulsionar uma ressignificação da própria atitude de ensinar e aprender. O que está em debate, portanto, é a

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necessidade da busca de sentido para o ensino contemporâneo, numa perspectiva não fragmentária.

A dicotomia entre sujeito e objeto, embora há muito tempo superada na história do pensamento humano, ainda é imperativa, não no campo conceitual do ensino, mas, ironicamente, na prática da sala de aula. Talvez possamos depreender deste contexto, analisado com a profundidade que o tema suscita, a necessidade de se procurar, tendo a lei como ponto de apoio, os princípios: *flexibilidade* e *interdisciplinaridade*. Deve esse resgate do sentido e da subjetividade, como atitudes necessárias às relações humanas contemporâneas, relacionar-se a um método de trabalho condizente com a inteligência não-fragmentária.

A flexibilidade curricular dos programas de ensino em todos os níveis, como atitude propositiva, dá, portanto, o crédito ao educando para que ele exerça sua autonomia na escolha de seus objetivos, ou seja, na busca do sentido para a sua vida acadêmica. A *interdisciplinaridade*, por outro lado, é a resposta do corpo docente à busca maior de sentido para a vida em comunidade.

De acordo com Jantsch, há três níveis na construção do conhecimento além da *disciplina*: o *Multidisciplinar*, no qual as disciplinas aparecem justapostas, com uma temática comum, porém sem integração entre as mesmas; o *Interdisciplinar*, que pressupõe integração entre as disciplinas e entre os ministrantes, a partir de um método de trabalho compartilhado; e o mais abrangente de todos, o *Transdisciplinar*, no qual não há necessariamente disciplinas, mas eixos integradores das áreas de conhecimento. Não há hierarquia entre essas áreas. O trabalho baseia-se no planejamento coletivo dos programas e em experimentos educacionais, que dão suporte a essa integração[4].

A legislação que ora está se construindo refere-se, usualmente, ao termo *interdisciplinaridade* [5]. Entretanto, para efeito de síntese, passaremos a refletir sobre o conceito de *transdisciplinaridade*, uma vez que os documentos que embasam a mudança paradigmática para o ensino superior, a nível mundial, adotam o conceito de transdisciplinaridade como referência. Estes documentos fazem parte do acervo das conferências mundiais realizadas pela UNESCO no evento *A Educação Superior para o Século XXl.*

Compreenderemos melhor a transdisciplinaridade como atitude propositiva se lembrarmos Os Quatro Pilares da Educação Para a Virada do Milênio, propostos pela UNESCO: **aprender a conhecer, aprender a fazer, aprender a viver em conjunto e aprender a ser** [6].

No contexto de transição que ora vivemos, necessitamos resgatar o convívio dos grupos, estabelecendo um colóquio transdisciplinar permanente que dê conta de uma resposta mais convincente à sociedade acerca de questões pragmáticas do ensino, como: Para que serve Cálculo e Didática? Mais especificamente, a disposição das disciplinas em gavetas isola os sentidos que se entrelaçariam naturalmente a partir da realização de uma meta comum a todas as disciplinas: formar um docente para a educação básica ou superior ou, ainda, formar um profissional para o mundo do trabalho. Neste contexto, a abordagem transdisciplinar tem muito a contribuir.

A hierarquização dos conteúdos, ou seja, o que se deve ensinar e em que ordem, também está em questão, assim como o currículo como modelo organizacional fechado e as relações hierárquicas entre as áreas de conhecimento, entre as disciplinas e entre os ministrantes e usuários desses modelos.

Jurjo Santomé[7], em seu levantamento sobre as tendências teóricas que subsidiam a prática pedagógica multi, inter e transdisciplinar, expõe diversos modelos que estão em funcionamento no panorama internacional, como: a interdisciplinaridade complementar, o ensino centrado em evidências, na resolução de problemas, ou baseado em projetos. O processo tutorial, já adotado por algumas instituições de ensino superior, demonstra resultados positivos. Neste método o papel do docente transcende ao mero instrucional, na medida em que os tutores colocam-se como guias auxiliares na busca de um caminho pessoal[8].
Uma vez equalizadas as áreas do conhecimento, abre-se naturalmente o caminho da flexibilidade, a partir da qual o educando defronta-se com o aprendizado autoconstruído. De acordo com [1]:

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[4] Consideramos esses três conceitos a partir dos referenciais de Jantsch (In: Santomé, Jurjo. *Globalização e Interdisciplinaridade- o currículo integrado,* Porto Alegre:Artes Médicas, 1998 e de Walgenbach, Wilhelm. *Interdisziplinäre System - Bildung*. Frankfurt: Peter Lang, 2000).

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[6] Relatório da Comissão Internacional sobre a Educação para o Vigésimo Primeiro Século, presidida por Jacques Delors, UNESCO, 1998,

[7] Op. Cit.

[8] Este método traz à cena a figura do *tutor*, que difere da figura do professor. De modo genérico, o tutor deve orientar o educando em seu projeto de trabalho. Isto quer dizer, que o educando é que deverá exercer sua autonomia no sentido de pesquisar individualmente, a partir da ***tutela*** de seu orientador. As práticas de orientação dos alunos nos projetos de conclusão de curso, constituem-se em valiosos experimentos para os docentes, na compreensão dessa modalidade, assim como as orientações individuais no âmbito da Pós-Graduação. Entretanto, num sistema de tutoria, não basta estar contemplada apenas a escolha da temática pelo educando. A atitude do tutor consiste, acima de tudo, em ***não ensinar as respostas às perguntas da pesquisa***. Cabe-lhe orientar o educando em suas escolhas, até que ele descubra, por si só, as respostas para suas investigações.

(...)Não é a assimilação de uma enorme massa de conhecimento científico que dá acesso ao espírito científico, mas a qualidade do que é ensinado. E aqui qualidade significa guiar o aluno até o verdadeiro coração da abordagem científica que é o permanente questionamento com relação ao que resiste aos fatos, às imagens, às representações e às formalizações.

Destacamos como fundamental a idéia de aprender a conhecer, na medida em que, num tempo onde as transformações se processam em impensável velocidade, apresenta-se como indispensável criar estruturas que sejam capazes de apreender essas mudanças no campo social, no caso especifico, no ensino, na sua dimensão mesmo de processualidade. Decorre, também, desse fato a necessidade de uma educação continuada e permanente, que aponte para novos formatos organizacionais das instituições.

PROPOSTAS CONCEITUAIS PARA DISCUSSÕES SOBRE CONSTRUÇÃO DE PLANOS PEDAGÓGICOS

Na tentativa de estimular o debate em torno das propostas de planos pedagógicos, sugere-se que se promova um estudo acerca da relevância de se adotar uma proposta pedagógica não-linear, capaz de estimular o discente a buscar espontaneamente a pesquisa dos conteúdos de formação básica, a partir da necessidade de solucionar problemas imediatos ou executar projetos.

Tal atitude poderá inverter o desenho fragmentário do currículo *em gavetas*, dando lugar a um currículo mais dinâmico e transdisciplinar. A realização de um projeto ou a pesquisa de soluções para a resolução de problemas requer, ao mesmo tempo, criatividade e objetividade – ou seja: de um lado, o exercício do pensamento divergente, criativo, aberto ao novo e, de outro, a busca do pensamento convergente, seletivo, objetivo e conclusivo.

A dissociação entre a teoria e a prática gera desinteresse e falta de sentido para a vida dos acadêmicos, muitas vezes intimidados pelo estilo magistral da aula teórica convencional, centrado na memorização de conteúdos objetivos que, via de regra, não estimula a inventividade dos alunos e não lhes confere a devida autonomia para dar vazão ao seu espírito crítico e promover um envolvimento efetivo com o tema abordado.

Estudos contemporâneos no campo do ensino afirmam que o problema está na hierarquização das disciplinas e nas relações de poder que se estabelecem entre os docentes das áreas de conhecimento mais ou menos prestigiadas. Para [3], nada é mais importante, para os professores, do que a autoridade e o controle, que pode configurar-se como uma imposição externa a eles que contamina o currículo.

A escolha dos temas ou conteúdos praticados no currículo deverão ser relevantes para cada unidade social e não apenas protocolares, taxionômicos. Avalia-se, portanto, na rotina de sala de aula, não só o produto final do estudo, mas também o processo de aprendizagem, o método de ensino dos docentes e a dinâmica do trabalho em grupo.

O que muda, pois, notadamente, na construção de um currículo mais transdisciplinar, é, na base de sua construção, adotar como ponto de partida não a *disciplina*, mas o *conteúdo essencial* como elemento gerador de um sistema que irá desdobrar-se, entrelaçando-se com outros conteúdos essenciais. A organização do currículo por *módulos* ou por *eixos transversos* é decorrente deste enfoque, assim como a flexibilidade e a autonomia dos alunos na escolha de seus objetivos de estudo geram, por conseqüência, as chamadas *ênfases*, que são terminalidades dos cursos, diversificando as especificidades e ampliando o leque de profissões.

O que ocorre no modelo compartimentalizado dos currículos atuais é a justaposição de disciplinas, cujos solitários ministrantes, normalmente, não tecem comentários com os alunos acerca das relações entre as suas disciplinas e as demais. Tais relações, de fato, existem e, provavelmente, deram origem à proposta pedagógica inicial, mas, ao longo do tempo, deixaram de ser explicitadas. É comum, entre os docentes, a impaciência, ao perceberem a alienação dos alunos quanto aos reais objetivos dos cursos, e de não lembrarem de determinados referenciais já trabalhados em disciplinas anteriores, cujos pré-requisitos foram cuidadosamente colocados com a finalidade de embasar o conhecimento específico a ser desenvolvido.

Entretanto, em desenhos de currículos flexíveis, é o próprio aluno que irá buscar os referenciais para embasar sua pesquisa. Neste percurso, de imersão total no tema e de exercício de sua inventividade, seu processo de aprendizagem como um todo será valorizado e sua memória irá registrar a presença de um novo componente muito importante, que irá constituir-se no diferencial para incorporar definitivamente os conteúdos objetivos trabalhados: seu envolvimento afetivo com a temática escolhida e a valorização de sua performance pessoal.

Outro problema do modelo convencional, alvo das críticas de alunos e docentes, é a sobreposição dos mesmos conteúdos, que aparecem em diferentes disciplinas, com enfoques, por vezes, antagônicos ou dissociados entre si. Não há, em geral, uma orientação pedagógica nos cursos capaz de coordenar um debate sobre as diferentes tendências pedagógicas presentes na prática dos docentes. Seria bem-vindo um fórum permanente em que essa diversidade pudesse ser explicitada em prol de uma elucidação de conceitos e de linhas filosóficas, de modo a contribuir para uma formação menos fragmentária, menos competitiva e, por fim, menos *esquizofrênica* dos alunos.

Em decorrência, a partir de um enfoque dialógico, centrado no debate e no trabalho em equipes, poderia constituir-se, na esfera dos cursos e entre os cursos, nas suas áreas proximais, finalmente, a prática do trabalho interdisciplinar. Para [4], é importante o trabalho em parceria, característica fundamental desta modalidade.

Há muitos modelos de currículos interdisciplinares, uns mais centrados na resolução de problemas, outros na aquisição de um conhecimento mais globalizado, outros voltados para interesses do mercado, alguns mais artesanais, mais multiculturais, outros mais voltados para a tecnologia informatizada. Enfim, o importante, concordando com [5], é que se promova o debate em torno das peculiaridades de cada curso, da realidade particular, de todas as histórias de vida dos grupos constituídos e que este debate possa enriquecer o imaginário de cada curso.

O Projeto Pedagógico para o Curso de Bacharelado em Sistemas de Informação da Universidade de Caxias do Sul

Tendo por referência as considerações anteriores, este Projeto Pedagógico não privilegia a manifestação formal de um currículo, mas concentra-se na concepção sistêmica do curso e nas respectivas formas de organização e estruturação. A formalização do desenvolvimento da proposta de um curso por meio de uma "grade curricular" não implica, por si mesma, a efetivação de compartimentalização metodológica e do conhecimento; por outro lado, a formalização em módulos ou unidades de ensino também não garante a efetivação de multi, inter, ou transdisciplinaridade. Esta efetivação se concretiza na ação docente, na realização das atividades de ensino/aprendizagem norteadas pela concepção curricular do curso.

De acordo com [2], um Projeto Pedagógico deve constar os seguintes elementos constitutivos: a) Contexto de Inserção, 2) Referenciais Orientadores, c) Perfil do Egresso, d) Objetivos, e) Organização Curricular, f) Concepção da Organização Curricular, g) Estrutura do Currículo, h) Concepção Metodológica, I) Concepção de Avaliação, j) Articulação entre Ensino, Pesquisa e Extensão.

O que há de novo nesse Projeto Pedagógico é que a Organização Curricular está projetada em **Ciclos de Formação**, e está fundamenta em dois Eixos de Sustentação e um Eixo Central, a saber: Eixo de Formação em Informática e Eixo de Formação em Administração, como Eixos de Sustentação e Eixo de Formação em Sistemas de Informação como Eixo Central.

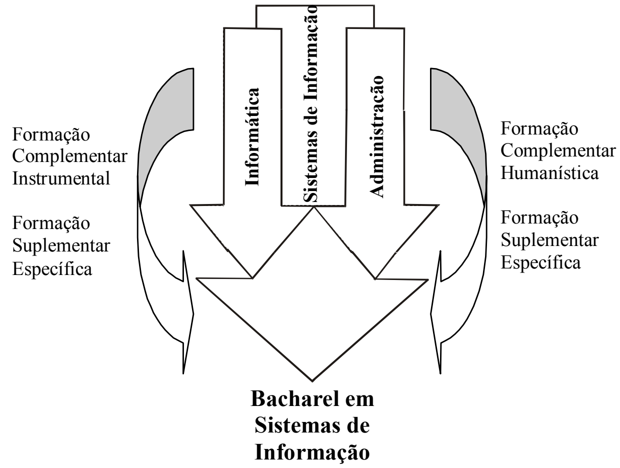

FIGURA. 1
EIXOS DE FORMAÇÃO

Ciclos de Formação

O desenvolvimento de competências/habilidades dentro dessa concepção curricular acontece de maneira contínua e gradual, isto é, em **Ciclos**. O foco central de formação, *desenvolvimento e aplicação de sistemas de informação no contexto das organizações*, reflete os objetivos do curso, permeia todo o processo de formação do profissional, em diferentes níveis de complexidade, e é abordado em cada Ciclo, de forma a contribuir para que os objetivos de aprendizagem sejam atingidos progressivamente. A cada Ciclo, **novos níveis de complexidade dos Sistemas de Informação e uma compreensão mais ampla e aprofundada do contexto organizacional** são contemplados na formação do profissional. A seguir, tem-se uma explanação dos objetivos e objetos de estudo de cada Ciclo do Curso de Bacharelado em Sistemas de Informação da Universidade de Caxias do Sul:

Objeto de estudo do Ciclo 1: Desenvolvimento de programas e o contexto das organizações.
Objetivo do Ciclo 1: Desenvolver habilidades de projetar e escrever programas de computador, considerando sua aplicação no contexto das organizações.

Objeto de estudo do Ciclo 2: Aplicação de tecnologia para tratamento da informação no desenvolvimento de programas e o contexto das organizações.
Objetivo do Ciclo 2: Projetar e escrever programas considerando sua aplicação em contextos organizacionais, agregando tecnologias e metodologias com maior grau de complexidade no tratamento da informação.

Objeto de estudo do Ciclo 3: Desenvolvimento e aplicação de sistemas de informação no contexto das organizações
Objetivo do Ciclo 3: Desenvolver e aplicar sistemas de informação com qualidade no contexto das organizações.

O trabalho realizado em cada módulo de ensino na estrutura curricular leva em consideração o Objeto de Estudo e o Objetivo do Ciclo em que está inserido. O desenvolvimento dessa estrutura é favorecido também pela proposição de um Problema Comum para um conjunto de unidades de ensino. Em cada unidade de ensino esse Problema Comum é retomado e são identificadas as contribuições que os elementos trabalhados naquela unidade podem dar para sua solução.

Em resumo, a organização curricular se configura em uma estrutura em Ciclos, que se desenvolvem em torno dos Eixos de Sustentação (Informática e Administração) e do Eixo Central (Sistemas de Informação) – pilares da formação técnica – e que se redimensionam pela formação Complementar Geral (Humanística e Instrumental) e Suplementar Específica. Abaixo é possível observar a inter-relação entre Eixos e Ciclos.

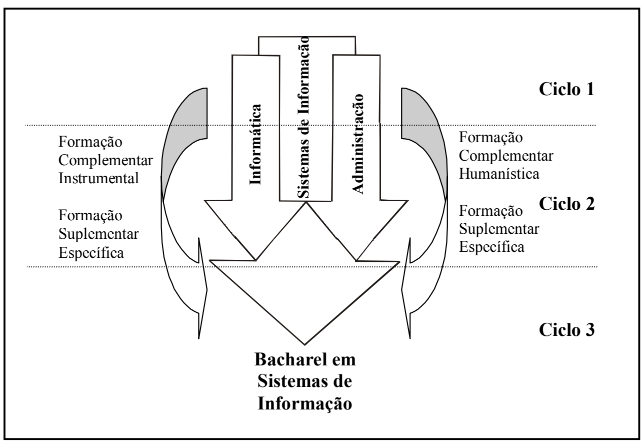

FIGURA. 2
CICLOS DE FORMAÇÃO

Na verdade, a concepção de um Curso em Ciclos de Formação pressupõe a busca de uma construção gradual de competências e habilidades. A meta final é atingir os objetivos do curso, contribuindo para o desenvolvimento do perfil profissional previsto. Nesse processo, em cada Ciclo, os objetivos são retomados em uma escala mais alta de complexidade. A Figura 3, mostra esse processo: cada quadrante representa uma área de formação, e as setas representam um crescente de complexidade. Ao final de cada Ciclo, um novo nível é atingido e, após a conclusão do curso, o processo de especialização continua em outros níveis de formação, ou mesmo, através auto-aprendizagem continuada.

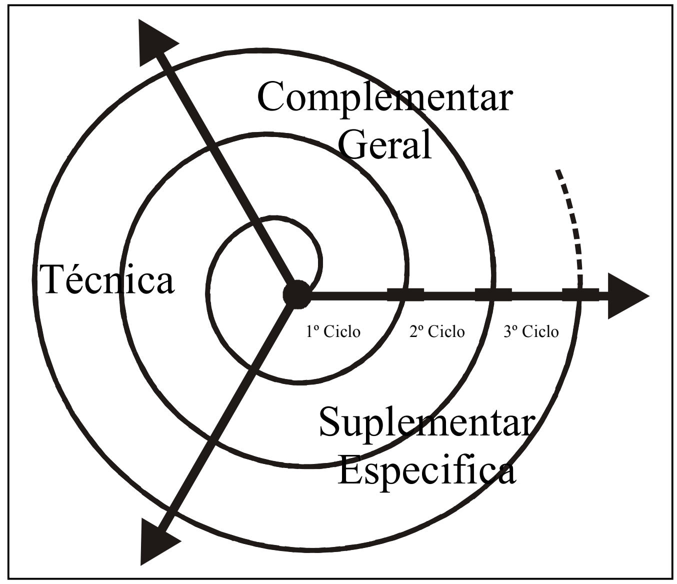

FIGURA. 3
CRESCIMENTO DOS NÍVEIS DE COMPLEXIADADE DE CADA FORMAÇÃO: TÉCNICA, COMPLEMENTAR GERAL E SUPLEMENTAR ESPECÍFICA EM CADA CICLO DE FORMAÇÃO

CONSIDERAÕES FINAIS

Conforme salientado, o presente Projeto Pedagógico, se, de um lado traduz uma perspectiva de mudança paradigmática nos referenciais científico-pedagógicos para o Curso de Bacharelado em Sistemas de Informação, de outro, traz uma alternativa de operacionalização, ainda que gradual, considerada possível e pertinente para que os agentes envolvidos (professores, alunos, coordenadores) possam progressivamente assimilar as referidas mudanças. Somente a discussão coletiva e contínua sobre o Projeto Pedagógico, permitirá, com maior adesão dos agentes, a efetivação das mudanças estruturais para as quais apontam os novos referenciais.

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INTERFACE COMPUTACIONAL PARA APLICAÇÕES DE ALGORITMO GENÉTICO

Max Ricardo Pantoja Trindade[1], Rejane de Barros Araújo[2] and Roberto Célio Limão de Oliveira[3]

Resumo *— O objetivo deste trabalho é apresentar um ambiente computacional, com interfaces amigáveis para ensino de Algoritmos Genéticos (AG's), de forma a facilitar ao usuário um melhor entendimento da aplicação do AG. Como o AG é um método utilizado basicamente para resolver problemas em pesquisa numérica, otimização de funções e aprendizagem de máquina, optou-se por escolher quatro aplicações diferentes usando o algoritmo genético: O Problema do Caixeiro Viajante, O Dilema do Prisioneiro, Otimização de Funções e a Sintonização de um PID (Controlador Proporcional Integral Derivativo).*

INTRODUÇÃO

Este artigo trata de *Algoritmos Genéticos,* que são definidos como uma família de modelos computacionais inspirados na teoria da evolução, que incorporam uma solução potencial para um problema específico numa estrutura semelhante a de um cromossomo e aplicam operadores de seleção e de "*cross-over*" a essas estruturas de forma a preservar informações críticas relativas à solução do problema (Barreto, 1999; Dias, 1998). Normalmente os AG's são vistos como otimizadores de funções, embora a quantidade de problemas para os quais os AG's se aplicam seja bastante abrangente. Uma das vantagens dos algoritmos genéticos é a simplificação que eles permitem na formulação e solução de problemas de otimização.

Em todas as quatro aplicações de AG, descritas a seguir, a estratégia adotada é a elitista (Sprinner, 1992 & Dias, 1998), na qual o indivíduo mais adaptado ao meio é sempre mantido na próxima geração. Uma outra estratégia adotada, e que se mostrou bastante eficaz no aumento da velocidade de convergência do AG, foi a aplicação de uma nova mutação com uma alta probabilidade (30-50%). Esta mutação adicional somente é aplicada quando o *fitness* do melhor indivíduo se mantém por várias gerações.

O Problema do Caixeiro Viajante (*Travel Salesman Problem* – TSP) consiste em visitar n cidades. O caixeiro sai de uma determinada cidade (por exemplo, cidade 1), vai visitando cada uma das $n-1$ cidades restantes, sem passar novamente pela cidade já visitada, e retorna para a cidade 1. Dessa maneira, a trajetória descrita pelo caixeiro forma um percurso fechado. O objetivo deste problema clássico de otimização é determinar a seqüência de cidades a serem visitadas, de forma que a distância total percorrido pelo caixeiro seja a menor possível (Sprineer, 1992).

No Problema do Dilema do Prisioneiro existem dois indivíduos (Alice e Bob) que são mantidos presos por terem praticado um crime em conjunto.

Os dois prisioneiros são mantidos em selas separadas, sem nenhuma possibilidade de comunicação entre ambos. A polícia oferece para Alice o seguinte trato: se ela confessar o crime e concordar em testemunhar contra Bob, ela ganha liberdade condicional, enquanto que Bob passa 5 anos na cadeia;

Entretanto, se ao mesmo tempo Bob confessar o crime e concordar em testemunhar contra Alice, esta última será desacreditada, e cada um deles irá cumprir 4 anos de pena por admitirem a culpa.

Alice é informada de que um trato nas mesmas condições está sendo oferecido a Bob. Ambos sabem que se permanecerem em silêncio e não se acusarem mutuamente, poderão ser condenados somente a uma pena mais branda de 2 anos na cadeia, cada um.

Portanto existem duas escolhas: Cooperar (C) mantendo silêncio, ou trair (D) (to defect) acusando-o.

Os resultados possíveis para uma única partida são descritos na matriz de recompensa ilustrada na Tabela I.

Tabela I: Matriz de recompensa

		Jogador B	
		Cooperar (C)	Trair (D)
Jogador A	Cooperar (C)	(3,3)	(0,5)
	Trair (D)	(5,0)	(1,1)

O dilema consiste no fato de que se ambos os jogadores traírem, cada um recebe uma recompensa menor de que aquela que ganharia caso os dois cooperassem (Fogel, 1995).

Na Otimização de Função, implementou-se um AG para encontrar os pontos de máximos ou de mínimos de uma funções de duas variáveis.

Para o caso da sintonização do PID, O AG é utilizado para encontrar os valores ótimos de K_P (Ganho Proporcional), K_i (Ganho Integral) e K_d (Ganho Derivativo), para uma planta qualquer de no máximo 3ª ordem, que minimize o sinal de erro entre a saída da planta e o sinal de referência (Rensburg, 1998), como mostra a Figura 1. Nesta implementação, utilizou-se os modelos discretos (método de Tustin) da planta e do controlador.

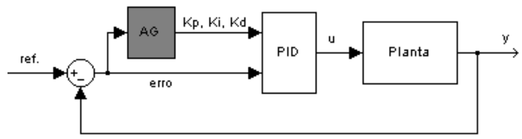

Figura 1: Sistema em Malha Fechada com uma Planta, Controlador PID e AG.

VISÃO GERAL DO AMBIENTE

Os Ambientes Computacionais para Ensino de Engenharia vem ganhando espaço de forma progressiva e significativa na área educacional e até mesmo nas industriais, para treinamento de pessoal. Este recurso é capaz de substituir vários aparelhos eletrônicos de propósito específico e aparelhos de medições, por computadores de propósito geral munidos de *hardware* e *software* específicos para o tratamento dos dados. Há vários aspectos vantajosos no emprego destes ambientes, como: flexibilidade, versatilidade e principalmente boa relação entre custo e benefício. Hoje existe uma forte demanda para desenvolvimento de ambientes computacionais de ensino de engenharia de propósito

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geral ou específico, que venham atender à realidade das instituições de ensino de engenharia do país.

O ambiente foi criado levando-se em consideração aspectos como: modularidade, simplicidade de uso e facilidade de manutenção.

A modularidade permite que futuras extensões, manutenções e atualizações possam ser realizadas de forma rápida e segura. A *interface* simples e intuitiva ao usuário deve propiciar o mínimo de tempo possível para adaptação ao ambiente, evitando-se assim possíveis desmotivações por parte do mesmo.

O ambiente foi desenvolvido no Matlab & Guide (Mathworks, 1997), pelo mesmo apresentar várias características desejadas, como: fácil manipulação pelos usuários (por ser bastante difundido no meio acadêmico), ter funções definidas (pois facilita a implementação do AG e diminui o esforço computacional) e facilidade de desenvolver interfaces amigáveis para o usuário.

FUNCIONALIDADE DO AMBIENTE

Neste tópico são apresentadas de forma sistêmica as interfaces criadas. A figura 2 apresenta a tela principal do ambiente, onde pode-se observar os botões que dão acesso as quatro aplicações atuais.

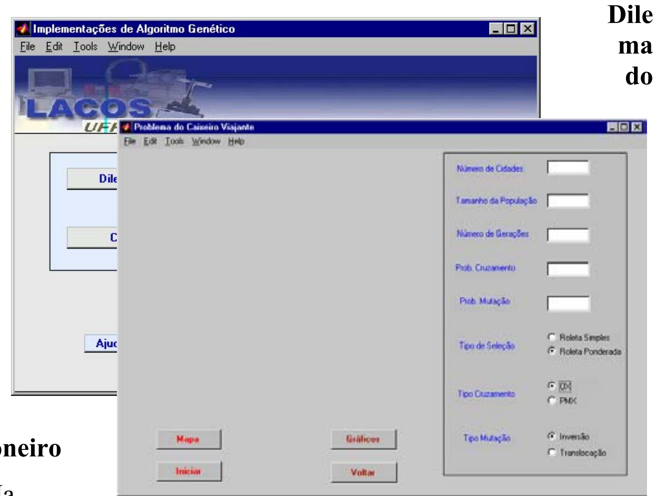

Figura 4: Interface do Caixeiro Viajante

Dilema do Prisioneiro

Na interface do Dilema do Prisioneiro o usuário pode escolher dois tipos de seleção para implementar o AG: roleta simples ou roleta ponderada. O botão **O Que é o Dilema do Prisioneiro?** dá acesso a uma pequena descrição do problema para que o usuário tenha conhecimento do mesmo. O usuário poderá escolher os valores de probabilidade de mutação (P_m), probabilidade de cruzamento (P_c), tamanho da população e número de gerações. Depois da sintonização de todos os parâmetros, existe um botão para iniciar o AG e um outro botão para visualizar os gráficos da média e do melhor indivíduo por geração, como pode ser visto na figura 3.

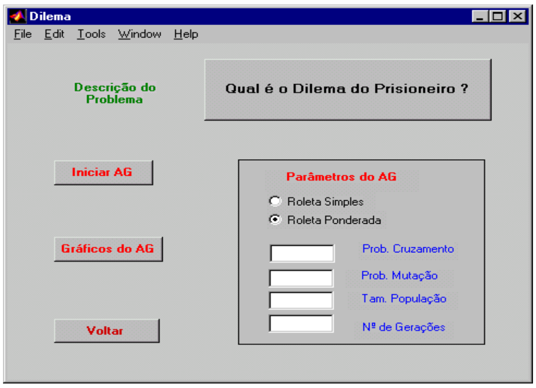

Figura 3: Interface do Dilema do Prisioneiro

Com esta implementação, o usuário tem a oportunidade de analisar o problema do dilema com mais de um tipo de seleção e valores diferentes de P_m, P_c, tamanho da população e número de gerações, podendo analisar a influência dos mesmos no comportamento do AG.

Caixeiro Viajante

Na interface do Caixeiro Viajante, o usuário pode escolher os parâmetros do AG, ou seja, P_m, P_c, tamanho da população e número de gerações, assim como o número de cidades a serem visitadas. O usuário poderá também escolher o tipo de seleção (roleta simples ou ponderada), cruzamento (OX ou PMX) e mutação (inversa ou translocação) a ser utilizado (Sprineer, 1992). Após o usuário clicar no botão **Mapa**, aparecerá na tela em cinza o mapa do Estado do Pará, com as cidades dispostas aleatoriamente. A partir desse ponto, pode-se iniciar o AG, clicando-se no botão **Iniciar**. O melhor caminho é mostrado no mapa a cada 10 gerações. A adaptação média da população e do melhor indivíduo podem ser vistas após a finalização do AG, através do botão **Gráficos** da figura 4**.**

Otimização de Função

Na interface da Otimização de Função, o usuário poderá encontrar os pontos de máximos ou mínimos de qualquer função de duas variáveis. Nesta interface, o usuário precisará digitar a função desejada e escolher se quer maximizar ou minimizar. Além disso, deve-se definir os pontos de máximos (X_{1max} e X_{2max}) e de mínimos (X_{1min} e X_{2min}), que são os intervalos de busca da solução.

Antes de iniciar o programa de Otimização de Função, o usuário deve escolher os parâmetros do AG, como P_m, P_c, tamanho da população e número de gerações. O tipo de seleção também é uma outra flexibilidade da interface, ou seja, o usuário pode fazer a análise do AG tanto com seleção simples, como seleção ponderada. Depois de todos os parâmetros serem estabelecidos, o usuário deve clicar no botão **Iniciar AG** da figura 5, e apareceram na tela branca um gráfico 3D da superfície da função sob estudo e seu ponto de mínimo ou de máximo obtido pelo GA, a cada 10 gerações. O *fitness* médio e do melhor indivíduo também podem ser vistos, após o usuário clicar no botão **Gráficos do AG**.

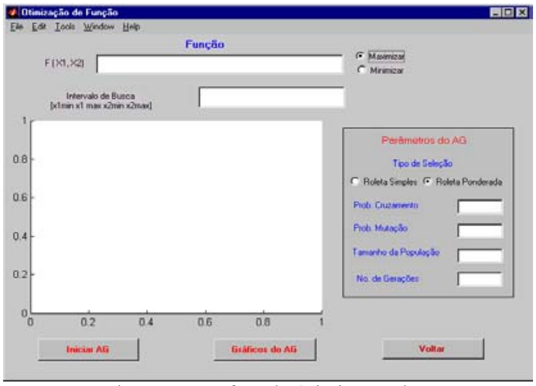

Figura 5: Interface da Otimização de Função

Sintonização do PID

Na interface da Sintonização de um PID (Controlador Proporcional Integral Derivativo), o usuário poderá obter os melhores valores de K_p (Ganho Proporcional), K_i (Ganho Integral) e K_d (Ganho Derivativo), usando o AG para qualquer planta de, no máximo 3ª ordem, bastando para isso escolher os parâmetros do AG, ou seja, P_m, Pc, tamanho da população e número de gerações. O usuário deve escolher também a planta a ser controlada, tendo que digitar o numerador, o denominador e o período de amostragem. Deve-se ter a preocupação de escolher adequadamente os limites de K_p, K_i e K_d (Datta, 2000). Após o usuário clicar no botão **Iniciar AG**, aparecerá na tela branca, a cada dez gerações, o sinal da saída da planta controlada pelo PID, cujos parâmetros são obtidos pelo AG. Para visualizar o *fitness* médio da população e o do melhor indivíduo, deve-se clicar no botão **Gráficos do AG** da figura 6.

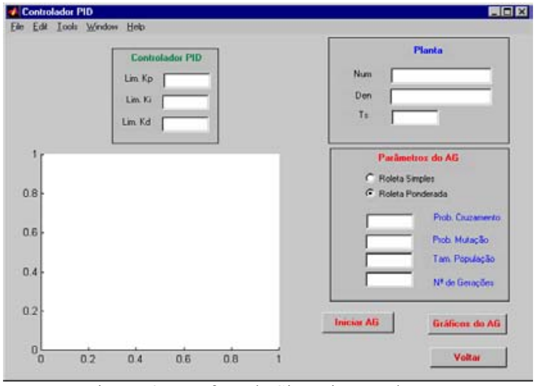

Figura 6: Interface da Sintonização do PID

SIMULAÇÕES OBTIDAS

Foram realizadas algumas simulações utilizando os recursos das interfaces, para se mostrar a funcionalidade de cada uma delas no estudo dos Algoritmos Genéticos. Em seguida, serão mostrados os resultados de uma simulação de cada aplicação.

Dilema do Prisioneiro

Para o Dilema do Prisioneiro escolheu-se os seguintes parâmetros do AG: $P_m = 0{,}01$; $P_c = 0{,}85$; tamanho da população de 20 indivíduos, 400 gerações e seleção do tipo roleta simples. Com esses parâmetros, obteve-se os gráficos do *fitness* médio da população e *fitness* do melhor indivíduo, como pode ser visto na figura 7.

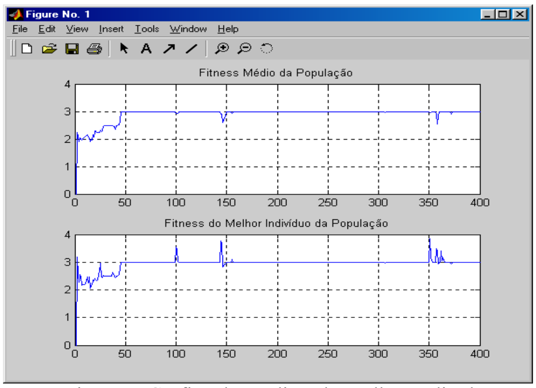

Figura 7: Gráfico da Média e do Melhor Indivíduo por Geração para o Dilema do Prisioneiro

Fazendo-se uma análise do gráfico observa-se que a partir da geração 50 o AG converge, mantendo os indivíduos melhores adaptados nas próximas gerações. Os resultados são bem satisfatórios, pois o AG consegue convergir para um valor ótimo, em poucas gerações.

Caixeiro Viajante

No caso do Caixeiro Viajante, deseja-se determinar o menor caminho percorrido pelo caixeiro para visitar 15 cidades, dispostas aleatoriamente no mapa do Estado do Pará. Os pontos em azul indicam as localizações das cidades e as linhas em amarelo definem o menor caminho percorrido pelo caixeiro, após execução do AG.

Os parâmetros do AG, o tipo de seleção, cruzamento e de mutação podem ser vistos na figura 8. Os resultados do *fitness* médio da população e do melhor indivíduo são mostrados na figura. 9. Nela, observa-se que o menor caminho, ou seja, o maior valor de *fitness* do melhor indivíduo é obtido na geração 37, isto mostra que para os parâmetros utilizados, o AG pode ser considerado eficiente.

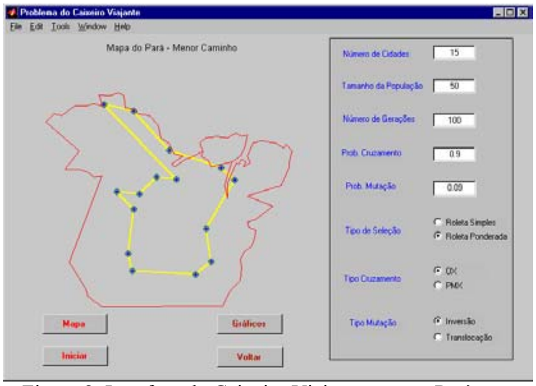

Figura 8: Interface do Caixeiro Viajante com os Parâmetros Escolhidos e o Menor Caminho obtido pelo AG

través de várias simulações, o usuário poderá verificar que os tipos de cruzamento e de mutação não exercem influências significativas na velocidade de convergência do AG. Por outro lado, a utilização da estratégia elitista neste problema é de extrema importância, pois garante que o melhor indivíduo (menor caminho) não seja perdido durante os processos de seleção, cruzamento e mutação. Já o tipo de seleção tem uma grande influencia na velocidade de convergência do AG.

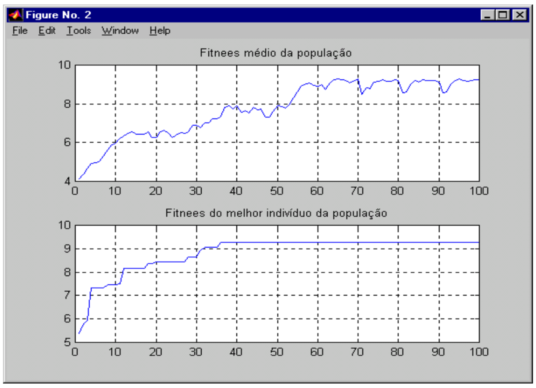

Figura 9: Gráfico da Média e do Melhor Indivíduo a cada Geração para o Caixeiro Viajante

Otimização de Função

Para a Otimização de Função, digitou-se uma função de duas variáveis e escolheu-se a opção maximizar, definindo-se também o intervalo de busca da solução, como mostrado na figura 10.

A figura 10 mostra os parâmetros necessários para executar o AG. Depois de iniciar o AG, observa-se um gráfico em 3D, onde o ponto em vermelho é o valor obtido pelo AG e o ponto em azul é o valor máximo da função.

Na figura 11, observar-se o *fitness* médio e *fitness* do melhor indivíduo da população por geração. Neste ultimo,

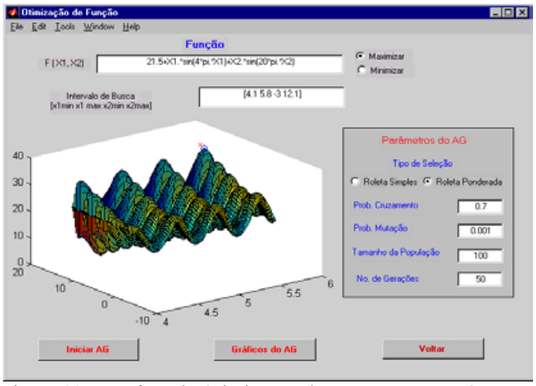

Figura 10: Interface da Otimização da Função com Parâmetros

verifica-se que o ponto máximo da função é obtido na geração 18. A partir da geração 35, observa-se através do gráfico, *fitness* médio, que há uma grande variação na curva da adaptação média da população. Isto ocorre devido a estratégia adotada nas implementações do AG, na qual há um grande aumento na probabilidade de mutação dos indivíduos da população, quando o valor do *fitness* do melhor individuo é mantido por algumas gerações.

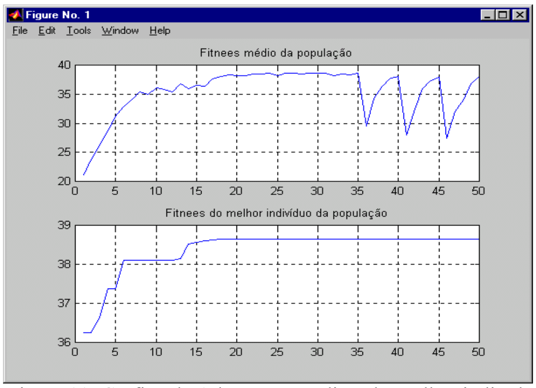

Figura 11: Gráfico da Adaptação Média e do Melhor indivíduo por Geração da Otimização de Função.

Sintonização do PID

Na sintonização do PID, utilizou-se uma planta de 2ª ordem com pólos complexos e conjugados em –0,6 ± j1,9079 e sem zeros, cuja resposta ao degrau é mostrado na figura 12. Na implementação do Algoritmo Genético para esta aplicação, a planta e o controlador PID são discretizados com período de amostragem de 0.05 segundos.

Os parâmetros do AG implementado para sintonizar o Controlador PID e os limites de K_p, K_i e K_d estão mostrados na figura 13, onde se tem o gráfico de saída da planta com o controlador PID, no qual se observa uma redução consideravelmente no número de oscilações e na amplitude do sobressinal do sistema. Observa-se também que o sistema não tem erro em regime permanente, o que era de se esperar por causa da parte integral do controlador. Para esta situação, o AG obteve os seguintes valores dos parâmetros do Controlador PID: Kp=3.56, Ki=2.45 e Kd=0.62.

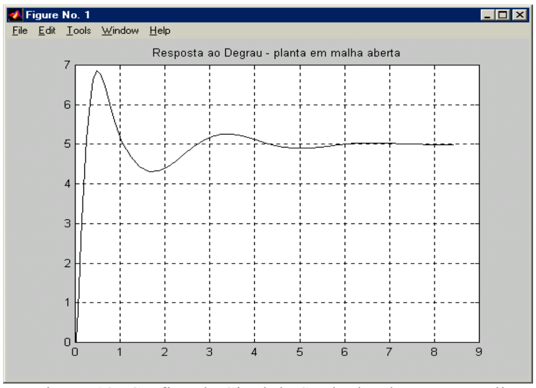

Figura 12: Gráfico do Sinal de Saída da Planta em Malha Aberta

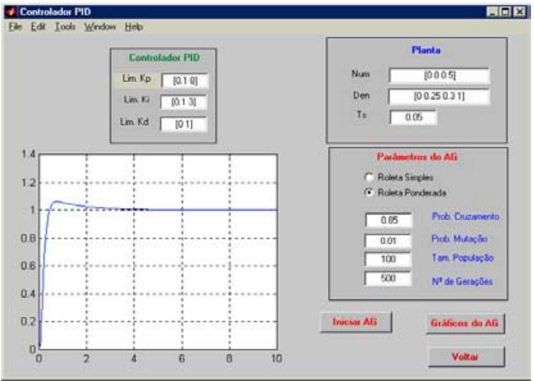

Figura 13: Interface da Sintonização do PID com o Gráfico de Saída da Planta com o Controlador Sintonizado.

Na figura 14 têm-se o *fitness* médio e o *fitness* do melhor indivíduo por geração. Nela pode-se observar que na geração 50 o AG consegue convergir, adaptando sempre o melhor indivíduo da geração anterior à próxima (elitista), melhorando assim o desempenho do controlador.

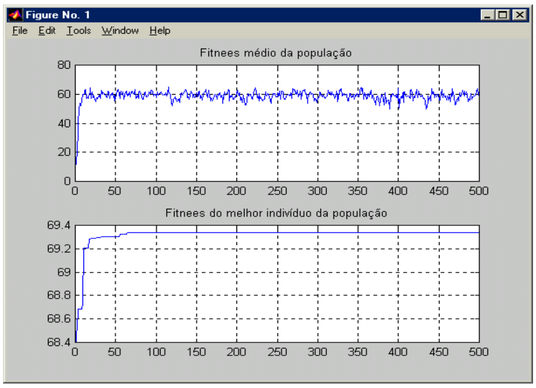

Figura 14: Gráfico da Média e do Melhor Indivíduo por Geração

CONCLUSÕES

As interfaces criadas para a simulação de várias técnicas de implementação de AG foram bastante satisfatórias, conseguindo-se fazer adaptações e colher resultados bastante interessantes, além de se ter conseguido criar interfaces simples e interativas com os usuários.

Observou-se também que as estratégias utilizadas no Algoritmo Genético mostram-se bastante eficazes na solução de problemas de otimização de funções, entre outros. Entretanto, o tempo de processamento gasto para realizar todas as operações, tais como seleção, cruzamento e mutação, é relativamente alto e aumenta consideravelmente quando o número de indivíduos da população cresce. Portanto, a utilização do AG's na forma híbrida, como por exemplo: métodos matemáticos de otimização-AG, RNA-AG, Lógica Fuzzy-AG, podem ser uma ótima opção, para superar esta dificuldade.

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PROJETO DE GRADUAÇÃO EM ENGENHARIA QUÍMICA/UNISANTA

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Resumo *— Criativos, empreendedores, inovadores, atualizados, ousados, éticos, bem-humorados, flexíveis e que gostem de trabalhar em equipe, são alguns dos requisitos considerados básicos para um bom profissional, além de uma formação técnica abrangente na área. Objetivando contribuir com o desenvolvimento destes predicados comportamentais-sociais e multidisciplinares dos graduandos do curso de Engenharia Química da UNISANTA, foi criada as disciplinas Projeto de Graduação em Engenharia Química I e II.*

Palavras chave — Engenharia química, projeto de, graduação, trabalho de conclusão de curso, requisitos comportamentais-sociais e multidisciplinares.

INTRODUÇÃO

O Curso de Graduação em Engenharia Química da Universidade Santa Cecília contempla no nono ciclo da grade curricular a disciplina denominada Projeto de Graduação em Engenharia Química I (PGEQ I) e no décimo e último ciclo a disciplina PGEQ II. A primeira tem por objetivo apresentar, com laboratórios, trabalhos teóricos em grupos, miniexposições orais pelos alunos e pelo docente, o caráter interdisciplinar dos fundamentos desenvolvidos nos oito ciclos anteriores. Objetiva também aplicar estes conceitos multidisciplinares para o projeto, seleção e análise dos principais equipamentos e acessórios de indústrias químicas, petroquímicas, alimentícias e estações de tratamento de efluentes visando fornecer os fundamentos práticos e teóricos para a disciplina PGEQ II. Esta última disciplina enfatiza a criação, o empreendedorismo, o trabalho em grupo, o desenvolvimento da metodologia científica, a pesquisa bibliográfica a apresentação oral (com vários ensaios ao longo do semestre) e a redação de um trabalho científico oriundo de experimento em laboratório livre com um ou mais equipamentos na escala de bancada. Os grupos, de no máximo quatro alunos, possuem um ou dois professores orientadores e recebem suporte de oficina mecânica, elétrica/eletrônica e de computação. Os graduandos apresentam e defendem os trabalhos perante uma banca examinadora composta de pelo menos dois professores ou engenheiros de indústrias da região especialistas no assunto.

Projeto de Graduação em Engenharia Química I

A disciplina semestral PGEQ I, com uma aula por semana, possui uma carga total de 68 horas/semestre.

O desenvolvimento de todos os tópicos desta disicplina se inicia no Laboratório de Engenharia Química (Figura 1) junto com o equipamento ou a planta em estudo onde se discute, com a participação de todos os alunos, a aplicação, os fundamentos teóricos e o equacionamento da unidade ou do processo (motivação e desenvolvimento da exposição oral). O tópico é concluído com problemas e projetos resolvidos em grupos pelos graduandos. A resolução pelos grupos se inicia na sala de aula (acompanhamento continuo do aprendizado e aperfeiçoamento da sociabilidade).

A Tabela 1 apresenta, como exemplo, a programação do curso ministrado no primeiro semestre de 2002.

TABELA 1

PROJETO DE GRADUAÇÃO 1. PRIMEIRO SEMESTRE DE 2002

Aula	Laboratório	Tópico abordado
1	a) Medidores de massa, vazão, (placa de orifício, venturi, rotâmetro, vertedouro e calha parshall), pressão, temperatura, concentração, potência, viscosidade, massa específica e b) Sedimentador contínuo.	ESTÁTICA DOS FLUIDOS E BALANÇO DE MASSA EM REGIME PERMANENTE COM E SEM REAÇÃO
2	a) Tanque com diluição de sal e b) Tanque com várias alimentações e saídas	BALANÇO DE MASSA EM REGIME TRANSIENTE
3	a) Medidores de força, potência e corrente elétrica; b) Caldeira; c) Evaporador; d) Compressor; e) Turbina; f) Válvula de expansão e g) Bocal	BALANÇO DE ENERGIA, ENTALPIA
4	a) Geladeira; b) Ar condicionado e c) Unidade com bomba, caldeira, evaporador, condensador e torre de resfriamento	CICLO DE REFRIGERAÇÃO E CICLO DE VAPOR
5	a) Tanque com aquecimento e b) Termômetro de precisão	BALANÇO DE ENERGIA EM REGIME TRANSIENTE

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[3] Gilmar Alcântara, FEQ/UNISANTA. Rua Oswaldo Cruz, 266, Boqueirãso, 11045-907, Santos, SP, Brazil, unisanta@usc.stcecilia.br.
[4] Volnei de Lemos, FEQ/UNISANTA. Rua Oswaldo Cruz, 266, Boqueirãso, 11045-907, Santos, SP, Brazil, unisanta@usc.stcecilia.br.
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TABELA 1 (CONTINUAÇÃO)

PROJETO DE GRADUAÇÃO 1. PRIMEIRO SEMESTRE DE 2002

Aula	Laboratório	Tópico abordado
6	a) Bombas em série e em paralelo, NPSH; b) Tanques em desnível com escoamento por gravidade e c) Bomba com motor em balanço (potência).	BALANÇO DE ENERGIA MECÂNICA
7	a) Dutos com curvas e bocais	BALANÇO DE QUANTIDADE DE MOVIMENTO
8	a) Viscosímetro rotativo	BALANÇO DIFERENCIAL
9	Revisão	DAS AULAS DE 1 A 8
10	Prova (P.1)	DAS AULAS DE 1 A 8
11	a) Trocador casco e tubos, duplo tubo e a placas; b) Sistema com caldeira, desumidificador, purgadores, válvula redutora de pressão, manômetros e termômetros; c) Evaporador contínuo e d) Cristalizador	TROCA DE CALOR, EVAPORAÇÃO E CRISTALIZAÇÃO
12	a) Moinho de bolas; b) Jogo de peneiras; c) Filtro; d) Sedimentador contínuo; e) Leito fluizado; f) Transportador pneumático; g) Secador de bandeja e h) Spray dryer	OPERAÇÕES COM SÓLIDOS: COMINUIÇÃO, SEPARAÇÃO SÓLIDO/FLUIDO FLUIDIZAÇÃO, TRANSPORTE PNEUMÁTICO E SECAGEM
13	a) Coluna de absorção; b) Coluna de adsorção em leito fixo e c) Tanque com impulsor com adsorvente em líquido	ABSORÇÃO (DE GÁS EM LÍQUIDO); ADSORÇÃO (DE GÁS EM SÓLIDO E ADSORÇÃO (DE LÍQUIDO EM SÓLIDO)
14	a) Coluna de destilação contínua; b) Coluna de destilação em batelada e c) Unidade com quatro extratores	DESTILAÇÃO, EXTRAÇÃO E SEPARAÇÃO POR MEMBRANA
15	a) Reator descontínuo; b) Reator contínuo de mistura e c) Reator tubular	CINÉTICA E REATORES
16	Unidades em miniatura: bombas, tanques (vasos), trocadores de calor, torres de resfriamento, colunas de adsorção, colunas de absorção, colunas de destilação, secadores, separadores sólido/fluido, evaporadores, caldeiras e turbinas	PROCESSOS QUÍMICOS
17	Válvulas de controle e controladores	CONTROLE E AUTOMAÇÃO DE PROCESSOS QUÍMICOS

TABELA 1 (CONTINUAÇÃO)

PROJETO DE GRADUAÇÃO 1. PRIMEIRO SEMESTRE DE 2002

Aula	Laboratório	Tópico abordado
18	Revisão	DAS AULAS DE 11 A 17
19	Prova (P.2)	DAS AULAS DE 11 A 17

PROJETO DE GRADUAÇÃO II

A programação da disciplina PGEQ II lecionada no primeiro semestre de 2002 também, como no caso da PGEQ I, com 68 horas/semestre pode ser vista na Tabela 2.

TABELA 2

PROJETO DE GRADUAÇÃO II. PRIMEIRO SEMESTRE DE 2002

Aula	Atividade
1	Formação dos grupos/Redação técnica (ABNT)
2	Redação em sala: título do trabalho, capa, página de rosto, dedicatória, agradecimentos, sumário e resumo (importância, objetivo, equipamento, metodologia, resultados e conclusões)
3	Redação em sala: introdução com generalidades e objetivos • apresentação individual: resumo e objetivos
4	Redação em sala: revisão bibliográfica • apresentação individual: equações (fundamentos teóricos)
5	Redação em sala: revisão bibliográfica • apresentação individual: introdução com generalidades e objetivo
6	Redação em sala: materiais e métodos (com fundamentos teóricos dos métodos). • apresentação individual: revisão bibliográfica
7	Ensaios com a unidade experimental
8	Ensaios com a unidade experimental
9	Ensaios com a unidade experimental
10	Ensaios com a unidade experimental • apresentação individual; materiais e métodos. • Entrega do texto com os itens: capa, página de rosto, dedicatória, agradecimentos, sumário, resumo, introdução (com generalidades e objetivos), revisão bibliográfica e materiais e métodos (com fundamentos teóricos dos métodos).
11	Ensaios com a unidade experimental
12	Ensaios com a unidade experimental
13	Redação em sala: resultados e discussão • apresentação individual: resultados dos ensaios
14	Redação em sala: conclusões e susgestões, bibliografia e apêndice

TABELA II (CONTINUAÇÃO)
PROJETO DE GRADUAÇÃO II. PRIMEIRO SEMESTRE DE 2002

Aula	Atividade
15	Entrega do texto completo para correção com os itens: capa, página de rosto, dedicatória, agradecicmentos, sumário,resumo, introdução (com generalidades e objetivos), revisão bibliográfica, materiais e métodos, resultados e discussões, conclusões e sugestões, bibliografia e apêndice.
16	Ensaio da apresentação para a defesa
17	Ensaio da apresentação para a defesa
18	Ensaio da apresentação para a defesa
19	Defesa do trabalho
20	Defesa do trabalho.

As disciplinas PGEQ I e II são ministradas no Laboratório de Engenharia Química da UNISANTA (Figura 1, www.quimica.unisanta.br) em uma área aproximada de 500m^2 contendo mais de 40 equipamentos didáticos diferentes, uma oficina mecânica para construção e manutenção destas unidades de ensino, uma sala para computadores, uma sala de aula com equipamentos em miniaturas e maquetes e uma sala de projeto com mais de 700 livros específicos de Engenharia Química. O suporte bibliográfico para as disciplinas supracitados também é fornecido pela Biblioteca Central da Universidade com acervo aproximado de 80 000 volumes.

Figura 1 – Laboratório de Engenharia Química da UNISANTA.

CONCLUSÃO

A boa avaliação destas duas disciplinas feita pelos graduandos, o número crescente de contratações dos formandos por empresas que realizam provas técnicas e dinâmica de grupo e a apresentação e publicação de vários dos trabalhos desenvolvidos na PGEQ II em congressos de iniciação científica, são indicadores positivos da adequação da técnica adotada.

USO DE ENSAIOS EM LABORATÓRIO COMO FERRAMENTA METODOLÓGICA NO ENTENDIMENTO DO PROCESSO DE ADSORÇÃO

Frede O. Carvalho[1]; Christiano C. Rodrigues[2]; Selêude W Nóbrega[3] e Deovaldo M. Júnior[4]

Resumo — *A adsorção é uma operação unitária muito importante na Engenharia Química devido a sua flexibilidade de poder ser usada como uma técnica de separação de tratamento de efluentes. Apesar desta importância, a adsorção ainda não é explorada nos cursos de graduação como a destilação, evaporação e outras operações unitárias. Dentro deste contexto, este trabalho tem como objetivo apresentar um experimento de montagem simples para a determinação da curva de adsorção de um gás em um leito fixo (curva de ruptura). A montagem experimental é composta de uma coluna em aço inox aquecida por resistência elétrica. O leito é formado por partículas de carvão ativado, adsorvente comum e fácil de ser encontrado. Quanto à mistura gasosa utiliza-se o ar e gás amoníaco, que são facilmente encontrados em cilindros nas distribuidoras de gases. A montagem experimental possui ainda válvulas para o controle da vazão dos gases, medidores de vazão e indicadores de temperatura. Os ensaios consistem na determinação da concentração do gás amoníaco na saída do leito, usando titulação em função do tempo. Estes dados são usados para a construção da curva de ruptura que junto com um balanço de massa no leito possibilita o cálculo da capacidade que o leito tem de adsorver o gás amoníaco.*

Palavras-chaves — Adsorção, Operação Unitária, Leito Fixo.

INTRODUÇÃO

O primeiro registro do uso da adsorção se deu na antiguidade, quando se observou o fato de que a água mudava de gosto quando entrava em contato com a madeira queimada [1].

Durante o século XV descobriu-se que alguns materiais possuíam a característica de remover cor de soluções, porém apenas no final do século XVIII utilizou-se comercialmente carvão obtido a partir da queima de ossos para descolorir soluções de açúcar. No entanto, a adsorção só foi usada em escala comercial no início deste século, quando em 1920 as empresas Bayer (Alemanha) e Union Carbide (Estados Unidos) utilizaram esta técnica para recuperação de vapores orgânicos [1].

As referências [1] a [4], entre outras, apresentam definições para o fenômeno da adsorção que podem ser resumidas da seguinte forma: processo de transferência de massa, no qual uma mais substância (adsorvato) presente em uma corrente gasosa ou líquida é transferida de forma seletiva para a superfície de um sólido poroso (adsorvente).

A adsorção pode ser de dois tipos: física ou química. Na adsorção física, também chamada de fissorção, o processo envolve apenas forças físicas, enquanto na adsorção química, também conhecida por quimissorção, o processo envolve reação química.

A adsorção física ocorre quando as moléculas de uma substância são retidas na superfície de um sólido adsorvente, devido à existência de forças físicas, em especial as de Van der Waals, sem a ocorrência de reação química. Neste tipo de adsorção a superfície do adsorvente é coberta com uma camada de moléculas do adsorvato e sobre esta camada outras podem ser depositadas. Este tipo de fenômeno é muito rápido e permite a recuperação do adsorvato através do processo inverso (dessorção), por diminuição da pressão ou aumento da temperatura do sistema, permitindo assim a recuperação do adsorvato e regeneração do adsorvente para posterior reutilização [2].

A recuperação do adsorvato através da dessorção é possível porque na adsorção física as forças de atração envolvidas são mais fracas que as ligações químicas. Em alguns casos a recuperação do adsorvato não é uma prática usual. Dessa forma, o mesmo pode ser removido do adsorvente por destruição térmica ou outra reação química, ou ainda em outros casos o adsorvente impregnado pelo adsorvato é simplesmente descartado [1].

A adsorção química envolve a transferência ou compartilhamento de elétrons entre o adsorvato e o adsorvente, como em compostos químicos. Como uma reação química ocorre entre o adsorvato e o adsorvente, um novo composto é formado na superfície do sólido. A ligação de uma substância quimissorvida sobre a superfície do adsorvente é em geral muito forte, o que torna o processo praticamente irreversível. Assim, a substância quimissorvida não pode retornar a condição inicial através da dessorção, seja pelo aumento da temperatura ou pela diminuição da pressão do sistema. Durante a quimissorção, as moléculas das substâncias removidas são ligadas à superfície do sólido de modo que somente a camada superficial reage e as camadas internas do adsorvente permanecem inutilizadas [2].

A adsorção pode ser realizada em diferentes configurações, no que se refere a sua operação. Entretanto as mais usadas são o reator de mistura para líquidos ou a coluna com leito fixo para líquidos, gases e vapores.

A configuração mais simples de uma unidade adsorvedora é o reator de mistura. Neste tipo de configuração o adsorvente (sólido particulado) é misturado com a corrente líquida contendo o adsorvato até ser alcançado o equilíbrio. Atingido o equilíbrio, as duas fases

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são separadas para tratamento posterior ou disposição final. Entretanto este tipo de configuração não é muito eficiente e, para melhorar a eficiência, é necessário o uso de mais de uma unidade em série [5].

O adsorvedor com configuração do tipo coluna com leito fixo e operação contínua é o mais usado para líquidos, gases ou vapores. Nesta configuração a unidade consiste de uma coluna com leito adsorvente fixo através do qual a corrente do fluido a ser tratado passa continuamente. O fluido é alimentado até que a concentração do adsorvato na saída da coluna alcance um valor pré-determinado ou o valor da concentração na alimentação, definindo assim a saturação do leito. Em geral opera com duas colunas, de forma a permitir que enquanto uma esteja em operação de adsorção a outra esteja em dessorção ou manutenção. A Figura 1 apresenta um desenho esquemático de uma unidade de adsorção com leito fixo [5]-[6].

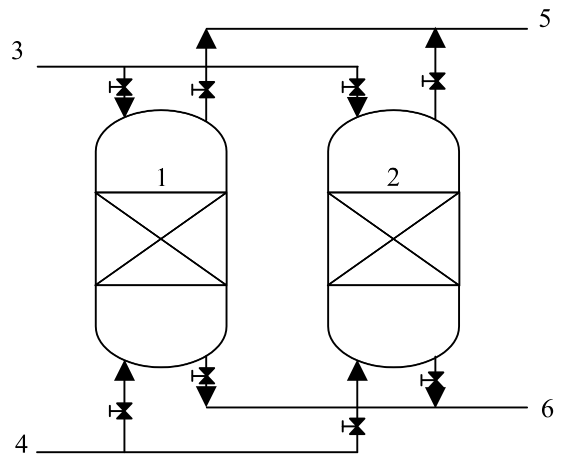

FIGURA 1
ESQUEMA DE UMA UNIDADE ADSORVEDORA: 1) E 2) ADSORVEDORES; 3) ENTRADA DO GÁS A SER PURIFICADO; 4) ENTRADA DO GÁS REGENERADOR; 5) SAÍDA DO GÁS REGENERADOR COM O ADSORVATO; 6) SAÍDA DO GÁS PURIFICADO

O processo de adsorção é muito complexo e depende da natureza química e física do adsorvato e do adsorvente em questão. Dessa forma é muito difícil generalizar o projeto de uma unidade adsorvedora e, em geral, os projetos são feitos baseados em experiências com outros casos similares ou a partir de experimentos em laboratórios ou plantas pilotos [7]. Além da necessidade do conhecimento da natureza química e física do sistema, é necessário também o conhecimento dos parâmetros de equilíbrio e da taxa de adsorção suportada pelo adsorvente. Estas informações são, usualmente, determinadas em experimentos em escala de laboratório [5].

A adsorção tem sido usada com destaque no controle da poluição por gases ou líquidos ou processos de separação, sendo aplicada por exemplo na purificação de gases de exaustão, recuperação de solventes orgânicos e fracionamento de gases [4].

Assim, pelo exposto, o projeto e a análise de uma unidade adsorvedora requer o conhecimento de diversas informações como as características do adsorvente, as relações de equilíbrio entre o adsorvato e adsorvente, a dinâmica do processo, as condições de operação e os conceitos para a ampliação de escala do adsorvedor desde uma unidade de bancada até uma unidade em escala comercial.

Dentro deste contexto, este trabalho tem como objetivo apresentar uma metodologia relativamente simples, para a realização de ensaios de adsorção que permitam a determinação de alguns parâmetros de projeto de uma coluna adsorvedora.

MATERIAIS E MÉTODOS

Material Adsorvente

O adsorvente utilizado foi carvão ativado comercial de biomassa, produzido a partir da casca de coco. Esse material foi inicialmente lavado com água para a retirada do pó mais fino, gerado no processo de produção do mesmo, que fica aderido às partículas maiores. Após secagem, o material foi classificado granulometricamente por peneiramento, permitindo assim uma separação do carvão por faixa de diâmetro de partículas. A faixa de diâmetro das partículas do carvão escolhida e utilizada neste trabalho foi de 1,2 mm a 1,4 mm.

A preocupação em usar um carvão com uma estreita faixa granulométrica, resulta das conclusões apresentadas por [8] que mostram como uma das maiores dificuldades de operação com leito fixo não consolidado, a obtenção da reprodutibilidade e homogeneidade do empacotamento do leito. Assim, para minimizar este problema, o autor recomenda a utilização de um recheio com menor variação possível do diâmetro das partículas, para que o mesmo apresente um empacotamento mais uniforme.

Mistura Gasosa

A mistura gasosa foi produzida usando gás amoníaco (NH_3) puro (99,9%) em cilindros e ar comprimido alimentado de um compressor, que antes de ser misturado com o gás amoníaco passava por um filtro com válvula reguladora de pressão e um leito de sílica gel para eliminação de impurezas e umidade, respectivamente.

Unidade Experimental

A Figura 2 apresenta um desenho esquemático da unidade experimental usada. A mesma é composta, basicamente, por uma coluna de adsorção, um sistema de aquecimento com controle de temperatura, medidores de vazão, frascos absorvedores, medidor de pressão e válvulas.

A coluna de adsorção foi construída em aço inox com 47 mm de diâmetro interno e 400 mm de altura. Na base da coluna foi fixada uma tela de aço inox para servir de suporte ao adsorvente. A 200 mm da base da coluna foi fixado um termopar (item 12 na Figura 2) para medir e permitir o controle da temperatura no interior do leito adsorvente durante os ensaios de adsorção.

O aquecimento do leito foi feito usando uma resistência elétrica, recoberta com miçangas de cerâmica e enrolada ao longo da coluna (item 2 na Figura 2). O isolamento térmico da resistência foi feito por uma manta de fibra de vidro coberta com alumínio corrugado. Esta resistência foi ligada a um controlador de temperatura digital tipo PID modelo Incon CNT 110 (item 10 na Figura 2) que mantinha constante a temperatura no leito.

A unidade possui ainda duas tampas em aço inox para fechar a coluna, com pontos para medida de pressão. A pressão nestes pontos foi medida usando um manômetro digital modelo TSI-MD200D (item 9 na Figura 2). Acoplada a coluna existiam tubulações para entrada e saída da mistura gasosa e rotâmetros (item 4 na Figura 2) para medida das vazões do ar e do gás amoníaco.

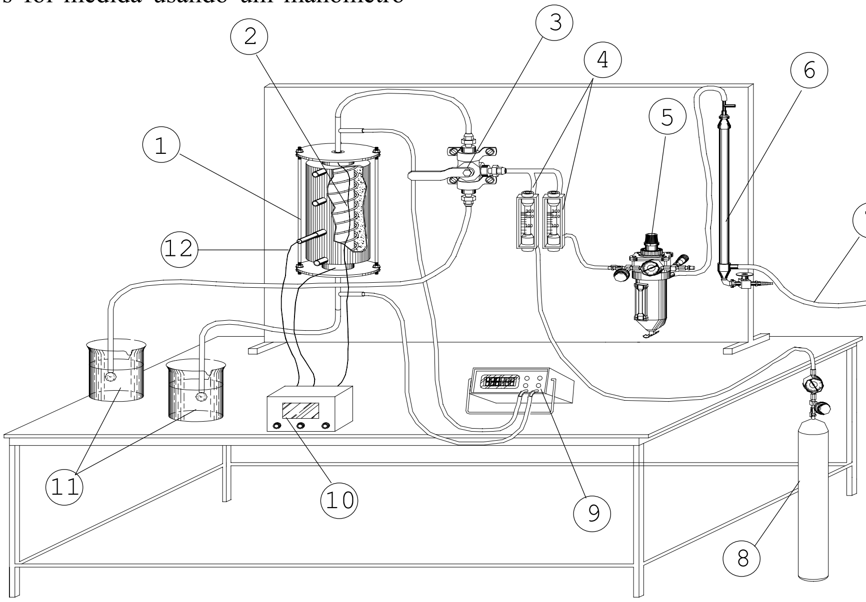

FIGURA 2
UNIDADE EXPERIMENTAL: 1) COLUNA; 2) RESISTÊNCIA ELÉTRICA; 3) VÁLVULA CONTROLADORA DE FLUXO; 4) ROTÂMETROS; 5) VÁLVULA CONTROLADORA DE PRESSÃO DO AR; 6) FILTRO DO AR; 7) LINHA DE AR COMPRIMIDO; 8) CILINDRO DE GÁS AMONÍACO; 9) INDICADOR DE PRESSÃO; 10) CONTROLADOR DE TEMPERATURA; 11) ABSORVEDORES; 12) TERMOPAR.

Medida da Concentração do Gás Amoníaco

A determinação da concentração do gás amoníaco foi feita por titulação, borbulhando-se por um tempo fixo de 1 min a mistura gasosa ar-gás amoníaco em 50 ml de uma solução de ácido bórico gelado. Durante o borbulhamento da mistura gasosa na solução de ácido bórico, a seguinte reação acontece:

$$H_3BO_{3(l)} + NH_{3(g)} \rightarrow NH_4H_2BO_{3(l)} \qquad (1)$$

Após a formação do $NH_4H_2BO_3$, a solução que é incolor assume uma cor marrom com a adição do indicador (solução alcoólica a 1% de verde de bomocresol e vermelho de metila). Esta solução é então titulada com ácido clorídrico padronizado, até que sua coloração mude para verde, quando a seguinte reação acontece:

$$NH_4H_2BO_{3(l)} + HCl_{(l)} \rightarrow H_3BO_{3(l)} + NH_4Cl_{(l)} \qquad (2)$$

Assim, pode-se calcular a concentração do $NH_4H_2BO_3$ através da seguinte equação:

$$V_{NH_4H_2BO_3} . M_{NH_4H_2BO_3} = V_{HCl} . M_{HCl} \qquad (3)$$

na qual $V_{NH_4H_2BO_3}$ é o volume do borato de amônia, $M_{NH_4H_2BO_3}$ é a molaridade do borato de amônia, V_{HCl} é o volume do ácido clorídrico e M_{HCl} é a molaridade do ácido clorídrico.

Com a concentração do $NH_4H_2BO_3$ calculada, é possível determinar a massa de amônia presente na solução, após o borbulhamento da mistura gasosa, usando a seguinte equação:

$$m_{NH_3} = M_{NH_4H_2BO_3} . V_{NH_4H_2BO_3} . PM_{NH_3} \qquad (4)$$

na qual m_{NH_3} é a massa de amônia e PM_{NH_3} é o peso molecular da amônia.

Calculada a massa de amônia, determina-se a concentração do gás amoníaco na mistura gasosa dividindo-se a massa pelo volume de gás borbulhado na solução de ácido bórico através da seguinte equação:

$$C_{NH_3} = \frac{m_{NH_3}}{Q_T . t_b} \qquad (5)$$

na qual C_{NH_3} é a concentração da amônia, Q_T é a vazão total da mistura gasosa e t_b é o tempo de borbulhamento.

Ensaios de Adsorção

Os ensaios de adsorção realizados para a construção das curvas de ruptura usaram as condições de operação apresentadas na Tabela 1.

TABELA 1

CONDIÇÕES DOS ENSAIOS DE ADSORÇÃO

Variáveis	Valores Utilizados
C_o [ppm]	600; 1200; 1800; 2400
T_L [ºC]	40
M_L [g]	100
Q_T [l/h]	160

Uma massa fixa de carvão previamente seca em estufa era pesada e colocada na coluna de adsorção. O preenchimento da coluna com o carvão era feito sempre da mesma maneira, procurando manter constante a altura de queda do carvão na coluna, seguida de batidas na mesma, a fim de que o leito obtido fosse o mais homogêneo e reprodutível possível [8].

Após a montagem do leito e da coluna iniciava-se o aquecimento, fixando-se no controlador de temperatura (item 10 na Figura 2) o valor desejado para o ensaio de adsorção em questão. Atingida a temperatura pré-fixada, alimentava-se ar puro ao leito com a mesma vazão total da mistura gasosa (ar-gás amoníaco) a ser usada na adsorção, com o objetivo de ajustar a temperatura do leito e as perdas de carga na linha de alimentação da coluna e de medida da concentração inicial nas condições de operação. Estabilizada a temperatura, a alimentação do ar era desviada da coluna de adsorção para um frasco absorvedor e, iniciava-se então a alimentação do gás amoníaco puro na linha de ar com uma vazão conhecida, objetivando produzir uma mistura com a concentração inicial (C_0) desejada. Após o início da alimentação do gás amoníaco na linha de ar, media-se a concentração do mesmo na corrente gasosa. Quando a concentração atingia o valor desejado, media-se a concentração por mais três vezes em intervalos de 10 minutos e, se o valor permanecesse constante, a mistura era então desviada para a coluna de adsorção. Caso contrário, faziam-se ajustes na vazão do gás amoníaco e novas medidas da concentração eram feitas, até que o valor desejado fosse alcançado. As concentrações de entrada C_0 experimentais tiveram um pequeno desvio em relação às fixadas na Tabela 1.

Após o início da alimentação da mistura gasosa na coluna, media-se a concentração de saída (C) a cada 5 minutos até que a concentração na saída (C) fosse igual à concentração na entrada (C_0).

Terminado o período de adsorção, a alimentação da mistura gasosa era interrompida, o aquecimento desligado e a coluna desmontada para limpeza e o início de um novo ensaio. Os dados obtidos para a concentração de saída em função do tempo de adsorção e da concentração de entrada, foram utilizados na construção das curvas de ruptura de cada ensaio.

Em geral, as curvas de ruptura típicas do processo de adsorção apresentam o formato de "S". Assim, a partir dos dados experimentais, foram feitos ajustes para cada ensaio, usando-se uma equação do tipo sigmoidal, para encontrar uma expressão que representasse a relação de C/C_0 em função de t. A expressão usada foi:

$$\frac{C}{C_0} = \frac{t}{t + A' e^{-B' t}} \qquad (6)$$

na qual C é a concentração do adsorvato na fase fluida na saída da coluna, C_0 é a concentração do adsorvato na fase fluida na entrada da coluna, t é o tempo de adsorção e A' e B' parâmetros de ajuste de (6).

Os dados experimentais de todos os ensaios foram usados para ajustar (6), estes ajustes foram utilizados nos cálculos referentes às curvas de ruptura.

Cálculo da Capacidade de Adsorção

A capacidade de adsorção pode ser calculada usando as curvas de ruptura e um balanço de massa no leito [3].

A massa adsorvida pelo leito pode ser calculada usando a seguinte expressão:

$$M_{ads} = M_e - M_s \qquad (7)$$

na qual, M_{ads} é a massa de adsorvato adsorvida, M_e é a massa do adsorvato que entra no leito e M_s é a massa do adsorvato que sai do leito.

As massas do adsorvato que entra e sai no leito podem ser representadas por (8) e (9) respectivamente:

$$M_e = Q_T C_0 t \qquad (8)$$

$$M_s = Q_T C_o \int_0^t \frac{C}{C_o} dt \qquad (9)$$

nas quais Q_T é a vazão total da mistura gasosa.

Substituindo-se (8) e (9) em (7), obtém-se a expressão para o cálculo da M_{ads}:

$$M_{ads} = Q_T C_o \int_0^t \left(1 - \frac{C}{C_o} \right) dt \qquad (10)$$

Com a massa adsorvida, calculada a partir de (6) e (10), pode-se determinar a capacidade de adsorção do leito dividindo-se a massa adsorvida pela massa do leito:

$$W = \frac{M_{ads}}{M_L} \qquad (11)$$

na qual W é a capacidade de adsorção do leito e M_L é a massa do leito.

A capacidade de adsorção foi determinada como sendo a máxima na condição de saturação definida para a razão de C/C_0 igual a 0,95.

Determinação das Isotermas de Adsorção

As isotermas de adsorção foram construídas usando os valores das capacidades máximas de adsorção do gás amoníaco, calculadas por (11), em função da concentração de entrada do gás amoníaco na mistura gasosa.

Após a construção das isotermas de adsorção, foi feito um ajuste usando-se os modelos de isotermas propostos por Langmuir e Freundlich [9], representados por (12) e (13), respectivamente:

$$W = \frac{W^0.b.C_o}{1 + b.C_o} \quad (12)$$

$$W = K_F C_0^{\frac{1}{n}} \quad (13)$$

nas quais b é o coeficiente de adsorção de Langmuir, W^0 é a concentração do adsorvato no adsorvente para uma cobertura total dos poros disponíveis, K_F é a constante característica da isoterma de Freundlich e n é o expoente da isoterma de Freundlich.

RESULTADOS E DISCUSSÕES

A Figura 3 mostra que de uma forma geral os ensaios produziram curvas de ruptura típicas para o processo de adsorção, com um formato de "S". Os dados das curvas mostradas na Figura 1 foram usados para ajustar (6). Todos os ajustes apresentaram um coeficiente de correlação (R^2) superior a 0,98. Este valor para o coeficiente de correlação, é um indicativo de que a equação de ajuste do tipo sigmoidal escolhida, representou de forma coerente os dados experimentais.

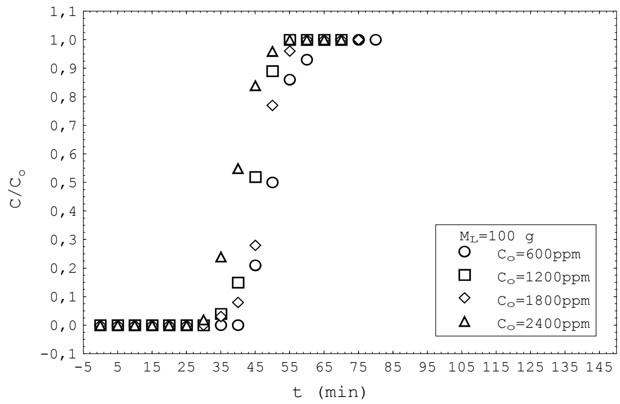

FIGURA 3
CURVAS DE RUPTURA

A partir das curvas de ruptura e dos resultados dos ajustes de (6), foi determinada a massa do gás amoníaco adsorvida (M_{ads}) na condição de saturação (C/C_0=0,95) em cada ensaio usando (10) e a capacidade de adsorção do leito (W) usando (11). Estes resultados foram usados para construir a isoterma de adsorção, apresentada na Figura 4.

A curva obtida foi comparada aos modelos de isotermas de Langmuir (12) e Freundlich (13). A Tabela 2 apresenta os parâmetros de ajuste de cada modelo de isoterma bem como o coeficiente de correlação (R^2) para cada ajuste. Os resultados apresentados na Figura 4 e Tabela 2 mostram que os pontos experimentais podem ser representados de forma coerente pelos dois modelos de isotermas usados. A determinação da isoterma experimental e a escolha de um modelo ou equação que represente esta isoterma é essencial, pois as isotermas são largamente usadas nos projetos de unidades adsorvedoras e na modelagem de sistemas de adsorção.

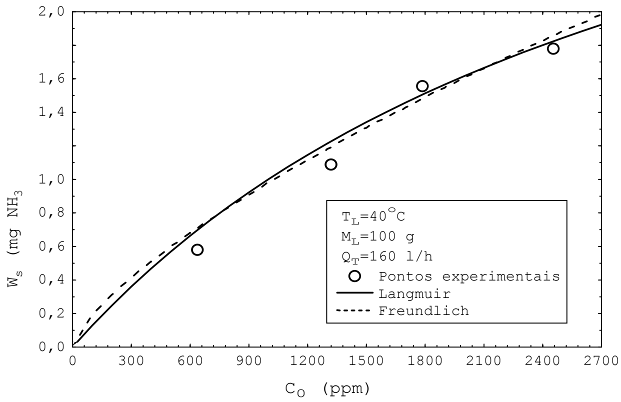

FIGURA 4
ISOTERMA DE ADSORÇÃO

TABELA 2
PARÂMETROS DE AJUSTE DA ISOTERMA DE ADSORÇÃO

Langmuir		
W^0	b	R^2
4,034	3,17 x 10^{-4}	0,993
Freundlich		
K_F	n	R^2
3,5 x 10^{-3}	1,245	0,994

CONCLUSÕES

A partir dos resultados obtidos e da discussão apresentada, pode-se concluir que os objetivos propostos neste trabalho foram satisfatoriamente alcançados, pois a unidade experimental e a metodologia usada permitiram a obtenção de dados que caracterizam a operação de adsorção, indicando que a realização destes ensaios de montagem relativamente simples é uma importante ferramenta para a fixação dos conceitos desta operação unitária importante na indústria química.

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ORGANIZAÇÕES DE AGENTES NO APOIO AO ENSINO-APRENDIZAGEM DE COMPUTAÇÃO

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Resumo — *Este artigo apresenta dois ambientes de aprendizagem modelados com metodologias que adotam a visão de estrutura organizacional na forma de agentes: O TUTA, um sistema tutor inserido na Arquitetura de uma Classe Virtual Adaptativa (ACVA) para aprendizagem colaborativa de orientação a objetos e o MEDIADOR, um ambiente multiagente para apoio a aprendizagem orientada a projetos, com suporte inteligente à mediação, utilizado no contexto da disciplina de compiladores. Na metodologia utilizada, a idéia é comparar um sistema baseado em agentes a uma organização humana constituída de papéis como "aprendiz", "professor" (ou "mediador"), "monitor" e assim por diante. A metodologia utilizada nos dois ambientes fornece uma notação que oferece suporte às características de continuidade temporal, autonomia, reatividade, flexibilidade e pró-atividade dos agentes modelados e implementados. As arquiteturas resultantes desses trabalhos são mostradas de acordo com as vantagens e desvantagens observadas.*

Palavras-chave — *TUTA, MEDIADOR, ambientes de aprendizagem, sistemas multiagentes, compiladores, orientação a objetos, metodologia orientada a agentes.*

I. INTRODUÇÃO

A ampla utilização das redes de computadores tem favorecido significativas mudanças nos mecanismos de apoio ao processo de ensino-aprendizagem.

No contexto da computação, o ensino precisa de inovações, porque envolve conhecimentos cuja aprendizagem requer grande esforço cognitivo para aprender assuntos como programação de computadores, utilização de softwares, bem como o manuseio de softwares específicos [9]. Elaborar soluções algorítmicas para problemas reais, utilizando um conjunto de comandos de uma linguagem exige do aluno diversos conhecimentos como capacidade de abstração e organização das idéias, conhecimentos e habilidades que caracterizam um programador como perito [10].

Segundo Rodrigues et al. [9], a prática de ensino de computação é afetada pela inexistência de literatura de referência sobre construção e utilização de metodologias e materiais didáticos para o ensino de computação, pela escassez de professores com capacitação específica para ensinar computação e pela ignorância sobre as potencialidades das tecnologias educacionais, especialmente da multimídia e dos softwares de autoria que são recursos indispensáveis ao processo ensino-aprendizagem [10]. O desafio tem sido, atualmente, a adoção de suportes computacionais que conduzam a um processo de construção do conhecimento ao mesmo tempo em que destacam a importância da aprendizagem colaborativa e cooperativa [16].

Nos últimos anos, é freqüente a utilização da tecnologia de agentes no projeto e construção de ambientes de aprendizagem informatizados, devido às potencialidades que incorporam em tais ambientes. A adequação do paradigma de agentes para o desenvolvimento de ambientes de aprendizagem pode ser demonstrada pelo poder de abstração desse paradigma para se construir aplicações complexas [14]. Esse paradigma permite a modelagem de entidades autônomas que, juntas, cooperam para atingir um objetivo comum[14]. Assim, ambientes de aprendizagem podem ser observados como organizações onde interagem agentes humanos e agentes artificiais [8].

Este artigo apresenta duas aplicações desenvolvidas para apoiar o processo de ensino-aprendizagem de computação, modeladas sob a forma de estruturas organizacionais e discute as arquiteturas utilizadas e as vantagens e desvantagens dessas arquiteturas. Para isso, constitui-se de mais 5 seções distribuídas da seguinte forma: a seção 2 apresenta a modelagem de organizações de agentes em ambientes de aprendizagem; as seções 3 e 4 apresentam duas aplicações modeladas segundo a visão organizacional de agentes, a seção 5 apresenta as considerações sobre as arquiteturas projetadas e, finalmente, a seção 6 apresenta as conclusões finais desse artigo.

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II. ORGANIZAÇÕES DE AGENTES EM AMBIENTES DE APRENDIZAGEM

Dentre as abordagens utilizadas na modelagem e construção de ambientes e softwares de apoio à aprendizagem, as metodologias que consideram a visão de sistema organizacional como abstração para a organização de agentes apresentam-se bastante apropriadas [14]. Essas metodologias são fundamentadas na visão de um sistema como uma organização computacional que consiste de vários papéis interagindo e são aplicáveis a uma grande variedade de sistemas, tratando dos aspectos nos níveis macro (de sociedade) e micro do agente.

No contexto da utilização de agentes em ambientes de aprendizagem, a idéia é comparar um sistema baseado em agentes a uma organização humana constituída de papéis como "aprendiz", "professor" (ou "mediador"), "monitor" e assim por diante. Assim, os papéis são instanciados como os indivíduos existentes: existirá um indivíduo que assume o papel de aprendiz, outro que assume o papel de professor ou monitor, entre outros. Porém, a instanciação não é necessariamente estática. Muitos indivíduos podem assumir o papel de "mediador", por exemplo. Além disso, não existe necessariamente um mapeamento um-para-um entre papéis e indivíduos. Também é possível que um indivíduo assuma muitos papéis, como um aprendiz também ser um "monitor". Da mesma forma, pode haver muitos indivíduos que assumam um único papel como, por exemplo, "observador" [14].

Dentre as metodologias que apóiam a visão de sistemas baseados em agentes como organizações tem-se as metodologias GAIA[17] e ZEUS [4]. A metodologia ZEUS [4] é direcionada para a construção de agentes utilizando-se uma ferramenta computacional. Essa metodologia, assim como a GAIA [17] é orientada a papéis, que atuam no sistema para realizar suas responsabilidades [1]. GAIA [17] e ZEUS [4] capturam aspectos como: a flexibilidade do agente, o seu comportamento autônomo, as interações e a complexidade das estruturas organizacionais nas quais os agentes estão inseridos.

Na GAIA [17], um papel é definido através de três atributos: responsabilidades, permissões, e protocolos. A influência da modelagem de papéis, apesar de estar diretamente relacionada com a análise e especificação de requisitos, se estende à fase de projeto no momento em que um agente executa vários papéis, e assim, durante o projeto, os papéis previamente identificados serão compostos em agentes e só então a funcionalidade associada com cada papel pode ser implementada.

III. TUTA

O TUTA [10] é um sistema tutor para um grupo de alunos virtual e está inserido na Arquitetura de uma Classe Virtual Adaptativa (ACVA) [7]. Esse tutor considera os princípios e modelos de um sistema tutor inteligente e o seu domínio no contexto da ACVA é representado pela reutilização de entidades didáticas (associadas a um domínio) contidas em um servidor.

A arquitetura ACVA prevê que uma Classe Virtual é composta por um grupo de camadas. Desta forma, o acoplamento das camadas *SF_Grupo* e *SF_Básicos* permitem que se tenha um sistema tutor dedicado a aprendizagem de um domínio em particular e associado a um determinado nível de conhecimento. Os principais elementos que devem fazer parte dessa camada são os seguintes (figura 1): o servidor de entidades didáticas associadas a um domínio, o comportamento dos alunos durante a sessão, que são considerados através dos perfis individuais e de grupo, o funcionamento do tutor do ponto de vista didático, o qual depende da recuperação e execução de estratégias didáticas e a interação amigável dos estudantes com o sistema tutor, que é controlada pela interface.

A modelagem do ambiente realizou-se através de duas etapas: a primeira fase orientada a agentes e a segunda fase orientada a objetos.

Utilizando a metodologia GAIA, os elementos do TUTA (Interface, Servidor de Entidades Didáticas, Estratégias Didáticas, Comportamento do Aluno, Comportamento do Grupo e Coordenador de Grupo), são comparados a departamentos, responsáveis pela execução das atividades de treinamento do TUTA.

Após a identificação dos agentes associados aos papéis e a comunicação entre eles propõe-se então a arquitetura detalhada do tutor baseada em agentes [13] baseada nos modelos de papéis, interações, agentes e comunicação da metodologia GAIA [9].

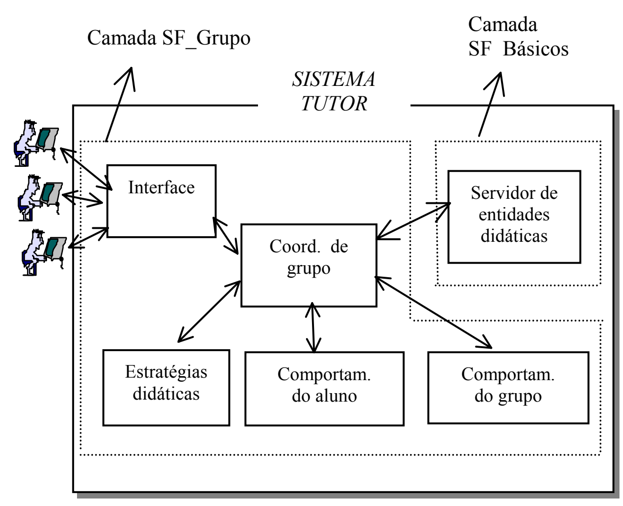

FIGURA 1
ELEMENTOS DO TUTOR NO CONTEXTO DA ACVA

O Funcionamento geral do TUTA ocorre da seguinte forma [10]: Presumindo que um *Professor* possua interesse em utilizar o TUTA para auxiliá-lo no ensino de Orientação a Objetos, ele então notifica o *Administrador do Sistema* a respeito do seu interesse. O *Administrador do Sistema*, após analisar a solicitação do *Professor*, autoriza-o a utilizar o sistema. A partir de então, o *Professor* poderá a qualquer momento, realizar a especificação de um curso; sessões; estratégias e entidades didáticas a serem utilizadas; e registrar os alunos e o grupo de alunos que podem participar do curso. Essa especificação deve ocorrer através do *Agente Interface Especificação Curso.* O *Agente Interface Especificação Curso,* por sua vez, solicitará que um dos agentes pertencente ao *Conjunto de Agentes* armazene os dados em suas respectivas bases de dados (*Sessões de Ensino*, *Estratégias Didáticas*, *Domínio*, *Perfil Aluno* e *Perfil Grupo*). A partir de então, torna-se possível a execução das sessões de um curso. Cada *Aluno*, após receber uma notificação de que haverá sessão, pode utilizar o sistema para participar de tal sessão, juntamente com os demais membros do *Grupo* e o *Professor*. A participação dos Alunos em uma sessão de treinamento do TUTA acontece através dos *Agentes Interfaces de Sessão*. Cada aluno possui o seu *Agente Interface Aluno* e o *Professor* também possui o seu *Agente Interface Professor.* A seguir, o *Conjunto de Agentes do TUTA* começa então a agir, conforme uma *Estratégia Didática* especificada pelo *Professor*.

O funcionamento de uma sessão de ensino no TUTA é determinado pelo módulo de estratégias (multi-estratégias) que permite a interpretação de qualquer estratégia definida pelo professor (armazenada em arquivo). Uma estratégia é representada via um conjunto de primitivas básicas que permitem a definição de um algoritmo-estratégia e o Módulo Didático é representado por um Servidor de Objetos Didáticos, que está associado aos objetos do domínio.

IV. MEDIADOR

Dentre as várias abordagens pedagógicas existentes, a pedagogia de projetos se apresenta como uma abordagem que valoriza a aprendizagem significativa, a cooperação e a colaboração entre aprendizes e mediadores [13]. Essa abordagem é particularmente adequada em disciplinas onde o desenvolvimento do projeto aparece de forma faseada, como é o caso do projeto de um compilador.

Na pedagogia de projetos, os projetos se constituem em planos de trabalho e conjunto de atividades que podem tornar o processo de aprendizagem mais dinâmico, significativo e interessante para o aprendiz, deixando de existir a imposição dos conteúdos de maneira autoritária. A partir da escolha de um tema, o aprendiz realiza pesquisas, investiga, registra dados, formula hipóteses, analisa, aplica e avalia o artefato construído [3].

Nesta concepção, cada mediador tem suas formas de avaliação e acompanhamento dos projetos desenvolvidos pelos grupos que acompanha. Essas formas de avaliação e acompanhamento podem ser vistas como estratégias de acompanhamento. As estratégias de acompanhamento devem servir para identificar falhas no processo, além de motivar o componente do grupo (ou o próprio grupo) para desenvolver as atividades planejadas.

O problema das estratégias de acompanhamento tratado no MEDIADOR é similar ao problema nos Sistemas Tutores Inteligentes (STIs), tratado em Giraffa [6], com a diferença de se tratar de "acompanhamento" de projetos e não de tutoria.

Em um projeto, a responsabilidade e a autonomia dos aprendizes são essenciais. Os aprendizes são co-responsáveis pelo trabalho e pelas escolhas realizadas ao longo do desenvolvimento do projeto. Em geral, essas escolhas são realizadas em equipe, motivo pelo qual a cooperação está também quase sempre associada ao trabalho de projetos. A cooperação é necessária uma vez que o desenvolvimento de um projeto envolve complexidade e resolução de problemas. O objetivo central do projeto constitui um problema que exige o planejamento e a execução de uma ou mais atividades para sua resolução. A execução dessas atividades acontece de forma faseada, ou seja, percorrendo várias fases, conforme sugerem Menezes et al. [8]: identificação do problema, observação e mineração, coleta de dados, análise, síntese, formalização e validação.

No contexto da educação orientada a projetos, as ferramentas de suporte ao processo de aprendizagem a distância devem prever um meio de comunicação multidirecional eficiente entre seus participantes (mediadores, aprendizes e colaboradores), de forma a substituir a interação pessoal entre eles por uma ação sistemática e conjunta de diversos recursos didáticos, proporcionando um aprendizado independente e flexível aos estudantes. Ao contrário de uma sala de aula, não é necessário que todos os aprendizes estejam realizando as mesmas tarefas, ou em um mesmo ponto em relação ao conteúdo e objetivos do curso. Dessa maneira, seria inadequado insistir na prática de longas aulas de exposição de temas e na hierarquia de papéis de mediadores e aprendizes [13].

O foco, na abordagem orientada a projetos, é acompanhar as participações para promover a integração do aprendiz no processo de aprendizagem. No decorrer desse processo, algumas das dificuldades relatadas durante o acompanhamento dos projetos, por mediadores de cursos a distância, *online* e orientados por projetos, permitiram definir uma classificação para esses problemas, detalhados por Tavares et al. [13]: acompanhamento dos aprendizes, sobrecarga dos mediadores, agendamento e comunicação. Os problemas são levantados a partir da experiência dos mediadores do curso de especialização *lato sensu* em informática educativa (formação de multiplicadores do PROINFO), iniciado em Julho de 1999. Esse curso usou, como suporte à interação, a primeira versão do AmCorA, baseado na proposta de Menezes et al [8]. O ambiente AmCorA segue uma abordagem construtivista, com forte enfoque à cooperação. A partir dos problemas identificados, um conjunto de requisitos é proposto por Tavares et al. [13].

Para atender aos requisitos identificados, o MEDIADOR propõe uma solução em três camadas, adicionando uma camada de inteligência sobre as camadas: (C1) de serviços básicos de interação (ferramentas síncronas e assíncronas); e, (C2) desenvolvimento de projetos (cronograma de planejamento do grupo e área para desenvolvimento e divulgação dos projetos). Na camada inteligente (C3) estão as diversas organizações de agentes montadas para facilitar o uso do ambiente pelos participantes do processo (aprendizes, mediadores, colaboradores, administradores do ambiente etc.). O foco da proposta do MEDIADOR está na modelagem de uma organização de agentes que atuam na camada de inteligência (C3), monitorando e acompanhando os aprendizes (e grupos de aprendizes) no desenvolvimento de seus projetos através da definição de estratégias de acompanhamento definidas pelos mediadores.

A modelagem do ambiente em camadas facilitou o desenvolvimento do ambiente, reduzindo a complexidade e permitindo o desenvolvimento incremental. As camadas C1 e C2 foram modeladas segundo o paradigma da orientação a objetos, facilitando, a seguir, a identificação dos agentes da camada de mediação (suas responsabilidades, interações e permissões).

A organização de agentes é baseada nos seguintes papéis (figura 2): Gerenciador de Estratégias; Interpretador de Estratégias; Executor de Estratégias; Acompanhador do Aprendiz; Acompanhador de Grupo; Acompanhador do Mediador; Mensageiro; .Atendente do Mediador e Atendente do aprendiz; Avaliador de Estratégias; Gerenciador de Ferramenta de Comunicação; Gerenciador da Agenda; e, Gerente de Projeto e Gerenciador de Conteúdo.

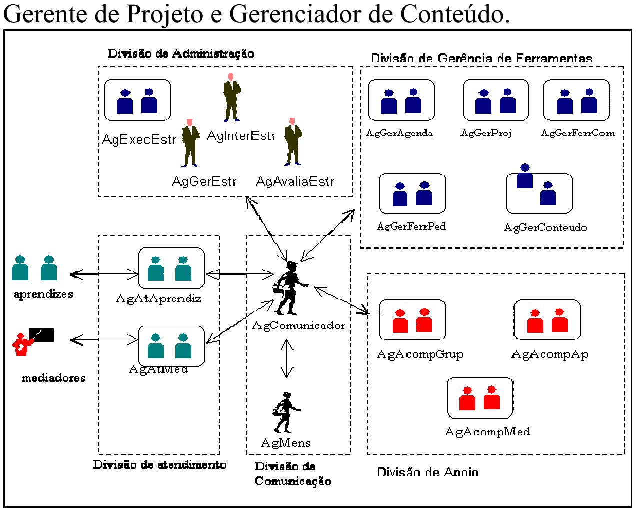

FIGURA 2
MODELO ORGANIZACIONAL DOS AGENTES NO MEDIADOR

Para compreender o funcionamento da organização, abstraindo-se a função do agente comunicador, basta analisar os papéis desempenhados pelos agentes: o agente Gerenciador de Estratégias (AgGerEstr) monitora as estratégias e quando identifica que houve modificação em alguma estratégia, ou se nova estratégia foi definida, encaminha para Interpretador de Estratégias (AgInterEstr). Este, por sua vez, interpreta cada uma das táticas definidas nas estratégias e encaminha para o Agente Executor de Estratégias (AgExecEstr). O agente Executor repassa a condição estabelecida na estratégia para o agente responsável por analisá-la (nesse caso, os agentes monitores das ferramentas presentes na divisão de gerência de ferramentas) e aguarda até que todas as condições estabelecidas na estratégia sejam encontradas. Nesse caso, o Executor de Estratégia deve iniciar a execução (que pode ser, por exemplo, uma mudança na agenda, um aviso no mural ou o envio de mensagens, via e-mail ou através de agentes de interface). Quando mais de uma condição remete à execução de ações, o executor deve solicitar a revalidação das condições encontradas. Por exemplo, a condição 1 pode ter sido encontrada 3 dias de antecedência da condição 2 e, nesse momento, a condição 1 pode não ser mais válida para aquele aprendiz.

V. CONSIDERAÇÕES QUANTO À ARQUITETURA

Os sistemas baseados em agentes são tipicamente distribuídos e, portanto, o projeto de arquitetura deve descrever a organização de um modo que seja possível implementar a comunicação entre eles. Nessa etapa, algumas considerações devem ser feitas, considerando o modo de comunicação e a arquitetura que deve atender a essa comunicação [5]: arquitetura (agentes são, tipicamente, processos separados, que podem estar processando no mesmo espaço ou em máquinas diferentes) e comunicação (suportando mensagens de um agente para um conjunto de agentes ou um-para-um).

O modo de comunicação um-para-um remete ao projeto de organizações baseadas na arquitetura ponto-a-ponto (P2P - peer-to-peer) [14]. Essa arquitetura apóia-se na comunicação direta entre os agentes, garantindo a extensibilidade da organização, de forma que qualquer agente, em qualquer momento, pode juntar-se à organização e instantaneamente colocar novos serviços à disposição da organização. Segundo Szoke, [13], a tolerância à falhas nesses sistemas é grande, visto que a derrubada de algum agente não oferece impacto ao resto da organização (dependendo, é claro, do tipo de serviço oferecido). Uma desvantagem dessa topologia é que, na prática, os algoritmos requeridos para manter uma organização com a comunicação descentralizada acarretam uma sobrecarga, dificultando o desempenho de organizações com um grande número de agentes.

De outro modo, uma arquitetura que atende aos requisitos de comunicação baseia-se na inserção de um agente para gerenciar a comunicação no sistema. Nesse modelo, cada agente, quando inicializado, se apresenta ao comunicador indicando sua posição na rede e fornecendo a sua identificação dentro da organização. Essa opção garante flexibilidade e autonomia, além de permitir a inserção de novos agentes sem necessitar alterar toda a organização (os endereços dos agentes não precisam ser conhecidos a priori, apenas o endereço do comunicador deve ser conhecido). A opção pelo comunicador possibilita executarem vários agentes pertencentes à mesma organização [14]. Esses agentes podem estar em máquinas distintas na rede (Internet ou intranet) ou na mesma máquina e, desde que conheçam o endereço do comunicador, podem interagir entre si e realizar os objetivos da organização. Também é possível criar organizações cooperativas entre si, bastando criar outros agentes de comunicação, cada um responsável por uma organização [1], configurando uma topologia P2P híbrida [13].

Um dos pontos fracos da opção pelo agente comunicador está no aspecto centralizador. A centralização torna a organização vulnerável no sentido em que toda a troca de mensagens depende do agente de comunicação. Caso ocorram falhas com esse agente, toda a organização fica comprometida. Além disso, existe uma sobrecarga causada pela retransmissão da mensagem. Na opção por essa topologia, essa sobrecarga deve ser avaliada em relação à sobrecarga causada pelos algoritmos para gerenciar a comunicação na topologia totalmente descentralizada.

VI. Conclusões

Este artigo apresentou dois ambientes de aprendizagem modelados com metodologias que adotam a visão de estrutura organizacional na forma de agentes. A adequação desse paradigma na construção de ambientes de aprendizagem pode ser observada pelo fato desses sistemas proverem uma estrutura, onde se pode identificar entidades cooperantes, que podem ser diretamente modelados como sendo agentes autônomos, com suas próprias capacidades e potencialidades. A metodologia utilizada fornece uma notação que oferece suporte às características de continuidade temporal, autonomia, reatividade, flexibilidade e pró-atividade dos agentes. Nas duas aplicações apresentadas, o poder da abstração de agentes (na verdade, de papéis) foi combinado com um projeto e implementação orientado a objetos significativamente simplificado e com alta reusabilidade. A grande vantagem dessas estruturas está nas características pró-ativas que incorporam aos ambientes

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PARNASO: UMA FERRAMENTA P2P PARA O COMPARTILHAMENTO DE PROJETOS DE COMPILADORES

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Resumo — *Dentre as arquiteturas que favorecem a comunicação e a colaboração entre aprendizes está a arquitetura P2P (peer-to-peer), cujos objetivos podem ser diretamente associados com as propriedades desejáveis em comunidades virtuais: autonomia, privacidade e dinamismo. Essas propriedades permitem que os membros de um grupo criem e administrem as áreas de colaboração de sua comunidade em tempo real. Este artigo apresenta a modelagem e implementação de uma ferramenta para o compartilhamento de projetos de compiladores, utilizando a arquitetura P2P e técnicas de extração de informações em textos. Essa ferramenta é utilizada no contexto do projeto MEDIADOR, inserindo recursos para facilitar o compartilhamento dos projetos desenvolvidos e em desenvolvimento. No protótipo implementado, um aprendiz pode compartilhar artefatos (partes de códigos e documentação do seu projeto), identificar outros artefatos compartilhados, comunicar-se com outros aprendizes e professores, capturar artefatos compartilhados por outros aprendizes, pesquisar e interagir com outros aprendizes através de recursos de comunicação síncrona ou assíncrona.*

Palavras-chave — MEDIADOR, pedagogia de projetos, compiladores, arquitetura P2P, compartilhamento, cooperação, colaboração.

I. INTRODUÇÃO

Nos últimos anos, é freqüente a utilização de redes de computadores no projeto e construção de ambientes de ensino-aprendizagem informatizados, devido às potencialidades que incorporam em tais ambientes. Apesar desse fato, características como o auxílio personalizado, o suporte à cooperação e o suporte às atividades docentes para lidar com um grande volume de usuários demonstram que os ambientes disponíveis, atualmente, ainda sofrem de limitações, que envolvem desde os aspectos tecnológicos até os aspectos pedagógicos. No sentido de minimizar essas limitações, as pesquisas prosseguem e, a cada tempo, os ambientes são melhorados com novas tecnologias que fundamentam as teorias de ensino-aprendizagem adotadas.

Segundo Brito et al. [1], o aspecto cooperação, considerado uma característica essencial nos ambientes de aprendizagem, vem sendo atacado com o uso de novas tecnologias de desenvolvimento de sistemas, como a incorporação das redes de computadores, a exemplo da Internet, facilitando a colaboração e a cooperação entre pessoas geograficamente distantes. Tais possibilidades expandem as vantagens obtidas com o uso de ambientes de aprendizagem através do reuso de conhecimento, do compartilhamento de informações e da cooperação, além de possibilitarem a integração entre pessoas com diferentes interesses e níveis de conhecimento.

No contexto do modelo pedagógico, dentre as abordagens existentes, destaca-se a pedagogia de projetos, que se insere como uma abordagem que valoriza a cooperação e a colaboração entre aprendizes e mediadores. O MEDIADOR [1] é um ambiente desenvolvido em três camadas: serviços básicos de interação (*chat*, fórum, mural, agenda etc.); camada de projetos, contemplada com ferramentas para apoiar a pedagogia de projetos; e, uma camada de suporte inteligente às atividades de mediação, exercido por uma organização de agentes. O PARNASO está inserido na camada de projetos como um recurso de compartilhamento que permite que os membros de um grupo criem e administrem as áreas de colaboração de sua comunidade em tempo real.

Este artigo constitui-se mais 5 seções distribuídas da seguinte forma: a seção 2 discute a pedagogia de projetos; a seção 3 apresenta o projeto MEDIADOR; a seção 4 apresenta o PARNASO, ferramenta para o compartilhamento de projetos inserida na camada de projetos do MEDIADOR e, finalmente, a seção 5 apresenta as considerações finais desse trabalho.

II. COMUNIDADES VIRTUAIS E A PEDAGOGIA DE PROJETOS

A proposta da pedagogia de projetos reflete os conceitos construtivistas de Piaget, as idéias de Vygotsky [13] e, mais recentemente, encontra nas idéias de Resnick [11], sobre o construcionismo distribuído, um suporte computacional através da utilização de redes de computadores. Além disso, as mídias interativas têm trazido motivação entre os

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aprendizes, fortalecendo a cooperação e colaboração entre eles.

Segundo Resnick [11], a teoria construcionista de Papert, está baseada em dois tipos de construções. A primeira construção baseia-se na afirmação de que as pessoas constroem conhecimento de acordo com as suas experiências no mundo. A última defende que as pessoas constroem um novo conhecimento apenas quando estão comprometidas com o mesmo.

A teoria do construcionismo distribuído [11] é uma extensão do construcionismo, e está voltada especificamente para as atividades de projeto e construção. Resnick defende na sua teoria que uma forma efetiva para construir conhecimento é através de atividades colaborativas que envolvam as etapas de projeto e construção de artefatos em ambientes distribuídos (através de redes de computadores, correio eletrônico, grupos de discussão, fóruns, etc.), que são classificadas em três categorias [11]:

- **construções de discussões**: ocorrem através da troca de idéias, dicas e estratégias sobre projetos e atividades de construção;
- **construções de compartilhamento**: ocorrem através do compartilhamento de construções, encorajando os estudantes a experimentar e "reusar" construções uns dos outros;
- **construções de colaborações**: ocorrem através da colaboração em tempo real dos projetos de construção.

Segundo Costa [3], as comunidades virtuais só sobrevivem quando estas preenchem alguma necessidade real do participante. O participante dessa comunidade precisa conhecer antecipadamente e de forma clara quais são os benefícios que obterá com essa participação. Nesse sentido, é fundamental, para a formação de uma comunidade que a aprendizagem seja significativa. Na concepção da pedagogia de projetos, os alunos são distribuídos em grupos, cabendo a cada grupo investigar e construir conhecimento sobre um tema. A escolha do tema é norteada pela curiosidade visando com isso tornar a aprendizagem mais significativa possível [1].

As atividades cooperativas, através de ambientes distribuídos baseados na Internet não constituem uma mídia recente. Em 1976, Turoff, citado por Rheingold [12], criou um sistema conhecido como "EIES" (*Electronic Information Exchange System*), que tinha por objetivo o intercâmbio de informações eletrônicas. Segundo Turoff, a conferência através de computadores promove um meio para grupos de pessoas exercitarem a capacidade de "inteligência coletiva". Resnick [11] reconhece que a cognição e a inteligência não são propriedades de um indivíduo, mas surgem de interações de uma pessoa com o ambiente ao seu redor. Partindo desse princípio, diversos projetos têm tentado utilizar as redes de computadores para facilitar o desenvolvimento de "comunidades de construção de conhecimento" nas quais grupos de pessoas constroem e estendem coletivamente o conhecimento [11].

Segundo Castells [2], comunidades virtuais são redes eletrônicas de comunicação interativa autodefinidas, organizadas em torno de um interesse ou finalidade compartilhados. Curiosamente, Rheingold [12] destaca um lado prático das comunidades virtuais. Em uma conversa "real", não é educado manter uma comunicação em paralelo com várias pessoas ao mesmo tempo, porém isso não constitui problema algum em um ambiente virtual.

As colaborações, nas comunidades virtuais, são formadas a partir de afinidades de interesses [10] e, no desenvolvimento de um projeto, a partir da escolha do tema e do "par mais capaz" [14]. Segundo Lévy [5], a responsabilidade individual, a opinião pública e seu julgamento aparecem fortemente, favorecendo o desenvolvimento de uma forte moral social, e de um conjunto de leis não escritas, que governam suas relações, principalmente com relação à pertinência das informações que circulam na comunidade.

Desta forma, durante os processos de interação, os participantes ativos constroem e expressam competências, as quais são reconhecidas e valorizadas de imediato pela própria comunidade. A total liberdade de opinião é conferida igualmente a todos os participantes de uma comunidade, sendo que as regras que regulam as interações são construídas na coletividade, isso se opõe fortemente a qualquer tipo de censura e possibilita a exploração de novas formas de opinião pública [2].

A presença de conflitos é parte integrante no desenvolvimento dos projetos, principalmente quando um dos participantes infringe as regras acordadas pela comunidade. Por outro lado, constroem-se afinidades, parcerias e alianças intelectuais, sentimentos de amizade e outros, que se desenvolvem nos grupos de interação, da mesma forma como acontece entre pessoas que se encontram fisicamente para conversar. A personalidade de cada participante acaba sendo expressa através do estilo de escrita, competências, tomadas de posição, evidenciadas nas relações humana presentes nas interações [2].

Também dessa forma, as comunidades não estão livres de manipulações e enganações, assim como em qualquer outro espaço de interação social. Uma comunidade que sustente uma rede ativa de comunicação aprenderá com seus próprios erros, pois serão difundidos por toda a rede e voltarão para a sua origem ao longo de laços de realimentação. Devido a isso, a comunidade pode corrigir seus erros, auto-regulando-se e auto-organizando-se [2].

III. PROJETO MEDIADOR

No contexto da educação orientada a projetos, as ferramentas de suporte ao processo de aprendizagem a distância devem prever um meio de comunicação multidirecional eficiente entre seus participantes (mediadores, aprendizes e colaboradores), de forma a substituir a interação pessoal entre eles por uma ação sistemática e conjunta de diversos recursos didáticos, proporcionando um aprendizado independente e flexível aos estudantes. Ao contrário de uma sala de aula, não é necessário que todos os aprendizes estejam realizando as mesmas tarefas, ou em um mesmo ponto em relação ao conteúdo e objetivos do curso. Dessa maneira, seria inadequado insistir na prática de longas aulas de exposição de temas e na hierarquia de papéis de mediadores e aprendizes [TAV 2001].

O MEDIADOR [1] propõe uma solução em três camadas (figura 1), adicionando uma camada de inteligência sobre as camadas de serviços básicos de interação e desenvolvimento de projetos. Nessa camada estão as diversas organizações de agentes montadas para facilitar o uso do ambiente pelos participantes do processo (aprendizes, mediadores, colaboradores, administradores do ambiente etc.). O foco da proposta do MEDIADOR está na modelagem de uma organização de agentes para atuar na camada de inteligência no sentido de facilitar o trabalho dos mediadores.

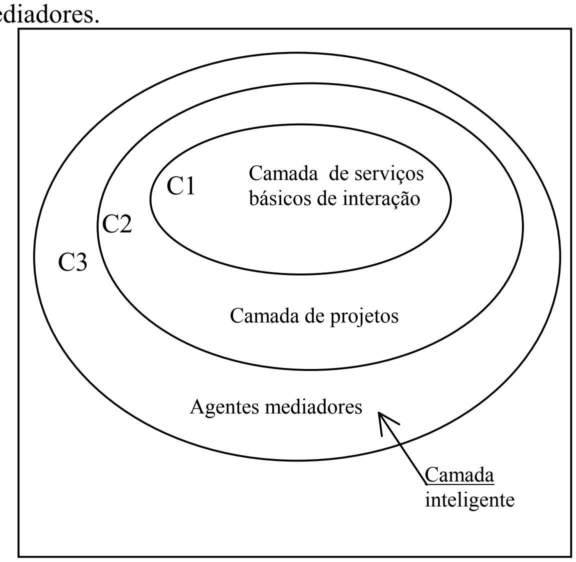

FIGURA 1
MEDIADOR – ARQUITETURA EM 3 CAMADAS

A modelagem do ambiente em camadas facilitou o desenvolvimento do ambiente, reduzindo a complexidade e permitindo o desenvolvimento incremental.

O PARNASO está inserido na camada de projetos, como uma ferramenta para facilitar o compartilhamento dos diversos arfefatos produzidos no desenvolvimento dos projetos de aprendizagem.

IV. PARNASO

Distribuído através de uma arquitetura de rede de computadores peer-to-peer (P2P), o PARNASO permite o compartilhamento de artefatos (partes de códigos e documentação do seu projeto). Essa ferramenta atende alguns requisitos da camada de serviços básicos de interação (C1) permitindo que aprendizes e mediadores possam comunicar-se entre si, capturar artefatos compartilhados por outros aprendizes, pesquisando e interagindo com outros aprendizes através de recursos de comunicação síncrona ou assíncrona.

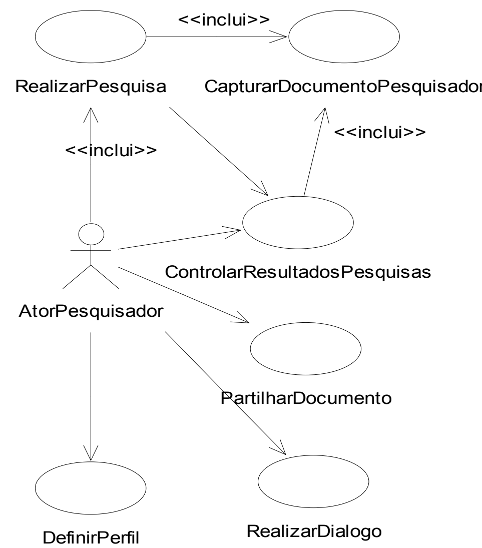

FIGURA2
DIAGRAMA DE CASOS DE USO DO PARNASO

O aprendiz, ao entrar no PARNASO pode, portanto realizar uma série de tarefas, como: compartilhar artefatos, identificar os artefatos partilhados de sua autoria (ou do seu grupo), comunicar-se com outros aprendizes/mediadores, capturar artefatos compartilhados por outros grupos, identificar as áreas/subáreas do seu projeto, procurar aprendizes e procurar artefatos através de atributos como título, autor(es), palavras-chaves e tipo de artefato (gramática, especificação do analisador léxico, ações semânticas, estruturas de dados).

Arquitetura *peer-to-peer*

A arquitetura de redes *peer-to-peer* (P2P) não é baseada em nenhum conceito novo. Diferente da arquitetura cliente/servidor, a arquitetura P2P é uma classe de sistemas e aplicações que emprega a distribuição de recursos para executar tarefas de forma descentralizada. Devido à descentralização, a arquitetura P2P possui vantagens como [7]: maior escalabilidade, infra-estrutura barata e integração de recursos de *hardware* mais barata e autônoma.

Alguns dos objetivos da arquitetura P2P podem ser diretamente associados com as características desejáveis em comunidades virtuais:

- **Autonomia, anonimato e privacidade:** Em muitos casos, usuários de um sistema distribuído estão pouco dispostos a confiar em qualquer provedor de serviços centralizado, preferindo que todos os dados sejam trabalhados localmente, mantendo o anonimato e a privacidade, e impedindo que qualquer pessoa ou provedor acesse informações particulares. Sistemas P2P apóiam esse nível de autonomia, pois estes sistemas requerem que o nó local trabalhe em nome de seu usuário [7];

- **Dinamismo**: Sistemas de P2P apóiam ambientes altamente dinâmicos, ou seja, recursos, como nós computacionais, estão entrando e saindo continuamente do sistema [7];
- **Possibilitar a Comunicação ad-hoc (sem a necessidade de nenhuma estrutura pré-existente a não ser os computadores que irão se comunicar) e a colaboração**: os membros sócios podem ir e vir, baseados talvez em seus locais físicos ou em seus interesses atuais. A arquitetura P2P se ajusta naturalmente a esta classe de aplicações, pois trata essas mudanças de maneira mais natural e dinâmica por não possuir uma infra-estrutura estática [7], permitindo que os membros de grupos criem e administrem áreas de colaboração em tempo real [9];
- **Agentes inteligentes**. Segundo P2PWG [9], a arquietetura P2P permite que redes de computadores trabalhem dinamicamente juntas, utilizando agentes inteligentes. Os agentes residem nos computadores clientes e informam vários tipos de informação, tanto para a rede, quanto para o cliente. Agentes também podem iniciar tarefas em benefício de outros clientes. Essa característica é particularmente interessante no caso do projeto MEDIADOR [1] que conta com uma camada de agentes inteligentes.

A arquitetura P2P é diversificada devido às diversas topologias que atende, porém a classificação não é de consenso na literatura especializada. Szoke [13] classifica as topologias dessa arquitetura em centralizada, descentralizada e híbrida.

A topologia centralizada baseia-se na centralização do despacho de tarefas em um componente central. Esse componente é responsável apenas por receber e distribuir as consultas feitas pelos *peers*, com o mínimo de computação necessária. As vantagens dessa topologia são a simplicidade de manutenção dos dados, uma facilidade maior de impor regras de segurança e de se medir a escalabilidade do sistema. As desvantagens dessa topologia são a dificuldade de estender as redes e a ausência de tolerância a falhas [13].

Na topologia descentralizada, cada *peer* é ao mesmo tempo cliente e servidor. Para se juntar a uma rede, o *peer* anuncia a sua entrada a um determinado grupo de *peers*, e estes últimos anunciam a entrada do primeiro *peer* a outros *peers* e esse processo continua recursivamente, e o processo de busca de dados nos *peers* segue o mesmo caminho do anúncio de entrada na rede. Segundo Szoke [13](, a escalabilidade de sistemas agrupados nessa topologia é difícil de avaliar. Em teoria, quanto mais computadores forem adicionados, mais escalável torna-se a rede. Na prática, os algoritmos requeridos para manter um sistema descentralizado coerente possuem um grande sobrecarga. Se essa sobrecarga cresce com o tamanho do sistema, então o mesmo perde em escalabilidade.

A grande vantagem de sistemas descentralizados é a facilidade de extensão e a tolerância à falhas. A queda de um *peer* não oferece impacto ao resto do sistema.

Segundo Szoke [13], um sistema descentralizado nem sempre é melhor ou pior que um sistema centralizado. A escolha depende inteiramente das necessidades da aplicação. A simplicidade dos sistemas centralizados torna o gerenciamento e controle mais fácil, enquanto os sistemas descentralizados crescem de maneira mais eficaz, são mais tolerantes a falhas ou quedas.

Existem ainda as topologias híbridas, que segundo Szoke [13], são ao mesmo tempo centralizados e descentralizado, apresentam poder de escalabilidade e capacidade de extensão, enquanto mantém a coerência dos sistemas centralizados. Segundo Minar [8], nessa topologia, a maioria dos *peers* tem um relacionamento com um *super-peer* centralizado, e direcionam todas as requisições para o mesmo. Porém, ao invés de utilizarem servidores centralizados eles dividem a capacidade de toda a rede entre vários servidores, propagando as requisições.

Topologia do PARNASO

A arquitetura *Peer-to-peer* é utilizada no PARNASO (figura 3) para atender parte dos requisitos identificados a partir dos problemas encontrados na utilização massiva da arquitetura cliente servidor. Além disso, diversos autores [8] [13] [7] referenciam essa arquitetura como sendo a mais apropriada, atualmente, para aplicações que oferecem suporte à colaboração e cooperação.

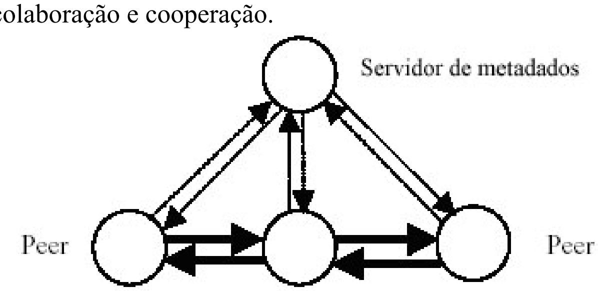

FIGURA 3
TOPOLOGIA DO PARNASO

Apesar da arquitetura P2P sugerir que os participantes da rede comuniquem-se uns com os outros, isso não implica que o sistema deve ser totalmente descentralizado. Um sistema P2P pode ter um servidor de meta-dados, para manter, como neste caso, um servidor de nomes. Esse servidor mantém as informações necessárias com o objetivo de registrar e coordenar as ações dos participantes [4].

Para representar as consultas, selecionaram-se técnicas que atendem a usuários com necessidades dinâmicas e amplas, visto que o sistema é voltado para usuários sem perfil pré-definido. A escolha das técnicas de representação de documentos baseou-se nas características dos artefatos compartilhados. As técnicas escolhidas são descritas a seguir [6]: associação de atributos (título, autor, data de criação);

consultas por navegação, através de *links; b*usca por artefatos relevantes (indicação do próprio autor). A apresentação de resultados é realizada através da localização do *peer* que contém o documento em conjunto com a sua identificação (título, autor)

Os artefatos compartilhados são identificados nas seguintes classes: *units* (procedimentos semânticos), analisadores sintáticos (arquivos com extensão '.y') e analisadores léxicos (arquivos com extensão '.l').

As aplicações Peer e Servidor de Metadados são projetadas para atender às solicitações dos pesquisadores. Embora os métodos implementados sejam específicos para cada uma dessas aplicações, algumas operações podem ser descritas de modo genérico, conforme apresentado na Tabela I.

TABELA I

EVENTOS E AÇÕES DAS APLICAÇÕES PEER E SERVIDOR DE METADADOS

Evento	Descrição	Tarefas que devem ser realizadas
Inicializar	O pesquisador inicia a conexão com o servidor de metadados ou entre peers	Autenticar conexão entre peers ou entre peer e servidor metadados; Preparar metadados;
Solicitar Informações Compartilhadas	Ocorre quando um peer realiza uma pesquisa;	Realizar uma pesquisa junto ao servidor metadados; Capturar material que se encontra em outros peers;
Responder Solicitações	Ocorre quando o servidor metadados recebe qualquer solicitação de um peer;	Direcionar conexões entre peers; Responder a solicitações de pesquisa;
Responder Solicitação Material	Um peer recebe a solicitação de transferência de um arquivo a partir de outro peer;	Transferir material para um peer requisitante;
Finalizar	Uma transferência de material entre peers é finalizada, ou quando um peer desconecta-se do servidor metadados.	Limpar metadados; Finalizar conexão entre peers e/ou entre peer e servidor metadados;

V. CONCLUSÕES

A ampla utilização das redes de computadores e das redes de comunicação, de modo geral, tem favorecido significativas mudanças tecnológicas nos mecanismos de apoio ao processo de ensino-aprendizagem. O desafio tem sido, atualmente, a adoção de suportes computacionais que conduzam a um processo de construção do conhecimento ao mesmo tempo em que destacam a importância da aprendizagem colaborativa e cooperativa. Nesse sentido, uma diversidade de suportes computacionais tem sido desenvolvida para apoiar abordagens que, como a pedagogia de projetos, tornem a aprendizagem significativa, além de favorecer a interação entre os diversos participantes do processo. Nesse contexto encontra-se o MEDIADOR [1] como uma proposta para apoiar a abordagens de projetos. O PARNASO, por utilizar uma arquitetura que naturalmente favorece a construção de comunidades de aprendizagem, está, inicialmente, inserido no contexto do projeto MEDIADOR [1], pode encontrar utilidade nos mais diversos ambientes de aprendizagem, uma vez que fornece o suporte básico para o compartilhamento e as discussões entre os aprendizes.

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UM AMBIENTE VIRTUAL PARA APRENDIZAGEM DE COMPILADORES COM SUPORTE INTELIGENTE À MEDIAÇÃO

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Resumo — *Dentre as abordagens pedagógicas existentes, a pedagogia de projetos (PP) destaca-se por valorizar a cooperação e a colaboração entre os envolvidos. Essa abordagem é particularmente adequada em disciplinas onde o desenvolvimento do projeto aparece de forma faseada, como é o caso do projeto de um compilador. Para suportar a PP, é imprescindível a utilização adequada de tecnologias que apóiem a cooperação, característica considerada essencial em um ambiente de apoio à aprendizagem (AAA), e que, atualmente, é tratada com a utilização de recursos como as redes de computadores. Tais possibilidades expandem as vantagens obtidas com o uso de AAA por meio do reuso de conhecimento, do compartilhamento de informações e da cooperação. Este trabalho apresenta a modelagem e implementação de um ambiente virtual para a aprendizagem orientada a projetos com suporte inteligente à mediação, modelado em três camadas: camada de interação, camada de projetos (para apoiar o desenvolvimento de projetos de compiladores) e camada de inteligência (contendo uma organização de agentes para facilitar o trabalho dos mediadores).*

Palavras-chave — *MEDIADOR, agentes inteligentes, pedagogia de projetos, compiladores, compartilhamento, cooperação, colaboração.*

I. INTRODUÇÃO

Nos últimos anos, é freqüente a utilização da tecnologia de agentes no projeto e construção de ambientes de aprendizagem informatizados, devido às potencialidades que incorporam em tais ambientes. Apesar desse fato, características como o auxílio personalizado, o suporte à cooperação e o suporte às atividades docentes para lidar com um grande volume de usuários demonstram que os ambientes disponíveis, atualmente, ainda sofrem de limitações, que envolvem desde os aspectos tecnológicos até os aspectos pedagógicos. No sentido de minimizar essas limitações, as pesquisas prosseguem e, a cada tempo, os ambientes são melhorados com novas tecnologias que fundamentam as teorias de ensino-aprendizagem adotadas.

O aspecto cooperação, considerado uma característica essencial nos ambientes de aprendizagem, vem sendo atacado com o uso de novas tecnologias de desenvolvimento de sistemas, como a incorporação das redes de computadores, a exemplo da Internet, facilitando a colaboração e a cooperação entre pessoas. Tais possibilidades expandem as vantagens obtidas com o uso de ambientes de aprendizagem através do reuso de conhecimento, do compartilhamento de informações e da cooperação, além de possibilitarem a integração entre pessoas com diferentes interesses e níveis de conhecimento.

Além da utilização de redes de computadores, o paradigma de agentes, visa reduzir a complexidade de construção dos ambientes de aprendizagem, permitindo que um sistema trabalhe de maneira cooperativa, considerando agentes humanos externos e agentes artificiais internos ao sistema, num esforço de tornar os ambientes de aprendizagem mais adaptativos e interessantes para seus usuários. Muito do esforço empenhado pelos pesquisadores na utilização do paradigma de agentes no contexto dos ambientes de aprendizagem está na tentativa de incorporar características pró-ativas, reduzindo o sobrecarga dos mediadores (professores) com tarefas repetitivas e permitindo uma adaptação maior ao estilo próprio do aprendiz (alunos) e do mediador.

Do ponto de vista do mediador, ainda são relatadas experiências onde a sobrecarga de trabalho com o acompanhamento dos aprendizes é substancialmente maior do que no ensino presencial [9]. Do ponto de vista dos aprendizes, maior flexibilidade e adaptabilidade são necessárias para que o modelo pedagógico adotado possa ser adequado ao modelo do aprendiz. Essas limitações se devem tanto ao modelo pedagógico adotado, quanto à necessidade de ferramentas que apóiem o mediador nas suas atividades de acompanhamento.

No contexto do modelo pedagógico, dentre as abordagens existentes, destaca-se a pedagogia de projetos, que se insere como uma abordagem que valoriza a cooperação e a colaboração entre aprendizes e mediadores. Para suportar a pedagogia de projetos, é imprescindível a utilização adequada de tecnologias que auxiliam o trabalho cooperativo entre os participantes do processo.

No contexto do ensino de computação, a disciplina de compiladores freqüentemente exige do aprendiz o desenvolvimento de um projeto (o projeto do compilador). Esse desenvolvimento ocorre de forma faseada , através da construção dos diversos componentes do compilador.

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Esse artigo apresenta a arquitetura para um ambiente de aprendizagem para apoiar o ensino de compiladores, baseado na pedagogia de projetos e com suporte inteligente à mediação. Constitui-se de mais 4 seções distribuídas da seguinte forma: a seção 2 apresenta a pedagogia de projetos no curso de compiladores; a seção 3 apresenta o MEDIADOR, um ambiente para apoio a aprendizagem baseada em projetos com suporte inteligente à mediação e, finalmente, a seção 6 apresenta as considerações finais.

II. PROJETOS DE COMPILADORES

Na concepção da pedagogia de projetos, os alunos são distribuídos em grupos, cabendo a cada grupo investigar e construir conhecimento sobre um tema. A escolha do tema é norteada pela curiosidade visando com isso tornar a aprendizagem mais significativa possível [9].

Nessa abordagem, os projetos se constituem em planos de trabalho e conjunto de atividades que podem tornar o processo de aprendizagem mais dinâmico, significativo e interessante para o aprendiz, deixando de existir a imposição dos conteúdos de maneira autoritária. A partir da escolha de um tema, o aprendiz realiza pesquisas, investiga, registra dados, formula hipóteses, analisa, aplica e avalia o artefato construído [1]. A aprendizagem é significativa uma vez que a definição de um tema para o projeto pressupõe que o aprendiz possui algum conhecimento prévio sobre o tema proposto, levando em consideração que este se encontra dentro de seu foco de interesse.

A proposta da pedagogia de projetos reflete, portanto, os conceitos construtivistas de Piaget, as idéias de Vygotsky [10], e, mais recentemente, encontra nas idéias de Resnick [7], sobre o construcionismo distribuído, originado do construcionismo de Papert [6] um suporte computacional através da utilização de redes de computadores.

Nessa abordagem, não há professor no sentido clássico do termo. Ao invés disso, cada projeto conta com um, ou mais, mediadores. O envolvimento dos aprendizes é fundamental, sendo uma característica chave do trabalho de projetos. Além disso, a responsabilidade e a autonomia dos aprendizes são essenciais: os aprendizes são responsáveis pelo trabalho e pelas escolhas ao longo do desenvolvimento do projeto [9].

Grégoire & Laferrière [3] defendem a idéia de que um projeto será bem sucedido se a participação dos aprendizes e sua contribuição ao tema tiverem sido importantes para o grupo de maneira geral. Isso acontece se os artefatos de um pequeno grupo de aprendizes atraírem o interesse de outros, permitindo que esses outros expandam ou refinem o seu próprio processo de aprendizagem. Os artefatos são produtos produzidos ou consumidos nas diversas atividades durante a construção do projeto [9].

Em um projeto, a responsabilidade e a autonomia dos aprendizes são essenciais. Os aprendizes são co-responsáveis pelo trabalho e pelas escolhas realizadas ao longo do desenvolvimento do projeto. Em geral, essas escolhas são realizadas em equipe, motivo pelo qual a cooperação está também quase sempre associada ao trabalho de projetos. A cooperação é necessária uma vez que o desenvolvimento de um projeto envolve complexidade e resolução de problemas. O objetivo central do projeto constitui um problema que exige o planejamento e a execução de uma ou mais atividades para sua resolução [5]. A execução dessas atividades acontece em fases [4]: identificação do problema, observação e mineração, coleta de dados, análise, síntese, formalização e validação.

Ao criar um novo curso, o mediador deve definir [9]:

- um conjunto de tarefas a serem realizadas, que podem ser, por exemplo, as etapas do processo descritas na seção anterior;
- a estratégia de execução das tarefas;
- os métodos e as técnicas que serão usados no desenvolvimento de cada tarefa;
- as ferramentas que vão automatizar a aplicação dos métodos e técnicas.

O mediador tem a liberdade de decidir, por exemplo, diferentes estratégias (figura 1) para conduzir os aprendizes durante a aprendizagem, podendo, por exemplo, realizar uma ou mais fases de análise e síntese, antes de partir para a fase de formalização, ou adotar modelos cíclicos em que após a fase de validação, o processo volta à fase de identificação do problema, permitindo que o aprendiz vá amadurecendo seus conceitos a cada iteração do ciclo.

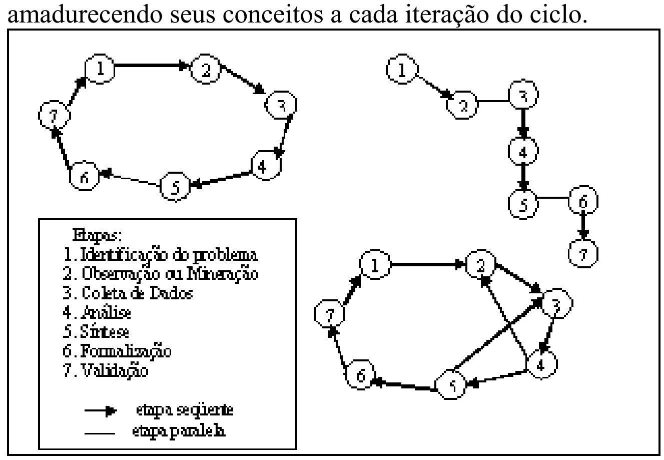

FIGURA 1
ALGUMAS FORMAS DE ESTRUTURACAO DO PROCESSO DE APRENDIZAGEM [9]

No contexto do ensino de compiladores, a pedagogia de projetos pode facilitar a integração com outras disciplinas, como a engenharia de software, favorecer a aprendizagem cooperativa e promover maior envolvimento do aprendiz. Nessa disciplina, o aprendiz, freqüentemente desenvolve o projeto de um compilador de acordo com as especificações de linguagem definidas pelo professor. O projeto de compilador é desenvolvido através de um processo, definido pelos aprendizes, sendo muitas vezes ad-hoc. Apesar disso, o aluno tem a oportunidade de aplicar conceitos e técnicas estudadas no desenvolvimento prático do seu projeto.

III. MEDIADOR

O MEDIADOR [1] é um ambiente virtual para a aprendizagem orientada a projetos modelado em três camadas (figura 1): camada de interação, camada de projetos e camada inteligente, onde atua uma organização de agentes para facilitar o trabalho dos mediadores.

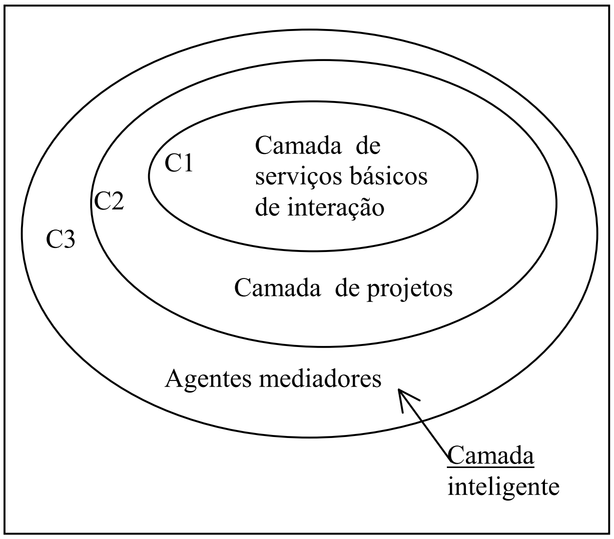

FIGURA 1

MEDIADOR – ARQUITETURA EM 3 CAMADAS [1]

Camada de serviços básicos de interação

Nesta camada estão presentes as ferramentas que facilitam a interação entre os participantes. Essas ferramentas visam atender os requisitos de interação entre os participantes. Entre as ferramentas de interação assíncrona que compõem essa camada, estão: Fórum, Mural, Correio Eletrônico, Mecanismo de Decisão, Listas de Discussão. Entre as ferramentas de comunicação síncrona, tem-se: *Chat* (sala de bate-papo) e Mensagens Instantâneas.

Camada de projetos

Para apoiar as atividades desenvolvidas no ciclo de desenvolvimento de projetos, a camada de projetos propõe mecanismos que permitam planejar, desenvolver e avaliar os projetos realizados pelos aprendizes. Essa camada atende os seguintes requisitos [1]:

- controlar os acessos mediante *login* e senha e permitindo ao aprendiz identificar a comunidade (turma ou grupo) que participa;
- permitir que os participantes (aprendizes, mediadores, colaboradores e observadores) proponham temas para os projetos;
- permitir que os aprendizes formem grupos (comunidades) de trabalho dentro de uma turma;
- permitir a seleção de temas propostos (dentre os vários temas propostos, um número limitado pode ser selecionado para os participantes desenvolverem seus projetos);
- permitir que grupos selecionem temas para desenvolvimento dos projetos; uma vez que um tema seja selecionado, ele está disponível para que um (ou vários) grupos o selecione para elaborar um projeto;
- No desenvolvimento do projeto: prover agenda para marcação dos compromissos da comunidade (grupo ou turma); uma área de trabalho (compartilhada) para o desenvolvimento dos projetos (incluindo o controle de versões);

No processo de desenvolvimento de um projeto de compilador, o primeiro passo consiste na definição da linguagem para a qual o compilador deverá ser desenvolvido. Para essa etapa, o mediador propõe um conjunto de especificações mínimas para cada grupo. Todos os participantes podem sugerir novos requisitos/linguagens que, mais tarde, poderão passar a constituir projetos. Os temas (especificações) propostos podem ser votados através de ferramentas apropriadas (enquetes). Finalmente, após a etapa de votação, os mediadores aprovam os projetos selecionados e uma nova etapa se inicia.

Os participantes formam grupos e selecionam um projeto para ser desenvolvido. Nesse momento, todo o espaço para o desenvolvimento do projeto é criado (agenda, área de desenvolvimento, mecanismos de comunicação). Após a definição do projeto, o ambiente passa a controlar as ferramentas disponíveis para cada projeto.

Durante o desenvolvimento dos projetos, os aprendizes utilizam a agenda do grupo, correio, listas de discussão, reuniões virtuais síncronas (chat) e assíncronas (fórum), para promover a comunicação, a cooperação e a interação. Documentos e porções de códigos para avaliação podem ser disponibilizados, utilizando-se uma área compartilhada. Os diversos artefatos produzidos pelo grupo em etapa do processo (como estruturas de dados, gramáticas, analisadores léxicos) podem ser compartilhados, de modo a promover seu registro e compartilhamento.

Em diferentes etapas do processo de aprendizagem, o mediador precisa intervir. Exemplos dessa intervenção estão relacionados ao acompanhamento das agendas de grupos e no cumprimento das atividades (grupos/participantes). Essa intervenção pode acarretar em uma sobrecarga no trabalho do mediador comprometendo suas atividades de mediação. Assim, a camada de agentes mediadores atua sobre as camadas C1 e C2 no sentido de minimizar essa sobrecarga.

Camada de agentes mediadores

Para apoiar as atividades de mediação, os agentes mediadores, dispostos sobre uma camada inteligente, passam a monitorar e acompanhar os aprendizes no desenvolvimento de seus projetos. A abordagem de agentes é apropriada por inserir características pró-ativas ao ambiente, reduzindo, dessa forma, a sobrecarga de trabalho do mediador no acompanhamento dos aprendizes através do monitoramento de suas ações.

A organização de agentes é projetada segundo a metodologia Gaia [WOO 2000], considerando-se, na modelagem, as camadas C1 e C2 (figura 1) como o ambiente percebido pelos agentes. A metodologia Gaia [WOO 2000] considera o projeto de sistemas multiagentes como uma organização artificial, permitindo combinar o poder da abstração de agentes (na verdade, de papéis) com um projeto e implementação orientados a objetos (ou outro paradigma) significativamente simplificados e com alta reusabilidade. Uma característica particular da metodologia está na ênfase do uso de classes abstratas de agente, como um meio de agrupar papéis durante a análise e durante o refinamento do modelo. Desse modo, algumas decisões sobre agentes podem ser postergadas até a fase de projeto. Assim, alterações quanto a granularidade, por exemplo, remetem a modificações apenas nos modelos de projeto, garantindo que os papéis não sejam modificados. Os seguintes papéis foram identificados [1]:

- **GerEstr**: papel gerenciador de estratégias, responsável pela carga e gerenciamento das modificações nas estratégias definidas pelos mediadores;
- **InterpretEstr**: papel interpretador de estratégias, responsável pela interpretação e delegação de responsabilidades para as condições e ações definidas nas estratégias;
- **ExecutorEstr**: responsável pela execução das ações definidas nas estratégias (para o grupo ou para um componente do grupo);
- **AcompAprendiz**: analisa as ações executadas e acompanha o aprendiz em suas ações, registrando essas ações para auxiliar no processo de mediação;
- **AcompGrupo**: analisa as estratégias e táticas empregadas no acompanhamento dos aprendizes participantes de um grupo/turma, realiza estatísticas de grupo e atende a solicitações relativas a essas informações;
- **AcompMediador**: armazena e analisa as ações do mediador, buscando dar suporte na definição de estratégias para o acompanhamento dos aprendizes;
- **Mensageiro**: realiza as comunicações definidas nas táticas das estratégias. Essas comunicações podem acontecer de forma síncrona ou assíncrona. Para este trabalho as comunicações possíveis são através de correio eletrônico, quadro de avisos (Web) ou agente de interface;
- **AtMediador**: efetua as interações entre o mediador, a organização de agentes virtuais e o ambiente;
- **AtAprendiz**: efetua as interações entre o aprendiz, a organização de agentes virtuais e o ambiente;
- **AvaliadorEstr**: esse papel registra todas as comunicações entre agentes virtuais e entre agentes virtuais e aprendiz. Ele é responsável por avaliar as estratégias definidas, no sentido de auxiliar o mediador com estatísticas relacionadas às ações executadas ou não das estratégias. Para isso, utiliza os registros de comunicação;
- **GerFerrComunic**: fornece informações solicitadas sobre as ferramentas de comunicação no ambiente para um grupo ou para um aprendiz participante de um grupo/turma;
- **GerAgenda**: fornece informações solicitadas sobre a agenda de um grupo/turma ou para um componente de grupo/turma;
- **GerProjeto**: fornece informações solicitadas sobre o andamento do projeto de um grupo/turma;
- **GerFerrPedagogica**: fornece informações sobre usos de ferramentas pedagógicas disponíveis para um grupo/turma;
- **GerConteudo**: fornece informações sobre acessos a conteúdos disponibilizados para turma/grupo;

O modelo de comunicação (figura 2) entre papéis é apresentado na figura 2.

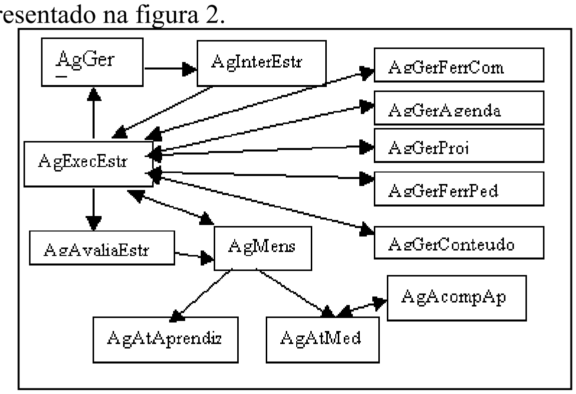

FIGURA 2

MODELO DE COMUNICAÇÃO DOS AGENTES

Uma vez que o projeto orientado da metodologia GAIA não especifica os detalhes para a implementação, realizou-se a modelagem orientada a objetos para cada agente modelado, de forma consistente com a implementação em linguagem orientada a objetos (JAVA). Em tempo de projeto, um novo agente foi projetado para a organização (o agente comunicador), atendendo aos requisitos de comunicação entre agentes.

Para compreender o funcionamento da organização de agentes, abstraindo-se a função do agente comunicador, basta analisar os papéis desempenhados pelos agentes: o agente Gerenciador de Estratégias (AgGerEstr) monitora as estratégias e quando identifica que houve modificação em alguma estratégia, ou se nova estratégia foi definida, encaminha para Interpretador de Estratégias (AgInterEstr). Este, por sua vez, interpreta cada uma das táticas definidas nas estratégias e encaminha para o Agente Executor de Estratégias (AgExecEstr). O agente Executor repassa a condição estabelecida na estratégia para o agente responsável por analisá-la (nesse caso, os agentes monitores das ferramentas presentes na divisão de gerência de ferramentas) e aguarda até que todas as condições estabelecidas na estratégia sejam encontradas. Nesse caso, o Executor de Estratégia deve iniciar a execução (que pode ser, por exemplo, uma mudança na agenda, um aviso no mural ou o envio de mensagens, via e-mail ou através de agentes de interface). Quando mais de uma condição remete à execução de ações, o executor deve solicitar a revalidação das condições encontradas. Por exemplo, a condição 1 pode ter sido encontrada 3 dias de antecedência da condição 2 e, nesse momento, a condição 1 pode não ser mais válida para aquele aprendiz.

Uma das ações estabelecidas nas estratégias pode ser uma parada na estratégia. Nesse caso, o Executor informa ao Gerenciador de Estratégias que a estratégia deve ser desativada e solicita a interrupção de todos os outros serviços. Uma vez que todas as comunicações entre agentes são registradas, o Avaliador de Estratégias (AgAvalEstr) é responsável por acompanhar os registros de comunicação e enviar mensagens (através do Agente Mensageiro – AgMens) para o mediador informando sobre a situação da estratégia. Os agentes Acompanhadores (na divisão de acompanhamento) são responsáveis por fornecer informações (quantitativas) relativas às ações de grupo, aprendiz e mediador, quando solicitadas.

V. Conclusões

O MEDIADOR foi desenvolvido, inicialmente, a perspectiva de ser incorporado ao AmCorA [4], de forma que possa ser utilizado em disciplinas ou cursos que favorecem a utilização da pedagogia de projetos (como é o caso da disciplina de Compiladores, Inteligência Artificial, entre outras).

A utilização do ambiente e acompanhamento da organização de agentes é fundamental para avaliar os requisitos e identificar novos requisitos necessários para atingir os objetivos propostos. Requisitos de interface, por exemplo, podem ser identificados através da utilização do ambiente (visualizar mensagens de acordo com as preferências do aprendiz etc).

Fundamentalmente, deve-se considerar que essa proposta é fortemente baseada nas questões de interatividade do ambiente. A definição de estratégias cujas táticas sejam baseadas na interatividade só pode efetivamente ser avaliada conforme o uso do ambiente por aprendizes e mediadores.

Finalmente, as estratégias definidas nessa proposta baseiam-se em critérios quantitativos. Para uma análise qualitativa do ambiente, a integração desta proposta a outras ferramentas, como [8] e [2] é fundamental, para que se possam obter melhores resultados na execução das estratégias.

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TEAVIC: UMA APLICAÇÃO DE TEATRO VIRTUAL NO APOIO AO PROCESSO DE ENSINO-APRENDIZAGEM

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***Resumo*— Esse artigo apresenta o TEAVIC, uma aplicação de teatro virtual baseada na Web, que combina a abordagem de agentes sintéticos com conceitos de improvisação dirigida e do modelo social-psicológico, permitindo interação e dinamismo na exibição das estórias. A arquitetura apresentada contempla o modelo dos agentes, a formação de scripts, a configuração (definida pelo usuário/sistema), e uma ferramenta de autoria para esses scripts. O artigo propõe a utilização dessa ferramenta por aprendizes da disciplina de Introdução a Ciência da Computação como uma tecnologia para apoio à síntese, através da elaboração de estórias no contexto da disciplina.**

***Palavras-chave* — Teatro virtual, agentes improvisacionais, modelo sócio-psicológico, atores virtuais, agentes sintéticos .**

I. INTRODUÇÃO

A área de entretenimento tem evoluído rapidamente com a utilização de recursos de redes de computadores e hipermídia, sendo crescente o número de aplicações e jogos que oferecem elevado grau de interatividade e atratividade. Dentre as abordagens mais recentemente utilizadas, a tecnologia de agentes sintéticos encontra sua aplicação no desenvolvimento de ambientes interativos de aprendizagem, favorecendo o processo de aprendizagem através de recursos que tornam essas aplicações mais interessantes e atrativas aos usuários.

O teatro virtual é uma aplicação dentro da área de entretenimento que pode ser direcionada para o desenvolvimento de habilidades como a criatividade, a imaginação, a interpretação crítica, a concentração e a expressão. Nesse sentido, é um recurso que encontra, na educação, uma vasta área de aplicação quando considerado como uma ferramenta pedagógica.

Este artigo apresenta o TEAVIC - uma aplicação de teatro virtual baseada na Web, que permite a interação do usuário durante a exibição das peças. A arquitetura proposta contempla o modelo dos agentes, a formação dos scripts, a configuração (definida pelo usuário ou pelo sistema), e a incorporação de uma ferramenta de autoria para esses scripts.

Além dessa introdução, este artigo está organizado em mais 5 seções: a seção 2 apresenta o conceito de teatro virtual; a seção 3 discute a utilização do teatro virtual como uma ferramenta pedagógica; a seção 4 apresenta uma aplicação de teatro virtual e as possibilidades pedagógicas e, finalmente, na seção 5 são apresentadas as conclusões finais.

II. TEATRO VIRTUAL

O conceito de teatro virtual é vago e não existe um consenso para uma determinação aceita para esse termo. O termo adotado nesse artigo baseia-se na visão de que o teatro virtual pode ser visto como um mundo habitado por agentes sintéticos [7] que agem e interagem de forma independente ou seguindo instruções, que podem vir do usuário ou serem previamente projetadas para execução por outro agente (por exemplo, um agente com papel de diretor da peça) [2]. Destacam-se como algumas aplicações de teatro virtual:

- **Teatrix**. Desenvolvido para fins educativos, é um ambiente de aprendizagem que envolve noções de teatro e de criação de estórias com o propósito de auxiliar aprendizes e professores, em todo o processo de criação de estórias de forma colaborativa. Proporciona à criança o desenvolvimento das noções de narrativas, através da dramatização de diversas situações [4]. Como em um teatro convencional, esta aplicação é divida em fases e cada fase possui um módulo desenvolvido [6].
- **Cybercafé**. Desenvolvido para alcançar um modelo de mente para agentes vrtuais, o Cybercafé [7] apresenta três atores sintéticos, sendo dois autônomos (um garçom chamado Otto, e um cliente chamado Jim) e um avatar (um cliente chamado Gaby). Enquanto os atores autônomos são responsáveis por suas próprias ações, o avatar é controlado pelo usuário selecionando os botões correspondentes às ações que podem ser representadas pela Gaby no contexto corrente. Estas ações são descritas textualmente em uma janela. O cenário explorado é a interação entre os personagens em um bar (cybercafé). A cada exibição do Cybercafé, variam as falas e os comportamentos dos personagens.

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III. TEATRO VIRTUAL E A EDUCAÇÃO

O teatro virtual tem sido tradicionalmente defendido no contexto educacional para o desenvolvimento de habilidades como a criatividade, a imaginação, a interpretação crítica, a concentração e a expressão. Uma aplicação de teatro virtual deve envolver mais do que um simples diálogo entre homem-computador por intermédio de uma interface, proporcionando ao usuário a sensação de sentir-se dentro da interface computacional e dialogar com outras entidades que também habitam esta interface [1].

O teatro virtual encontra, na área de educação, uma vasta área de aplicação quando considerado como uma ferramenta pedagógica. Do ponto de vista da aprendizagem, sabe-se que com qualquer metodologia adotada, ela só é obtida com sucesso se houver o comprometimento e a interação entre todas as pessoas envolvidas no ambiente de aprendizagem.

Nesse contexto, quando um educador elege uma aplicação de teatro virtual como recurso metodológico para apoiar o processo de ensino-aprendizagem, é porque está comprometido com os aspectos referentes ao processo de conhecimento e compreensão [9] dos aprendizes. Ensinar com o auxilio de teatro virtual é traçar um paralelo com o ensino que utiliza o conto-de-fadas, o cinema, a televisão ou as estórias em quadrinhos. Segundo Rahde, citado por [8], esses recursos são excelentes para iniciar os jovens à forma expressiva, à linguagem própria que tais meios utilizam.

A contribuição do teatro virtual para a educação, a exemplo das estórias em quadrinhos [8], deve ser analisada por parte dos educadores e psicólogos de forma que a sua aplicação, inicialmente recreativa, seja efetivamente considerada como recurso às atividades envolvidas no processo de ensino-aprendizagem. Essa contribuição pode se dar através de diversos aspectos:

- a imagem é instantânea, enquanto que a palavra é sucessiva, ou seja, precisa que os símbolos (letras) sejam decodificados e interpretados. A imagem possibilita que o aprendiz explore a sua interpretação subjetiva, fornecendo o alimento a sua fantasia, podendo ser observada e interpretada de diferentes maneiras. Dessa forma, a potencialidade pedagógica firma-se no fato de que esta atividade proporciona o desenvolvimento da criatividade, promovendo o debate sobre um tema gerador e sobre os aspectos narrativos da estória[8]. Essa prática auxilia no processo de compreensão [9];
- a utilização do recurso de áudio associados às imagens e à movimentação do cenário incorpora o dinamismo necessário para tornar a ferramenta mais atrativa e interessante aos aprendizes assim como também facilita nos processo de conhecimento e compreensão. Segundo [9], na etapa de conhecimento, a ênfase está nos processos psicológicos da memória, determinando um acréscimo de percepção por parte do aprendiz e na compreensão espera-se do aprendiz que, ao enfrentar uma comunicação, seja capaz de entender o conteúdo que lhe é transmitido e de fazer algum uso dos materiais ou idéias nela abrangidos. Essa comunicação, no caso do teatro virtual, pode ser oral, escrita ou simbólica. Normalmente, a compreensão é a classe mais enfatizada pela escola e para que ela aconteça, é necessária a evocação de algum conhecimento;
- teatro virtual pode ser utilizado pelos aprendizes na composição de suas próprias estórias, transmitindo (comunicando) a sua compreensão sobre determinado conteúdo ou atividade aprendida e estimulando a interação entre os participantes do processo de aprendizagem.

No contexto da computação, o ensino precisa de inovações, porque envolve conhecimentos cuja aprendizagem requer grande esforço cognitivo para aprender assuntos como programação de computadores, utilização de softwares, bem como o manuseio de softwares específicos [12]. Elaborar soluções algorítmicas para problemas reais, utilizando um conjunto de comandos de uma linguagem exige do aluno diversos conhecimentos como capacidade de abstração e organização das idéias, conhecimentos e habilidades que caracterizam um programador como perito [13].

Segundo Rodrigues et al. [12], a prática de ensino de computação é afetada pela inexistência de literatura de referência sobre construção e utilização de metodologias e materiais didáticos para o ensino de computação, pela escassez de professores com capacitação específica para ensinar computação e pela ignorância sobre as potencialidades das tecnologias educacionais, especialmente da multimídia e dos softwares de autoria que são recursos indispensáveis ao processo ensino-aprendizagem [13]. Nesse contexto encontram-se as aplicações de teatro virtual, especificamente como ferramentas de autoria: nelas, uma estória pode ser a estruturação de um algoritmo, onde, no ambiente, podem estar as diversas estruturas (de dados) necessárias para a solução do problema. Para compor uma estória, o aprendiz necessita evocar o conhecimento sobre os dados do problema, decompor problemas grandes em subproblemas menores, que podem ser resolvidos com mais facilidade. Adiciona-se a isso, as vantagens de se utilizar um recurso multimídia, que valoriza a expressão escrita e o envolvimento dos aprendizes.

O teatro virtual, como uma ferramenta de síntese, permite explorar a percepção do aprendiz de que os conceitos científicos não são estanques na divisão em disciplinas. Nesse sentido, os professores podem estruturar trabalhos que exijam do aluno a estruturação de uma estória onde diversos conceitos sejam utilizados. No teatro virtual, o aprender aproxima-se do mundo real, de forma que é possível que o aprendiz explore a sua interpretação subjetiva, fornecendo o alimento a sua fantasia e poder de abstração.

IV. TEAVIC

Uma aplicação para teatro virtual apresenta atores representados por agentes sintéticos [7] que atuam em um ambiente interativo, seguindo instruções do usuário ou agindo de forma autônoma. Para atender a esse objetivo, um conjunto de requisitos deve ser atendido. Esses requisitos são descritos em termos das características do sistema (comportamento e funcionalidades que deve prover) e dos agentes que atuam nesse sistema. A figura 1 apresenta o diagrama de casos de uso da aplicação TEAVIC [11].

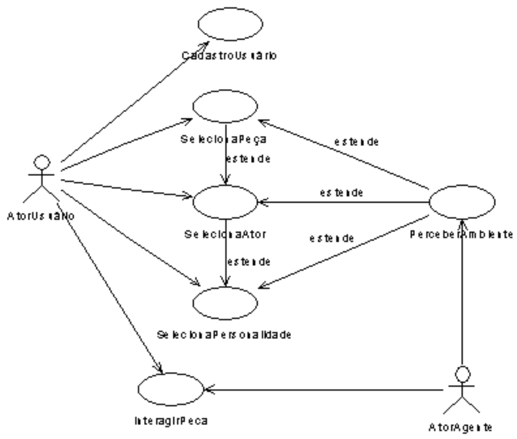

FIGURA 1
DIAGRAMA DE CASO DE USO

O aprendiz (AtorUsuário), para utilizar o sistema, deve ter realizado o seu cadastro. Para se cadastrar, deve preencher um formulário informando seus dados pessoais, login e senha. Entretanto, esse cadastro não precisa ser realizado no caso de desejar apenas conhecer e ter acesso a informações disponíveis na página de Visão Geral do Sistema.

Para acessar as estórias dessa aplicação de teatro virtual, o aprendiz pode selecionar a categoria da estória (contos, desafios lógicos, etc.), a estória desejada, os agentes para cada papel, o narrador, e suas respectivas personalidades, nessa ordem. O sistema pode fazer escolhas automáticas das opções não selecionadas pelo aprendiz.

O usuário pode parar a peça quando desejar e no próximo acesso ao teatro virtual será apresentado ao aprendiz uma opção de continuar a estória de onde parou, com os mesmos agentes e personalidades escolhidas para os mesmos.

Os agentes do teatro virtual saúdam o aprendiz quando esses iniciam o sistema e se despedem do mesmo ao término da interação. Esses agentes improvisam seus comportamentos, ou seja, a cada interação modificam suas falas e ações, mantendo o mesmo contexto, e de acordo com as escolhas do usuário. Para isso, utilizou-se a técnica de improvisação dirigida [7] e a tecnologia MsAgent [5] em conjunto com tecnologias para Web e acesso a banco de dados. O uso desta tecnologia facilita no que diz respeito ao fato da interface gráfica e das ações já estarem prontas.

O TEAVIC também conta com um ambiente para a construção de *scritps* (estórias), onde o próprio usuário pode criar suas peças teatrais.

Utilizou-se a orientação a objetos para a modelagem dos agentes (e do ambiente) em termos de seu comportamento (ações físicas e ações verbais) e sua personalidade. Apesar desse diagrama contemplar uma modelagem genérica para suportar diversas personalidades e comportamentos, a complexidade de se definir essas características requer uma abordagem especificamente desenvolvida para o projeto de agentes sintéticos. Essa abordagem é necessária para detalhar as características do personagem de forma que o modelo fique consistente. A figura 2 destaca a modelagem do personagem (que representa o agente desempenhando um papel com uma determinada personalidade na peça) no diagrama de classes. Em tempo de projeto dos agentes, esses personagens são projetados segundo o modelo social-psicológico [7].

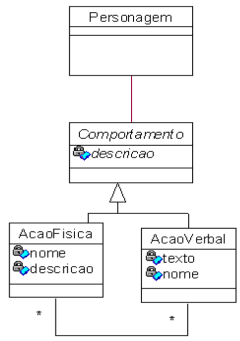

FIGURA 2
MODELAGEM DO PERSONAGEM

A Tabela I apresenta um exemplo de um modelo social-psicológico, a Tabela II apresenta alguns possíveis comportamentos para agentes no teatro, a Tabela III apresenta possíveis ações verbais e a Tabela IV apresenta algumas ações físicas. As tabelas I, II e III são baseadas na peça ‘Contando até o Infinito’, adaptada do livro ‘O diabo dos números’ [10], cujos personagens são um aprendiz, o diabo dos números e um narrador .

TABELA I
EXEMPLO DE UM MODELO SÓCIO-PSICOLÓGICO

Papel	Diabo dos Números
Agente	Merlin
Personalidade	Rabugento
Humor	Irritado
Atitudes	Ações claras, porém ríspidas

TABELA II
EXEMPLOS DE COMPORTAMENTOS

agradar	entristecer-se	mostrar
alertar	escrever	mover-se
anunciar	explicar	observar
aparecer	fazer mágica	ocultar-se
atrair atenção	felicitar	pensar
declinar-se	gesticular	reconhecer
descansar	ler	saudar

TABELA III
EXEMPLOS DE AÇÕES VERBAIS

Categoria: Contos	
Estória: Contando até o Infinito	
Ato 1: Aparição do Diabo dos Números	
Ator: Merlin	
Papel: Diabo dos Números	
Cena 1	
Comportamento do Papel	**Instância da ação verbal**
Estender os braços ao lado Juntar as mãos e sorrir	"Sou o Diabo dos Números"
Coçar a cabeça Abrir as mãos para frente	"Ah, é? Então, porque você está falando comigo?"
Passar uma mão na barba Coçar a cabeça	"Mereço cada coisa nessa vida! Logo, logo explodirei!"

TABELA IV
EXEMPLOS DE AÇÕES FÍSICAS

aparecer	esconder-se	gesticular para cima
aplaudir	ficar alerta	levar um susto
bocejar	ficar parado	pedir atenção
curvar-se	gesticular para a direita	piscar
coçar a cabeça	gesticular para a esquerda	respirar
dar adeus	gesticular para baixo	sorrir e unir as mãos

A arquitetura do TEAVIC é apresentada na figura 3 e apresenta o funcionamento do TEAVIC de acordo as modelagens realizadas. Para atender aos requisitos especificados, essa arquitetura é composta de quatro papéis relevantes que, combinados, realizam todas as funcionalidades necessárias:

- um autor que possui como função a elaboração dos scripts (textos das peças) – neste caso, essa função é realizada pelos projetistas;
- atores (agentes) que são responsáveis pela interpretação dos papéis nas peças e pelo auxilio no uso do sistema;
- um diretor que é a parte do sistema responsável pelas escolhas não realizadas pelo usuário e por e outras decisões relevantes para o funcionamento do sistema - no caso do protótipo implementado, a função de diretor não é realizada por um agente de interface, mas sim através de funções do sistema;
- usuários podem fazer papel de diretor ou simplesmente assistir a exibição da peça, interagindo com o cenário.

Os cenários são trocados de acordo com a apresentação da peça e da situação corrente dos personagens. Nesse caso, as instruções são necessárias para a escolha correta do cenário para cada situação.

O objetivo de uma ferramenta de autoria para os scripts das peças é auxiliar o autor na criação de estórias podendo, principalmente, estender esta função ao aprendiz.

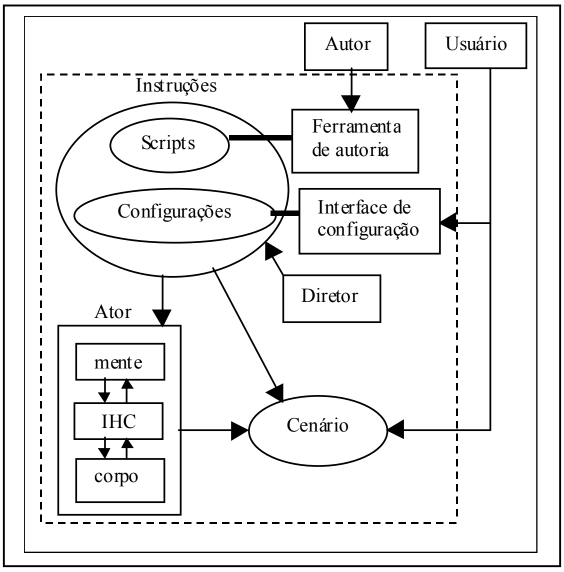

FIGURA 3
ARQUITETURA DO TEAVIC

Através da ferramenta de autoria para os scripts das peças é possível explorar o teatro virtual como uma ferramenta de síntese [9] para os aprendizes. Através dessa interface, é possível que o usuário componha suas próprias estórias, transmitindo (comunicando) a sua compreensão sobre determinado conteúdo ou atividade aprendida, estimulando a interação entre os participantes do processo de aprendizagem.

A estória composta através de scripts é apresentada por meio da tela de exibição de uma peça (Figura 4). Para a exibição desta cena foram selecionados pelo usuário (caso deseja-se) a categoria da estória, a estória e os agentes para cada personagem com suas personalidades.

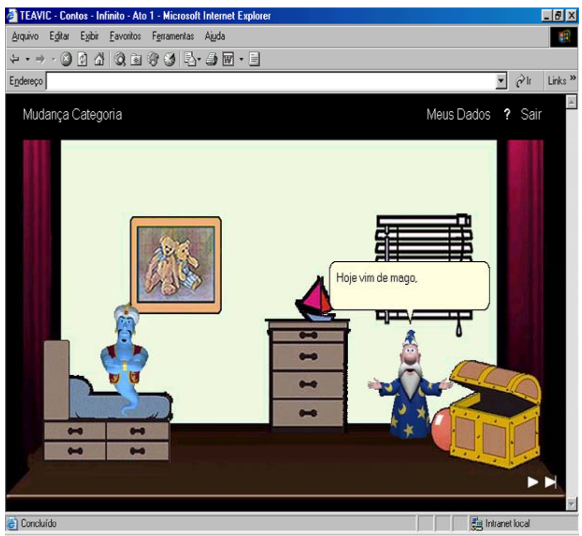

FIGURA 4

APRESENTAÇÃO DE UMA PEÇA NO TEAVIC

V. CONCLUSÕES

Atualmente, uma das preocupações dos educadores é a de trabalhar buscando abordagens educacionais que valorizem o envolvimento do aprendiz através da aprendizagem significativa e oferecendo diferentes recursos tecnológicos. O projeto TEAVIC oferece as mais diversas possibilidades, podendo estar inserido em diferentes abordagens pedagógicas. Os professores podem elaborar atividades curriculares interdisciplinares envolvendo temas da computação e até mesmo problemas que envolvam soluções algorítmicas. A partir da utilização desse recurso, pretende-se identificar requisitos que permitam fornecer registros de forma a potencializar as atividades mediação do processo de aprendizagem.

A metodologia adotada para a concepção do TEAVIC é uma combinação da abordagem de agentes sintéticos com conceitos de improvisação dirigida e do modelo social-psicológico. A combinação dessas abordagens foi adotada com o objetivo de desenvolver personagens com comportamentos, objetivos e características completamente independentes. Nesse modelo, cada agente pode interpretar diferentes papéis, sendo que suas características (personalidade, humor, etc.) e objetivos são determinados, ou escolhidos, de acordo com o papel que interpretam, possibilitando que cada agente apresente diferentes comportamentos.

Finalmente, o objetivo dessa proposta está no projeto e implementação de uma aplicação de teatro virtual que, quando devidamente interpretada e avaliada por educadores e psicólogos, possa ser utilizada como recurso pedagógico nas escolas ou até mesmo em ambientes educacionais informatizados. Entretanto, independentemente de sua aplicação na educação, o teatro virtual é facilmente considerado uma atividade de recreação estimulante da criatividade.

No contexto da computação, a utilização do recurso de áudio associados às imagens e à movimentação do cenário incorpora o dinamismo necessário para tornar a ferramenta mais atrativa e interessante aos aprendizes assim como também facilita nos processo de conhecimento e compreensão. Além disso, é uma ferramenta que valoriza a expressão escrita e pode ser utilizada para direcionar as mais diversas questões no ramo da computação: ética, algoritmos, temas da computação nas disciplinas introdutórias onde o aluno possui pouco ou nenhum conhecimento sobre o currículo.

Finalmente, o potencial pedagógico firma-se no fato de que esta ferramenta proporciona a adaptação às preferências dos aprendizes através das diversas escolhas que fornece aos aprendizes, como as opções de cenários e as escolhas dos comportamentos dos agentes. Esperam-se desenvolver mecanismos para que esse recurso melhore o grau de interatividade e envolvimento dos aprendizes (permitindo a construção cooperativa de scripts). Esse parece ser o caminho para aumentar a efetividade dos ambientes de ensino-aprendizagem e promover maior envolvimento dos aprendizes com os diversos aspectos da computação.

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REQUISITOS DE UMA INTERFACE PARA APOIO À APLICACÇÃO DA REVISÃO PELOS PARES NA APRENDIZAGEM

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Resumo— O controle de qualidade da ciência, o processo de revisão pelos pares, vem sendo aplicado no escopo da aprendizagem visando promover à melhoria da expressão escrita, pensamento crítico e responsabilidade profissional. Resultados publicados sugerem avanços significativos na busca por uma mudança de paradigma: da aprendizagem passiva e dependente para a aprendizagem pró-ativa, independente e responsável. A aplicação do processo envolve extraordinário trabalho administrativo, dificultando a utilização em uma sala de aula por um único instrutor. Um sistema computacional de auxílio à aplicação do processo de revisão em sala de aula é de grande valia na sua difusão. Este artigo revisa os conceitos básicos da revisão pelos pares, e apresenta a análise de requisitos para uma interface de suporte a aplicação do processo de revisão pelos pares em sala de aula. Recomendações para trabalhos futuros são aventadas.

Palavras Chaves — Revisão pelos pares na aprendizagem, Engenharia de Requisitos, Informática na Educação.

1. INTRODUÇÃO

Os profissionais recém formados encontram um mercado de trabalho cada vez mais exigente e seletivo. Além de uma boa formação acadêmica, diversas habilidades pessoais são indispensáveis em um mundo cada vez mais competitivo. Prática na expressão escrita e falada, senso de responsabilidade profissional e pensamento crítico são algumas das qualidades exigidas para a boa colocação no mercado. Mas, como auxiliar o aperfeiçoamento destas características em um ambiente de aprendizagem?

A aplicação do processo de revisão pelos pares no meio acadêmico auxilia o desenvolvimento destas habilidades [1]-[4]. Entretanto, a burocracia envolvida no processo dificulta sua utilização em uma sala de aula brasileira, na qual o professor é responsável por orientar e organizar todo o processo. A disponibilidade de uma ferramenta de auxílio à aplicação da sistemática de revisão pelos pares em sala de aula é fundamental para sua plena realização.

O presente artigo apresenta um estudo sobre requisitos desejáveis de uma ferramenta de apoio à aplicação da revisão pelos pares na aprendizagem. A seção 2 apresenta a revisão pelos pares, sistema de controle de qualidade da ciência – seus primórdios e evolução. A seção 3 aborda a sistemática aplicada à aprendizagem, complementada pela seção 4, que apresenta as etapas envolvidas neste processo. A seção 5 lista os requisitos desejáveis de uma ferramenta de apoio à aplicação pelos pares, sendo as considerações finais apresentadas na seção 6.

2. REVISÃO PELOS PARES

Antigamente os cientistas trocavam cartas entre si para comunicar os resultados de suas pesquisas. Na idade moderna surgiram as primeiras revistas científicas, e a troca de correspondência foi substituída por publicações nestas revistas especializadas. Segundo [5], a Royal Society of London, em 1753, começou a utilizar o Conselho da Sociedade como avaliador do material a ser publicado em sua revista, marcando o início oficial da aplicação da revisão pelos pares.

A revisão pelos pares surgiu da necessidade de avaliar a produção científica. Conforme [5], a sistemática não surgiu de forma acabada e vem sofrendo alterações face a uma série de críticas motivadas principalmente por distorções no uso.

Através da revisão pelos pares os congressos científicos avaliam a conveniência de aceitar um artigo para publicação [6]. Os responsáveis pela organização do evento recorrem a pares do autor (pesquisadores cuja especialidade relaciona-se ao tópico do artigo) e solicitam seus pareceres para subsidiar a decisão.

O sucesso da sistemática de revisão pelos pares baseia-se fortemente no compromisso que assumem autor, revisor e editor com a qualidade do trabalho publicado. A próxima seção discute a potencialidade desta sistemática aplicada à aprendizagem, para estimular entre aprendizes um alto nível de comprometimento com a qualidade do que produzem enquanto aprendem.

3. REVISÃO PELOS PARES NA EDUCAÇÃO

Códigos de ética e conduta profissional apontam a habilidade de oferecer e receber crítica como fundamentais para profissionais de Computação. O código de ética da Association for Computing Machinery (ACM) [7], por exemplo, requer dos membros a busca por crítica ao próprio trabalho, e o oferecimento de crítica documentada ao trabalho de terceiros. Currículos de Computação [8]-[10], entretanto, não contemplam o desenvolvimento destas

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habilidades compatível com a importância sugerida pelo código de ética da ACM.

Desde 1997, a revisão pelos pares vem sendo aplicada na UNIVALI por [11], buscando o rompimento com o paradigma tradicional de aprendizagem e desestabilizando o papel tradicional do aluno, de forma que este assuma responsabilidade por sua aprendizagem. Outras experiências da aplicação da sistemática na educação podem ser encontradas em [1]-[2].

Na abordagem utilizada por [11], acontece a simulação de um congresso em sala de aula com a participação de alunos e professor, cada qual desempenhando determinados papéis, e ao final da experiência são produzidos diversos artigos, resultantes do trabalho colaborativo entre os participantes. A tabela 1 resume os principais papéis e responsabilidades assumidas pelos envolvidos.

TABELA 1
PAPÉIS DESEMPENHADOS PELOS PARTICIPANTES DO CONGRESSO EM CLASSE

Papel	Desempenhado por	Principal atribuição
Organizador e editor	Professor	Orientar e coordenar atividades, caderno técnico
Autor	Aluno	Pesquisar e escrever artigo
Revisor	Aluno	Avaliar artigo

O professor orienta e coordena os trabalhos, publica a convocatória de artigos, o formulário de revisão e o caderno técnico do congresso. Define as datas limites para as etapas do processo, diretrizes para pesquisa em grupo, redação, estilo e formatação.

Nesta aplicação da revisão pelos pares no meio acadêmico, os alunos desempenham dois papéis: autor e revisor. Como autores, sua principal atribuição e a realização da pesquisa e a redação do artigo. Na situação de revisores, devem avaliar artigos dos colegas de maneira crítica e responsável.

4. ETAPAS PARA APLICAÇÃO DA REVISÃO PELOS PARES NA EDUCAÇÃO

A aplicação do processo de revisão pelos pares, conforme a abordagem utilizada por [11], envolve extraordinário trabalho administrativo, dificultando a aplicação em sala de aula por um único instrutor, que deve ser responsável por toda a organização.

A figura 1 apresenta tarefas, responsabilidades e fluxo de documentos envolvidos na aplicação da sistemática em sala de aula. As tarefas são listadas a seguir.

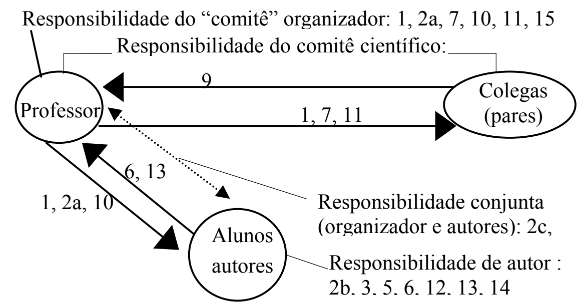

FIGURA 1
RESPONSABILIDADES E FLUXO DE DOCUMENTOS NA REVISÃO PELOS PARES APLICADA À APRENDIZAGEM [7].

1. Proposta;
2. Preparação: (a) Sugestão, (b) Seleção, (c) Aprovação do tema;
3. Esboço;
4. Apreciação do esboço;
5. Redação;
6. Submissão de originais;
7. Alocação e distribuição dos originais;
8. Revisão pelos pares;
9. Submissão de revisões;
10. Distribuição das revisões;
11. Feedback sobre revisões;
12. Apropriação do feedback;
13. Submissão final;
14. Apresentação;
15. Edição do caderno técnico;

Visando a facilitar a aplicação do processo em sala de aula, torna-se indispensável a utilização de um software capaz de facilitar a execução das etapas envolvidas no processo, minimizando o trabalho administrativo. A próxima seção discute os requisitos desejáveis a uma ferramenta desta espécie, utilizando a abordagem definida em [11].

5. PRINCIPAIS REQUISITOS DE UMA FERRAMENTA DE SUPORTE À APLICAÇÃO DA REVISÃO PELOS PARES NA EDUCAÇÃO

Uma ferramenta de suporte a aplicação da revisão pelos pares na educação tem como principal objetivo permitir aos envolvidos a simulação de um fórum científico sem sobrecarregar o organizador do evento com trabalho burocrático. Existem algumas ferramentas disponíveis na Internet que implementam algumas das funcionalidades necessárias, inclusive algumas gratuitas [12], mas a aplicação do processo no meio acadêmico possui requisitos específicos não completamente atendidos por tais ferramentas.

Os requisitos são as definições que delineiam as funções e características que um produto deverá possuir, depois de construído, sem referir-se ao modo utilizado na resolução. Ou, conforme [13], requisitos são características e propriedades que um produto deve apresentar para a resolução de um problema específico do mundo real.

O levantamento de requisitos, ou análise de requisitos, é vital para qualquer projeto de software e deve ser coerente com a real necessidade dos clientes e usuários. Os requisitos podem ser documentados de várias maneiras, usando métodos e linguagens.

A referência [13] apresenta o template Volere para a especificação de requisitos e restrições, estabelecendo um arcabouço para redação. Segundo os autores, existem 26 tipos de requisitos agrupados em quatro categorias:

Restrições: limitações e restrições aplicáveis ao projeto e ao produto

Requisitos funcionais: funcionalidade do produto

Requisitos não funcionais: qualidades do produto

Questões de projeto: questões aplicáveis ao projeto para a construção do produto

As quatro sub-seções a seguir detalham cada uma das categorias definidas, bem como apresentam os requisitos de uma ferramenta de suporte à aplicação da revisão pelos pares na aprendizagem, classificado-os segundo os tipos definidos no template Volere.

5.1 Restrições e limitações do produto

Para [13], encontram-se nesta classe os tipos de requisitos que definem como o produto resultante se adequará ao mundo. São os requisitos que definem, por exemplo, o propósito do produto, seus clientes, usuários, suposições e fatos relevantes. A seguir detalham-se requisitos deste tipo.

1. Propósito do produto: o principal foco da ferramenta é fornecer meios que facilitem a simulação de um congresso em sala de aula. O produto deve, entre outras funcionalidades, auxiliar a formação dos grupos de autores, a publicação de material bibliográfico de apoio, a submissão dos artigos, a alocação dos artigos a seus revisores, e o trâmite de documentos.

2. Freguês, clientes e interessados (stakeholders): os potenciais fregueses (aqueles que poderão adquirir o produto) são professores interessados em aplicar a revisão pelos pares na aprendizagem. O cliente (aquele para quem o produto está sendo desenvolvido) são gestores de ensino e pesquisa, pedagogos, alunos e outros que desejem conhecer a sistemática.

3. Usuários: os usuários são professores e alunos que participam da aplicação da revisão pelos pares na aprendizagem, segundo os papéis descritos na seção 3.

Enquanto as restrições, recém descritas, dão forma geral ao produto, as coisas que o produto faz são documentadas como requisitos funcionais, detalhados a seguir.

5.2 Requisitos funcionais

Requisitos funcionais são, conforme [13], necessidades de ações que o produto executa com a devida funcionalidade para o usuário. A complexidade de um projeto de software, segundo [14], é determinada parcialmente por suas funcionalidades. Existem dois tipos de requisitos nesta classe, conforme afirma **Erro! A origem da referência não foi encontrada.**:

Escopo do produto: limites e conexões com sistemas adjacentes.

Requisitos de dados e funções: coisas que o produto deve fazer e os dados manipulados pelas funções.

A tabela 2 apresenta a correspondência entre a lista de tarefas envolvidas na aplicação da revisão pelos pares na aprendizagem, esquematizadas na figura 1, e os índices dos principais requisitos funcionais identificados. Na seqüência, listam-se estes requisitos funcionais seguidos de uma explicação resumida:

TABELA 2

Correspondência entre as tarefas apresentadas na figura 1 e os requisitos funcionais identificados.

Tarefas da revisão pelos pares aplicada à aprendizagem	Requisito funcional
1. Proposta	1,2,3,4,5
2. Preparação: sugestão, seleção e aprovação de tema	6,7,9
3. Esboço	8
4. Apreciação do esboço	8
5. Redação	-
6. Submissão de originais	12
7. Alocação e distribuição dos originais	10,11
8. Revisão pelos pares	13
9. Submissão de revisões	13
10. Distribuição das revisões	18
11. Feedback sobre revisões	16
12. Apropriação do feedback	14
13. Submissão final	12
14. Apresentação	19
15. Edição do caderno técnico	20

1. Preparação do congresso: o software deve permitir ao editor-organizador a criação de uma edição de congresso na qual acontece a aplicação do processo de revisão pelos pares. Deve permitir diversas edições ocorrendo simultaneamente, sem restrição de participação em vários papéis e vários eventos.

2. Definição de proposta: o software deve permitir ao organizador a definição da proposta de trabalho com a anexação de um arquivo eletrônico (meta-artigo) contendo a descrição detalhada sobre formatação dos artigos a serem submetidos e outras orientações aos autores.

3. Publicação de ficha de avaliação: **Erro! A origem da referência não foi encontrada.** afirma que uma das formas de minimizar os erros de julgamento da revisão pelos pares é a utilização de questionários de revisão com critérios norteadores. Portanto, cada edição de congresso deve possuir seus próprios quesitos de avaliação. 4. Definição de prazos: o processo de revisão pelos pares subdivide-se em várias etapas (formação de equipes, submissão do esboço, etc) cada qual com sua data limite. O organizador deve informar estas datas ao futuro sistema, que enviará um lembrete aos participantes sobre a proximidade de uma data limite.

5. Inscrição de participantes: o futuro sistema deve permitir a inscrição e suspensão de participantes. Cada autor realiza sua própria inscrição e o organizador deve manter as informações.

6. Formação de grupos: o software deve facilitar a formação de grupos de autores, permitindo a inclusão e consulta das áreas de interesse de pesquisa.

7. Publicação de temas: o organizador deve poder incluir diversos temas que podem ser abordados pelos artigos a serem escritos. Os autores podem consultar as publicações para auxiliar na definição do tema a abordar.

8. Apreciação de esboço: o sistema deve oferecer meios para que o autor possa realizar a submissão do esboço do artigo e o organizador possa apreciar e comentá-lo.

9. Cadastro de fontes de referência: permitir ao organizador e autores a publicação de informações de apoio. Endereços de Internet que possuam algum material relevante para o congresso e bibliografias. O sistema deve comunicar aos participantes a inclusão de novas fontes de referências, permitindo a consulta.

10. Levantamento de intenção em revisar: após os grupos estarem com os temas dos artigos definidos, pode existir um interesse, por parte de determinado revisor, em revisar um artigo específico. Portanto, a futura ferramenta deve permitir ao revisor informar esta intenção. Esta indicação pode auxiliar o organizador no momento da alocação dos revisores.

11. Alocação de artigos: deve haver mecanismos que facilitem o trabalho de associação dos artigos a seus revisores. Este requisito é de suma importância para facilitar o trabalho do organizador, portanto deve ser simples e prático, de preferência de forma gráfica. Também deve permitir a consulta das alocações já realizadas, com possibilidade de alterações.

12. Submissão dos artigos: os autores devem poder transferir os artigos originais para que sejam armazenados pela ferramenta. Podem ser submetidas diversas versões de um mesmo artigo, desde que respeitadas as datas limites.

13. Preenchimento das revisões: os revisores devem possuir meios para preencher e submeter a ficha de avaliação de cada artigo alocado para receber o seu parecer.

14. Refutar / aceitar revisão: o sistema, após receber revisões sobre um determinado artigo, deve permitir aos autores a concordância ou discordância sobre determinados pontos das revisões. As partes da revisão onde houver divergência de opinião poderão ser refutadas com a devida justificativa.

15. Protocolo de envio / recebimento: o sistema de suporte à revisão pelos pares trabalha com trâmite de arquivos eletrônicos. Estas operações estão sujeitas à qualidade dos meios de transmissão. Uma forma de minimizar os problemas decorridos dos erros de transmissão é o fornecimento de um número de transação como garantia de que a operação foi realizada.

16. Revisões dos outros pares: após o término do prazo para o preenchimento das fichas de avaliação, os revisores podem consultar as revisões dos outros pares para avaliar e refletir sobre o conteúdo das demais avaliações.

17. Submissão final: após realizar todas as correções cabíveis, a equipe de autores deve realizar a submissão da versão final de seu artigo.

18. Distribuir revisões: a qualquer momento o organizador pode selecionar um ou todos os artigos para enviar as revisões recebidas.

19. Escalonamento de apresentações: o futuro sistema deve possuir uma espécie de agenda eletrônica onde cada grupo deve agendar uma data e horário para apresentação do seu artigo.

20. Publicação do caderno técnico: o software deve permitir ao editor publicar, em mídia impressa ou digital, os artigos resultantes do congresso. Opcionalmente, poderia ocorrer a publicação dos artigos originais (primeira submissão) juntamente com as revisões (anônimas) para reforçar o caráter reflexivo da experiência.

Para que a análise de requisitos esteja completa, os requisitos funcionais devem ser complementados com as questões de qualidade do produto, os requisitos não funcionais, que serão detalhados na próxima seção.

5.3 Requisitos não funcionais

Uma vez conhecido o que o produto deve fazer, devem-se detalhar questões de qualidade e desempenho através dos requisitos não-funcionais [13]. Estes requisitos tratam das questões de qualidade do software, especificam características relacionadas a aparência, usabilidade, desempenho, manutenibilidade e portabilidade, segurança, fatores humanos e questões legais. Normalmente, os requisitos não-funcionais estão vinculados aos requisitos funcionais e são críticos para o sucesso do projeto. A seguir detalham-se requisitos não funcionais:

1. Aparência: preferencialmente, o software deve oferecer uma interface gráfica que permita a utilização do mouse.

2. Usabilidade: a ferramenta tem potencial para utilização em ambiente de ensino a distância [11], deve haver meios para acesso remoto, não-presencial e assíncrono.

4. Manutenibilidade e portabilidade: a futura plataforma terá a maioria dos acessos remotos. Não há como determinar qual a plataforma operacional de cada cliente, portanto este projeto deve considerar a utilização da tecnologia menos restritiva possível.

5. Segurança: para que o objetivo da revisão pelos pares seja alcançado com êxito, o caráter confidencial do processo deve ser mantido. Ou seja, é preciso manter o anonimato de revisor e autor.

6. Questões legais: participantes do processo devem estar de acordo sobre as questões de direito autorais envolvidas na construção de seus artigos e na publicação do caderno técnico em meio digital.

7. Suporte multilingüe: necessidade da interface do software em múltiplas línguas permitindo a quebra de fronteiras geográficas ou institucionais.

Além de restrições e requisitos funcionais e não funcionais, há requisitos chamados por [13] de "questões de projeto". São questões alheias às características específicas do projeto e do desenvolvimento, mas podem influenciar decisões de projeto, portanto são discutidas a seguir.

5.4 QUESTÕES DE PROJETO

Algumas questões são fundamentais para o sucesso ou fracasso em um projeto de desenvolvimento de software. Diversas questões de projeto podem afetar o sucesso do produto, dentre elas: os custos e riscos envolvidos na construção, a existência de soluções prontas e o surgimento de novos problemas a partir da introdução do produto e a documentação para usuários [13].

Ainda, pode haver requisitos do tipo "sala de espera", cujo cumprimento não é urgente, mas que justificam a inclusão na documentação para desenvolvimento futuro. A seguir detalham-se as questões de projeto identificadas até o momento:

Questão aberta: Considerando a publicação dos artigos em meio digital, uma questão a ser abordada é o direito autoral sobre artigos originais, avaliações e versões finais, bem como o direito de cópia sobre o caderno de anais como um todo.

Sala de espera: algumas características avançadas já foram aventadas [11] e podem ficar em uma lista de requisitos futuros, como por exemplo: detecção de plágio, verificação automática de citações e referências, verificação automática de gramática e estilo.

6. CONCLUSÕES E RECOMENDAÇÕES

Este artigo discutiu brevemente a revisão pelos pares como sistema de controle de qualidade da produção científica, esboçou argumentos para evidenciar vantagens de sua aplicação na aprendizagem, e listou iniciativas pioneiras. As etapas da aplicação na aprendizagem, conforme propostas por [11], foram listadas. Uma série de requisitos para a construção de uma interface de apoio à aplicação foi detalhada.

A disponibilidade de uma interface com as características discutidas neste artigo viabilizará a dedicação do professor interessado em aplicar a revisão pelos pares a questões importantes de orientação e avaliação da experiência. Sem a interface, a experiência fica bastante limitada pela quantidade de trabalho burocrático envolvido.

O detalhamento dos requisitos baseado na abordagem de [13] permite sistematizar a busca de requisitos. A inclusão de requisitos do tipo "sala de espera" permite antever as possibilidades de extensão da ferramenta, que está em fase inicial de construção.

Em especial, a automatização da verificação metodológica e da detecção de plágio permitem vislumbrar oportunidades de desenvolvimento e pesquisa envolvendo processamento de linguagem natural e inteligência artificial. Além de tópicos específicos de Computação, vislumbram-se oportunidades de desenvolvimento e pesquisa voltados ao desenvolvimento de tecnologia educacional para educação a distância, avaliação acadêmica e trabalho colaborativo.

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FERRAMENTAS COLABORATIVAS VOLTADAS PARA A APRENDIZAGEM ATRAVÉS DA INTERNET

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Resumo — *Este trabalho tem por objetivo apresentar a construção de um protótipo para aprendizagem colaborativa baseada na Internet do tipo CSCL (Computer Supported Collaborative Learning) chamado CTELCS (Collaborative Training Environment of the Laboratory of Communications and Signals) englobando uma ferramenta para a disponibilização de conteúdo, uma aplicação colaborativa assíncrona parecida com um FAQ (Frequently Asked Questions) com algumas funcionalidades adicionais, uma ferramenta de exercícios síncrona que possibilita o trabalho em grupo com chat, vídeo e o exercício agregado e a modelagem do conteúdo de um curso dentro do ambiente. Na implementação do protótipo foi utilizado o modelo de arquitetura MVC (Model-View-Controller) com tecnologias independentes de plataforma baseada em XML, Applets Java, Java Media Framework, JSP/Servlets e MySQL.*

Palavras Chaves — aprendizagem colaborativa, CSCL, Java, MVC.

1. INTRODUÇÃO

No cenário global da educação observa-se atualmente uma grande procura por parte de instituições acadêmicas, empresas e até mesmo usuários por treinamento a distância através da Internet. Nesse tipo de treinamento pessoas em lugares e em tempos distintos podem fazer cursos utilizando ambientes de aprendizagem com ferramentas de administração de usuários e cursos, de inserção de conteúdos, comunicação e de controle do progresso dos estudantes. Essas ferramentas trabalham com diversos tipos de mídias (texto, áudio e vídeo), animações, simulações e exemplos na tentativa de auxiliar a aprendizagem. Também pode-se combinar uma abordagem individual com atividades colaborativas. Ambientes CSCL (*Computer Supported Collaborative Learning*) com algumas ferramentas que atuam como mediadoras do processo de ensino-aprendizagem podem ser utilizadas para prover a aprendizagem colaborativa [1][2].

Este trabalho propõe o desenvolvimento de um protótipo de ambiente CSCL chamado CTELCS (*Collaborative Training Environment of the Laboratory of Communications and Signals*) implementado sobre uma arquitetura MVC (*Model-View-Controller*) constituindo-se de [3]:

- Um módulo para inserção de conteúdo onde são colocados os textos, imagens, animações com uma interface simples e padronizada deixando o curso modelado mais atraente e motivador do ponto de vista do estudante. O curso Voz sobre IP foi escolhido para testar a modelagem dentro desta ferramenta.
- Uma ferramenta síncrona de aprendizagem com suporte ao trabalho cooperativo, voltada para a solução de exercícios relacionados ao conteúdo como uma forma de aumentar a interação entre os participantes e, permitir que as atividades em grupo contribuam para o aprendizado individual de cada aluno minimizando o aspecto de complexidade do assunto.
- Uma ferramenta de dúvidas e respostas estilo um FAQ modificado com esquema de busca interna por palavras chaves para facilitar a procura de informações por parte do aluno e professor. Esta facilidade, normalmente, não é encontrada em ambientes de aprendizagem com este tipo de aplicação. O módulo de conteúdo está internamente ligado ao FAQ pois cada parte de um curso é associada automaticamente, pelo ambiente, a um conjunto de suas palavras chaves.

Este artigo está organizado em seções conforme descrição abaixo:

- Na seção 2 são introduzidos os conceitos de ambientes CSCL e as tecnologias que podem ser utilizadas no desenvolvimento de ferramentas colaborativas.
- As propostas e os resultados obtidos com a implementação deste protótipo são descritos na seção 3.
- As conclusões e as propostas de trabalhos futuros foram colocadas na seção 4.

2. CSCL E TECNOLOGIAS: CONCEITOS E ESTADO ATUAL

2.1 CSCL (*Computer Supported Collaborative Learning*)

CSCL pode ser definida como uma estratégia relacionada a educação onde dois ou mais participantes constróem seu conhecimento através da discussão, reflexão e tomada de decisões por meio de recursos computacionais servindo como mediadores do processo de ensino-aprendizagem [1]. A CSCL surgiu a partir da CSCW (*Computer Supported Collaborative Work*) que também suporta trabalho em grupo

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mas com tarefas não relacionadas a educação, como por exemplo, um editor de texto compartilhado onde um grupo de pessoas trabalham para escrever um determinado documento. As principais diferenças entre a CSCL e a CSCW são ilustradas na Tabela I [2].

TABELA I
PRINCIPAIS DIFERENÇAS ENTRE A CSCL E A CSCW. ADAPTADA DE [2]

CSCW	CSCL
Focaliza sua atenção nas técnicas de comunicação.	Concentra sua atenção no que está sendo comunicado.
É mais usado principalmente no meio empresarial.	É normalmente explorado em ambientes relacionados a educação.
Tem como finalidade facilitar a comunicação e a produtividade do grupo.	A finalidade é prover uma aprendizagem eficaz em grupo.

O objetivo principal da CSCL é a aprendizagem, mais especificamente a colaborativa, e como ela pode ser facilitada com a ajuda do computador.

Do ponto de vista tecnológico, a colaboração entre usuários depende de duas tarefas: 1) a definição de um grupo e 2) o estabelecimento (síncrono ou assíncrono) de sessões de comunicação. Um outro ponto igualmente importante que deve ser tratado por aplicações colaborativas é a coordenação das interdependências entre as atividades que podem ser realizadas pelo grupo [4]. Alguns ambientes conhecidos contendo aplicações colaborativas são o JETS (*Java-Enabled Telecollaboration System*) e o JASMINE (*Java Application Sharing in Multiuser Interactive Environments*) [5]. Ambientes de aprendizagem, bastante conhecidos, que possuem algumas ferramentas colaborativas como *chat* e *whiteboard* é o WebCT (*World-Wide-Web Course Tools*) e o *Blackboard Learning System*^{TM} [6][7]. Um diferencial do protótipo CTELCS é a proposta de ferramentas colaborativas não encontrada em outros sistemas de aprendizagem [8].

2.1 Tecnologias para desenvolvimento de ferramentas Web

O desenvolvimento de aplicações de aprendizagem baseados na Internet pode ser realizado utilizando vários tipos de tecnologias. Pode-se gerar páginas estáticas com HTML puro até poderosas aplicações dinâmicas com CGI (*Common Gateway Interface*) e Servlets (*Dynamic WebPages in Java*) do lado servidor com a inclusão de Applets Java e JavaScript/CSS (*Cascading Styles Sheets*) do lado cliente permitindo a modificação ou adaptação do conteúdo a ser apresentado ao aluno dependendo de suas ações. XML/ XSL(eXtensible StyleSheet Language) que separa o conteúdo da apresentação também pode ser utilizado.

Qualquer linguagem pode ser utilizada na criação de programas CGI desde que o formato seja seguido. Exemplos de linguagens são PHP (*Personal Home Page*) e Perl (*Pratical Extraction and Report Language*). Apesar da transparência e uniformidade de busca à informação através da Web, CGI possui problemas de ineficiência ocasionados pelo alto *overhead* em servidores com muito acesso pois a cada requisição uma cópia do programa é disparada. Java Servlets é uma alternativa eficiente ao CGI. Um Servlet é uma classe Java que implementa uma interface de análise, execução e resposta ao cliente. Por ser Java os Servlets fazem uso de suas vantagens como portabilidade, poder, capacidade e produtividade e apresentam melhor desempenho do que CGI pois utilizam *threads* para processamento de requisições simultâneas e a exclusão de linguagens puramente interpretadas [9].

Applets Java são pequenos programas inseridos em páginas HTML que podem ser executados no cliente a partir de sua solicitação. Tem como vantagens criação de interfaces mais complexas, a independência de plataforma, sem necessidade de instalação e atualização pelo aluno além de ser removido depois do término do seu processamento. Há algumas restrições de segurança que impedem ler ou escrever arquivos no disco local e a comunicação fica restrita somente ao servidor de origem do Applet. Uma forma de contornar esta restrição é modificar a política de segurança da JVM (*Java Virtual Machine*) ou realizar autenticação do Applet. Pode-se também utilizar a plataforma de objetos distribuídos RMI (*Remote Method Invocation*) como uma forma eficiente de comunicação entre os clientes e servidores e JMF (*Java Media Framework*) para desenvolvimento de aplicativos de vídeo[10].

JavaScript é uma linguagem interpretada que associada ao CSS possibilita desenvolver páginas dinâmicas com maior interação permitindo a criação de interfaces mais atraentes que podem motivar o aprendizado e prender a atenção do aluno [11][12].

XML é uma metalinguagem para a criação de novas linguagens de marcação, definindo a forma de descrever a informação para uma classe de documentos. A definição do tipo de "conteúdo" e dos marcadores é feito utilizando-se um DTD (*Document Type Definition*). O formato de apresentação dos dados é realizado utilizando-se CSS ou XSL[11].

O desenvolvimento deste protótipo e seus módulos (*groupwares)* são baseados em Servlets, HTML e JavaScript/CSS para a interface de conteúdo de um curso, Servlets e XML/XSL para o módulo do FAQ e Applet/RMI na criação da ferramenta colaborativa de projeto.

O servidor de banco de dados escolhido para armazenamento das informações foi o MySql por possuir suporte a um grande número de plataformas e múltiplas linguagens, confiabilidade, velocidade e controle de acesso [10].

3. PROPOSTAS E RESULTADOS

3.1 Descrição Geral do Ambiente CTELCS

A proposta do ambiente CTELCS é ser um ambiente de aprendizagem colaborativo (CSCL) para treinamento através da Internet com alta escalabilidade, onde o objetivo principal é prover a colaboração entre os usuários com o intuito de realizar um melhor aprendizado com o uso de duas ferramentas colaborativas[1][2][8].

Um ponto a ser observado é que nenhum software adicional é instalado na máquina do aluno.

Para atender tais objetivos foi selecionada a disciplina de pós-graduação denominada Voz sobre IP com conteúdo totalmente disponível e utilizado de forma presencial.

3.2 Arquitetura do ambiente CTELCS

A arquitetura elaborada para o desenvolvimento do protótipo CSCL segue o modelo em três camadas MVC (*Model View Controller*) como uma tentativa de produzir uma boa modularização e alto nível de abstração com ganhos certos em manutenções futuras [3].

A Fig. 2 ilustra as partes da arquitetura da aplicação. Nesta figura observa-se a camada de apresentação onde foi incluído os elementos de exibição no cliente como HTML, XML, JSP ou *applets* Java, a camada de controle que é a camada intermediária entre a apresentação e a lógica da aplicação agindo como controladora, fornecendo o modelo para a visualização e regulando a comunicação entre as outras duas camada e a camada de lógica de aplicação, onde é realizado efetivamente o processamento, armazenando e gerando dados, cuidando dos aspectos de encapsulamento e comportamento, por exemplo, ela se encarrega de realizar consultas em banco de dados, efetuar cálculos e processamentos gerais. Assim sendo, ela pode ser reposicionada fora das aplicações *web*, já que seu processamento não é centrado na *web*.

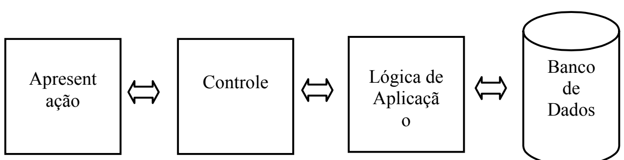

FIGURA. 2
ARQUITETURA DO DESENVOLVIMENTO DO PROTÓTIPO DE AMBIENTE CSCL

3.3 Módulos do Protótipo Desenvolvido

O protótipo é subdivido em 4 módulos distintos, conforme Fig. 3.

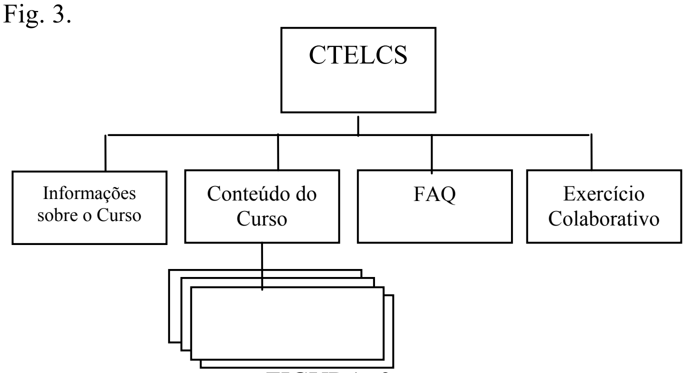

FIGURA. 3
MÓDULOS DO AMBIENTE CTELCS

Da Fig. 3 observa-se um módulo contendo informações gerais sobre o programa do curso, um módulo de conteúdo dividido em partes com animações, acesso a exercícios e a ferramenta de dúvidas e dois módulos colaborativos, o FAQ e o exercício.

Os dados necessários para a geração da interface e desenvolvimento dos módulos foram modelados com um diagrama entidade relacionamento (DER) que forneceu as tabelas necessárias. A criação destas tabelas possibilita o uso genérico do ambiente em qualquer curso bastando para isto modelar e inserir os dados relativos ao curso. A Fig. 4 ilustra o DER desenvolvido.

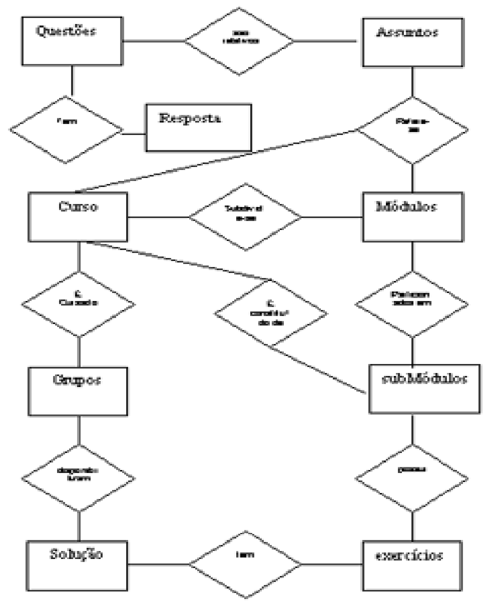

FIGURA. 4
DER PARA O PROTÓTIPO DE AMBIENTE CTELCS

3.4 Resultados Obtidos

Na montagem do protótipo foi criada uma interface inicial (Fig. 5) que fornece o acesso ao material modelado e aos módulos colaborativos.

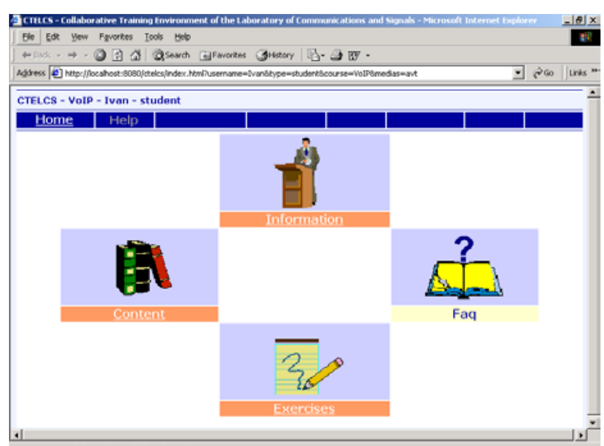

FIGURA. 5
TELA DE ENTRADA NO CTELCS

A primeira das opções, denominada *Information*, permite ao aluno visualizar dados gerais como o título do curso, data de início e término, requisitos, conteúdo programático a ser abordado no curso e observações gerais (Fig. 6).

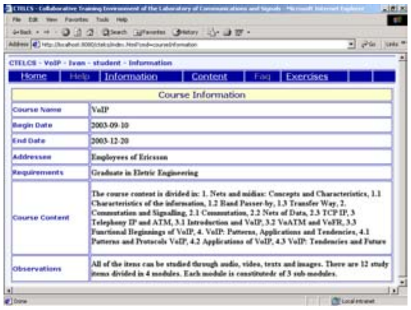

FIGURA. 6
INTERFACE CONTENDO INFORMAÇÕES GERAIS SOBRE O CURSO MODELADO

A opção *Content* exibe a interface que ilustra a modelagem realizada para um curso com as divisões em módulos e sub-módulos. Associado a cada item de conteúdo há um *link* que dá acesso ao conteúdo modelado. Há também palavras chaves associadas a cada conteúdo que possibilita ao aluno solicitar as dúvidas e respostas da ferramenta de FAQ. Na modelagem deste módulo e do seu conteúdo foram analisados critérios de usabilidade e comunicabilidade tentando-se criar uma interface e conteúdo mais agradáveis e motivadores [13]. Exemplos de interface do conteúdo e de sua modelagem podem ser visualizados na Fig. 7.

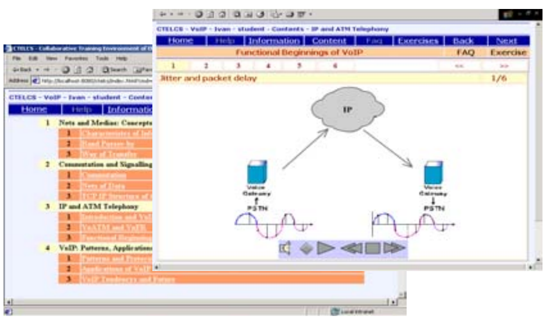

FIGURA. 7
INTERFACE CONTENDO A MODELAGEM DOS MÓDULOS, SUAS DIVISÕES E UMA TELA DE CONTEÚDO COM IMAGENS, ANIMAÇÃO E SOM.

O processo de geração das interfaces de conteúdo e de informações de um curso são obtidas através da solicitação do usuário a um *link* de uma página HTML. Esta solicitação é enviada ao Servlet no servidor de aplicações que trata e devolve a página resultante. As páginas possuem JavaScript/CSS como uma forma de tentar melhorar aspectos de navegação e interação do usuário com o conteúdo (Fig. 8)[10].

Para a opção FAQ a proposta é a construção de uma ferramenta assíncrona não presencial, onde o aluno pode colocar e responder dúvidas no momento do estudo de algum tópico do curso. As respostas às dúvidas podem ser realizadas de maneira cooperativa por qualquer integrante do curso. É importante observar que este módulo diferencia-se dos FAQs conhecidos por permitir ao aluno/professor inserir palavras chaves associadas à questão/resposta. Estas palavras chaves, como citado anteriormente, são ligadas diretamente ao módulo de conteúdo fazendo com que o aluno ao selecionar o FAQ acesse diretamente as dúvidas e respostas já inseridas, que se relacionam ao assunto do conteúdo.

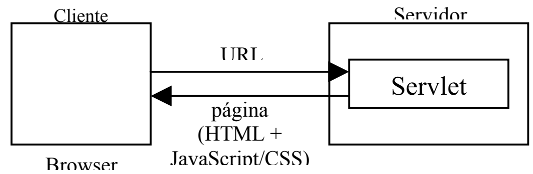

FIGURA. 8
PROCESSO DE GERAÇÃO DAS INTERFACES DE CONTEÚDO E DE INFORMAÇÕES DA DISCIPLINA

Quando o usuário faz uma solicitação do FAQ em algum ponto do conteúdo dentro do CTELCS, são enviados ao servlet as palavras chaves onde são obtidos do banco de dados as dúvidas e respostas relacionadas e montado um documento XML[11]. Este é processado e agregado ao correspondente XSL e devolvido para o cliente que visualiza o conteúdo.

O FAQ é uma ferramenta colaborativa assíncrona com compartilhamento de informações. Tanto professor quanto aluno podem estar interagindo com a ferramenta, por isso há uma interface diferenciada para professor e aluno permitindo um maior controle por parte do professor (Fig. 9)

A opção *Exercises* permite o acesso ao conjunto de exercícios colaborativos ou não que foram elaborados para o curso (Fig. 10). Um exemplo de exercício é o aplicativo síncrono não presencial que possibilita o trabalho cooperativo para a sua solução em grupo de 3 pessoas previamente definidas. Vale ressaltar que este tipo de ferramenta é interessante para o processo de aprendizagem, principalmente quando aborda assuntos com alto grau de complexidade. Por outro lado são relativamente dependentes do tipo de curso que estão inseridas. Tentando minimizar este problema foram desenvolvidos três *applets* agregados em uma única página HTML que são um *applet* para exibição de vídeo, um *chat* e um outro para o desenvolvimento da solução do exercício. Dessa maneira, para um reaproveitamento desta ferramenta basta inserir um *applet* contendo o novo exercício que a ferramenta já estará pronta. (Fig. 10).

FIGURA. 9
MÓDULO DE FAQ: A INTERFACE DO ALUNO (Á ESQUERDA) E A INTERFACE DO PROFESSOR (A DIREITA)

O tratamento da interdependência das atividades em grupo é tratada de forma simples. Somente um dos integrantes do grupo estará trabalhando na interface colaborativa, assumindo o papel de coordenador de atividades e os outros integrantes, denominados colaboradores, estarão sugerindo abordagens de solução e visualizando o resultado. A troca de papel entre os participantes do evento é de total responsabilidade do coordenador, podendo trocar de função se for solicitado por algum integrante ou se assim desejar.

A proposta da implementação da ferramenta como um Applet evita a necessidade de instalação de alguma aplicação na máquina do cliente e possibilita a criação de uma interface mais elaborada.

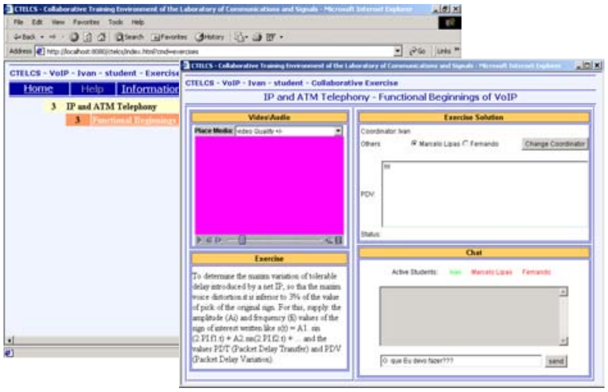

FIGURA. 10
INTERFACE DE ACESSO AOS EXERCÍCIOS PROPOSTOS E UM MODELO DE TELA DE EXERCÍCIO COLABORATIVO

4. Conclusões e Trabalhos Futuros

Os critérios de *design* e a modelagem aplicados tanto ao módulo de conteúdo como ao texto do curso escolhido permitiram obter uma interface de navegação simples e fácil, com uma estrutura robusta e padronizada, constituindo-se de animação e elementos interativos dentro do curso que certamente são um fator de atração e motivação aos usuários deste ambiente CSCL.

O módulo de FAQ associado ao módulo de conteúdo possibilita que o aluno acesse diretamente dúvidas e respostas com palavras chaves previamente inseridas dentro do módulo e, também possibilita ao professor realizar uma análise das dúvidas mais comuns e quais são os assuntos do módulo considerados mais complexos por parte dos alunos.

O módulo de exercícios foi desenvolvido com alto grau de modularidade entre seus miniaplicativos facilitando a alteração e/ou inclusão de novos exercícios colaborativos .

Como trabalhos futuros podem ser citados:

- A criação de mecanismos que automatizem a criação de grupos conforme as afinidades dos estudantes com o uso da tecnologia de agentes inteligentes.
- Desenvolver outros módulos como, por exemplo, um módulo de *login* e senha possibilitando um controle de acesso mais adequando ao ambiente e a possibilidade de realizar estatísticas de acesso e uso dos módulos.
- Desenvolver um esquema de tratamento das interdependências mais elaborado.

Agradecimentos

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O USO DA INTERNET COMO FERRAMENTA DE APOIO AO PROCESSO DE ENSINO-APRENDIZAGEM: ESTUDO DE CASO COM BASE NO SITE ESCOLA24HORAS

Regiane Rodrigues da Silva[1], *Juliano Schimiguel*[2]

***Resumo** – A Internet é um recurso muito benéfico para o ensino em geral. Ela permite o acesso fácil de professores e alunos a uma infinidade de material informativo sobre grande parte dos assuntos da cultura alvo. Além de dar muitos exemplos concretos e de mostrar as possibilidades de usar a rede para projetos interativos e para a formação e capacitação de professores, este trabalho dá um resumo da história e do funcionamento dos procedimentos básicos da Internet como ferramenta de aprendizagem.*

Palavras-chave: Internet, Ensino-Aprendizagem, Escola 24Horas

***Abstract** – The Internet is a very beneficial resource for education in general. It allows to the easy access of teachers and pupils to a infinity of informative material on great part of the subjects of the white culture. Besides giving many concrete examples and showing the possibilities to use the net for interactive projects and the formation and qualification of teachers, this work gives a history summary and the functioning of the basic procedures of the Internet as learning tool.*

Index-Terms: Internet, Learning-Education, 24Horas School

INTRODUÇÃO

A Internet nos oferece inúmeros recursos para estudo, avaliação e sua utilização. Há muitos sites web didáticos, preocupados em disponibilizar aulas gratuitamente. Há cursos que exigem uma inscrição, mas que oferecem aulas demonstrativas gratuitamente. Além destes, há vários sites web que são úteis para formar a opinião do usuário, pois servem como fontes de consulta na internet.

O assunto tem merecido a atenção da imprensa brasileira. A Folha de São Paulo, por exemplo, trouxe uma seleção de 110 sites educacionais em janeiro de 1999 e um enorme Guia da Internet em outubro do mesmo ano [9].

Na atual situação do ensino virtual temos, de um lado, o problema da transmissão de dados, que é considerada lenta, e do outro, o fato de os professores terem que se acostumar com as novas tecnologias. O que temos visto é o desenvolvimento de uma série de sites web educacionais, que visam facilitar a vida dos professores, pesquisadores e alunos [13].

Com a utilização desta nova ferramenta de trabalho, surge no mercado a necessidade de um novo tipo de profissional. Como os alunos tem acesso a várias fontes de informação através da Internet, o professor será considerado muito mais um "maestro" e deverá estar apto para atender as expectativas e responder a dúvidas-questões dos alunos. Além disso, a cobrança para os professores será maior, se considerarmos a interação professor-aluno [11].

Muitos alunos não têm coragem de fazer perguntas ao professor em público, o que pode ser contribuído através do uso do bate-papo on-line, por exemplo, que é um dos recursos disponibilizados por sites web educacionais. Acredita-se, então, que o mercado de trabalho abrirá portas para novos profissionais. Serão indivíduos com especialização em recursos tecnológicos, não apenas o uso do computador, mas qualquer ferramenta tecnológica que dê às suas aulas um toque diferencial.

REFERENCIAL TEÓRICO

Segundo Lévy [13] os sistemas de educação estão sofrendo hoje novas obrigações de quantidade, diversidade e velocidade de evolução dos saberes. Num plano puramente quantitativo, jamais foi tão maciça a demanda por formação. Os dispositivos de formação profissional e contínua estão saturados. A título de ilustração, dir-se-á que metade da sociedade está, ou gostaria de estar, na escola.

Será impossível aumentar o número de professores proporcionalmente à demanda de formação que é, em todos os países do mundo, cada vez mais diversa e maciça [13]. A questão do custo do ensino surge mais especialmente nos países pobres. Ou seja, será necessário decidir-se a encontrar soluções que apelem para técnicas capazes de multiplicar o esforço pedagógico dos professores e dos formadores.

Audiovisual, multimídia interativa, ensino assistido por computador, televisão educativa, cabo, técnicas clássicas de ensino à distância fundamentadas essencialmente na escrita, monitorado por telefone, fax ou internet… todas essas possibilidades técnicas, de uma maior ou menor pertinência,

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conforme seu conteúdo, a situação, as necessidades do aprendiz, podem ser consideradas e já têm sido amplamente testadas e experimentadas. Tanto no plano das infra-estruturas materiais quanto no dos custos de operação, escolas e universidades virtuais custam menos do que as escolas e universidades que ministram aulas presenciais [13].

A demanda por formação não só está passando por um enorme crescimento quantitativo, como também está sofrendo uma profunda mutação qualitativa, no sentido de uma crescente necessidade de diversificação e personalização. Campbell [3] afirma que os indivíduos suportam cada vez menos acompanhar cursos uniformes ou rígidos que não correspondem às suas reais necessidades e à especificidade de seus trajetos de vida. Uma resposta ao crescimento da demanda por uma massificação da oferta (mas, da mesma coisa, com o fim de alcançar economias de escala) seria uma resposta «industrialista» à antiga, inadaptada à flexibilidade e à diversidade futuramente requeridas.

Vê-se como o novo paradigma de navegação, que está se desenvolvendo nas práticas de coleta de informação e de aprendizado cooperativo no seio do ciberespaço; mostra a via de um acesso ao mesmo tempo maciço e personalizado ao conhecimento [3].

As universidades e, cada vez mais, as escolas de primeiro e segundo graus oferecem aos estudantes a possibilidade de navegar sobre o oceano de informação e conhecimento acessível pela internet. Programas educativos podem ser seguidos à distância pela World Wide Web (WWW). Os correios e as conferências eletrônicas servem para a monitoração inteligente e são postos ao serviço de dispositivos de aprendizado cooperativo. Os suportes hipermídia (CD-ROM, bancos de dados multimídia interativos) permitem acessos intuitivos rápidos e atrativos a grandes conjuntos de informação. Sistemas de simulação permitem que os aprendizes se familiarizem de maneira prática e barata com objetos ou fenômenos complexos sem, por isso, sujeitarem-se a situações perigosas ou difíceis de controlar [4, 5, 6, 7].

Os especialistas da área reconhecem que a distinção entre ensino em presencial e ensino à distância será cada vez menos pertinente, pois o uso das redes de telecomunicação e dos suportes multimídia interativos está integrando-se progressivamente às formas de ensino mais clássicas [9].

O aprendizado cooperativo e o novo papel dos docentes

O ponto essencial aqui é a mudança qualitativa nos processos de aprendizado. Procura-se muito menos transferir cursos clássicos em formatos hipermídia interativos ou "abolir a distância" do que implementar novos paradigmas de aquisição dos conhecimentos e de constituição dos saberes [3]. A direção mais promissora, que aliás traduz a perspectiva da inteligência coletiva no campo educativo, é a do aprendizado cooperativo.

Certos dispositivos de aprendizado em grupo foram especialmente concebidos para a partilha de diversos bancos de dados e o uso de conferências e mensagens eletrônicas. Fala-se, então, em aprendizado cooperativo assistido por computador (em inglês: Computer Supported Cooperative Learning ou CSCL).

Nos novos campos virtuais, professores e estudantes põem em comum os recursos materiais e informacionais à sua disposição. Os professores aprendem ao mesmo tempo que os estudantes atualizam continuamente tanto seus saberes disciplinares, quanto suas competências pedagógicas. A formação contínua dos docentes é uma das aplicações mais evidentes dos métodos do aprendizado aberto e à distância [1].

Os estudantes podem participar de conferências eletrônicas desterritorializadas, nas quais intervêm os melhores pesquisadores de sua disciplina. Assim sendo, a função-mor do docente não pode mais ser uma difusão dos conhecimentos, executada doravante com uma eficácia maior por outros meios. Sua competência deve deslocar-se para o lado do incentivo para aprender e pensar. O docente torna-se um animador da inteligência coletiva dos grupos dos quais se encarregou. Sua atividade terá como centro o acompanhamento e o gerenciamento dos aprendizados: incitação ao intercâmbio dos saberes, mediação relacional e simbólica, pilotagem personalizada dos percursos de aprendizado, etc [2].

Rumo a uma regulação pública da economia do conhecimento

As reflexões e as práticas sobre a incidência das novas tecnologias na educação têm-se desenvolvido em diversos eixos. Temos exemplos de trabalhos que foram realizados sobre a multimídia, enquanto suporte6 de ensino, ou sobre os computadores (ensino assistido por computador ou EAC).

Nessa visão — extremamente clássica — a informática oferece máquinas para auxiliar a ensinar. Seguindo outra abordagem, os computadores são considerados como instrumentos de comunicação, de pesquisa, de informação, de cálculo, de produção de mensagens (textos, imagens ou som) a serem postos nas mãos dos aprendizes [1].

Ao prolongar certas capacidades cognitivas humanas (memória, imaginação, percepção), as tecnologias intelectuais com suporte digital estão redefinindo seu alcance, seu significado, às vezes até sua natureza [14].

As novas possibilidades de criação coletiva distribuída, de aprendizado cooperativo e de colaboração em rede propiciada pelo ciberespaço estão questionando o funcionamento das instituições e os modos habituais de divisão do trabalho, tanto nas empresas quanto nas escolas.

O que está em jogo na cybercultura, tanto no plano da redução dos custos como no do acesso de todos à educação, não é a passagem do presencial para a distância e, tampouco, da escrita e do oral tradicionais para a multimídia. Mas sim a transição entre uma educação e uma formação estritamente institucionalizada (escola, universidade) e uma situação de intercâmbio generalizado dos saberes, de ensino da sociedade por ela mesma, de reconhecimento autogerido, móvel e contextual das competências [14].

Nesse quadro, o papel do poder público haveria de ser [11]:

1. Garantir a cada pessoa uma formação de qualidade;

2. Permitir um acesso aberto e gratuito, à centros de orientação, documentação e autoformação, a pontos de entrada no ciberespaço, sem negligenciar a indispensável mediação humana do acesso ao conhecimento;

3. Regular e animar uma nova economia do conhecimento, na qual cada indivíduo, cada grupo , cada organização sejam considerados como recursos potenciais de aprendizado ao serviço de formação contínuo e personalizado.

Evidentemente, é para esse novo universo que a educação deve preparar. Simetricamente, no entanto, deve-se admitir também o caráter educativo ou formador de muitas atividades econômicas e sociais, o que levanta evidentemente o problema de seu reconhecimento ou validação oficial, sendo que o sistema de diplomas parece cada vez menos adequado. Por outro lado, o tempo necessário para a homologação de novos diplomas e para a constituição dos currículos que levam a eles não está mais em fase com o ritmo de evolução dos conhecimentos [14].

Um grande número de processos vigentes em curso, por meio de dispositivos formais de formação contínua, para falarmos apenas das competências adquiridas durante as experiências sociais e profissionais dos indivíduos, não geram hoje nenhuma qualificação. A relação com o saber emergente, cujas grandes linhas foram esboçadas, trazem o questionamento da estreita associação entre duas funções dos sistemas educativos: o ensino e o reconhecimento dos saberes. Como os indivíduos aprendem cada vez mais fora das fileiras acadêmicas, cabe aos sistemas de educação implantarem procedimentos de reconhecimento dos saberes e *know-how* adquiridos na vida social e profissional. Para esse fim, serviços públicos que explorassem em grande escala as tecnologias da multimídia (testes automatizados, exames em simuladores) e da rede interativa (possibilidade de fazer testes ou fazer reconhecer suas aquisições com a ajuda de orientadores, monitores e examinadores em linha) poderiam aliviar os docentes e as instituições educacionais clássicas de uma tarefa de controle e validação menos “nobre” — mas ainda necessária — do que o acompanhamento dos aprendizados.

A evolução do sistema de formação não pode ser dissociada da evolução do sistema de reconhecimento dos saberes que o acompanha. Utilizar todas as novas tecnologias na educação, sem nada mudar os mecanismos de validação dos aprendizados equivale, ao mesmo tempo, a aumentar os músculos da instituição escolar e a bloquear o desenvolvimento de seus sentidos e cérebro [8].

Uma desregulação controlada do atual sistema de reconhecimento dos saberes poderia favorecer o desenvolvimento das formações alternadas e de todas as formações que conferissem um lugar importante à experiência profissional. Ao autorizar a invenção de modos originais de validação, tal desregulação encorajaria também as pedagogias pela exploração coletiva e todas as formas de iniciativas a meia distância entre a experimentação social e a formação explícita [8].

Semelhante evolução não deixaria de gerar interessantes retroefeitos para certos modos de formação de tipo escolar, freqüentemente bloqueados em estilos de pedagogia pouco aptos para mobilizar a iniciativa, por orientar-se apenas pela sanção final do diploma. Numa perspectiva ainda mais ampla, a desregulação controlada do reconhecimento dos saberes aqui referida estimularia uma socialização das funções públicas da escola. Com efeito, ela permitiria que todas as forças disponíveis concorressem ao acompanhamento de trajetos de aprendizados personalizados, adaptados aos objetivos e às diversas necessidades dos indivíduos e das comunidades implicadas [14].

Segundo Erickson [8], os desempenhos industriais e comerciais das empresas, das regiões, das grandes zonas geopolíticas estão em estreita correlação com políticas de gestão do saber. Conhecimentos, know-how, competências são hoje a principal fonte da riqueza das empresas, das grandes metrópoles, das nações. Existem grandes dificuldades na gestão dessas competências, tanto no nível de pequenas comunidades como no das regiões. Do lado da demanda, observa-se uma inadequação crescente entre as competências disponíveis e a demanda econômica. Do lado da oferta, um grande número de competências não são nem reconhecidas, nem identificadas, mais especialmente entre os que não possuem um diploma. Esses fenômenos são particularmente sensíveis nas situações de reconversões industriais ou de atraso de desenvolvimento de regiões inteiras [10].

Deve-se, paralelamente aos diplomas, imaginar modos de reconhecimento dos saberes, que possam prestar-se para uma visualização em rede, da oferta de competência e a uma “pilotagem” dinâmica retroativa da oferta pela demanda. Para tanto, a comunicação através do ciberespaço pode ser uma grande ajuda.

Uma vez aceito o princípio segundo o qual toda e qualquer aquisição de competência deve poder dar lugar a um explícito reconhecimento social, os problemas da gestão das competências, tanto na empresa como no nível das coletividades locais, estarão a caminho, se não de sua solução, ao menos de sua mitigação [12].

MÉTODOS E FONTES

A pesquisa proposta será desenvolvida através da aplicação de um estudo de caso com foco em contextos e processos, pelos quais está ocorrendo a introdução de novas tecnologias, particularmente, a informática, em escolas de ensino médio e fundamental. A preocupação central é construir um corpo teórico a partir de estudos de caso e contribuir para avançar na construção do campo de pesquisa, identificando problemas e formulando hipóteses que, por sua vez, sejam geradoras de conhecimento e, portanto, de novas interrogações.

Não se trata de pesquisa de avaliação, mas sim de pesquisa explicativa, com recurso à análise documental, à observação direta e participante, nas modalidades livre e sistemática, à obtenção de depoimentos por meio de entrevistas.

As fontes para obtenção de dados para elaboração deste trabalho serão coordenadores, professores e alunos envolvidos na utilização da ferramenta "Internet" no processo de ensino-aprendizagem. Tem-se como pretensão entrevistar cinco indivíduos de cada categoria.

Para o desenvolvimento deste trabalho, estaremos aplicando uma pesquisa descritiva e outra explanatória [16]. A pesquisa descritiva busca associações entre variáveis de caráter quantitativo; e a explanatória diz que, em virtude de se obter os fatos de um caso avaliado, realiza-se explicações alternativas sobre esse caso, gerando-se, dessa forma, uma conclusão baseada na explicação mais coerente com os fatos.

Estaremos trabalhando sobre um estudo de caso – o Portal Educacional da Escola24Horas (Figura 1) – como ferramenta de apoio ao processo de ensino-aprendizagem. Os dados serão coletados através de entrevista e observação. A observação será não participativa, devido ao fato de não interferir no desempenho das atividades, tendo uma interação com os usuários do site. A entrevista será feita através de questionários com perguntas abertas, para efetuar o diagnóstico de falhas, entraves ou problemas que dificultam o atual acesso e utilização do site.

ESTUDO DE CASO

O estudo de caso que estaremos adotando diz respeito ao portal educacional da Escola24Horas (Figura 1), que possui atualmente cerca de dez mil usuários cadastrados. Este trabalho terá como objetivo utilizar uma parcela do potencial da Internet como ferramenta de apoio ao desenvolvimento do processo de ensino-aprendizagem, através do emprego efetivo de alguns de seus recursos, além disso, avaliar como se processa a ação de professores-alunos-pesquisadores diante dos recursos da informática e de que forma será utilizada no processo de aprendizagem, na concretização do saber, que é um dos objetivos da escola.

O uso de um portal educacional trás todo um contexto diferenciado da linguagem visual e textual, e tomadas de decisão no acesso e seleção desse material, que são de suma importância, além de um acesso ilimitado a todo tipo de informação e áreas de conhecimento.

FIGURA.1
TELA PRINCIPAL DO PORTAL EDUCACIONAL ESCOLA24HORAS [15]

CONTRIBUIÇÕES E CONCLUSÕES

Ensinar sem os recursos da Internet não faz sentido nos nossos dias, uma vez que lidamos com a "Geração Net" (crianças que crescem utilizando e compartilhando o computador); ativa na revolução científica e tecnológica em curso, e, sendo assim, este é o recurso mais eficaz para motivar a atual geração.

Ao aproveitar o potencial da Internet, professores sentem-se mais motivados para ensinar-formar cidadãos dotados de conhecimentos, competências, comportamentos e atitudes adequados. Para que os alunos sintam-se realizados a nível pessoal e, também posteriormente, a nível profissional; a que os levar a procederem a uma análise e a uma síntese da imensa massa de dados disponíveis; a que os levar a dominar as tecnologias da informação e comunicação. Contribuir para a formação de indivíduos capazes de efetuarem uma inserção crítica e criativa no mundo atual, deve ser um imperativo de atuação do sistema educativo.

Não se pode esquecer que professores estão a ensinar-formar uma geração que já nasceu e está a crescer rodeada de mídias digitais. A tecnologia para os jovens de hoje é como o "ar que se respira"; por isso, professores-formadores só terão sucesso (no sentido de aproveitar todas as virtualidades que a Internet pode trazer à formação pessoal e social dos alunos) se freqüentarem cursos de formação e utilizarem websites educacionais como ferramentas de trabalho.

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E-VALUATION: A AVALIAÇÃO ELETRÔNICA COMO INSTRUMENTO DE ACOMPANHAMENTO DE APRENDIZAGEM

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Abstract *— This paper shows a proposal of architecture for implementing electronic evaluation processes into a distance learning context, specifically inside the WEL (Web Engineering for Learning) Project. WEL's main purpose is to establish a generic, reusable framework for developing learning objects for distance learning programs. A sort of these learning objects is named e-valuations, which are electronic exercises that are used in formative evaluation. These exercises are built according to the topics of the curriculum that are being studied, and they are randomly assigned to the students for each topic that is covered on the content. Every student's behavior when doing an e-valuation is meant to be stored and after used in order to evaluate not only students' performance, but also the efficacy of the learning objects that were used by them, thus contributing to courses' optimization.*

Index Terms — Distance Learning, Electronic Evaluation, Learning Objects, Formative Evaluation.

INTRODUÇÃO

A expansão do uso das novas tecnologias da informação e comunicão (TICs) traz junto consigo um conjunto de novos paradigmas a serem analisados, ao mesmo tempo em que força a reflexão sobre antigas e bem estabelecidas estratégias que podem ou não se adequarem a esses novos paradigmas.

Em relação ao processo de avaliação, muito pouca coisa se alterou em relação a modelos pedagógicos clássicos de uso da avaliação, que a encaram como um acontecimento pontual dentro de um dado contexto contínuo de aprendizagem, onde as respostas dadas em um certo momento são decisivas na progressão ou não do aprendiz no processo.

Mesmo com o uso das TICs como apoio ao processo de ensino-aprendizagem a distância, é bastante comum se presenciar a implementação de modelos avaliativos antigos utilizando novas tecnologias, incorrendo no erro de propor, em um contexto de educação a distância, formas de avaliação talvez mais adequadas para situações presenciais.

No que se refere aos sistemas de suporte ao ensino-aprendizagem a distância, o processo de avaliação nem sempre é contemplado satisfatoriamente pelas ferramentas hoje disponíveis, quer seja pela limitação no que tange aos tipos possíveis de questões, ou no que diz respeito à complexidade em elaborá-las, ou mesmo à inexistência de algoritmos eficientes de processamento de linguagem natural para a análise de respostas discursivas.

Neste artigo será apresentada uma proposta de uso de ferramentas avaliativas no contexto de uma avaliação continuada e progressiva da aquisição de competências por parte do aprendiz. Este trabalho é parte de um projeto temático sendo desenvolvido pelo Núcleo de Pesquisa em Computação e Tecnologia da Informação (NCTI) da UNICSUL (Universidade Cruzeiro do Sul), em São Paulo. Tal projeto denomina-se WEL (*Web Engineering for Learning*) que visa à produção de objetos de aprendizagem [7] como apoio ao processo de ensino-aprendizagem [1][2].

O presente trabalho encontra-se organizado como segue: no próximo item, serão analisadas e classificadas algumas estratégias de avaliação. Apresenta-se depois uma proposta de um sistema de suporte ao processo de avaliação eletrônica (WEL *e-valuation*), seguida de uma discussão técnica a respeito da arquitetura do sistema proposto. Por fim, são apresentadas algumas conclusões e perspectivas de trabalhos futuros.

FORMAS DE AVALIAÇÃO

É ponto pacífico a necessidade de um processo de avaliação em um contexto de ensino-aprendizagem, seja este presencial ou a distância. Deve-se discutir, todavia, uma série de pontos essenciais à definição do tipo de avaliação que se pretende estabelecer.

Uma decisão é crucial no processo de introdução do mecanismo de *e-valuation* em um contexto de ensino-aprendizagem: deve-se estabelecer qual o objetivo primordial da avaliação dentro desse contexto, ou seja, se a mesma será utilizada como mero instrumento de medida ou como referência para contribuir em futuras aprendizagens. A partir dessa análise, escolhas adequadas podem ser feitas de acordo com o critério de avaliação estabelecido.

Claramente, o que está sendo decidido é a opção pela avaliação somativa ou formativa, respectivamente [4][10]. A

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opção pela primeira traz para um âmbito de educação a distância uma estratégia que por sua vez é caracterizada pela necessidade de aplicação presencial, já que se tratam de eventos pontuais com o propósito de estabelecer uma medida para o conhecimento acumulado. Já a segunda orpção parte do pressuposto que através da análise de resultados de um certo aprendiz podem ser traçadas novas estratégias de ensino que o conduzam a novos caminhos de aprendizagem, de maneira individualizada, servindo também como instrumento para a aprimoração do próprio curso, de forma que favoreça a reprodução de operações bem sucedidas e a reflexão sobre as que não o foram. Conclui-se então que trata-se um processo em andamento a ser considerado em todos os estágios da instrução que permite o aprimoraento do curso, facilitando a adaptação dos objetos de aprendizagem às necessidades individuais e identificando falhas no planejamento e necessidade de ajustes [9].

Piaget e Vigotsky [5][6] estabeleceram as bases para o construtivismo partindo do princípio de que o conhecimento é construído a partir do desenvolvimento cognitivo, o que leva a uma conclusão bastante óbvia: se o aprendizado depende mais do agente do que do objeto, logo é necessário fazer com que o objeto adeque-se ao agente, e não o contrário.

Assim sendo, o papel da avaliação formativa é o de adaptar o dispositivo pedagógico à realidade das aprendizagens dos alunos, estando presente de forma ubíqua em todos os pontos do processo de ensino e aprendizagem, pois torna-se parte do processo, e não mecanismo de medida de qualidade deste [4][8][9]. Além disso, também serve como uma medida de qualidade em se tratando de avaliar os objetos – e não somente os agentes – de aprendizagem, de maneira singular, identificando, através do desempenho dos alunos, quais objetos são ou não eficazes na construção do conhecimento, indicando possíveis substituições, melhorias ou mudanças de estratégia pedagógica.

Ao contrário da avaliação formativa, a somativa tem como característica básica o foco no impacto pedagógico dos objetos nos agentes, geralmente através de medidas numéricas tomadas ao final de um ciclo de aprendizagem ou ao se completar um subconjunto do currículo em estudo. Assim, da mesma forma que se pode utilizá-la como uma maneira de medir o desempenho dos aprendizes, também pode servir como uma medida dos resultados obtidos – e não do processo como um todo.

Em termos de implementação das supracitadas estratégias de avaliação em um processo de ensino-aprendizagem a distância, o que ocorre é que, apesar de serem de mais rápido e fácil desenvolvimento, estratégias de avaliação somativa sofrem o problema estrutural de, na maioria das vezes, dependerem de um *momentum* de avaliação presencial, por se tratar de um ou mais eventos pontuais em um determinado espaço de tempo que servirão como medida da eficácia de todo um processo de ensino-aprendizagem. Logo, sua aplicação a distância incorre nas inúmeras possibilidades abertas por métodos não-lícitos que porventura possam vir a ser aplicados para tal.

Apesar desse risco não ser completamente extirpado em situações onde se aplica o processo de avaliação formativa, seu impacto é diminuído, uma vez que não são somente incursões pontuais que determinam a competência adquirida pelo aluno durante o processo, mas sim o que é avaliado a partir do acompanhamento do processo em si, o que se torna o principal instrumento de avaliação.

O item a seguir demonstra uma propsta de arquitetura para a implantação de estratégias de *e-valuation* em um contexto de ensino-aprendizagem a distância.

UMA ARQUITETURA PARA E-VALUATION

Um dos pontos específicos dentro do Projeto WEL é a elaboração de *e-valuations*, que são exercícios em caráter de avaliação formativa,. Cada exercício, por sua vez, é um objeto de aprendizagem pertencente a um *framework* genérico e reutilizável definido em [3], sendo utilizado em todo o Projeto WEL. A arquitetura implementada é cliente-servidor, utilizando ferramentas de autoria na elaboração de interfaces para os exercícios. A mesma é mostrada na Figura 1, a seguir.

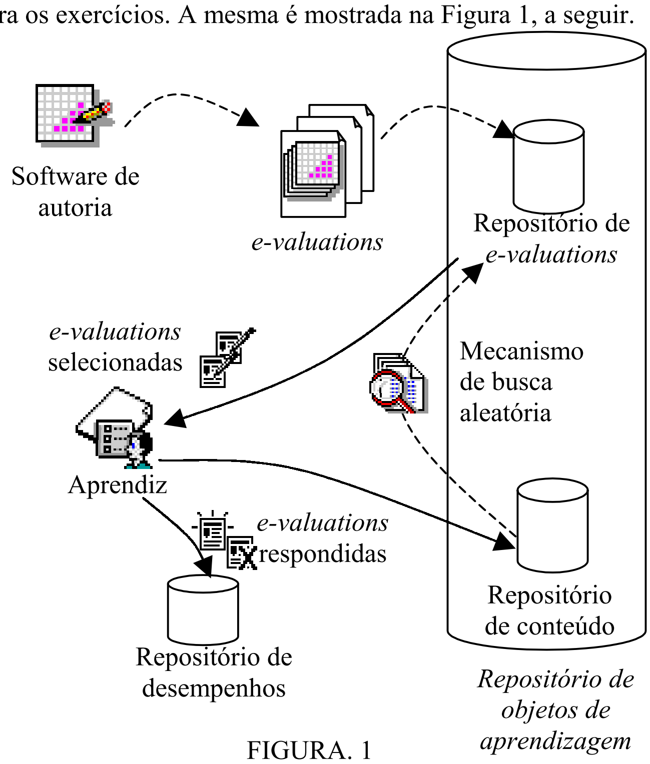

FIGURA. 1
ARQUITETURA DO WEL E-VALUATION

Conforme pode ser observado na Figura 1, o processo inicia-se pela criação de *e-valuations* e sua organização em um Repositório de *e-valuations*, que por sua vez é parte de um repositório maior, o Repositório de Objetos de Aprendizagem.

Ao acessar um determinado conteúdo, um mecanismo de busca aleatória fornece ao aluno um conjunto de *e-valuations* extraído do Repositório de *e-valuations*. A Figura 2 demonstra dois possíveis *e-valuations* para um mesmo conteúdo, relativo à ementa de árvores, no contexto de uma disciplina introdutória de Estruturas de Dados, e que poderiam ser atribuídos a alunos diferentes em um mesmo contexto de aprendizagem, ou ao mesmo aluno, em momentos distintos.

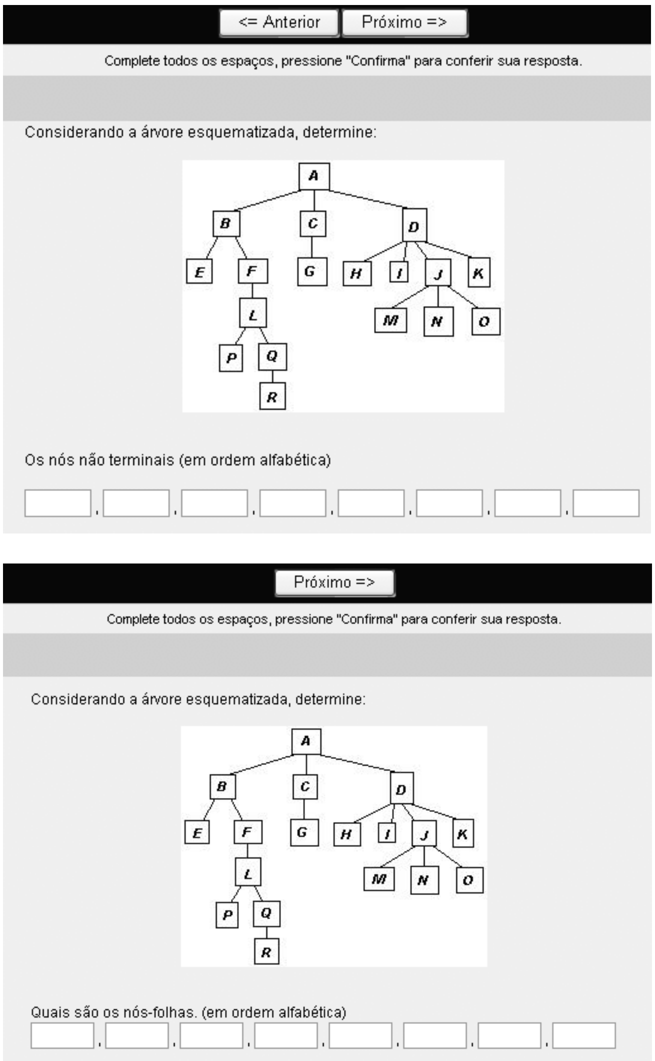

FIGURA. 2
DUAS POSSÍVEIS E-EVALUATIONS PARA UM MESMO CONTEÚDO

Caso o aluno se proponha a solucionar as *e-valuations* a ele atribuídas , seu desempenho, bem como seu comportamento (número de tentativas, o tempo gasto para elaborar uma resposta, etc.) são armazenados de forma a servirem para uma análise bilateral, envolvendo tanto o processo de construção do conhecimento do aluno quanto a eficiência dos objetos de aprendizagem aos quais o mesmo foi submetido. Tais dados podem ser utilizados em conjunto com demais dados comportamentais, como o percurso realizado pelos alunos, uso de chat, quantidade e qualidade de contribuições nos fóruns, por exemplo, de forma a obter mais dados, quantitativos e qualitativos, a respeito do processo de aprendizado [4].

DETALHAMENTO DA ARQUITETURA

A Arquitetura proposta é implementada através uma solução 100% Java, cujo projeto organiza-se em camadas com baixo grau de acoplamento, permitindo maior flexibilidade e manutenibilidade. A Figura 3 mostra a divisão em camadas da solução proposta.

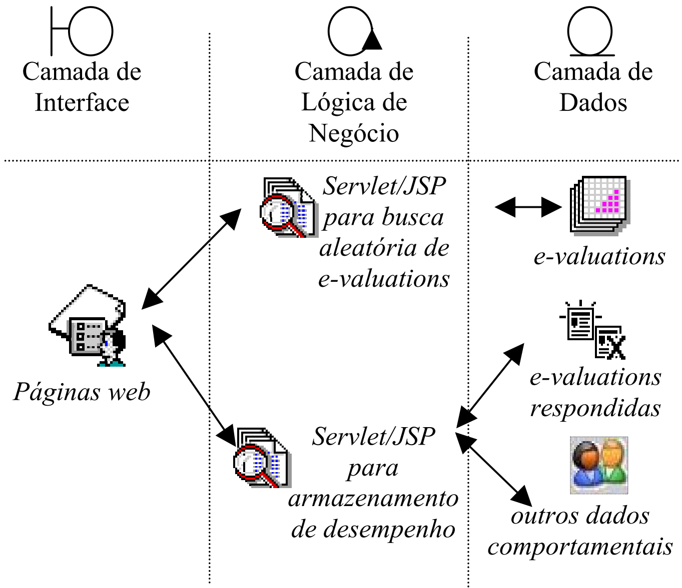

FIGURA. 3
ARQUITETURA EM TRÊS CAMADAS

Há que se notar, em relação à arquitetura, que a mesma denota tão somente uma camada de abstração lógica, não havendo qualquer pressuposição em relação à distribuição dfísica da mesma, de forma que se pode, por exemplo, distribuir fisicamente os repositórios segundo algum critério de distribuição, como por exemplo o tipo de objeto de aprendizagem armazenado. Da mesma maneira, não há nenhum empecilho, a não ser os relativos a custo e performance, para sua implementação de forma centralizada.

Um outro ponto a ser ressaltado é o de que, apesar de o sistema estar sendo utilizado principalmente na realização de avaliação formativa, sua arquitetura é flexível o bastante para adaptar-se a esquemas de avaliação distintos, como a somativa ou mesmo a diagnóstica [4].

CONCLUSÕES

Os processos avaliativos, enquanto ferramenta de acompanhamento da construção do conhecimento por parte do aprendiza e da eficácia dos objetos de aprendizagem nessa construção, desempenha um papel extremamente importante no processo de ensino-aprendizagem como um todo.

O presente trabalho procurou demonstrar a necessidade de utilização de estratégias de avaliação formativa em um contexto de educação à distância, de forma a obter uma avaliação mais adequada ao novo paradigma de aprendizagem em questão.

Deve-se ressaltar que a proposta da arquitetura, por integrar-se ao *framework* genérico do WEL, pode ser reutilizada em virtualmente qualquer área do conhecimento.

Trabalhos futuros apontam para a realização de experiências em outros cursos, além de uma análise estatística para fins de validação da proposta junto a alunos em situações reais de aprendizagem.

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DESIGN DE UM GERENCIADOR DE FLUXO DE TAREFAS NO CONTEXTO DE APRENDIZADO EM MANUFATURA

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Resumo *— O objetivo deste trabalho é apresentar uma abordagem para design de um gerenciador de fluxo de tarefas, que será integrado ao sistema Pokayoke, um sistema de CSCW para suporte à discussão e resolução de problemas de forma cooperativa no contexto de manufatura. Pokayoke aborda a questão da resolução de problemas, porém não dá suporte ao controle do fluxo das informações e nem à documentação deste fluxo durante as fases da resolução. A abordagem adotada propõe a utilização de técnicas e metodologias de IHC, CSCW e Workflow no design do ambiente, bem como para lidar com o impacto que estes sistemas causam nas organizações. O CSCW objetiva dar suporte a grupos de usuários em trabalho cooperativo/colaborativo. A tecnologia Workflow será usada visando que a integração do sistema ao Pokayoke proporcione o controle e a documentação dos processos, agilizando e tornando o processo de resolução de problemas mais eficiente. Neste trabalho ilustraremos o uso da abordagem com o design do Pokayoke-Flow.*

Palavras chaves — CSCW , IHC, Workflow.

INTRODUÇÃO

Com as mudanças de paradigmas ocorridas nos sistemas produtivos nos últimos anos, as indústrias ocidentais têm procurado se enquadrar nas novas tendências do mercado mundial. O avanço tecnológico dos últimos anos traz consigo a globalização do mercado que se caracteriza por forte competição e requer melhoria no desempenho empresarial.

Cada vez mais as empresas estão fazendo uso de sistemas de comunicação interna, ou *groupware*, integrando-os à Internet e a bases de dados corporativos para gerenciar um dos mais importantes ativos das companhias: o conhecimento. A gestão eficiente desse recurso pode significar não só a solução de problemas como também redução de custos, melhoria nos serviços e aumento da produtividade [1]. O sucesso de sistemas para apoio ao trabalho cooperativo está diretamente ligado à facilidade de uso e adequação de sua interface ao contexto de trabalho. A área de IHC (Interação Humano-Computador) propõe métodos e técnicas de design para sistemas computacionais voltadas às necessidades das pessoas, de forma que estas possam executar suas atividades produtivamente e com segurança. Como tal, mostra-se essencial à proposta de abordagens ao design de tais sistemas.

Este trabalho se insere na continuidade de um projeto de parceria entre o Núcleo de Informática Aplicada à Educação (NIED-Unicamp) e a Delphi-Automotive Systems. Neste projeto a aprendizagem é entendida em um contexto mais amplo do que a aprendizagem que se refere a atividades de treinamento com o uso do computador. A aprendizagem auxiliada por sistemas computacionais a que nos referimos neste projeto não se limita ao objetivo intencional de formação, mas é contextualizada no dia-a-dia de trabalho (mediado por sistemas computacionais) dos funcionários.

Dentro deste escopo está sendo desenvolvido o sistema *Pokayoke*. Este sistema dá suporte para que a resolução de problemas e tomada de decisão ocorra de forma colaborativa/cooperativa. Neste sistema, os trabalhadores envolvidos na resolução tem a oportunidade de discutir e refletir sobre ações tomadas para solucionar problemas passados e para o problema atual desencadeando um processo de aprimoramento contínuo. Entretanto este sistema não possui um mecanismo para controle do fluxo das tarefas desenvolvidas durante a resolução do problema. Este mecanismo é importante para que os trabalhadores tenham a real dimensão sobre o impacto das ações tomadas e também das dificuldades na sua implementação. Isso possibilitará uma discussão e reflexão mais aprofundada.

Este trabalho apresenta e discute uma abordagem ao design de ferramentas de apoio ao gerenciamento do fluxo de tarefas em um sistema voltado à resolução de problemas no contexto de uma organização de manufatura.

A estrutura do trabalho está organizada da seguinte maneira: na segunda seção apresentamos o contexto de trabalho envolvido no estudo, na terceira seção apresentamos o referencial teórico usado no desenvolvimento da pesquisa, na quarta seção apresentamos os modelos de design de workflow comumente praticados, na quinta seção apresentamos os resultados preliminares do trabalho e por fim uma conclusão.

O CONTEXTO ENVOLVIDO NO TRABALHO

Novas técnicas de manufatura levaram as organizações industriais para uma nova filosofia de produção chamada "produção enxuta". Colocada como evolução do sistema de produção em massa, o desafio deste tipo de produção

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é otimizar a utilização de todos os recursos, visando um produto com maior qualidade e menor preço. Nestas organizações os funcionários devem ser flexíveis; suas habilidades vão além de suas funções particulares, devem possuir senso crítico e um bom desempenho no trabalho em grupo.

Assim, estas novas indústrias privilegiam programas de educação continuada a seus funcionários e projetos que possibilitem a aprendizagem e o entendimento do processo global de produção de onde trabalham. Estes funcionários devem aprender enquanto trabalham, para estarem aptos a evoluir junto à organização [2].

A Delphi-Automotive Systems, que possui parceria com o NIED-Unicamp no contexto deste projeto, é uma indústria que pratica idéias da produção enxuta e produz componentes para a indústria automotiva. Esse projeto de parceria envolve o design de ambientes de aprendizagem onde o foco da atividade do aprendiz é a resolução de problemas de forma colaborativa/cooperativa e contextualizada na sua realidade de trabalho, por intermédio de sistemas computacionais.

Rotineiramente as organizações enfrentam inúmeros problemas que exigem discussão e colaboração entre indivíduos de um grupo para resolvê-los. Estes problemas, sejam administrativos, gerenciais ou de produção, necessitam que conhecimentos especializados, simulação de resultados, geração de idéias, sugestões e críticas sejam inseridos no tratamento do problema, tornando importante a integração e coordenação de esforços para tomadas de decisão dentro da organização.

Nesse contexto está sendo construído o sistema *Pokayoke*, um sistema de CSCW (Computer Supported Cooperative Work), nome que se dá as atividades de trabalho cooperativo auxiliadas por computador. Este sistema dá suporte a resolução de problemas e a tomada de decisão no contexto de uma organização de manufatura que adota o paradigma de "produção enxuta". Ele inclui algumas das principais ferramentas para a resolução de problemas que era utilizada previamente pelo departamento de qualidade, em papel.

O *Pokayoke* é baseado em um procedimento existente na fábrica para analisar e implementar ações corretivas, preventivas, de segurança e saúde, conhecida como "cinco passos". O objetivo deste procedimento é sistematizar o processo da fábrica em lidar com problemas que ocorrem na rotina da produção. Toda vez que uma não conformidade é identificada, uma ação deve ser tomada para corrigi-la e dificultar que exista uma nova ocorrência. Também toda vez que uma situação potencial de não conformidade é indicada, uma ação de caráter error proofing (Poka Yoke) deve ser realizada.

Ferramentas para dar suporte a resolução de problemas são distribuídas em diferentes fases do processo, por exemplo: diagramas de *Ishikawa* são utilizados durante o passo III, *Brainstorming* no passo II e IV, e "5-porquês" no passo III. Esta ferramentas estão embutidas no sistema e são combinadas com artefatos de comunicação assíncrona que permitem que estas sejam utilizadas por grupos de pessoas de maneira cooperativa [3].

O sistema *Pokayoke* também inclui uma ferramenta para a "gerencia de conhecimento" a qual facilita a recuperação e a manipulação de problemas já solucionados na empresa. O suporte a tomada a decisão é realizado por agentes artificiais que atuam propondo soluções para o problema e analisando as ações tomadas pelos usuários.

O sistema *Pokayoke* aborda a questão da resolução de problemas, porém não dá suporte ao controle do fluxo das informações e nem à documentação deste fluxo durante as fases da resolução. O sistema proposto neste trabalho é uma extensão ao sistema *Pokayoke*, objetivando o controle e a documentação dos processos, através do gerenciamento do fluxo de tarefas e acompanhamento das soluções de problemas, com base no conceito de workflow. Com estas ferramentas o usuário pode gerenciar as ações tomadas para solucionar o problema, sabendo exatamente qual é o estágio de desenvolvimento destas ações.

O Referencial Teórico: IHC, CSCW e Workflow

A área de IHC tem papel no desenvolvimento de todo tipo de sistema [4]. Conforme Thives Jr.(2000) o termo 'sistema' adotado se refere não somente ao hardware e ao software mas a todo o ambiente que usa ou é afetado pelo uso da tecnologia computacional.

As metodologias de design da interação humano-computador foram desenvolvidas focando tipicamente o trabalho individual do usuário; porém, com as redes de computadores conectando mais e mais usuários, tornam-se fundamentais abordagens à interação de pessoas trabalhando em grupo. CSCW, objetiva estudar e desenvolver sistemas para dar suporte a grupos de usuários em trabalho cooperativo/colaborativo [5].

Suporte à interação em CSCW envolve amplamente o projeto da interface de usuário. Dois aspectos devem ser considerados: o desenvolvimento de sistemas que suportam troca de informações entre grupos de usuários e sistemas que possibilitam o compartilhamento de informações, permitindo cooperação entre indivíduos do grupo [6].

O ambiente de trabalho organizacional requer ferramentas que facilitem o trabalho em grupo. CSCW possibilita a colaboração entre múltiplos usuários [7] através de um conjunto de ferramentas de software, chamados groupware. A tecnologia de groupware apresenta componentes que têm como objetivo a comunicação (sistema de mensagens), a colaboração (compartilhamento de informações) e a coordenação (tecnologia de workflow).

Dentre os componentes da tecnologia de groupware, os sistemas de workflow, que permitem automatizar e controlar o fluxo de tarefas necessárias para realizar um trabalho, têm recebido atenção e aceitação nas organizações nos últimos anos [8].

Modelos de Design de Workflows

A tecnologia de workflow pode ser implementada na arquitetura cliente servidor ou para utilização em Intranets e na Internet [7]. Neste trabalho estamos considerando a implementação em Intranets, dado o contexto de fábrica que nos servirá de laboratório para este trabalho.

No aspecto de software, além do gerenciamento do ambiente de rede propriamente dito, a comunicação entre usuários do workflow deve ser gerenciada.

Os sistemas SGWFs atuais são baseados em determinados conceitos anteriormente chamados de: automação de escritórios, gerenciamento de banco de dados, e-mail, gerenciamento de documentos, aplicação de groupware.

Com o crescimento da tecnologia workflow no decorrer dos anos, diversas técnicas e modelos para modelagem de sistemas workflows foram propostos. No entanto, a maioria destes modelos utilizam a estrutura organizacional apenas para obter informações sobre os participantes do processo, como o Meta-Modelo proposto pela WfMC. Nestes modelos propostos até então apenas parte do conhecimento da organização é utilizado na modelagem. Este trabalho busca uma nova abordagem para design de sistemas SGWFs, utilizando conceitos de IHC,CSCW e Workflow

Propomos este referencial buscando suprir todas as necessidades do sistema proposto. Tal sistema engloba o fluxo das tarefas em um processo de solução de problemas de forma cooperativa em um sistema de CSCW, através de e-mail. Para tal os conceitos de CSCW e Workflow se adequam a estas necessidades, porém alguns problemas relacionados a resistências humanas, influem no desenvolvimento da implantação de workflow.

Os problemas citados envolvem dificuldades técnicas e informais. As dificuldades técnicas surgem em virtude das limitações da própria tecnologia e, possivelmente, podem ser sanadas conforme seu avanço e aperfeiçoamento. Já as dificuldades informais são resultado do impacto que o workflow causa no trabalho e nas pessoas que compõem a organização [8].

Neste trabalho propomos lidar com esse impacto utilizando metodologias e técnicas de IHC e CSCW no design do gerenciador de fluxo de tarefas.

ABORDAGEM PROPOSTA

Alguns problemas citados na literatura que certamente influem no desenvolvimento da implantação de workflow envolvem dificuldades técnicas e informais. As dificuldades técnicas surgem em virtude das limitações da própria tecnologia e, possivelmente, podem ser sanadas conforme seu avanço e aperfeiçoamento. Já as dificuldades informais são resultado do impacto que o workflow causa no trabalho e nas pessoas que compõem a organização [9].

O objetivo deste trabalho é utilizar técnicas e metodologias de IHC para lidar com este impacto. O propósito é criar um gerenciador de fluxos baseado no referencial apresentado (Workflow, CSCW, IHC), e integrá-lo ao sistema *Pokayoke*.

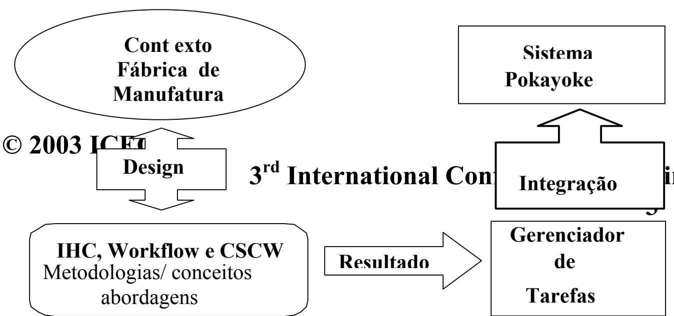


FIGURA. 1
ABORDAGEM PROPOSTA

A Figura 1 apresenta a abordagem proposta para a implementação do gerenciador de tarefas. O design do ambiente proposto envolveu a aplicação de técnicas de design participativo (DP) junto à organização. Este gerenciador de tarefas é resultado da aplicação destas técnicas e será integrado ao sistema *Pokayoke*, que adotou a mesma abordagem metodológica.

O DP emprega várias técnicas para conduzir o design "com" o usuário, e não "para" o usuário. Estas técnicas possibilitam que designers e usuários possam discutir o impacto que o workflow causaria no ambiente de trabalho, durante o design do sistema, construindo assim soluções mais apropriadas através de um entendimento comum entre designers e usuários.

O ambiente gerado a partir da abordagem proposta irá integrar o *Pokayoke* agregando ao mesmo funcionalidades que acarretarão na eficácia do processo de resolução de problemas proposto pelo mesmo. A Figura 2 apresenta a arquitetura do sistema *Pokayoke* com a integração do gerenciador de tarefas (em tom escuro), que passa a se chamar *Pokayoke-Flow*.

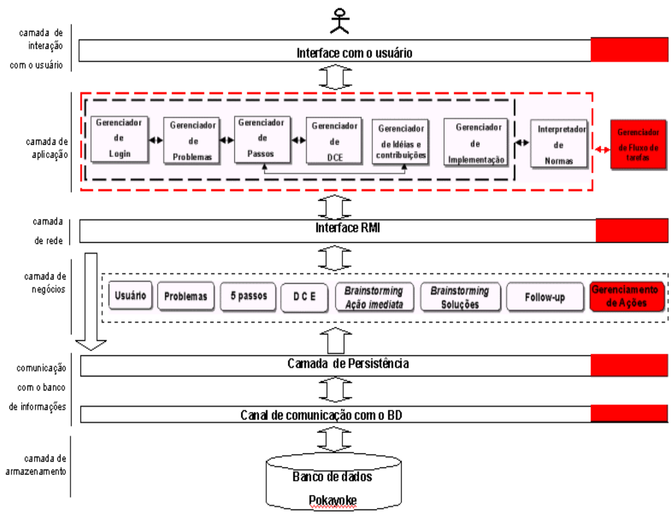


FIGURA. 2
ARQUITETURA *POKAYOKE* COM INTEGRAÇÃO DO GERENCIADOR DE TAREFAS

Ao ser integrado ao *Pokayoke* este sistema deverá prover o gerenciamento e documentação do fluxo de tarefas decorrente da resolução de problemas no ambiente, tendo em vista o controle sobre o estado do problema e sobre a solução proposta.

Um exemplo do uso integrado do gerenciador no *Pokayoke*: no passo 2 (plano de ação imediata) acompanhar o desenvolvimento das ações propostas para a solução imediata do problema e no passo 4 (plano de ação corretiva) acompanhar a implementação das ações adotadas para a solução definitiva do problema. Com o uso do gerenciador de fluxos será possível gerenciar e documentar o andamento de cada ação, informando o seu estado (em execução, parado, etc.) aos respectivos responsáveis, através de ferramentas de comunicação [3].

Uma vez que o gerenciador de fluxo se encontre em funcionamento os responsáveis por determinada ação terão controle sobre "o que", "quando" e "quem" deverá executar cada tarefa na busca pela resolução do problema. Isso possibilitará "lembrar" ou mesmo "cobrar" o(s) responsável(s) por uma tarefa que não foi cumprida dentro do prazo estipulado, assim agilizando e tornando o processo de resolução de problemas mais eficiente. O aspecto de controle do processo através das ações dos usuários no sistema envolvem relações entre as pessoas da organização que podem tornar crítica a aceitação do sistema, se essas ações forem distantes da prática de trabalho.

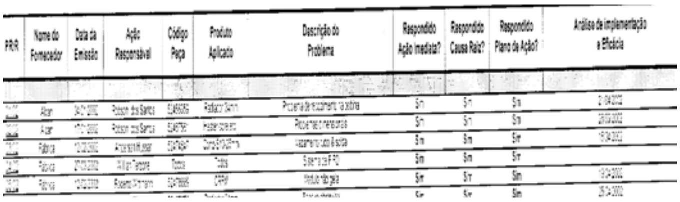
RESULTADOS PRELIMINARES

No sistema *Pokayoke-Flow* o gerenciamento do fluxo decorrente da solução do problema foi integrado ao *Pokayoke*, por ser de grande importância na fábrica. Através do gerenciamento das tarefas obtém-se o controle sobre o estado do problema e da solução proposta para este, ou seja, quem é o responsável e em qual estado se encontra. Se por algum motivo a solução estiver parada, é necessário o controle sobre onde está parada, qual o motivo da parada e quem é o responsável no determinado ponto para que os problemas sejam resolvidos com maior agilidade e eficiência.

O objetivo do sistema proposto vai além do gerenciamento de fluxos no processo de resolução de problemas, buscando também facilitar a documentação do problema, apoiar resoluções de problemas semelhantes; gerar maior eficiência no processo, lidar com as resistências causadas por este tipo de sistemas às organizações, ser um ambiente de workflow menos competitivo e mais colaborativo.

Para o desenvolvimento deste sistema usamos a abordagem proposta (Figura 1). Usando técnicas participativas contextualizadas no dia-a-dia dos funcionários modelamos o gerenciamento das ações corretivas dentro da fabrica a partir de uma planilha eletrônica, conforme ilustrado parcialmente na Figura 3.

Os dados da planilha são preenchidos por um funcionário, e nem sempre atualizados, o que compromete a eficiência do processo de resolução.

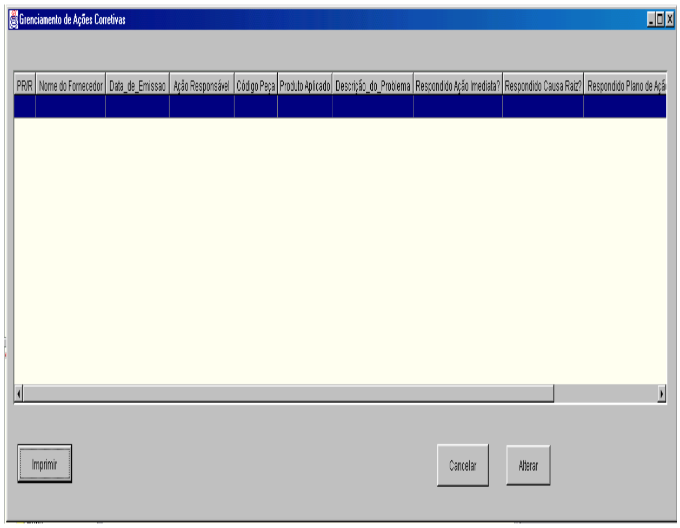


PRR	Nome do Fornecedor	Data da Emissão	Ação Responsável	Código Peça	Produto Aplicado	Descrição do Problema	Respondido Ação Imediata?	Respondido Causa Raiz?	Respondido Plano de Ação?	Análise de implementação e Eficácia
[illegible]	[illegible]	[illegible]	Robson dos Santos	[illegible]	[illegible]	[illegible]	Sim	Sim	Sim	[illegible]
[illegible]	[illegible]	[illegible]	Robson dos Santos	[illegible]	[illegible]	[illegible]	Sim	Sim	Sim	[illegible]
[illegible]	Fabrica	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Sim	Sim	Sim	[illegible]
[illegible]	Fabrica	[illegible]	[illegible]	Todos	Todos	[illegible]	Sim	Sim	Sim	
[illegible]	Fabrica	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Sim	Sim	Sim	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Sim	Sim	Sim	[illegible]

FIGURA. 3
PARTE DA PLANILHA ELETRÔNICA USADA NA ORGANIZAÇÃO

No *Pokayoke-Flow* a planilha foi implementada de maneira que os dados são alimentados a partir de informações do banco de dados. Isso garante estar sempre atualizada e consistente. Através desta planilha é possível no decorrer do processo rastrear o *status* de cada ação, obtendo quais ações estão paradas, e verificar o motivo através de uma consulta a determinada ação. A interface em questão oferece ainda a funcionalidade de impressão, conforme Figura 4.

FIGURA. 4
GERENCIAMENTO DE AÇÕES CORRETIVAS



Folow-up uma outra funcionalidade que está sendo implementada no *Pokayoke-Flow*. Através desta interface o responsável ao entrar no sistema é informado sobre quais ações estão pendentes e suas informações relevantes. Com isso o responsável tem a opção de cobrar ou mesmo lembrar via e-mail o(s) respectivo(s) responsável(s), evitando assim atraso na execução das atividades, e promovendo um processo mais eficiente.

O fluxo das atividades dentro do sistema, é resultado de técnicas participativas no com os usuários e é ilustrado na Figura 5. Esta figura mostra todos os 5 passos para resolução de problemas e o fluxo durante o processo de resolução no *Pokayoke.*

Dentro das atividades integradas ao *Pokayoke* citamos ainda, o "lembrar ". Definidas as ações no passo II o responsável pelo passo "lembra" aos responsáveis a ação e o período de tempo para execução da mesma, através de e-mail contendo as informações de cada ação bem como um texto detalhando a(s) atividade(s) a ser executada(s), conforme ilustra a Figura 6.

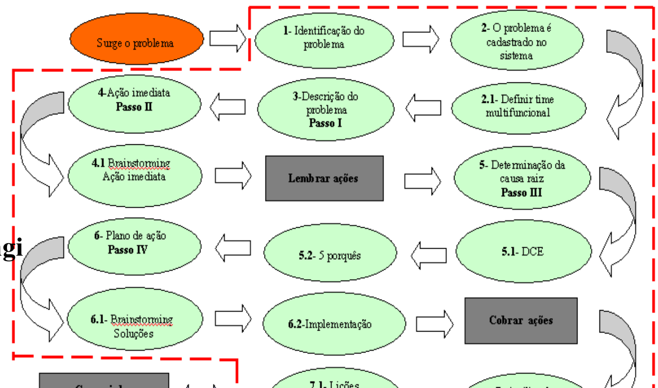


FIGURA. 5
FLUXO DAS ATIVIDADES NO SISTEMA *POKAYOKE*

No passo IV do *Pokayoke* são definidas as ações corretivas que serão implementadas para solução definitiva do problema. Implementado no *Pokayoke-Flow* a funcionalidade "cobrar", objetiva que a ação seja implementada dentro do prazo, assegurando assim a eficiência no processo de resolução. O responsável é avisado a medida que uma ação está se aproximando do prazo determinado para execução e não foi concluída, e cobra do responsável enviando-lhe um e-mail, contendo as informações da ação. A Figura 7 ilustra o acesso a essa funcionalidade.

O gerenciador de tarefas no *Pokayoke-Flow* é resultado de atividades participativas onde foram levantados os requisitos para o sistema e o fluxo decorrente da resolução de problemas. Como resultado destas atividades podemos citar: o que deve ser gerenciado, como é feito no contexto real, e como deve ser feito. Também a definição das características do sistema de workflow a ser implementado, como por exemplo as informações sobre o envio de e-mail alertando sobre ações, quem deve receber estes e-mails e quando devem recebê-los.

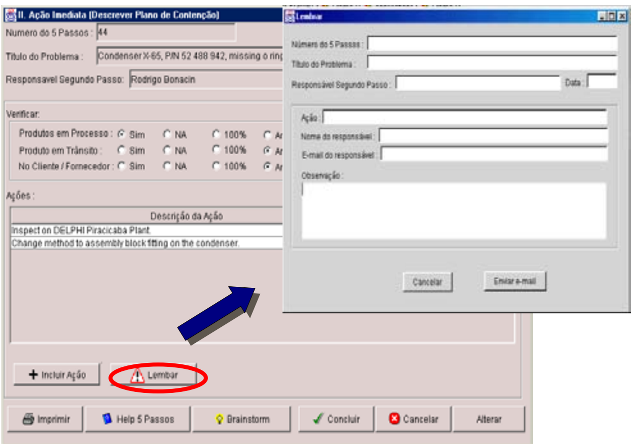


FIGURA. 6
LEMBRAR AÇÃO

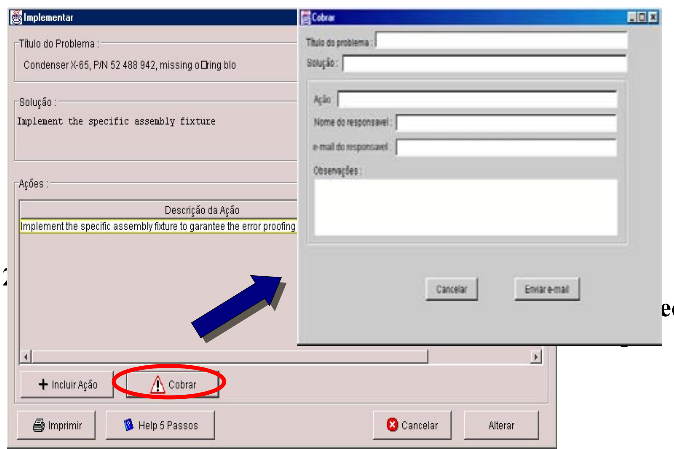


FIGURA. 7
COBRAR AÇÃO

Conclusão

O gerenciador de fluxo de tarefas é um sistema em desenvolvimento que integrará o sistema *Pokayoke*. O design da interface para o ambiente proposto utilizou técnicas de IHC, em especial metodologias participativas, visando capturar o fluxo de tarefas no cotidiano da prática do trabalho e potencialmente conseguir a aceitação do sistema no ambiente. Os próximos passos envolvem o acompanhamento da implantação do *Pokayoke* na organização citada para futura integração do sistema de controle de fluxo do processo de resolução de problemas.

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ESTÍMULO AO ESTUDO ESPONTÂNEO DESAFIOS E PROPOSTAS

C.A. Tassinari [(1,2)], B.F. Giannetti [(1)]

Abstract *– O processo descrito tem o intuito de motivar os alunos desenvolver tarefas semanais que compõem a nota bimestral, juntamente com as provas oficiais. Cada tarefa aceita recebe uma nota de avaliação. Os trabalhos são divididos em obrigatórios e espontâneos, devendo o aluno "administrar" sua situação na disciplina. A lista de trabalhos espontâneos é conhecida, mas não há previsão de quando serão solicitados, nem garantias de que haverá a solicitação. Porém, quando tal solicitação ocorre, não há prazo, a entrega tem que ser imediata. Além de estimular a assiduidade do aluno às aulas, o processo objetiva o desenvolvimento do hábito da busca de informações em literatura e o de estudar de forma espontânea, por meio da preparação de trabalhos, que podem até não ser solicitados. Os resultados mostram eficácia e suprem deficiências apresentadas pelos calouros, especialmente quando não houve contato anterior com a disciplina.*

Índice de Termos – estímulo e motivação, estudo espontâneo, sistema de avaliação, superação de deficiências.

Atualmente, o Ensino Público brasileiro é muito discutido e criticado pelo baixo rendimento apresentado pelos alunos. Da Escola Fundamental ao Ensino Médio o fracasso é indiscutível [1].O processo de avaliação continuada que aboliu a reprovação, permitiu o agravou a situação formando alunos sem os conhecimentos básicos necessários [1]. A este contexto, acrescentam-se os salários inadequados que tornaram os professores desinteressados e desmotivados; o baixo aproveitamento escolar das crianças mais pobres, [2]–[3]; condições precárias das escolas, defasadas tanto na estrutura física com também em relação ao material pedagógico, bibliotecas e outros requisitos inerentes ao ensino de boa qualidade [1]. Agravando esta situação, constantes greves de professores comprometem o planejamento das disciplinas pela não reposição das aulas perdidas. A partir daí, a formação do aluno fica comprometida e as deficiências do processo podem ser constatadas pela análise dos resultados do Exame Nacional de Cursos do Ensino Médio – ENEM, amplamente divulgadas pela mídia.

Tais fatores acabam criando barreiras praticamente intransponíveis para os que ingressam nos cursos superiores de graduação.

Os efeitos das deficiências do Ensino Médio se mostram com maior intensidade no Ensino Superior privado. Tal fato é de fácil explicação pois é nas escolas particulares que ingressa a maior parte dos alunos egressos das escolas públicas e de cursos técnicos profissionalizantes alternativos, ministrados em Instituições como o SENAI e outras.

A experiência tem mostrado que a necessidade de conhecimentos sólidos em Física, Matemática, Química, Desenho, dentre outros, que constituem os pré-requisitos para os cursos de Engenharia, acentua os efeitos das lacunas de conhecimento. As dificuldades a serem enfrentadas são tão grandes que transformam-se em fatores de desmotivação que têm como conseqüência níveis altos de desistência nos primeiros anos dos cursos.

A perda irrecuperável de tempo, o prejuízo financeiro e a frustração do aluno, bem como as distorções nas previsões de Receitas e a impossibilidade de planejamento de investimentos por parte das Instituições de Ensino, são danos incalculáveis decorrentes do processo.

Nesse contexto, formas de orientação de estudo e de ajuda ao aluno para superar suas dificuldades devem ser buscadas, a fim de capacitá-lo ao aprendizado dos conhecimentos ministrados nas diferentes disciplinas dos cursos de graduação.

Tendo em vista que o preenchimento das lacunas de conhecimento não pode ficar a cargo do curso de graduação somente, devem ser encontrados caminhos que estimulem a busca espontânea de conhecimentos pelo aluno, fazendo com que o mesmo participe do processo de forma pró-ativa.

Algumas etapas importantes desse processo podem ser descritas como:

- o estímulo à busca de informações em bibliotecas e a consulta a outros livros diferentes do texto adotado;
- o desenvolvimento da percepção do aluno quanto às diferentes formas de abordagem usadas pelos diversos autores para descrever o mesmo fenômeno, ou o mesmo problema;
- o cultivo do hábito do estudo espontâneo, mostrando que esse caminho permite

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encontrar as respostas dos problemas que estão por surgir.

O sistema de avaliação pode ser transformado em importante recurso para tal fim.

Experiências têm sido realizadas desde 1996 no primeiro e segundos semestres dos cursos de Engenharia da Universidade Paulista – UNIP, na disciplina Química Geral. Após diversas tentativas, correções e adaptações no que era praticado anteriormente, desenvolveu-se um sistema que contempla, pelo menos em parte, os objetivos pretendidos.

O sistema de avaliação aplicado na disciplina antes do início desse processo era constituído por:

- 4 provas bimestrais;
- 1 prova substitutiva;
- Exame Final
- Exame de segunda época, aplicado quando necessário.

O cálculo da Média de Aproveitamento baseava-se na média aritmética das notas obtidas pelo aluno nas provas bimestrais, conforme a seguir:

$$A = \frac{B_1 + B_2 + B_3 + B_4}{4}$$

De acordo com o Regimento da Universidade, o aluno é aprovado sem exame se alcançar pelo menos 7 (sete) na Média de Aproveitamento. Caso contrário, deve submeter-se ao Exame no qual deve obter uma nota tal que somada à Media de Aproveitamento totalize 10 (dez) pontos.

Na primeira tentativa, ao sistema descrito, foram acrescentados:

a) um conjunto de 20 trabalhos obrigatórios; e

b) um fator que multiplica a média aritmética das notas obtidas nas provas bimestrais pelo aluno, cujo valor dependia da quantidade e qualidade dos trabalhos do aluno.

Os trabalhos foram elaborados de forma a exigir na sua execução a aplicação dos conceitos apresentados em aula. O prazo máximo estabelecido para a entrega de cada trabalho foi fixado em uma semana, de forma a exigir que a aplicação dos conceitos vistos fosse praticamente imediata. Dessa forma, o aluno era obrigado a estudar os conceitos logo a seguir, facilitando a memorização dos mesmos.

O intervalo de variação do fator foi fixado em 0,7 a 1,3 de acordo com o número de trabalhos entregues e pelo aluno e aceitos pelo professor.

A aceitação foi vinculada à qualidade do trabalho no que diz respeito ao seu conteúdo, desenvolvimento e consistência e entrega no prazo estipulado.

Vencido o prazo de entrega, um gabarito do trabalho era colocado à disposição do aluno no setor de cópias da Universidade, para que o mesmo pudesse comparar com o trabalho entregue e buscar orientação quanto às divergências verificadas.

Desta forma, a Media de Aproveitamento passou a ser assim calculada:

$$A = \frac{B_1 + B_2 + B_3 + B_4}{4} \times \text{fator}$$

onde: B_i são as notas obtidas pelo aluno nas provas bimestrais.

Os resultados obtidos deixaram muito a desejar e a principal falha que pode ser notada foi o valor mínimo de 0,7 para o fator, que tornou-se cômodo demais para o aluno. A maior parte dos alunos optava por fazer um número mínimo de trabalhos, apenas suficiente para elevar para 1,0 o valor do fator.

A fim de melhorar a eficiência do processo, nova tentativa foi realizada diminuindo o valor mínimo do fator de multiplicação da média das provas bimestrais, o qual passou a variar de 0,3 a 1,3.

Para tanto, introduziu-se no critério de avaliação, uma nota complementar (NC) a qual deveria ser "construída" pelo aluno ao longo do ano letivo. A cada trabalho semanal entregue pelo aluno e aceito pelo professor, somava-se 0,5 pontos à nota complementar do aluno.

Levando em conta este critério, para que o aluno elevasse para 1,0 o valor do fator, deveria conseguir a aceitação de pelo menos 14 trabalhos ao longo do ano. Se o número de trabalhos entregues e aceitos fosse maior, passaria a ter vantagens no cálculo da Media de Aproveitamento, cujo cálculo passou a ser feito de acordo com a fórmula abaixo:

$$A = \frac{B_1 + B_2 + B_3 + B_4}{4} \times \left(0{,}3 + \frac{NC}{10}\right)$$

onde NC é a Nota Complementar do aluno calculada por:

NC = 0,5 x número de trabalhos entregues pelo aluno e aceitos pelo professor.

Esperava-se que a necessidade de maior número de trabalhos alcançar o valor 1,0 no fator trouxesse algum progresso. Mas o que se notou é que a dificuldade na execução dos trabalhos era grande e fazia-se necessário tanto auxílio como acompanhamento para o aluno. Diante disso, monitores foram colocados à disposição dos alunos diariamente, em horários fixos e previamente informados. Muitos alunos passaram

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a usar de forma sistemática esse recurso. Para outros, especialmente nos cursos noturnos, era difícil adequar seu horário de chegada à Universidade à disponibilidade dos monitores. Boa parte porém ignorou a ajuda.

Uma análise dos resultados mostrou que o sistema ainda apresentava falhas, dentre as quais podem ser citadas:

- o prazo de um ano letivo para que o aluno "construísse" sua Nota Complementar mostrou-se demasiado longo. Pouca atenção era dada à execução e ao prazo de entrega dos trabalhos. Muitas vezes, quando o aluno percebia que sua situação estava se tornando insustentável, tentava entregar um grande número de trabalhos atrasados, os quais não passavam de cópias dos gabaritos obtidos no setor de cópias da Universidade. A aceitação dos trabalhos nessas condições, constituiria uma negação aos objetivos que se pretendia alcançar, razão pela qual os mesmos eram rejeitados;
- a exigência de busca de informações pelo aluno tinha que ser restrita àquelas que o mesmo podia encontrar no livro texto adotado;
- o monitor funcionava como fonte de auxílio, mas de alguma forma o aluno tinha ser direcionado para uma fonte de conhecimentos, como uma biblioteca e estimulado a consultar outros livros;
- a busca de informações e conhecimentos não deveria restringir-se à revisão dos conceitos apresentados nas aulas, deveria funcionar também como forma de suprir deficiências de conhecimentos que seriam necessários para o perfeito entendimento de conceitos ainda não estudados no curso.

Foram então feitas as seguintes modificações no sistema de avaliação:

a) a fim de tornar o aluno mais atento aos trabalhos obrigatórios e aos prazos de entrega, foi abolida a Nota Complementar. A mesma foi substituída por um fator bimestral que varia de 0 (zero) a 1,25 e multiplica a nota de cada prova do aluno.

Tal fator é calculado com base na entrega e aceitação dos trabalhos obrigatórios, os quais foram divididos em 4 grupos de 5 trabalhos, sendo um grupo para cada bimestre. A cada trabalho entregue pelo aluno e aceito pelo professor soma-se 0,25 ao valor do fator bimestral. A Média de Aproveitamento do aluno passou a ser calculada da seguinte forma:

$$A = \frac{B1 \times f1 + B2 \times f2 + B3 \times f3 + B4 \times f4}{4}$$

onde: B_i são as notas das provas bimestrais obtidas pelo aluno; e

f_i são os fatores bimestrais

b) além dos trabalhos obrigatórios, um novo conjunto contendo 18 trabalhos foi criado. Cada um desses trabalhos foi elaborado de forma que a sua execução exige consultas em literatura. Os conhecimentos que devem ser buscados servem como suporte para o entendimento de tópicos que serão apresentados no desenvolvimento do curso. Desta forma as deficiências básicas que o aluno possui podem ser sanadas previamente, diminuindo o grau de dificuldade para assimilar os novos conhecimentos.

A lista dos trabalhos com os respectivos temas abordados são divulgados no início do período letivo, possibilitando a sua execução antecipada, que é o principal objetivo da proposta.

Tais trabalhos foram chamados e tratados como espontâneos. Não são obrigatórios, e a não entrega do mesmo em nada prejudica o aluno. Esses trabalhos são solicitados nas aulas, sem prévio aviso e concede-se um prazo máximo de dois minutos para a entrega do mesmo. Cada aluno pode entregar somente o próprio trabalho, não são aceitos trabalhos de alunos ausentes. Toda vez que um trabalho espontâneo é aceito soma-se 0,5 pontos à nota da prova bimestral do aluno. A cada bimestre são feitas até 4 solicitações, o que eqüivale a um acréscimo de 2,0 (dois) pontos na nota da prova bimestral.

Em situações especiais, quando se nota que determinados conceitos não estão bem sedimentados, são criados trabalhos extras abordando os temas necessários para superar as deficiências. Nessa situação, embora aumente o número de trabalhos espontâneos no bimestre, mantém-se o acréscimo máximo de 2,0 (dois) pontos na nota de prova, a qual recebe a devida compensação quanto à sua nota máxima.

Os resultados obtidos superaram as expectativas. Tudo leva a crer que a garantia de 2,5 pontos como nota mínima de prova (resultantes da entrega de todos os trabalhos do bimestre, tanto espontâneos como obrigatórios) despertou grande interesse no aluno. Tal fato pode ser constatado pelo número de alunos que sistematicamente entrega os trabalhos espontâneos (cerca de 90 %).

Como conseqüência o andamento do curso tem ocorrido de forma mais tranqüila, o que é notado pelo maior rendimento em cada aula. A assiduidade às aulas aumentou além do que o aluno evita de deixar a sala de aula (já que o

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trabalho pode ser solicitado enquanto ele estiver fora da sala).
No ano em curso (2002) o estágio atual do processo está sendo aplicado pela segunda vez. Criteriosa avaliação continuada do processo tem sido realizada, a fim de introduzir eventuais novas correções.

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A PESQUISA COMO FATOR MOTIVADOR DA APRENDIZAGEM: RENOVAÇÃO DO ENSINO E OTIMIZAÇÃO DE COMPETÊNCIAS

Ari Antonio da Rocha[1] *e Carlos Alberto Inácio Alexandre*[2]

Resumo *— A renovação do ensino tecnológico é uma condição que se impõe, como conseqüência da velocidade das transformações decorrentes dos avanços tecnológicos. que tornam o conhecimento rapidamente obsoleto. Os conceitos de "diploma" e "educação terminal" estão em declínio, obrigando a formação de um "novo profissional": empreendedor e com atitude pró-ativa. Isso vai exigir um esforço crescente das instituições de ensino, obrigadas a promover uma contínua revisão metodológica e de conteúdo dos cursos, além da requalificação de seu corpo docente, para que possam cumprir com suas responsabilidades de formar cidadãos aptos a exercer as funções que se configuram relevantes neste início de milênio. A forma mais efetiva de fazê-lo é através de ambientes colaborativos, vinculados a redes de conhecimento e que utilizem a pesquisa como fator motivador das atividades acadêmicas. Entretanto, a partir de meados da década de 1990, com o elevado número de aposentadorias precoces provocadas pela adoção de políticas equivocadas do ministério responsável pela reforma do Estado, as universidades perderam seus docentes mais qualificados. Desse modo, com apoio das agências federais de fomento e órgãos estaduais de amparo à pesquisa, a criação de Comitês de Consultores Sênior, de âmbito nacional e orientados para as diversas áreas do conhecimento, permitirá o aproveitamento de parcela expressiva dessa força de trabalho disponível, suprindo a carência atual de pessoal de alta qualificação.*

Palavras-chave — Renovação da Educação Tecnológica, Construção do Conhecimento, Pesquisa Científica e Tecnológica, Comitê de Consultores Sênior.

INTRODUÇÃO

> "Os alunos trazem uma cultura que valoriza muito mais o conhecimento prático - a fórmula matemática, a dica profissional - do que o aprender a conhecer, o processo real de aprendizagem e construção de conhecimento. (...) É preciso incomodar, desestabilizar, provocar e motivar o aluno, para que desenvolva a curiosidade, a iniciativa, o senso crítico e a criatividade"
>
> **Walter Antonio Bazzo** [1]

No ICECE – 1999, no Rio de Janeiro, foi apresentado um trabalho científico, liderado por BRITO [2], referindo a experiência realizada no curso de Engenharia da Universidade Católica de Santos, em que a pesquisa foi fortemente estimulada e passou a fazer parte das atividades cotidianas dos alunos, de modo a gerar conhecimento novo. Como conseqüência desse fato, foi possível trabalhar de forma mais aderente à realidade, propondo problemas concretos e soluções igualmente concretas, tornando-se um dos principais fatores de motivação da aprendizagem e de estímulo ao interesse dos alunos pela iniciação científica.

É preciso ter presente o fato de que, nos tempos atuais, o mundo atravessa uma fase de transição caracterizada pela velocidade das transformações, decorrentes da incorporação dos avanços tecnológicos ao cotidiano das pessoas, em escala global. Nesse contexto, são adotados novos conceitos de riqueza dos povos, em que se abandonam os antigos referenciais de posse da terra e dos meios de produção, provocando a mudança de paradigmas da sociedade, que passa a atribuir valor ao conhecimento.

É preciso, portanto, estar preparados para fazer frente ao cenário competitivo que se instalou em escala mundial. O País terá que implantar um processo permanente de qualificação de pessoal, o que aumenta de forma expressiva a responsabilidade das instituições de ensino, sobretudo nas áreas tecnológicas e afins, que deverão desenvolver esforços efetivos de reestruturação e adequação ao novo modelo, para poderem vencer esse tipo de desafio.

As ações propostas neste ensaio, dizem respeito à necessidade de superar diversos problemas que ocorreram de forma quase simultânea, comprometendo a capacidade das universidades, principalmente as públicas. Destacamos a seguir as duas principais dificuldades constatadas:

- perda de professores e pesquisadores de elevada qualificação, aposentados precocemente, em virtude da desastrada política de pessoal adotada pelo Ministério da Administração Federal e Reforma do Estado;
- redução no montante de recursos financeiros tanto para o ensino quanto para a pesquisa, que comprometeu em qualidade e quantidade a produção científica do país, bem como alguns avanços que haviam sido alcançados em nível nacional e internacional.

Em nosso país, os ambientes acadêmicos e centros de pesquisa vêm sendo responsáveis pela qualificação de pessoal de alto nível, bem como pela geração de novas tecnologias, transformando informação em conhecimento e este em inovação. Essas condições precisam ser preservadas, para garantir o crescimento econômico com produtos mais competitivos e, conseqüentemente a estabilidade social pelo crescimento dos níveis de emprego.

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O CONTEXTO NACIONAL

A globalização não é fato recente, como muitos imaginam, pois a própria nação brasileira se formou como conseqüência da experiência 'globalizante' do Ciclo das Grandes Navegações (a partir do Século XV), com a capacidade de comunicação eficiente e em tempo real, esse processo que abrange as atividades econômicas, comerciais, produtivas e até as idéias, tornando-se uma realidade marcante e inevitável. Do mesmo modo que ocorreu em épocas anteriores, no entanto, a simples contemporaneidade não vai garantir a todos os países um crescimento econômico compatível, nem na mesma escala do crescimento global.

O conhecimento passou a representar grande valor econômico, exigindo esforços na formação de recursos humanos, em particular na área técnico-científica, passando a ser fator fundamental para garantir maior competitividade para o País. A economia nacional depende de forma crescente da capacidade de exportar produtos com alto valor agregado e, como conhecimento é um importante valor agregado nos produtos atuais, as instituições de ensino tecnológico assumem uma decisiva responsabilidade no processo de desenvolvimento.

Mas para isso, terão que se adequar aos novos tempos, promovendo a formação de uma nova geração, de um novo tipo de profissionais. Terão ainda que apoiar as cadeias produtivas da sociedade do conhecimento, pois, somente que tiver maior qualificação estará apto a exercer funções relevantes neste início de milênio. Desse modo, destaca-se o papel da tecnologia como um dos fatores mais importantes para o desenvolvimento, principalmente para o Brasil, que já conta com um produtivo contingente de pesquisadores, além de um parque industrial moderno.

Os países mais desenvolvidos, rapidamente perceberam que a capacidade tecnológica era fator estratégico central, não somente em termos do poderio militar, mas também para o desenvolvimento econômico, social e político, adotando medidas para garantir seu poder hegemônico. A rapidez com que passaram a transformar informação em conhecimento, este em invenção e, a seguir, em inovação, permitiu a disseminação do seu uso prático e mudou de forma expressiva a visão que o homem tinha de si mesmo e a sua maneira de viver.

Esse cenário reforça a responsabilidade do Estado para criar programas estratégicos e iniciativas para a formação de um novo tipo de profissional. Só desse modo, será possível garantir o domínio dos conhecimentos científicos e tecnológicos indispensáveis para a consolidação da soberania da nação.

A responsabilidade para sua concretização, no entanto, terá que ser compartilhada com as instituições de ensino superior, a quem corresponde a formação dos recursos humanos que deverão implementar esse processo. Em sua longa existência, a universidade representa muito mais que mero conglomerado de escolas profissionalizantes, em contínua evolução, para cumprir seu papel num mundo em constante transformação.

No mundo contemporâneo, as instituições de ensino são fator importante na geração e difusão do conhecimento, além de terem a missão primordial de preparar os cidadãos para a vida, ensinando-lhes, entre outras coisas, uma profissão. Seu compromisso, portanto, precisa ser bem mais amplo que a mera reprodução do saber já dominado e consagrado nos livros, mas, principalmente, com a pesquisa, para a geração de novos conhecimentos e sua aplicação.

Para isso, torna-se indispensável a urgente reposição do pessoal de alta qualificação, que se aposentou precocemente em instituições públicas de ensino, principais geradoras de tecnologia que, como citado acima, ocorreu principalmente a partir de 1995.

Mas a dificuldade maior para que isso possa acontecer, diz respeito ao fato que esse tipo de recursos humanos não é facilmente substituível, sobretudo quando são exigidos fatores importantes como a experiência e a competência, que freqüentemente se apresentam associados a professores e pesquisadores portadores de titulação mais elevada. Será necessário encontrar uma solução alternativa, mesmo que temporária, para atenuar esse problema, pois, com a velocidade das transformações provocadas pelos avanços tecnológicos, qualquer atraso pode representar uma perda irrecuperável.

A QUESTÃO DO ENSINO

O ensino superior tardou a ser implantado no país. Por primeira vez aconteceu com a criação da Universidade do Paraná, em 1912.

Entretanto, consta que antes disso, no Brasil Imperial, mesmo que formalmente, teria ocorrido a criação de uma universidade que durou o tempo suficiente para que o Imperador pudesse conceder um título honorífico a um visitante estrangeiro ilustre.

Apesar de não se dispor de registros históricos desse fato, sua simples referência já é emblemática, porque reflete alguns dos problemas que seguem estigmatizando nossa cultura ao longo dos anos:

- entendimento da universidade como mera instituição burocrática, submetendo-a aos interesses do poder central em prejuízo das ações de ensino e pesquisa;
- valorização do aspecto institucional meramente formal, supervalorizando a concessão de títulos e honrarias;
- caracterização da instituição como simples referencial de ostentação e poder, não necessariamente sustentados por atividades efetivamente acadêmicas;
- predomínio de referenciais quantitativos em relação aos qualitativos, que hoje se reflete nos modelos de medição de desempenho, produção científica, etc.

No contexto atual, os desafios que se colocam para o setor acadêmico aumentam a importância da evolução do ensino e da pesquisa, particularmente para as áreas mais diretamente afetadas pelo avanço tecnológico, para poder transformar as idéias e inventos oriundos de qualquer área do conhecimento, em bens e serviços.

A área tecnológica assume um importante papel de transformar o conhecimento em produto, inventando ou mesmo inovando melhor, mais rápido e mais barato.

De uma maneira geral, nos países em desenvolvimento os investimentos na geração de conhecimento costumam ser pequenos e pouco valorizados. Esse é um panorama que precisa ser mudado, porque esse tipo de ação representa a única forma de tornar a indústria local mais apta a enfrentar os desafios hoje caracterizados pela competitividade dos mercados internacionalizados.

Os fatos recentes demonstram que a alternativa política, mesmo quando acompanhada da formação de um bloco econômico regional, não é suficiente para garantir os avanços da economia dos países que não investem no desenvolvimento tecnológico autóctone. Esse tipo de ação é o instrumento adequado para garantir a conquista de "nichos de mercado" para seus produtos e serviços.

Engenharia e Design sofrem as conseqüências da rápida obsolescência do conhecimento, obrigando as instituições de ensino a adotarem um processo de constante atualização e reciclagem, para evitar que os profissionais se transformem naquilo LONGO [3] define como "analfabeto tecnológico".

Para se manterem em sintonia com a dinâmica das exigências do mercado de trabalho, é indispensável adotar ações de Educação Continuada. Desse modo, poderão atender à forte demanda, até o presente ainda reprimida, para Cursos de Mestrado Profissional, de Especialização ou mesmo atividades de curta duração, como treinamentos e workshops, principalmente nos setores mais competitivos atendidos por nosso parque industrial.

Está cada vez mais evidente que não haverá mais formação profissional terminal, e que o conceito de "diploma" já perdeu seu antigo significado de símbolo de conhecimento. Hoje é preciso preparar o "novo estudante", consciente da necessidade de renovar permanentemente seus conhecimentos, principalmente depois da conclusão de seus estudos convencionais, tornando-se um "aprendiz vitalício".

Situação semelhante enfrenta o professor, que apesar de desfrutar de uma situação privilegiada por ser habilitado para a pesquisa e para a inovação, torna-se também um aprendiz. Desse modo será capaz de acompanhar a completa revisão metodológica e de conteúdo nos cursos que a universidade será obrigada a promover, pois nas últimas décadas as exigências sobre os profissionais dessa área evoluíram mais rapidamente do que a capacidade de adaptação do sistema educacional para poder atendê-las.

Em paralelo devem ser promovidas outras atividades cooperativas, visando a melhoria da qualificação do pessoal ligado ao setor produtivo, contribuindo assim para a indispensável capacitação tecnológica das empresas.

Para que as instituições de ensino possam adequar-se a essas novas exigências, é preciso desenvolver um intenso trabalho que crie as condições e a garantia de sua efetiva reestruturação. Essa atividade deve estar focada na própria capacitação institucional para o conveniente desempenho desse papel, de modo a tornarem-se aptas a atender tanto à crescente demanda de novos estudantes interessados em ingressar na carreira. Simultaneamente à necessidade de oferecer alternativas ao já expressivo número, não atendido, de profissionais interessados em reciclar conhecimentos e/ou ampliar sua qualificação.

RESPONSABILIDADE DO ESTADO

A política estratégica do Estado tem que prever futuras mudanças e antecipar soluções, de modo a consolidar a posição destacada que a ciência brasileira vem conquistando, graças aos esforços que permitiram um crescimento da produção científica a taxas superiores ao restante do mundo, garantindo sua liderança na América do Sul.

Há que ter presente, no entanto, que o cenário nacional não reflete a mesma situação dos países desenvolvidos, principalmente pela falta de regularidade dos investimentos públicos no setor, refletindo sobretudo a utilização de um artifício contábil. Adota-se o chamado contingenciamento dos recursos financeiros que, na prática caracterizam o não cumprimento dos orçamentos programados, como pode ser percebido pelas previsões contidas na Figura 1.

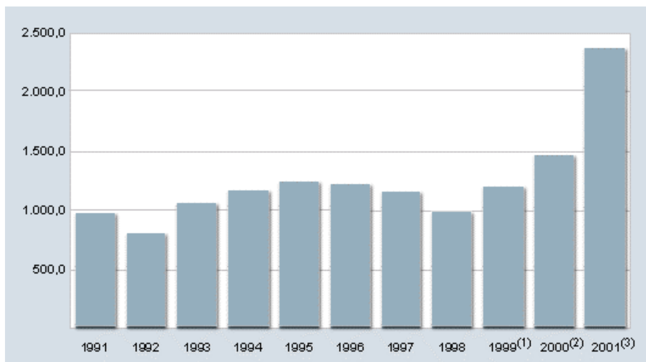

FIGURA 1 *fonte CNPq*

No ano de 2002 o problema ficou ainda mais agravado, levando as agências de fomento a situações dramáticas para honrar o pagamento de bolsas e apoios já concedidos, fato que afetou a ampliação do âmbito de ações anunciadas. Novos projetos, mesmo quando considerados meritórios acabaram não sendo contemplados, pela inexistência de recursos disponíveis para atender sua implementação, com evidentes prejuízos para a comunidade acadêmico-científica.

Por outro lado, essa situação reforça uma tendência preocupante, no que se refere ao atendimento da demanda por bolsas de Iniciação Científica, cuja oferta se encontra levemente superior aos níveis de 1995, mas principalmente nas de Pós-graduação "stricto sensu". No que se refere ao Mestrado, mantendo como referencial dos índices de 1995, o problema se configura como muito grave, porque hoje está sendo atendido um número equivalente a pouco mais que metade daquele ano. No Doutorado, que sofreu incremento da demanda para poder atender ao contingente de Mestres que se formou em período recente, o problema também é preocupante porque, na média de bolsas concedidas no país e no exterior, o número permaneceu praticamente invariável, frustrando expressivo número de interessados.

Por outro lado, programas como o Prodenge/REENGE, ao invés de serem ampliados para outras áreas, como Design, foram interrompidos comprometendo o estimulante processo de melhoria e renovação do ensino tecnológico no país. As instituições de ensino da área de Engenharia, lideradas pela ABENGE, vêm trabalhando para a retomada desse esforço, através de um novo programa, o PAEPE-Programa de Apoio ao Ensino e à Pesquisa em Engenharia.

O CENÁRIO BRASILEIRO

Os dados indicam uma evidente fragilidade dos esforços para a qualificação de pessoal na área tecnológica, fato que se constitui, no entanto, num desafio que indica algumas interessantes possibilidades a serem exploradas na superação dessas dificuldades.

Sem esse esforço, corre-se o risco de comprometer um fator de vitral importância para superar os problemas da competitividade de nossos produtos e serviços. Uma ação efetiva para vencer esses problemas poderá dotar o Brasil de uma estrutura tecnológica consistente, criando fatores diferenciadores que permitam fazer frente aos desafios do mercado internacional.

Os programas oficiais de âmbito nacional, criados com a finalidade de promover os produtos e desenvolver novas tecnologias, pelo tipo de escolha (política e não técnica) dos dirigentes, têm redundado em fracasso, até mesmo pela carência de dados e de informações sistematizadas.

Entretanto, casos de sucesso como calçados e mobiliário produzidos no país, mas principalmente os excelentes resultados recentemente alcançados pela Embraer, atestam claramente os resultados que esse tipo de estratégia pode trazer, favorecendo a melhoria de nossos produtos e a geração de novos empregos.

O parque industrial brasileiro tem se modernizado constantemente e alguns de seus produtos já começam a participar da disputa de mercados internacionais. Há um grande espaço para as empresas brasileiras, não somente nos países tradicionalmente consumidores, que atualmente ingressam num processo de dificuldades, mas no conjunto das economias emergentes, que podem representar a chance de novas parcerias, não somente comerciais, mas em vários campos de atividade.

O progresso técnico-científico provocou mudanças expressivas nos modos de produção, na distribuição e na qualificação da força de trabalho, demandando assim novas estratégias de capacitação tecnológica das empresas. Para torná-las mais competitivas no contexto internacional, é preciso disseminar, com urgência, um processo de melhoria da qualidade, que começa pela formação de um novo tipo de profissional, capaz de identificar problemas, propor soluções e enfrentar cada novo desafio que se apresente na vida profissional.

Essa necessidade vincula o sucesso das empresas à capacidade das instituições de ensino, que terão que iniciar um processo de mudanças. Uma das necessidades será a de introduzir a pesquisa como prática cotidiana, gerando subsídios para as atividades didáticas a partir de propostas integradas e baseadas em necessidades concretas.

Esta é uma interessante possibilidade de conferir melhor qualificação aos egressos, atendendo aos reclamos do setor produtivo por profissionais mais adequados às demandas do mercado de trabalho. Ao mesmo tempo, pode motivar tanto o corpo docente quanto o alunado, a desenvolver um trabalho mais criativo e eficaz, identificando problemas reais e gerando novos conhecimentos e propostas que permitam soluções viáveis e concretas.

A formação profissional ganha assim um novo impulso, porque não se conclui mais com a "formatura". Passa a constituir-se no estágio inicial indispensável, que tem como objetivo não somente formar, mas preparar o profissional para um contexto de constantes mudanças, apto a renovar continuamente seus conhecimentos. O egresso precisará incorporar novas habilidades na aprendizagem e ao longo de toda a vida profissional.

A produção de conhecimentos e geração de tecnologia deverá garantir maior autonomia à área acadêmica e afastar eventuais temores no relacionamento com o setor produtivo. Essa maior confiança dará novo sentido aos projetos de Interação Universidade/Empresa, cujo significado ainda pouco valorizado em nosso País. Nos países desenvolvidos esse relacionamento fortalece a ambos setores, permitindo que maior evolução das empresas com o aproveitamento dos avanços tecnológicos e modernização do parque industrial.

O APROVEITAMENTO DE COMPETÊNCIAS

A crescente velocidade dos avanços tecnológicos, sujeita as profissões vinculadas a suas aplicações a uma dinâmica de transformações, obrigando as instituições de ensino a realizarem uma revisão metodológica e de conteúdo dos cursos, para atender a essas novas demandas da sociedade. Os egressos também têm consciência da urgência em renovar/reciclar continuamente seus conhecimentos, estejam eles envolvidos com projetos de pesquisa de caráter acadêmico ou vinculados à atividade industrial.

Hoje, mesmo fora dos ambientes voltados à inovação, há consenso sobre a importância estratégica da educação tecnológica, frente à nova realidade baseada em informação e conhecimento. Além de mudarem os símbolos de riqueza dos povos, esses novos referenciais provocaram uma verdadeira revolução social, que colocou em evidência uma situação inusitada, que ROCHA [4] assim refere: "nunca, ao longo da história da humanidade, a academia e o setor produtivo foram tão próximos, nem estiveram tão identificados e com interesses tão convergentes".

As instituições de ensino terão que promover uma abertura no sentido da celebração de convênios e parcerias com suas similares, bem como com os centros de pesquisa tecnológica e com os grupos de P&D atuantes nas empresas. Esse tipo de aproximação deverá permitir um processo de ampliação da colaboração, que poderá se rebater em benefício das atividades acadêmicas e favorecer a formação de futuros profissionais.

Hoje, no entanto, com os prejuízos que a evasão dos professores e pesquisadores mais qualificados, afastados em função de aposentadorias precoces, as universidades públicas, responsáveis pela quase totalidade da pesquisa e geração de tecnologia no país, não têm como responder às exigências que precisará atender.

Parcela expressiva desses docentes se deslocou para as instituições privadas de ensino, apesar destas não favorecem o desenvolvimento de suas pesquisas, mesmo as já em andamento, provocando a descontinuidade da produção científica, em sua maior parte relatando ou apresentando reflexões sobre os resultados dessas atividades de pesquisa.

Isso deverá a médio/longo prazo provocar prejuízos no que se refere ao posicionamento do país no panorama da pesquisa em termos internacionais, além de comprometer sua atual liderança latino-americana, com conseqüências imprevisíveis em termos de geração de conhecimento.

Por outro lado, um expressivo contingente desses ex-docentes, deixou de lecionar e orientar estudantes tanto em nível de graduação, como (o que é mais grave e danoso) na pós-graduação e nos projetos de pesquisa. Diversos deles ainda prestam consultorias a escolas e/ou empresas mas, em sua maioria, tendem a se tornar improdutivos, o que representa um imperdoável desperdício de competências, para um país que tenha pretensões de assumir papeis mais importantes no cenário regional e internacional.

A Proposta

O aproveitamento desse contingente de pesquisadores afastados de suas atividades habituais, pode ser promovido por meio de ações simples como a criação de um quadro permanente de consultores sênior, com custos bem contidos, se tivermos em conta os resultados que podem gerar.

As instituições de ensino deverão estruturar propostas nos mais diversos níveis; desde a melhoria do ensino e qualificação de pessoal, de modo a promover a renovação dos conteúdos programáticos de seus cursos, até projetos de pesquisa mais alentados, que seriam avaliados por seus méritos, mas sempre incorporando a experiência desses consultores de alto nível que, por essas atividades, receberiam bolsas de pesquisa das agências de fomento ou entidades estaduais (ou municipais) de amparo à pesquisa.

Conclusões e Recomendações

Graças ao fomento à pesquisa e apoio a qualificação de pessoal, o Brasil conquistou significativa importância no novo contexto mundial em que o conhecimento é fator decisivo para o progresso sócio-econômico das nações.

No entanto, tendo presentes as questões sociais e a sociedade da informação, colocam-se hoje expressivos desafios para nossa ciência. O trabalho já realizado, que favoreceu a inserção de nosso País na estratégia global de desenvolvimento, permitindo que assumisse uma condição de liderança regional, mas gerando a urgente necessidade de novas iniciativas no campo científico, que possam contribuir para consolidar e ampliar os programas que conduziram o Brasil à sua posição atual como produtor de ciência.

Será indispensável promover uma revisão metodológica e de conteúdos, para adequação das instituições de ensino aos novos tempos e formação de recursos humanos que REICH [5] define como capazes de conceituar problemas e soluções, através de quatro aptidões básicas: abstração; raciocínio sistêmico; experimentação; colaboração.

Os estudantes deverão estar preparados para entender que sua atividade profissional faz parte e interage com os demais setores, tendo que atuar de forma transdisciplinar, o que exige a incorporação de um conjunto de competências que NICOLESCU [6] assim refere: aprender a aprender; aprender a fazer; aprender a conviver; aprender a ser.

É preciso uma revisão conceitual das instituições de ensino, incluindo a necessidade de investimentos em infra-estrutura, para adequar o ensino às novas condições de experimentação e participação, além de uma ação corajosa de, simultaneamente, promova a requalificação do quadro de docentes para atuar no âmbito dessa nova realidade.

Um importante passo nesse sentido é enfatizar a pesquisa como prática cotidiana, gerando conhecimentos para as atividades acadêmicas, de modo que o alunado possa incorporar esse novo tipo atuação, que deverá fazer parte de seu cotidiano ao longo de toda a vida profissional. Para isso deverão contar com programas especiais das instituições de ensino, apoiadas por quadros de professores/pesquisadores de alto nível, atuando com apoio (bolsas) das agências federais de fomento ou entidades locais de apoio à pesquisa.

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ADMINISTRACIÓN DE REDES CON ENFOQUE DE INGENIERÍA SOCIAL

José Gpe. Vargas Hernández[1]

Abstract *— Se revisan en esté trabajo, algunos de los métodos con la que los administradores de redes pueden defender sus sistemas de los principales ataques de seguridad existentes. En el presente documento se dan algunos consejos de cómo poder lograrlo. Principalmente esta enfocado a los ataques a la seguridad, denominados: Ingeniería Social, es decir los que se logran con errores y /o exceso de confianza del factor humano. Se realizó parte de la presente investigación con algunas encuestas dirigidas a algunos administradores de redes elegidos al azar, de una base de datos de empresas e instituciones de educación de México. Entre los resultados obtenidos destaca que la un buen porcentaje de nuestros administradores de redes, no tienen respaldado de manera correcta y eficiente sus sistemas.*

Index Terms — Administración de redes, Confidencialidad , Ingeniería social, Seguridad.

INTRODUCIÓN

En este siglo de grandes avances tecnológicos, en donde el uso de la computadoras ha sido generalizado. Las redes de computadoras han tenido un crecimiento sostenido en los últimos años, en donde cada vez un mayor numero de empresas e instituciones educativas, dependen gran numero de sus procesos y operatividad a estas.

Esta creciente expansión de las redes de comunicaciones ha hecho necesario la adopción y el desarrollo de herramientas de seguridad que protejan tanto los datos transmitidos como el acceso a los elementos de la red de los posibles ataques que pueda sufrir.Pero en las empresas e instituciones educativas este crecimiento en muchas ocasiones va mas a allá de la asimilación de la tecnología por sus usuarios y administradores; ya que muchos de los problemas de seguridad que se presentan en una organización esta fuertemente ligada, al facto humano: la famosa ingeniería social. La cual si nos remontamos a los años, en los que se desarrollo la Segunda Guerra Mundial, donde los Alemanes e Italianos tuvieron un mismo grado de confiabilidad al obtener secretos militares, pero uno con sofisticados métodos matemáticos, mientras el otro con el chantaje, robo y el encanto de sus mujeres.

Hoy en día existe la tendencia en el aumento de uso de sistemas Linux, aunque no ha bajado el porcentaje de uso de los sistemas UNIX, contrario a una tendencia a la baja de Novel, y la estabilidad en el uso de Windows es uno de lo aspectos sacados de las encuestas realizadas a administradores de redes, escogidos al azar de los institutos tecnológicos y algunas empresas privadas.

SEGURIDAD

Las normas sobre seguridad empezaron su desarrollo a finales de los años 70, cuando surgió la necesidad de proteger ciertas comunicaciones. Han surgidos diversos organismos que las regulan, como ISO(Organización de estándares Internacionales), ITU (Unión Internacional de Telecomunicaciones) y SC27 (Subcomité 27).

Podemos mencionar de una manera general que mantener un sistema seguro(o fiable) consiste básicamente en garantizar tres aspectos: confidencialidad, integridad y disponibilidad.

- **Confidenciabilidad**: Nos indica que los objetos de un sistema han de ser accedidos únicamente por elementos autorizados a ello y que esos elementos autorizados no van a convertir esa información en disponible para otras entidades.
- **Integridad**: Significa que los elementos solo pueden ser modificados por elementos autorizados, y de una manera controlada.
- **Disponibilidad**: Indica que los objetos del sistema tienen que permanecer accesibles a elementos autorizados; es el contrario de la negación de servicio.

Entre las cosas que debemos tener en mente al realizar un diseño de seguridad para establecer las politicas de seguridad de nuestra organización, es que queremos proteger ya sea el Software, el hardware y/o los datos.

Entre los puntos que debemos tener en cuantas como un buen administrador de red, son los tipos de amenazas contra la que necesitamos proteger nuestra información.

- **Interrupción de servicio.** Que por ninguna circunstancia se deje de ofrecer un servicio.
- **Interceptación de datos.** Los datos en un sistema solo podrán tener acceso los usuarios autorizados.
- **Modificación de nuestros datos.** Los datos solo serán modificados por usuarios validos.
- **Fabricación de nuevos datos o suplantación de identidad.** Que no existan formas no autorizadas para tener acceso a los datos, o que no se creen usuarios no autorizados.

Cuando se recibe alguno de los ataques anteriores, se pudieron realizar de cualquiera de las dos formas siguientes:

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- **Activos**: Ataques que se hacen de forma directa a los datos y/o equipos.
- **Pasivos**: Ataques que se realizan de forma indirecta a los datos y/o equipos.

El lograr tener una buena política de seguridad, se logra manteniendo mecanismos de seguridad fiables como por ejemplo :

- **Prevención.** Verificando con anterioridad posibles problemas de seguridad.
- **Detección**. Realizando una chequeo en línea de los ataques a la seguridad.
- **Recuperación.** Después de un problema recuperar las fallas ocurridas.

Para este ultimo podemos mencionar que las copias de seguridad del sistema son con frecuencia el único mecanismo de recuperación que poseen los administradores para restaurar una máquina que por cualquier motivo (no siempre se ha de tratar de un pirata que borra los discos), ha perdido los datos. Asociado a las copias de seguridad suelen existir unos problemas de seguridad típicos, p.e. la no verificación del contenido. Otro problema clásico de las copias de seguridad es la política de etiquetado, etc.

Para prevenir la entrada de usuario no validos se han establecido métodos de autenticación se suelen dividir en tres grandes categorías, en función de lo que utilizan para la verificación de identidad:

- **Algo que el usuario sabe**
- **Algo que éste posee**
- **una característica física del usuario o un acto involuntario del mismo.**

Esta última categoría se conoce con el nombre de autenticación biomética.

Pero podrán existir los mejores métodos, el equipo mas sofisticado, pero si los usuarios y/o administradores no llevan orden, y son descuidados con las políticas de seguridad establecidas. Se tendrá un sistema inseguro. En encuestas realizadas a un grupo elegido al azar de administradores de redes de las principales empresas e instituciones de educación superior de México.

Podemos establecer que uno de los ataques mas peligrosos y que dan origen a mayores riesgos son los denominados de ingeniería social, es decir los ocasionados por el factor humano. Ya sea por un descuido del administrador, por que el usuario sea malintencionado, o por descuido del usuario se obtenga, pierda o cambie información.

Por otro lado ocasionado por el factor humano es la resistencia al cambio por parte de miembros de nuestra organización, como lo descuido ocasionado por ello.

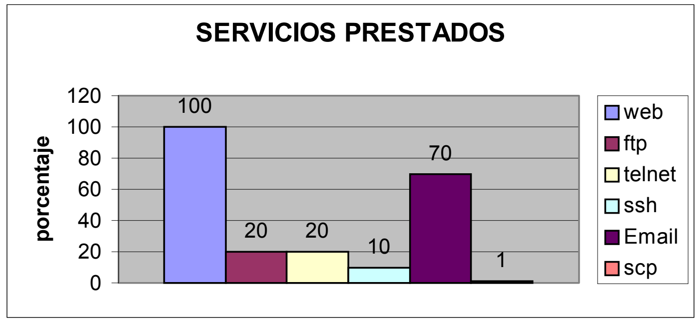

FIGURA. 1
SERVICIOS PRESTADOS

El 100% de los encuestados dan en cierta medida, acceso a Internet a sus usuarios, convirtiéndose esto en un problema de seguridad, ya que la mayoría de sus usuarios, utiliza servicio de Internet inseguros, como es el ftp, telnet, y www.

En la gran mayoría de las empresas e instituciones de educación no existen políticas, bien definidas de autoridad, y canales de mando en muchas de estas organización, en gran porcentaje de ellas el único que conoce las claves de administración, es el encargado. Esto mientras no exista mucha rotación de personal, es adecuado. ¿ Pero que pasaría si el encargado de la red, cambia de empresa?

Entonces podemos visualizar que lo anterior es uno de los principales problemas que se puede enfrentar, los administradores de la empresa. Y por lo que se debe tener un buen control del personal, capacitación al mismo y que estos quieran a la empresa, así como "amor a camiseta".

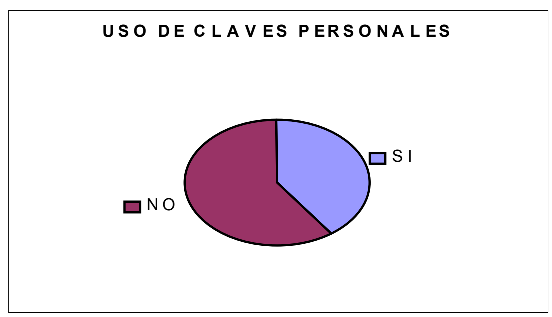

FIGURA. 2
USO DE CLAVES PERSONALES

Uno de los problemas mas graves que enfrenta un administrador de redes, es el descuido de sus usuarios al asignar sus contraseñas. Ya que muchas veces la clave que le asigna son muy sencillas. Así como del descuido de los mismos al no darle la seriedad que se merece al uso de las contraseñas, ya que piensa "..No tengo nada importante...", pero lo que no sabe es que puede usar su cuenta o equipo de pasarela, para atacar otros equipos que tengan información valiosa, aunque no este en la misma red. Aquí el inconveniente es que el prestigio de la institución a la pertenece o donde fue dirigido el ataque, es el que queda en entredicho.

Al no darle la importancia debida, y pensando que no existe nada que una persona curiosa quiera, se dejan muchos sistemas, completamente sin restricciones para un usuario curioso o con iniciativa. Con esto no se le da el valor que se debe al prestigio de la organización, y existen comentarios como: "... ellos siempre tienen virus..", "... hasta mi hermano de secundaria ha entrado a ese sistema...", etc

Ya que es posible que no se pierda información en ese punto, pero prestigió SI. En este punto un vandalo informatico, puede suplantar la identidad de alguien, y mandar por ejemplo un correo a un usuario pensando que lo manda un tercero.

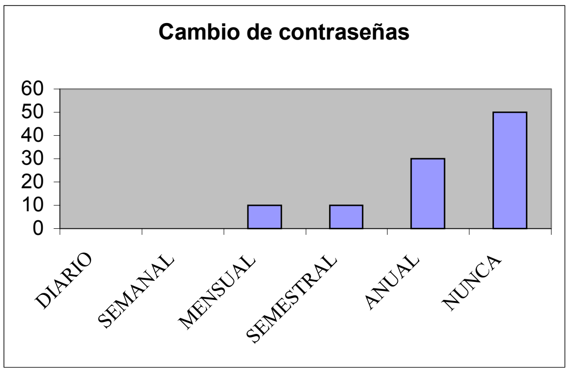

FIGURE 3
FRECUENCIA EN EL CAMBIO DE CONTRASEÑA

CONCLUSIONES

Cuando queremos proteger la información de nuestra organización, y por tanto tener nuestros sistemas confiables y seguros. No requerimos en la mayoría de los casos, conocer todos los huecos o fallas de seguridad de un sistema operativo, y demás programas que se requieren en una organización. Se necesita mas que nada la construcción de sistemas de autenticación fiables y baratos y/o el diseño de nuevos criptosistemas seguros.

Pero es preferible utilizar los existentes como DES, RSA o Kerberos que no tener ninguno como protección en la distribución y autentificación de claves. Otros de los puntos que podemos concluir es que existen en las diversas redes de nuestro país un uso generalizado de mas de dos sistemas operativos, conviviendo por recursos. Siendo este un punto débil en la seguridad de los sistemas, ya que por lo regular es un punto de "quiebra" de la seguridad, si no se tienen los conocimientos del funcionamiento de ambos a nivel de seguridad..

Eso aunado que en muchas instituciones de educación, por falta de recursos humanos, tienen a sus alumnos a cargo de muchos de los procesos informáticos dentro de ella, principalmente de telecomunicaciones.

Actualmente, casi cualquier sistema en Internet es vulnerable, y los problemas de seguridad causan grandes inquietudes en las industrias de ordenadores de comunicaciones. Las preocupaciones sobre los problemas de seguridad incluso han empezado a enfriar las sobrecalentadas esperanzas acerca de la capacidad de Internet para servir de soporte para las actividades comerciales.

EVALUACIÓN DE LAS EXPERIENCIAS PARA MEJORAMIENTO DEL PROCESO DE APRENDIZAJE EN ASIGNATURA INICIAL DE LA CARRERA INGENIERÍA INFORMÁTICA.

Nancy N. Figueroa [1], Fernando J. Lage[2], Zulma Cataldi[3] and Julia M. Denazis [4]

Abstract — *En comunicaciones previas se han descripto los resultados de las experiencias de aprendizaje basado en problemas (ABP) utilizando software para groupware, con estudiantes de cursos iniciales de Algoritmos y Programación. Las experiencias se llevaron a cabo usando el protocolo genérico de trabajo cuyo diseño se describe en Lage, Cataldi [12] y que se ha ajustado a este caso particular.*
En esta comunicación se presentan los resultados de los diferentes tipos de evaluaciones efectuadas para detectar si hubo un mejoramiento de los aprendizajes durante el 2000. A tal efecto se efectuó el análisis cualitativo y cuantitativo de los diferentes tipos de la micro interacciones producidas a través de los mensajes intercambiados por los estudiantes en forma asincrónica tal como se describe en Lage, Cataldi (2002) y efectuando las evaluaciones que aquí se describen.

Index Terms — *Aprendizaje basado en problemas, Mediación tecnológica Trabajo cooperativo–colaborativo,.*

INTRODUCCIÓN

En este trabajo se relata una experiencia realizada en la Facultad de Ingeniería de la Universidad de Buenos Aires, en la asignatura Algoritmos y Programación de la carrera de Ingeniería en Informática. En nuestra perspectiva confluyen las corrientes teóricas del aprendizaje colaborativo, el aprendizaje mediado y el acercamiento metodológico de micro-análisis de las interacciones. Estas corrientes permiten poner en práctica *principios pedagógicos que suponen que el estudiante es el principal actor en la construcción de sus conocimientos,* con base en situaciones (diseñadas y desarrolladas por el docente) que le ayudan a aprender mejor en el marco de una acción concreta y significante y, al mismo tiempo, colectiva.

La resolución de problemas en el marco del trabajo en grupos cooperantes y colaborativos a través de la mediación tecnológica permite a los estudiantes la construcción de sus aprendizajes estimulando su creatividad. De este modo se pretende formar sujetos capaces de desarrollar proyectos y por consiguiente de investigar, de evaluar y de resolver problemas.

Cuando se habla de *aprendizaje colaborativo* se hace referencia a la formación de grupos de trabajo con objetivos de aprendizaje determinados, y donde *cada participante del grupo interviene en todas y en cada una de las partes del proyecto o problema*. Para el caso del *aprendizaje cooperativo*, cada uno de los integrantes del grupo, tiene asignada *una tarea específica dentro del proyecto o problema a resolver.*

De este modo se puede decir que cada participante realiza una tarea más individual como parte del trabajo total.

El trabajo *cooperativo* aplicado a la resolución de problemas sigue la operatoria que se describe: dado un cierto problema, el mismo se debe completar *dividiendo las tareas* entre los agentes cooperantes. Cada uno es responsable de su parte para la resolución del problema en su totalidad. La *colaboración* en cambio incluye el compromiso mutuo de los participantes en un *esfuerzo coordinado para resolver los problemas juntos*. No es sólo un tratamiento de las tareas que causa efectos positivos en los participantes, sino que es una estructura social en la cual dos o más personas interactúan entre sí, bajo determinadas circunstancias siendo estas interacciones las que tienen y producen un efecto positivo. [6,7]

Tanto la cooperación como la colaboración son modalidades de interacción que se potencian cuando se las aplica en ambientes ricos en materiales y herramientas tales como los que proveen las nuevas tecnologías de la información y de la comunicación. [12,13,14]. Así, la colaboración, que puede ser definida como un *proceso de participación en comunidades de conocimiento*, aprovecha las posibilidades que ofrece el entorno material para facilitar el monitoreo y la comprensión mutua. Las computadoras, especialmente, pueden ofrecer un amplio repertorio de anclajes referenciales y de puntos de relación compartidos

Las NTIC (Nuevas Tecnologías de Información y Comunicación) en el ámbito educativo son un recurso que busca favorecer los aprendizajes de los estudiantes y constituyen una valiosa herramienta por la incidencia que tienen sobre la motivación de los alumnos, los que crecieron en un ambiente de transformaciones tecnológicas importantes que afectaron, cada una a su tiempo, las estructuras de comunicación dentro de la sociedad. De este modo, las generaciones jóvenes, tienen expectativas y necesidades nuevas que se manifiestan dentro de los variados ambientes de enseñanza, entre ellos la universidad. El impacto que las NTIC tienen en nuestra cultura, nos lleva a afirmar que hoy la realidad se construye mediáticamente. Las nuevas tecnologías de la información y de la comunicación son buenas aliadas para construir y aprender

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pero sus efectos no están relacionados con su naturaleza, sino, con la manera en que se las utilice. Es necesario entonces que los estudiantes y los docentes al involucrarse en experiencias de este tipo, asuman una postura crítica e identifiquen las ventajas y desventajas que ofrece su uso, evitando caer en el tecnocentrismo de sustituir el fin: ***el aprendizaje del alumno***, por el medio: ***la tecnología***. [25].

A partir del marco teórico descrito nos interesamos principalmente, en determinar: 1) cómo el aprendizaje colaborativo asistido por las tecnologías puede mejorar la interacción entre pares y el trabajo en equipos, y 2) cómo la colaboración, así como la tecnología facilitan el conocimiento compartido, además del desarrollo de habilidades y destrezas entre los miembros de la comunidad.

METODOLOGÍA

Se describe una de las experiencias de ABP, con un grupo de 60 alumnos de primer cuatrimestre de la carrera de grado Ingeniería Informática, utilizando el software explicado en trabajos anteriores [16,17]. El programa tiene las opciones básicas del software para groupware: navegador, correo electrónico, chat y pizarra de mensajes.

Durante la experiencia de resolución de problemas se usó el modelo de trabajo que se ha descrito en experiencias anteriores pero simplificado en tres etapas: cooperativa pura, colaborativa pura, y cooperativa–colaborativa, ya que el modelo completo estaba diseñado para otros criterios de uso. [19]

Considerando la colaboración como una forma especial de interacción entre los componentes del acto pedagógico, es decir entre el docente, el alumno, los contenidos y el medio tecnológico, tomamos como unidad de análisis para nuestro estudio *los niveles de interactividad en las comunicaciones entre los pares intervinientes*: Alumno–Alumno (AA), Alumno-Docente (AD), Alumno–Contenido (AC), Alumno–Medio (AM).

Los datos obtenidos surgieron a través del análisis de los mensajes electrónicos enviados por los grupos de los alumnos que participaron en el estudio, como también de la "trascripción" de conversaciones electrónicas, bajo la modalidad sincronizada (chat). Todas las interacciones entre los participantes fueron registradas. En una primera etapa se analizarán las intervenciones a través del correo electrónico para luego analizar los protocolos de las sesiones de chat. La información obtenida proveerá datos acerca de los tipos de interacciones: alumno-alumno (AA), alumno-docente (AD), alumno-contenido (AC) y alumno-medio (AM). A fin de sistematizar las relaciones entre el docente, los alumnos, los contenidos y el medio, se definieron algunas categorías de análisis tales como las de Gairín [4].

LA EXPERIENCIA

La necesidad de trabajar con ABP utilizando software para groupware se inició al detectar una serie problemas relacionados al bajo rendimiento de los estudiantes en un curso inicial de algoritmia. A partir de este dato sumado a la información provista por encuestas[5] que responden los estudiantes al aprobar la asignatura. Se indagó cómo los estudiantes preparaban sus exámenes y se descubrieron algunas evidencias tales como: la falta de consultas a bibliografía, poco de tiempo dedicado al estudio, la falta de metodologías de estudio, la ausencia de estrategias para la resolución de problemas [11]. Se observó que la mayor parte de los estudiantes no lee correctamente los enunciados y las consignas o las interpretan en forma errónea y que tienen dificultades para diferenciar la información relevante de la que no lo es. Esto revela problemas tales como la falta de atención y el conocimiento frágil de los estudiantes [23]. Centrados en estos cinco indicadores buscamos y diseñamos estrategias de estudio que a través de la tecnología favorezcan el trabajo colectivo, la modificación de actitudes hacia el estudio, la modificación de concepciones erróneas y de procesos cognitivos. [14,15]

Pensamos que con la incorporación de entornos tecnológicamente enriquecidos además de aprovechar el efecto *novedad* [1,2], podíamos introducir en nuestra tarea docente contenidos actitudinales y procedimentales, tales como el respeto al otro, la tolerancia y la solidaridad, dados por las ventajas que ofrece el trabajo en grupos cooperativos y colaborativos.

Con los objetivos de desarrollar un curso que fuera cautivante, estimulante, con aplicaciones tecnológicas que respondieran a las demandas crecientes de los alumnos del sistema, sin que por ello el medio de enseñanza prevaleciera sobre el mensaje transmitido y evaluar su impacto en los aprendizajes de los estudiantes, como profesores a cargo cumplimos con el doble rol de formador e investigador, documentando cuidadosamente cada una de las etapas del curso en proceso.

Desarrollo de la experiencia

Para la experiencia se siguieron las siguientes reglas básicas:

- Se conformaron grupos de trabajo de tres alumnos a los que les entregó el Trabajo Práctico a resolver.
- El tiempo entre la entrega del Trabajo Práctico y su devolución fue de 15 días.
- El mismo grupo se encargó de subdividir el trabajo de manera que cada integrante elaborara una parte.
- Cuando un alumno cooperante tenía una duda, esta se publicaba en la pizarra para que todos pudieran colaborar en la obtención de la solución.
- El proceso de negociación de las comunicaciones estuvo siempre supervisado por al menos un docente coordinador.
- Cuando se llegaba a un resultado correcto o factible, este se publicaba a fin de que el grupo pudiera seguir con su trabajo.

[5] Se hace referencia a las encuestas implementadas por la Facultad, que responden obligatoriamente los estudiantes de grado una vez que aprobaron la asignatura.

– Para este trabajo sólo se analizaron los registros de los mensajes del foro de discusión cerrado exclusivamente para los participantes del curso.
– Se llevó un registro de la cantidad y calidad de las intervenciones de cada uno de los alumnos colaborando con aquellos que tuviesen problemas, ya que se requiere de un mínimo de tres intervenciones para ser tenidas en cuenta como un porcentaje de la calificación final.
– Un 20 % de la calificación final estaba destinada a la colaboración con el resto, lo que beneficiaba al alumno que colaboraba y al alumno o grupo que tenía el problema.Como se ha planteado en los trabajos previos, [12] el procedimiento a seguir consta de los tres momentos que se describen a continuación:

1. Diseño de los problemas
2. Período de entrega del trabajo y desarrollo
3. Evaluación

En cada uno de estos momentos, se deben tomar diferentes decisiones que determinan el protocolo del trabajo, por lo que cada momento se puede desglosar como se describe a continuación:

Primer momento: diseño de los problemas

Los problemas a realizar por los alumnos en forma grupal, corresponden a los contenidos de la asignatura Algoritmos y Programación de la carrera de Ingeniería Informática de la Facultad de Ingeniería de la Universidad de Buenos Aires, y fueron confeccionados siguiendo los requerimientos dados [11] para poder efectuar un trabajo cooperativo y/o colaborativo.

Los problemas se concibieron en forma modular, cada módulo de actividades está limitado en tiempo, espacio y extensión. Los módulos están concebidos para favorecer la integración significativa de los temas y la construcción colectiva del conocimiento a través del intercambio efectivo de información y de la comunicación para poder resolver los problemas planteados. Para la solución de los mismos los estudiantes debieron reagrupar las actividades en subtemas de la temática general para concluir con el módulo en el tiempo estimado.

Segundo momento: los procesos interactivos

Se puede pensar en el ambiente de aprendizaje como un *ecosistema de aprendizaje* [22] en el cual todos participan con determinadas tareas específicas y realizan una serie de acciones (plantean preguntas, emiten respuestas, solicitan ayuda, información, etc.). De este modo se establece entre los estudiantes y el docente relaciones que producen retroalimentaciones, por lo que se puede definir a la ***interacción electrónica*** como el intercambio de mensajes electrónicos que tienen lugar entre dos o más personas que se influyen mutuamente enviando y recibiendo información, y produciendo resultados que probablemente ninguno de los actores hubiera producido por separado.

El seguimiento de las interacciones a través del tiempo de duración de las experiencias, del tipo de interacción, y de la calidad de las mismas permitirá dar a luz el impacto que el *ABL en grupos cooperantes y colaborativos a través de la mediación tecnológica* produce en la construcción de conocimientos y en la mejora de las estrategias de estudio usadas por el estudiante.

Tercer momento: La evaluación de los estudiantes y de la experiencia.

Las etapas seguidas fueron:
– Se realizaron evaluaciones parciales y evaluaciones integradoras en los temas tratados para la resolución del Trabajo Práctico y se los comparó con el rendimiento de los grupos de los períodos anteriores.
– Se comparó la eficiencia de los grupos en cuanto a la realización de los trabajos prácticos en los períodos en estudio.

Se hizo el seguimiento de la participación de los alumnos en la realización de los trabajos prácticos.

LAS EVALUACIONES

Para esta serie de experiencias se han tenido en cuenta tres tipos de evaluaciones inherentes a los sujetos: del desempeño grupal, de los aprendizajes, las autoevaluaciones individuales y grupales, y se ha efectuado una evaluación de la aplicación utilizada. También se ha tenido en cuenta cómo los estudiantes han recibido la experiencia a través de una encuesta que se describe en el apartado 4 donde se presentan algunos datos estadísticos relevantes.

A través de la bibliografía se ha observado que los procesos grupales se pueden estudiar a través de tres corrientes: la dinamista o lewiniana, la interaccionista o la psicoanalítica según Maissonaive [21]. Para éste análisis se adoptó la corriente interaccionista que se basa en la investigación a través de la observación sistemática de los procesos de interacción grupal. Para llevar a cabo la observación se tomaron las doce categorías que presenta Bales [21].

TABLA 1:
LAS CATEGORÍAS DE BALES [21]

Area socioafectiva positiva	Da muestras de solidaridad	
	Se muestra moderado	
	Aprueba	
Area de las tareas	Ofrece orientación o sugestión	
	Da una opinión	
	Da una información	
	Pide información	
	Pide opinión	
	Pide orientación	
Area sociofectiva negativa	Manifiesta molestia	
	Manifiesta agresividad	

La categorías se agrupan en tres grandes áreas: la socioafectiva positiva, la de las tareas y la socioafectiva negativa tal como se aprecia en la Tabla 1. Estas categorías son importantes en el momento de la evaluación ya que permiten focalizar en qué aspectos se centran las interacciones. Esta herramienta no es única, ya que se puede señalar otra tal como el formulario de observación estructurada, propuesto por Johnson, Johnson y Holubec [8] que se muestra en la Tabla 2. El mismo se puede ampliar incorporando otros tipos de observaciones que puedieran surgir de acuerdo a las características de las interacciones grupales, ya que se podría desplegar en el ítem denominado otros.

TABLA 2:
FORMULARIO DE OBSERVACIÓN ESTRUCTURADA DE JOHNSON, JOHNSON Y HOLUBEC [8]

Observador:			***Fecha:***	
Actores	***Alumno 1***	***Alumno 2***	***Alumno n***	***TOTAL***
Aporta ideas				
Estimula la participación				
Verifica la comprensión				
Orienta la grupo				
Otros:				
TOTAL				

La aplicación de este formulario (durante las prácticas, en este caso) consiste en tildar en las casillas correspondientes para obtener los datos iniciales y observar cómo van evolucionando a lo largo de la experiencia verificando el surgimiento y la persistencia de las *conductas positivas* a lo largo del tiempo, en la medida que el grupo o el individuo adquiera mayores competencias cooperativas y/o interactivas.

Considerando a los aprendizajes individuales, las evaluaciones se orientaron a fin de determinar el grado de *transferencia* adquirido por cada uno de los participantes. Es decir la capacidad de resolver situaciones problemáticas nuevas e integradoras a partir de los conocimientos y habilidades adquiridos, por reacomodación de las estructuras cognitivas. Para ello, se diseñan situaciones problemáticas a fin de establecer si los participantes pueden o no transferir lo aprendido.

Se dice que existe *transferencia* siempre que algo que se aprendió antes influye en el aprendizaje actual o cuando la forma de resolver un problema dicta la forma en que se resuelve uno nuevo. [20]. La transferencia puede ser general o específica. Es específica cuando lo aprendido se aplica a situaciones muy parecidas y es general cuando supone la aplicación de lo aprendido a situaciones nuevas y supone el uso de métodos heurísticos para resolución de problemas. [27]. Solomon y Perkins [26] descubrieron la existencia de dos tipos de transferencia: la cercana y la lejana. La primera es espontánea y automática de destrezas muy practicadas con poca necesidad de pensamiento reflexivo. La lejana es una aplicación consciente de los conocimientos aprendidos en una situación diferente y su clave principal reside en la abstracción consciente o identificación de principios generales o estrategias más allá del problema mismo, siendo esta abstracción parte del conocimiento metacognitivo que puede dirigir el aprendizaje y la solución de problemas futuros.

TABLA 3:
ENCUESTA DE EVALUACIÓN DE LA APLICACIÓN.

Evaluación de la aplicación (Marque con una X o responda)		
	Si	**No**
¿Es su primera experiencia de trabajo en la red?		
¿Accede con equipo propio a la red?		
¿Tuvo inconvenientes de tipo técnico para trabajar? ¿Cuáles?..		
¿Cuándo tuvo problemas consultó? Siempre....... a veces .... nunca........		
¿Obtuvo a tiempo la respuesta del docente?		
Sugerencias		

Finalmente, para conocer la opinión de todos los usuarios, se implementó una encuesta de evaluación de la aplicación para los alumnos como la que se muestra en la Tabla 3, se piensa que al analizar los resultados aparecerían aquellas categorías que consideren las interacciones AM (alumno–medio) y DM (docente–medio) que permitieran dilucidar algunos aspectos operativos acerca del funcionamiento de la aplicación.

LOS RESULTADOS DE LAS EVALUACIONES

La evaluación del desempeño grupal

Para la evaluación grupal se tuvieron en cuenta las interacciones de tipo AA (alumno–alumno), AD (alumno–docente) y DA (docente–alumno) descriptas en trabajos previos [19]. Para las interacciones de los tipos AD y DA, las categorías que aparecen están dentro del área de las tareas de acuerdo a la clasificación de Bales, tal como se describe en Maissonaive [21], siendo éstas casi exclusivamente referidas a la categoría de la gestión (da opinión, pide opinión, pide orientación, etc.). Esto permite obtener algunas pautas acerca del grado de independencia del alumno en el proceso grupal interactivo. En cuanto al análisis de la interacción AA aparecen las siguientes categorías referidas al también al área de las tareas:

Solicita aclaración
Clarifica
Aporta bibliografía
Pide información
Da información

La relación entre *Clarifican y Solicitan Aclaración* como medida de la *"actividad"*[6] está en el orden de 0,57, respecto de los valores entre los que este índice se mueve que son 0 y 1 y se pued edecir que es buena, ya que registra un mayor nievel de respuestas que de solicitudes..

La relación entre las categorías *Dan información y Piden información* es de 0,83, lo que representa una notable mejoría respecto de la relación anterior, deduciendose que la diferencia se da porque en éstas últimas categorías no están en juego directamente los contenidos.

También aparecen las categorías *Valoran y Ayudan a la Gestión*, que están referidas al área socioafectiva positiva y representan un 8,2% del total. Aunque se podría pensar que este valor es bajo respecto del que corresponde a otras categorías, se debe notar que no han aparecido categorías del área socioafectivas negativas y, que por el hecho de ser un grupo formado para llevar a cabo una tarea puede tomarse como medida de la interacción positiva del grupo la relación entre las categorías donde hay requerimientos tales como: *Solicita Aclaraciones o Pide Información*, respecto de las que satisfacen tales requerimientos tales como: *Clarifican, Dan información*, etc. Esto arroja un índice de 0,7, el cual se considera muy bueno respecto del óptimo que es 1. por este motivo se puede decir que la evaluación grupal ha sido positiva.

La evaluación de los aprendizajes

De los 60 estudiantes que iniciaron la experiencia hubo un desgranamiento del 10% y los abandonos se debieron a problemas laborales o económicos. Del total de las interacciones sólo el 60% fueron positivas ya que el resto fueron neutras.

A fin de tener referencias se comparó el resultado del examen Parcial (con iguales contenidos) de este grupo respecto de uno que no trabajó en la red y hubo un 5% más de alumnos aprobados en el primero que en el segundo.

No se utilizó la instancia del examen final integrador para la comparación pues los alumnos no asisten a la evaluación en forma conjunta sino que, en forma individual, optan por presentarse a lo largo de un periodo que excedía los límites de este trabajo. En una primera instancia, y sujeta a réplicas de la experiencia, se puede decir que la aplicación de esta metodología jugó un rol positivo favoreciendo los aprendizajes.

Se indagó cuál fue el nivel de *transferencia* cercana o próxima se construyó una tabla como la que se observa en la Tabla 4. Se uso una escala de calificaciones como la siguiente: *Notable (N), Bueno (B) y Reprobado (R).* Para dejar constancia de los conocimientos previos la escala fue *Tiene (T), Algunos (A), No Tiene (NT).* Las calificaciones se obtuvieron a partir de varias instancias de seguimiento para cada uno de los participantes a través del análisis de cada una de sus intervenciones y de las evaluaciones parcial y final integrador.

TABLA 4:
TABLA DE SEGUIMIENTO DEL ALUMNO.

Alumno	**Evaluación Diagnóstica**	**Instancias de Seguimiento**			**Evaluaciones**		**Estado Final**
					Parcial	**Final**	
A1							
A2							
....							
....							
An							

A partir de la Tabla 4, se efectuó el seguimiento de 10 alumnos elegidos al azar, a fin de obtener datos respecto de la transferencia. Se obtuvo un estado final con una capacidad de transferencia más que aceptable sujeto a la brevedada del período en estudio.

La autoevaluación individual y grupal

Se considera muy importante llevar a cabo las autoevaluaciones, puesto que ellas aportan información respecto de las habilidades de un individuo capaz de autogestionarse. Las autoevaluaciones se realizaron apuntando a dos aspectos: la autoevaluación acerca de la intervención en el ámbito grupal y la autoevaluación de los aprendizajes individuales.

Para la primera, cada alumno contó con un formulario como el mostrado en la Tabla 2, donde volcaron las impresiones respecto de su propia actuación. Durante las clases presenciales, los docentes pudieron confrontar los resultados con aquellos obtenidos por los alumnos. La segunda autoevaluación se llevó a cabo dando la oportunidad a los estudiantes de realizar las autocorrecciones de sus evaluaviones parciales.

Las dos autoevaluaciones se llevaron a cabo coincidentemente con las entregas de los Trabajos Prácticos y sus defensas. La autoevaluación de los aprendizajes individuales resultó positiva y no mostró mayores diferencias con las evaluaciones docentes; se piensa que la naturaleza lógico-matemática de los contenidos ayudó en este sentido. La autoevaluación grupal mostró mayor dispersión, lo que se atribuye a las dificultades por parte de los alumnos para la autoobservación conductual. Tanto para la autoevaluación de los aprendizajes individuales y como para la grupal, se observó una mayor coincidencia para el segundo Trabajo Práctico, realizado de este modo.

La evaluación de la aplicación

Para efectuar dicha evaluación se tuvieron en cuenta las interacciones AM (alumno-medio), DM (docente-medio) junto con las opiniones vertidas por los alumnos y docentes

[6] Definimos "*actividad*" como el cociente entre "dar ..." y "pedir ...", coeficiente que varía ente 0 y 1, a modo de rendimiento.

en la encuesta de evaluación diseñada para la aplicación. (ver Tabla 3)

El análisis de las interacciones mostró que el uso de la aplicación se presentó como un inconveniente de pocana incidencia en el trabajo. De la encuesta surge que los problemas básicamente derivaron de factores propios del sistema como problemas en la conexión, factores propios de la gestión como el retardo en las respuestas por parte del docente y otros factores concernientes a los alumnos, tales como la falta de experiencia en la operación de la aplicación en forma dinámica e interactiva.

Por otro lado, hubo encuestas en las que los individuos expresaron que el trabajo a través de la aplicación les resultó *"agradable"* y que la comunicación extra-clase los predisponía en forma favorable en la relación con sus compañeros y con el docente. Se puede decir que, si bien es perfectible, la aplicación es buena.

La Encuesta a los Estudiantes

Finalmente se efectuaron encuestas a los estudiantes a fin de revelar el grado de interés por este tipo de trabajo. Algunas de las preguntas fueron tomadas de la encuesta a estudiantes que efectúa la Facultad al aprobar cada asignatura, otras fueron pensadas para obtener información acerca de la modalidad de trabajo. Se pensó en efectuar tan sólo 12 preguntas abiertas, cerradas y de opción múltiple a fin de agilizar el tiempo de llenado de la misma, ya que se ha observado que requiere de un tiempo promedio de unos 5 minutos y que un número excesivo de preguntas agobia al encuestado. (según Kraus, [10] y Hernández Sampieri, [5]).

A continuación se transcribe el instrumento utilizado para recoger la información:

El Instrumento

1. ¿Qué modalidad de dictado de clases le fue más útil o efectiva?: Clases teórico-prácticas □ clases teóricas y prácticas por separado □ consultas personales/grupales □ otras □ Cuáles?.............
2. Indique cuáles clases le fueron más útiles o efectivas. Las que se dedicaron a:
   Manejo de información □ Comprensión de bibliografía □
   Conceptualización de temas □ Integración de contenidos □
   Resolución de problemas□
3. De acuerdo al programa de la materia: ¿Piensa que los temas fueron desarrollados con profundidad?.
   Ninguno □ algunos □ todos □ no sabe □
4. Para Ud. el tiempo de clases fue: escaso □ suficiente □ excesivo □ no sabe/nc □

5: Señale qué temas le parecieron difíciles:

....

6. El uso del foro de discusión le pareció una propuesta:
   mala □ buena □ innovadora □ no sabe/nc □
7. Pudo autoevaluar lo aprendido? Si □ Cuándo y cómo?
   .... No □ ns/nc □
8. Los trabajos en grupo le resultaron: útiles □ poco útiles □ para nada útiles □ no sabe/nc □
9. Considera justo el criterio de evaluación? Si □ No □ Por qué?
   ....
10. Cómo calificaría a sus docentes: (Escala: Excelente: 10, Muy Bueno: 8-9, Bueno 6-7 Regular: 4-5, Malo:1-3)

Docente __ Ayudante 1 __ Ayudante 2__ Ayudante 3 __

Comentarios al respecto:

....

....

11. Los docentes fomentaron el interés por la materia? Si □ No □ Explique

....

12. Indique los inconvenientes y/o problemas que tuvo durante el curso.

....

....(siga al dorso).

Sugerencias:...

.. (siga al dorso)

Justificación de las preguntas de la encuesta

Preguntas de 1 a 5: Fueron tomadas para indagar y saber efectivamente de acuerdo a las características de la asignatura qué requieren los estudiantes.

Las mismas se centran en la modalidad de dictado del curso si la preferencia se centra en clases teórico–prácticas o por separado, qué tipo de clases fueron más útiles en razón del tipo de tareas que efectuaron los estudiantes durante el curso, ya que no siempre todos los docentes estuvieron en la totalidad de las clases ya que hubo desdoblamiento de actividades y trabajo en simultáneo en el aula y en el laboratorio de PC.

La pregunta más importante es quizás la referida al tiempo de las clases, a pesar que durante los períodos en estudio docentes a cargo no perdieron más clases que las debidas a feriados nacionales previstas en el calendario, se desea saber si debería haber un reajuste del tiempo dedicado a algún tema en particular. En la pregunta 5 donde se pide saber qué temas les parecieron más difíciles permitirá efectuar dicho ajuste y planificar más tiempo dedicado a la ejercitación para el desarrollo de dichos temas.

Pregunta 6: Se refiere específicamente a la propuesta bajo análisis: a fin de indagar si el trabajo a través del foro de discusión les pareció un aporte innovador.

Pregunta 7: Apunta a la autoevaluación de los aprendizajes y se efectuó para saber si los estudiantes se pudieron autoevaluar en alguna instancia a fin de poner a prueba los nuevos conceptos que había incorporado y las habilidades que habían adquirido.

Pregunta 8: Se refiere al trabajo grupal y a través de ella se quieren obtener datos para saber si el trabajo en forma grupal les aportó beneficios o no.

Pregunta 9: Se les solicita que indiquen si el criterio seguido para la evaluación les parece justo a fin de saber si se adecua al cambio de paradigma de trabajo.

Pregunta 10: Se les pide la evaluación de la actuación de los docentes según la escala que se provee. Se deja un item abierto para comentarios a fin de saber qué docente quieren los estudiantes. Dicho de otro modo qué cualidades destacan y que modalidades los pueden perturbar.

Pregunta 11: Se desea saber si los docentes fomentaron en interés por la materia y que expliquen a través de que actitudes lo recibieron.

Pregunta 12: Se requieren los inconvenientes y problemas que tuvieron durante el curso a fin de cautelar esas cuestiones para los períodos siguientes si estuvieran al alcance de los docentes.

Luego, se dejó un item abierto para sugerencias de cualquier tipo y que pudieran expresar sus puntos de vista como sujetos activos en el proceso con voz para las propuestas factibles.

RESULTADOS OBTENIDOS Y ANÁLISIS ESTADÍSTICO

Se encuestó a una muestra de 56 estudiantes para los dos períodos consecutivos estudiados divididos en 36 y 20 cada uno respecto una la población total de 60 en cada caso. No se encuestó a la totalidad de los cursantes ya que no se pensó en utilizar los resultados estadísticos de la misma en su momento, sino tan sólo en llevar un registro de los cambios eventuales sugeridos por los estudiantes a modo cualitativo para estudiar la factibilidad de implementación. Debido a que la misma se la puede encuadrar como estratificada [9] según el ítem: estudiante que rinde en primera fecha de final integrador se tomó la decisión de relevar las preguntas que pudieran dar mayor información a fin de efectuar el análisis de los resultados.

En la pregunta 1 el 71% respondió que las clases teórico-prácticas les fue más útiles con sólo un 22% que respondió clases teórico-prácticas por separado. Respecto de las actividades (pregunta 2) un 33% señaló la resolución de problemas y un 27% la integración de contenidos, con un 14% tanto para la conceptualización de temas como para la comprensión de bibliografía.

La pregunta 3 no fue relevada en su sentido explícito, sino que la intención subyacente a ella es conocer si los alumnos han logrado percibir la importancia jerárquica entre los contenidos y las aplicaciones futuras en la realidad relacionadas con la transferencia lejana, ya que se piensa que en esta instancia de ingresantes a la carrera los alumnos no están capacitados para responder acerca de la profundidad explícita de los contenidos que requieren ya que a través de entrevistas se ha notado que confunden profundidad con exigencia.

Para la pregunta 4, el 83% piensa que el tiempo fue suficiente y que los temas más difíciles (pregunta 5) éstos fueron; archivos, arreglos, recursividad, validación y funciones. Los datos son tan sólo orientativos, a fin de saber cuál es el tema que les resulta más difícil, ya que se debe considerar el caso en que un mismo alumno tuvo dificultades en dos o más temas. En la pregunta 6, un 595 piensa que la propuesta es buena y un 29% que es innovadora.

Respecto de la autoevaluación (pregunta 7) un 89% ha podido llegar a su autoevaluación en las siguientes instancias: durante los trabajos prácticos, al estudiar en la casa, después de finalizar la evaluación parcial.

Según la pregunta 8, a un 88% los trabajos prácticos les fueron útiles, ya que les permitió autoevaluarse antes del final integrador, aunque hubo un 7% de ns/nc.

Un 85% opinó que el criterio de valuación le pareció justo (pregunta 9)sosteniendo que los docentes le dedican tiempo, son exigentes, permiten explicar los algoritmos oralmente, la idea de un promedio ponderado de las evaluaciones.

La pregunta 10 se relevó sólo para el docente a cargo de la materia, ya que los ayudantes rotaron en el curso, con un promedio estimado de 7.2 y 7.6 para cada uno de los dos grupos respectivamente.

En pregunta 11 un 84% respondió que se fomentó el interés por la materia ya que: hubo comprensión de casos laborales, se habló del aspecto laboral posterior al cursado, se mandó a investigar algunos temas, se enviaban tips de los temas vistos, se recomendaba bibliografía, incentivaban constantemente, se preocupaban si uno se atrasaba, hubo clases de consulta cuando fue necesario, tenían interés por que el alumno aprenda.

GRÁFICO 1:
ACTIVIDADES MÁS ÚTILES.

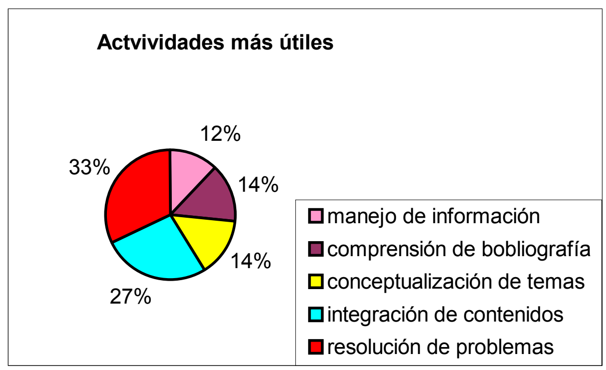


GRAFICO 2:
AUTOEVALUACIÓN DE LO APRENDIDO

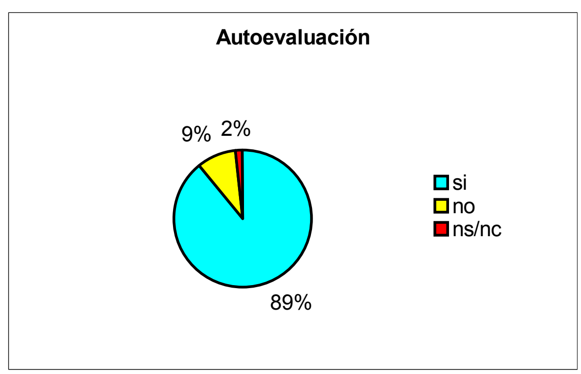
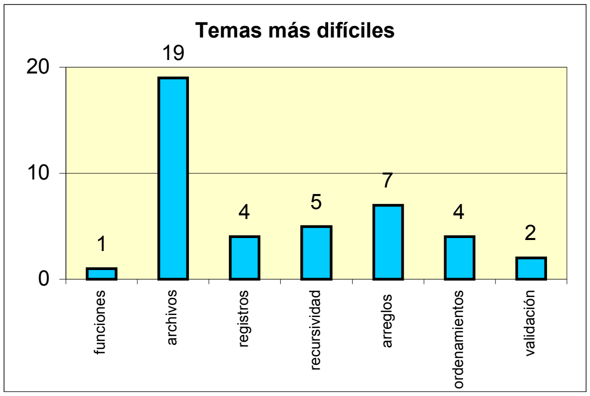


GRAFICO 3.
TEMAS QUE LES PARECIÓ MÁS DIFÍCILES.



A partir del Gráfico 1 se puede decir que la actividad que más útil les resultó a su parecer es la resolución de problemas y la integración de contenidos. En el Grafico 2 se observa que un 9% no se ha podido autoevaluar en ninguna de las instancias y un 2% de ns/nc que prefiere no responder.

En el Gráfico 3 se observa que tienen más dificultades con el tema final del período que es *archivos*, por lo que se puede señalar que esta altura del cuatrimestre se suman los examenes recuperatorios y las entregas de trabajos prácticos finales con lo que decae la atención y el rendimiento, y se incrementan las inasistencias que trae consigo la falta de continuidad en las clases.

Se ha observado que en la aplicación del instrumento se debería usar una terminología más sencilla, ya que a través de indagaciones se observó que la mayoría de los alumnos no diferencian entre *"integración de contenidos"* y *"conceptualización de temas",* por ejemplo. El ítem donde deben calificar a sus docentes también se presta a cuestionamiento, ya qué deberían comentar qué aspectos califican del mismo. Por otra parte a través de un instrumento con datos obtenidos en forma anónima, la evaluación final con la correspondiente calificación, se presta a un premio o castigo hacia el docente que evaluó. Por ello, luego de estas consideraciones se piensa que sería aconsejable una encuesta personalizada con resguardo de la identidad a fin cada uno de los comentarios emitidos por los alumnos fuera un dato fidedigno. En este caso, la aplicación de la encuesta apuntó tan sólo a la toma de datos para saber qué aspectos de la experiencia les resultaron más útiles, que temas les resultaron más difíciles y qué cualidades básicas demandan de los coordinadores.

CONCLUSIONES

Las evaluaciones permiten efectuar ajustes en el diseño de experiencias futuras tendientes a la mejora del rendimiento de los estudiantes. Se ha considerado de especial interés el estudio, y el análisis de las interacciones grupales que crean un ambiente de trabajo centrado en un ecosistema tecnológico que permite llevar a cabo los procesos de búsqueda y negociación de los significados.

En este contexto, se ha observado que para las interacciones de tipo AD y DA, aparecen categorías referidas al área de las tareas de acuerdo a la clasificación de Bales `21], es decir centradas en la de gestión. Es en este aspecto el que se desea subrayar ya que se pretende que los sujetos de la experiencia adquieran la habilidad de la autogestión siendo sujetos activos del proceso de aprendizaje. En cuanto al estudio de las interacciones del tipo AA aparecen también algunas categorías referidas al área de las tareas tales como: solicitar aclaraciones, clarificar, aportar bibliografía, pedir y dar información, lo que da idea de evolución del grupo, ya que se ha observado en los trabajos previos [11] justamente falta de metodología de estudio y falta de uso de materiales bibliográficos.

Respecto de la evaluación de los aprendizajes se ha podido hacer sólo un estudio de la transferencia cercana, ya que otro tipo de evaluaciones como el de la persistencia en el tiempo va más allá del alcance de esta experiencia.

Las autoevaluaciones individuales y grupales le permitieron a los estudiantes ponerse en contacto con sus errores y darse cuenta de las posibles formas de atacar el mismo problema para llegar a una solución factible.

Tanto para llevar a cabo las experiencias y como los procesos de evaluación descriptos se ha invertido más del doble del tiempo requerido para el dictado normal de la asignatura. Esto significa que durante un curso dictado en forma tradicional el tiempo disponible no alcanzaría para ir más allá de las evaluaciones tradicionales y de un simple análisis estadístico. Otra de las cuestiones que se ha observado es que el grupo de trabajo fue de unos 60 alumnos y que este número requirió de un trabajo exhaustivo.

Para grupos más numerosos como los que se ha observado se han constituido por política educativa en el último año, esta metodología podría ser poco eficiente desde el punto de vista que demandaría mucho más tiempo a los docentes. La relación entre los coordinadores y los estudiantes durante la experiencia estuvo en 1/15 aproximadamente dependiente del número de estudiantes por cada grupo. Una relación mayor demandaría tiempo adicional a los coordinadores. Salvando estás relaciones tiempo/esfuerzo/salario de los coordinadores los resultados son positivos.

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EL ESTADO ACTUAL DEL PLANTEL DOCENTE EN INGENIERÍA ANTE EL CAMBIO DE MODALIDAD DE PRESENCIAL A DISTANCIA

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Abstract — *Esta investigación permitirá determinar el estado del plantel docente que dicta sus asignaturas en modo presencial si las universidades decidieran implementar asignaturas de las carreras de ingeniería a través de la modalidad a distancia en un futuro cercano.*
Por este motivo surgió la pregunta que dio marco a la investigación: ***¿Están los actuales profesores presenciales de las carreras de ingeniería preparados para trabajar en la modalidad de educación a distancia?***
A fin de obtener los datos se indagó sobre los antecedentes, los conocimientos y las prácticas de los profesores presenciales de las carreras de ingeniería de diferentes universidades de "área metropolitana" de la República Argentina para poder compararlas con la preparación que debería tener un profesor tutor de educación a distancia.
Durante el año 2000, se encuestó a una muestra estratificada de 60 docentes de ingeniería, elegidos al azar, quienes debieron responder un cuestionario de 37 preguntas. A partir de los resultados obtenidos se elaboró un diagnóstico que permitirá efectuar las previsiones pertinentes.

Index Terms — Educación a distancia, Educación mediada, Profesor tutor.

INTRODUCCIÓN

Ante los acelerados cambios que está sufriendo actualmente el mundo, la universidad tradicional debe realizar una profunda reformulación de sus formas de enseñanza y aprendizaje. Para lo cual debe tener muy en cuenta los sistemas de educación no presencial utilizados cada vez más a nivel mundial.

Este trabajo de investigación pretende determinar el grado de adaptabilidad de los actuales docentes de las carreras de ingeniería al nuevo paradigma de la educación no presencial para poder elaborar, de ser necesario, un plan de reconversión de dichos docentes.

La rapidez de los cambios científico-tecnológicos y su incidencia en los modos de producción, en los hábitos culturales y en la vida cotidiana dejan definitivamente atrás el concepto de educación tradicional concebido como una etapa de la vida. Hoy, la educación constituye un proceso de aprendizaje permanente. Junto a los niveles tradicionales de la educación primaria, secundaria y universitaria, surge con creciente intensidad la necesidad de impulsar un "cuarto nivel" educativo, de características no formales, para garantizar la incorporación constante de conocimientos y capacidades nueva a lo largo de toda la vida. [5]

En el mundo de hoy, la posibilidad de trabajo está cada vez más vinculada con la educación, la formación y la capacitación profesional.

A mediano y largo plazo, la única respuesta de fondo al drama del desempleo pasa por la necesaria calificación de los recursos humanos para adecuarlos a las exigencias de un sistema económico signado por la incesante incorporación de nuevas tecnologías.

La recapacitación laboral, el reciclaje y la formación profesional constituyen herramientas insustituibles para el mejoramiento del capital humano, factor esencial en una economía cada vez más compleja y sofisticada. La vinculación entre el sistema educativo y el mundo laboral es una necesidad imperiosa en todas partes del mundo. Es la única forma eficaz de reducir las desigualdades sociales y de garantizar una auténtica igualdad de oportunidades para todos.

En la actualidad existe una creciente demanda de estudios conducentes a una formación profesional por parte de personas adultas que trabajan, pero dadas sus características no les es posible satisfacerla a través de los medios formales de educación, ya sea por obligaciones laborales, impedimentos geográficos, responsabilidades domésticas u otras. Se trata de personas excluidas de los sistemas de enseñanza tradicional, pero dispuestas a estudiar simultáneamente con la actividad laboral, por la necesidad de aprender y actualizar sus conocimientos, o bien, por el imperativo de tener que reinsertarse en una nueva fuente laboral.

Ante este contexto la educación a distancia constituye una alternativa viable.

Dentro de las formas y modalidades de educación sistemática vigentes en el mundo, la educación a distancia es la que ofrece mejores condiciones de flexibilidad para hacer procesos de integración socio-cultural a escala planetaria. Esta manera de enseñar y aprender ha incorporado

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progresivamente tecnologías informáticas y comunicacionales

Las experiencias en educación a distancia de distintos países dan cuenta de un alto porcentaje de alumnos cuya meta es obtener un título profesional, sin tener que desplazarse de su hogar la posibilidad de seguir un ritmo propio de trabajo; predilección por el estudio individual; actualizar y mejorar los conocimientos, satisfacción por el logro personal en el ejercicio de una profesión, reciclarse en una nueva fuente laboral un nuevo desafío en la vida y ser más culto. [4]

La educación a distancia implica la utilización de diversos medios individuales o colectivos, que facilitan la instrucción en situaciones donde no existe la contigüidad física de alumnos y docentes.

De esta manera, la diferencia fundamental con la enseñanza presencial se materializa en el modo *de tutela y entrega del* conocimiento. Sin embargo, la educación a distancia no puede considerarse sólo como una estrategia de expandir los conocimientos a más gente, ya que esto limitaría las posibilidades de este sistema. [8]

En un mundo en estado de revolución cultural, la institución oficialmente encargada de la tarea de transmisión cultural la educación escolarizada condensa el impacto de la crisis que se forma en la confrontación entre lo viejo y lo nuevo. Existen pocas instituciones tan conservadoras y tradicionalistas como la educación escolarizada. Su forma básica ha permanecido fundamentalmente sin cambios por no menos de dos siglos y su concepción básica ha resistido a todas las variaciones de regímenes económicos y políticos.

Es precisamente esta institución la que se ve particularmente envuelta en el torbellino de las actuales transformaciones que están alterando profundamente nuestro entorno cultural y social: en la economía y en la naturaleza de la organización del trabajo; en las relaciones entre naciones; en la tecnología, sobre todo en las comunicaciones y en los transportes; en la naturaleza, producción, almacenamiento y difusión del conocimiento y de la información; en el proceso de formación de la identidad cultural y social. [25].

Es por los motivos citados anteriormente, que en este trabajo de investigación se pretende determinar el grado de adaptación de los actuales docentes de las carreras de ingeniería al nuevo paradigma de la educación no presencial.

Características del Profesor de Educación a Distancia

Los rasgos propios de la educación a distancia se asientan en los procesos de autogestión del aprendizaje a partir de soportes tecnológicos y dirigidos a una población estudiantil predominantemente adulta y relativamente dispersa. [24]

Frente a esto se tiene al profesor universitario típico como un profesional (ingeniero, médico, contador, abogado, etc.), que brinda por razones de prestigio, en muchos casos, algunas horas de su tiempo activo para formar a las nuevas generaciones. Y, para enseñar, él se vale de los conocimientos teóricos que ha obtenido durante sus estudios profesionales previos y de la experiencia acumulada a través de su ejercicio profesional, que ocupa la mayoría de su tiempo. Su actividad docente se expresa principalmente mediante clases teóricas del tipo magistrales y unas pocas actividades prácticas, ejercitación, laboratorios o pasantías. La bibliografía de apoyo que leen los estudiantes está constituida principalmente por los apuntes tomados en clase. [6]

Y citando textualmente a Casas Armengol [6]:

…"para este "profesional-profesor", las teorías de aprendizaje y evaluación resultaban irrelevantes y generalmente poco conocidas."

Miguel Fernández Pérez [10] escribe:

"El sistema de selección y promoción vigente hasta ahora para los profesores de universidad no valora prácticamente la dimensión pedagógica de su puesto de trabajo, por más que la denominación del mismo sea en cualquiera de las facultades/escuelas y especialidades, la de "profesor de..." de manera que los profesores entienden su desempeño laboral ceñido más bien al contenido de sus mensajes didácticos (perfectamente rutinizable en la mayoría de las ramas del saber, aparte de copiable), ignorando olímpica e incomprensiblemente los aspectos del "cómo", de ese mensaje: atención hipertrófica (en el sentido de exclusiva, no en si misma, por supuesto) al contenido de la transmisión, por un lado, y descuido e ignorancia supina, por otro, de la transmisión que del contenido hay que hacer.

Se sigue de ello una esquizofrenia profesional muy objetiva: los Profesores se autoestiman por la temática científica a la que se dedican, no por la profesión que ejercen. Agotan toda su inteligencia (sin duda superior) y toda su moral profesional (que debe concederse, al menos, como normal) en el cuidado de "su" temática, degenerando, a la hora de su intervención profesional como docentes, en anacronismos insostenibles que rayan el ridículo tecnológico-social, tal y como denuncian los millares de estudiantes encuestados en nuestra investigación."

Ante un sistema social cambiante, sólo cabe un profesorado flexible y con la capacidad de ir incorporando en sus actuaciones personales y profesionales los diferentes sentidos que pueden adoptar la construcción del conocimiento y las formas de saber contemporáneos. [13]

Entre las variadas influencias que justifican y permiten transformar el rol del docente universitario, se destacan ahora por su extraordinaria y creciente importancia, un conjunto de tecnologías novedosas, principalmente las relativas a informática y telemática.

Las nuevas tecnologías cuentan con dos potencialidades a saber [14]:

– Una gran capacidad para socializar el conocimiento, ya que gracias a ellas se puede difundir información y capacidad de saber a muchas personas, con gran rapidez, con un alto nivel de interactividad y participación activa en un propio proceso de autoaprendizaje con gran

velocidad de transmisión y de posibilidades de aplicación.
– Una importante posibilidad es la de socializar el uso de nuevas tecnologías. Los programas de educación y formación tienden a la extensión social y a la democratización: si usan nuevas tecnologías, éstas van a ser accesibles para amplios sectores sociales que, si no fuera por estos programas, tendrían limitaciones o dificultades en ese sentido.

En el contexto actual se tiende cada vez más a que el estudiante pueda realizar estudios a través de sistemas no presenciales, lo que lleva a que el rol del docente cambie, así como también las características y aptitudes que debe tener quien se dedique a enseñar.

El rol que debe asumir un profesor es el de facilitador del aprendizaje para lo cual debe procurar una capacitación y actualización en los ejes en que se basan los procesos de enseñanza y aprendizaje [1]:

1. **El qué**. Los conocimientos que tienen que aprender y desarrollar los estudiantes.
2. **El cómo.** Las técnicas y métodos de enseñanza, materiales más idóneos e innovadores.
3. **A quién.** El conocimiento global del alumno que va a aprender, mental, física, emocionalmente, etc.
4. **El para qué.** Claridad en los objetivos que desea alcanzar y en el sistema de evaluación que va a aplicar.
5. **El por qué.** Tener siempre presente por qué se enseña esta asignatura y para qué va a valerles a los alumnos en el futuro.
6. **El cuánto y el dónde.** El tiempo y espacio precisos y más idóneos, para aplicar y desarrollar cada uno de los procesos educativos.

Ya que una de las principales características de la educación a distancia es que no exige la presencia física constante del profesor tutor y del estudiante ni un trabajo grupal permanente, cobra relevancia que los contenidos educativos se aborden a través de diferentes medios, en particular impresos, recurriéndose cada vez con mayor frecuencia a la utilización del audio, computadora o vídeo, por citar a los más comunes, cuyos contenidos son cuidadosamente diseñados con un carácter didáctico para facilitar el aprendizaje del estudiante.

Es entonces, que una formación autodidacta representa un reto para el estudiante y para las instituciones, por lo que el empleo de los medios de comunicación incluso los masivos juegan un importante papel. [2]

Además, se debe señalar que los principios pedagógicos y didácticos que sustentan los procesos educativos deben brindar el espacio necesario para incorporar "las herramientas poderosas" que la tecnología aporta, puestos al servicio de mejores formas de enseñar y aprender. [3]

Pero, conseguir profesores con una adecuada formación es una preocupación generalizada en las instituciones y sistemas educativos, tanto por sus repercusiones económicas, como por la preparación en avanzados recursos pedagógicos y en las nuevas tecnologías de apoyo. [7]

Se puede concluir que, las funciones que debe cumplir un profesor no presencial son entre otras, de acuerdo con los siguientes autores: Alonso García y Gallego Gil, [1]; Casas Armengol, [6]; Fainholc, [9]; González Pineda, y Jara Arancibia, [10]; Gutiérrez Pérez. y Prieto Castillo, [12]; Julia y Nitri [15]; Martínez Mediano [17,18]; Marturet [19]; Mena [20]; Mora y Tristán, [21]; Pérez Serrano y Sevillano García [22] y Rivera y Van Rafelghem [23].

– sugerir cursos de acción en función del proceso individual de capacitación;
– estimular la participación y el compromiso de cada destinatario;
– fomentar el autodidactismo
– detectar las problemáticas que surjan durante la capacitación;

Para lo cual el profesor debe tener:

– un conocimiento profundo, actualizado y teórico-práctico de su disciplina.
– dominio de teorías y metodologías de enseñanza y aprendizaje, en esencial de educación no presencial.
– manejo de las nuevas tecnologías informáticas y de comunicación y de su utilización en el proceso de aprendizaje.
– conocimiento de las características, necesidades y hábitos de los destinatarios del programa.
– buena relación con los alumnos

DESCRIPCIÓN DE LA PROBLEMÁTICA

Ante el avance que está adquiriendo a nivel mundial la implementación de estudios de todo tipo a través del sistema de educación a distancia, es probable que en un futuro cercano se inicien cursos de las carreras de ingeniería a través de esta modalidad. De ahí es que surge la siguiente pregunta:

¿Están los actuales profesores presenciales de las carreras de ingeniería preparados para trabajar en la modalidad de educación a distancia?

Es como consecuencia de esta pregunta que se ha realizado el presente trabajo de investigación que pretende recoger información sobre los antecedentes, conocimientos y prácticas de profesores presenciales de las carreras de ingeniería de diferentes universidades ubicadas en la zona definida como "área metropolitana" por el Ministerio de Educación de la República Argentina a fin de comparar dicha información con la preparación que debería tener un profesor tutor de educación a distancia.

SOLUCIÓN PROPUESTA

Para poder comparar las funciones que debe cumplir el profesor de enseñanza a distancia mencionados más arriba con las funciones que están cumpliendo hoy los profesores presenciales se diseñó una encuesta que gira en torno de los siguientes aspectos:

- Los datos personales, académicos y profesionales tales como: edad, estado civil, sexo, títulos de grado y postgrado, investigaciones, cursos de perfeccionamiento docente y de actualización profesional.
- Situación como profesor: materias en las que da clase, horas, cantidad de alumnos por clase.
- Su vinculación con los alumnos: evaluación de niveles de conocimiento previos, espacios de consulta fuera de la clase, si trata de enterarse de la situación particular de sus alumnos.
- Utilización de bibliografía y materiales didácticos: cómo se compone la bibliografía. Si es autosuficiente para el estudio de la asignatura, si usa elementos de apoyo en la clase como retroproyectores, computadoras, etc.
- Utilización de tecnología informática, si tiene correo electrónico, si usa Internet, cuáles son los programas que más utiliza

Para realizar la encuesta se utilizó una muestra de 60 profesores universitarios utilizando, para su selección, la técnica de muestreo accidental o casual. Se tuvo la precaución de que la muestra fuese lo más representativa posible y que estuvieran cautelados la mayoría de los centros educativos que cuentan con carreras de ingeniería ubicados en el área metropolitana (según Resolución 1618 del Ministerio de Cultura y Educación) [6]. Llegando a obtener muestras de 19 de las 21 Universidades e Institutos Universitarios ubicados en el área.

Se trata de una investigación de características sincrónicas y se realizó entre fines del año 2000 y fines del 2001.

El método de recogida de datos, para obtener información acerca de la práctica docente, ha sido una encuesta. Se consideró que era el instrumento más adecuado, puesto que se trata de un estudio descriptivo que busca conocer el trabajo que realizan los profesores presenciales y los aspectos de su práctica que puedan servir para la educación a distancia.

A fin de tomar los datos de confeccionó un cuestionario con preguntas cerradas y abiertas. El estilo de preguntas pretende ser concreto y claro; predominan las preguntas de opción múltiple, en general referidas a aspectos objetivos. Las respuestas están estructuradas con una opción libre.

La interacción entre el investigador y los profesores posibles tutores ha sido totalmente impersonal, ya que todas las encuestas fueron realizadas por un encuestador sin la presencia del investigador.

La extensión de la encuesta fue de 37 preguntas.

Como el número de preguntas es elevado, esto dificultó en su momento la devolución rápida, pero como contrapartida posibilitó la recogida de gran cantidad de información.

La estructuración del modelo de instrumento sigue un orden en función de las características que debe tener un profesor tutor de acuerdo a las condiciones señaladas anteriormente.

El criterio elegido para evaluar la validez de la encuesta ha sido el externo, a través de la opinión de expertos en investigación. Se pidió a 4 expertos de diferentes áreas (Ciencias Sociales, Inteligencia Artificial, Educación e Historia) que colaboraron en la evaluación del instrumento usado en la encuesta. Las sugerencias de los mismos se incorporaron en la versión final de la encuesta.

Una vez realizada la encuesta se procedió a la clasificación, análisis y evaluación de la información recibida a fin de redactar el informe final.

ANÁLISIS DE LOS DATOS

Al analizar los datos obtenidos de la encuesta se tiene que el profesor de ingeniería típico es de sexo masculino (81,7%), lo que demuestra que hay un condicionante de género. De 50 años o más (33,3%), ingeniero (56,7%), recibido en la década de los 80 (36,7%), dedicado a la docencia desde la misma época (33,3%), con estudios de posgrado (76,7%), realiza trabajos de investigación (51,7%), dicta entre 1 y 2 materias (58,3%) en una sola universidad (58,3%), no ha realizado cursos de perfeccionamiento docente en los últimos 3 años (65,0%) y tampoco cursos de perfeccionamiento en su especialidad en el mismo período (57,4%)

Si bien un 63,3% de los encuestados posee correo electrónico, sólo un 13,3% lo usa como herramienta de comunicación con sus alumnos.

Por el año en que se recibió se tiene que el 77,4% sería del grupo denominado “anterior a la PC” y el 73,0% ingresó a la docencia en la antes de la parición de la PC.

A pesar de que un 71,7% de los encuestados cree necesario evaluar el nivel de conocimientos previos de sus alumnos, sólo lo hace un 65,1%

El 75,0% tiene previsto un espacio para consulta de los alumnos fuera del horario de la clase, pero sólo el 31,1% tiene días y horarios determinados.

El 61,6% de los profesores considera que le da más importancia en las evaluaciones a los contenidos dados en clase, sólo el 25,0% considera como lo más importante los contenidos de la bibliografía obligatoria.

La bibliografía principal utilizada corresponde a libros de texto (71,6%) y material elaborado por la cátedra (63,3%), en cambio como bibliografía complementaria se tiene fundamentalmente libros de texto (66,7%)

El 63,3% utiliza algún material didáctico como ayuda para el desarrollo de la clase, de los cuales el más utilizado es el retroproyector (31,0%) seguido por la computadora (21,1%)

El 56,7% trata de enterarse de la situación particular de cada alumno y entre los que consideran que no necesitan mejorar su relación con los alumnos o no contestan se tiene 55,0%

El 63,3% tiene dirección electrónica y el 81,3% utiliza un procesador de textos, pero el tiempo de conexión a Internet para el 30,0% no pasa de 5 horas semanales.

CONCLUSIONES

Se pueden comparar las características que debe tener un profesor de educación a distancia respecto de las un profesor de ingeniería presencial típico, obteniéndose la Tabla 1:

TABLA 1
CARACTERÍSTICAS DEL PROFESOR DE EDUCACIÓN A DISTANCIA VERSUS EL PROFESOR PRESENCIAL

Características del profesor de educación a distancia	Características del profesor de ingeniería presencial típico de acuerdo a los resultados de la encuesta.
Un conocimiento profundo, actualizado y teórico -práctico de su disciplina.	A pesar de que el 76,7% de los profesores tienen estudios de posgrado y el 51,7% realiza trabajos de investigación, el 57,4% no ha realizado cursos de perfeccionamiento en su especialidad en los últimos 3 años
Dominio de teorías y metodologías de enseñanza y aprendizaje, en esencial de educación no presencial	El 65,0% no ha realizado cursos de perfeccionamiento docente en los últimos 3 años
Manejo de las nuevas tecnologías informáticas y de comunicación y de su utilización en el proceso de aprendizaje.	Si bien un 63,3% de los encuestados posee correo electrónico, sólo un 13,3% lo usa como herramienta de comunicación con sus alumnos. Por el año en que se recibieron se tiene que el 77,4% pertenece a la era anterior a la PC y el 73,0% ingresó a la docencia en la antes de la parición de la PC. Si bien el 63,3% utiliza algún material didáctico como ayuda para el desarrollo de la clase, de los cuales el más utilizado es el retroproyector (31,0%) sólo el 21,1% utiliza la computadora El 81,3% de los profesores encuestados utiliza un procesador de textos, pero el tiempo de conexión a internet para el 30,0% no pasa de 5 horas semanales.
Conocimiento de las características, necesidades y hábitos de los destinatarios del programa.	A pesar de que un 71,7% de los encuestados cree necesario evaluar el nivel de conocimientos previos de sus alumnos, sólo lo hace un 65,1% Un 26,7% indican que no es necesario evaluar el nivel de conocimientos previos de los alumnos. El 75,0% tiene previsto un espacio para consulta de los alumnos fuera del horario de la clase, pero sólo el 31,1% tiene días y horarios determinados. El 61,6% de los profesores considera que le da más importancia en las evaluaciones a los contenidos dados en clase, sólo el 25,0% considera como lo más imporante los contenidos de la bibliografía obligatoria. La bibliografía principal utilizada corresponde a libros de texto (71,6%) y material elaborado por la cátedra (63,3%), en cambio como bibliografía complementaria se tiene fundamentalmente libros de texto (66,7%)
Buena relación con los alumnos	El 56,7% trata de enterarse de la situación particular de cada alumno y entre los que consideran que no necesitan mejorar su relación con los alumnos o no contestan se tiene 55,0%

A partir del análisis del cuadro anterior se tiene que: ***"En Argentina hay pocos profesores universitarios de las carreras de Ingeniería que puedan trabajar, sin necesidad de una capacitación especial, en la modalidad de enseñanza a distancia"*** con lo que se llega a la conclusión que el profesor de educación presencial que tenga que trabajar en educación a distancia deberá ser capacitado para tal fin.

Se sugiere, por lo tanto, que la capacitación a esos profesores se realice mediante un sistema a distancia a fin de que pueda vivir la experiencia personal de lo que sentirán sus futuros alumnos en la modalidad, también se sugiere que estos profesores, durante su capacitación, interactúen en la modalidad realizando trabajos prácticos y también como profesores tutores de los alumnos inscriptos en el sistema a fin de tomar contacto con sus necesidades y características específicas.

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USO DE SISTEMAS INTELIGENTES COMO ELEMENTO DIDACTICO INNOVADOR EN LA ENSEÑANZA DE INGENIERIA EN COMPUTACION

Luis A. Caro S.[1], *Oriel A. Herrera G.*[2]

Abstract — En el área de Ingeniería en Computación se están produciendo cambios y tendencias que obligan a los ingenieros a ser más creativos e innovadores. El mercado demanda ingenieros con mayor capacidad de análisis, con un perfil integrador y con capacidad de trabajo en equipos multidisciplinarios. La ciencia básica aporta a los estudiantes un fuerte componente teórico, el que, muchas veces, se encuentra alejado de una contextualización en aplicaciones útiles y prácticas. Hemos usado los Sistemas Inteligentes basados en robots y microcontroladores como un elemento didáctico de apoyo al proceso de enseñanza aprendizaje. El artículo presenta la experiencia de uso de esta didáctica y sus resultados en alumnos de ingeniería en informática. Los estudiantes han aplicado sus conocimientos de manera más creativa e innovadora potenciando su capacidad de trabajo en equipo. Como próximo paso, estamos trabajando en formalizar un modelo pedagógico de contextualización e integración de la ciencia básica con estos elementos.

Index Terms — Contextualización, Educación en Ingeniería, Elemento Innovador, Sistemas Inteligentes, Trabajo en Equipo.

1. INTRODUCCIÓN

¿Hasta dónde sirve un conocimiento? Cuando deja de ser útil. Esta es una afirmación que todo ingeniero la ha experimentado en cualquier actividad donde tenga que trabajar con elementos hardware y software. Es importante el conocimiento y la teoría que permiten modelar el mundo que nos rodea. Pero una teoría o conocimiento que no pueda ser aplicada a dar solución a problemas de ingeniería, de cualquier ámbito, no sirve de mucho. Esto es aún más valido en el área de la ingeniería en computación e informática, en donde se trabaja con lenguajes computacionales, dispositivos digitales, robótica, transmisión de datos, etc., que rápidamente se vuelven obsoletos y que obligan estar al día en los avances de nuevas herramientas.

Hoy en día el ingeniero no sólo debe dominar, comprender y entender distintas teorías y materias de su área, sino que debe tener la capacidad de aplicarlas para dar soluciones a problemas concretos. Al ingeniero se le mide por la capacidad de dar soluciones creativas/innovadoras eficientes a los problemas de su área. La capacidad de trabajo en equipo es un elemento clave que se espera posean los ingenieros.

Bajo este escenario, nos encontramos con el desafío de formar a ingenieros que sean más creativos, con una clara capacidad analítica en la búsqueda de soluciones a problemas de manera eficiente e innovadora y que cuenten con un perfil integrador junto a equipos de trabajo multidisciplinarios.

En la Escuela de Informática de la Universidad Católica de Temuco estamos formando a ingenieros en informática bajo un modelo pedagógico experimental que recién esta siendo aplicado en la asignatura de "Sistemas Inteligentes", la cual tiene una alta demanda por los alumnos de la carrera. A corto plazo queremos integrar en este modelo pedagógico a alumnos de otras áreas, los cuales actuando como un equipo de trabajo multidisciplinario enfrenten y apliquen sus conocimientos a la generación de soluciones creativas e innovadoras en la solución a problemas de ingeniería.

Así, el presente articulo describe nuestra experiencia en la aplicación de este modelo pedagógico experimental y en una primera conceptualización del modelo, el cual a corto plazo se integrará en la malla curricular de la carrera de Ingeniería Civil Informática de la Universidad Católica de Temuco en Chile [1].

2. PROBLEMÁTICA ACTUAL EN LA ENSEÑANZA DE INGENIERÍA

La educación superior en ingeniería se puede ver como un sistema complejo, que ha sido abordado por un modelo tradicional que presenta diversos problemas. Algunos autores resumen estos problemas en los siguientes [2]:

- Clases expositivas, en donde el profesor es el principal actor de la clase con poca o nula participación del alumno.
- Visión reduccionista en el planteamiento y solución de los problemas del área, en vez de una visión holística.
- Trabajo individual y ausencia de equipos multidisciplinarios.
- Actitud crítica y creativa mínima por parte de los alumnos.

Nuestra Universidad, Facultad y Escuela no están ajenos a esta desfavorable situación. Los problemas se manifiestan durante los años de estudios en donde los alumnos son sometidos a la clásica enseñanza de ciencias básicas y de ingeniería, con una clara ausencia de integración y contextualización de los contenidos de sus asignaturas. Situación por lo demás preocupante si consideramos que el

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mercado profesional demanda profesionales con un perfil integrador y con capacidad de desarrollar trabajos en equipos multidisciplinarios.

3. MODELO PEDAGÓGICO

Una de las inquietudes que manifiestan los alumnos es la falta de aplicación real y práctica de los contenidos de sus asignaturas, los cuales no están contextualizados en un escenario adecuado, terminando el semestre sin vislumbrar el objetivo por el cual las cursaban.

Para satisfacer esta inquietud, hemos introducido un componente metodológico, el cual apoya la integración y contextualización de los contenidos de las asignaturas en proyectos concretos, que hace uso intensivo de elementos didácticos que apoyan el proceso de enseñanza aprendizaje. La figura 1 muestra de modo general el modelo utilizado.

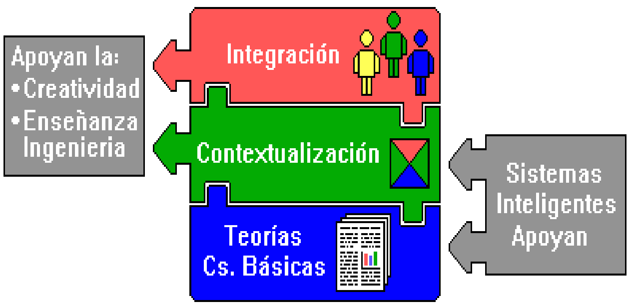

FIGURA 1.
MODELO DE USO DE LOS SISTEMAS INTELIGENTES COMO ELEMENTOS DIDÁCTICOS INNOVADORES EN LA ENSEÑANZA DE INGENIERÍA EN COMPUTACIÓN

Elemento clave en este modelo es el uso de los sistemas inteligentes basados en robots y microcontroladores. Estos elementos, que se orientan a didácticas netamente prácticas, aportan una riqueza conceptual teórica en diversos campos de la ingeniería.

El modelo pedagógico está compuesto por tres componentes: Teoría, Contextualización, Integración, los cuales interactúan entre sí. El componente teórico aporta los conocimientos desde una visión reduccionista, mediante el entendimiento y aplicación de las leyes globales que modelan y explican el mundo que los alumnos perciben. El componente Contextualizador permite aplicar estas leyes y conocimientos teóricos en un escenario real y tangible, el cual mediante el uso de robots, los alumnos adquieren una visión más holística del problema a solucionar. El componente Integrador incorpora en el análisis y diseño de la solución del problema un escenario de trabajo en equipo, en donde la interacción social, la cual facilita y apoya la especialización, permite una dinámica más rica en soluciones de equipo, más que soluciones individuales.

La dinámica que sustenta la aplicación del modelo se basa en nueve etapas:

- *Selección*: Antes de la inscripción de la asignatura, los alumnos son sometidos a una entrevista con el profesor para determinar sus reales motivaciones y si cumplen con los requisitos mínimos. Esta etapa es opcional, y aplicable sólo a cursos optativos.
- *Presentación metodológica*: Una vez que se han seleccionado los alumnos, se hace entrega del programa de la asignatura y se explican las reglas de trabajo, los proyectos y los criterios de evaluación. Se deja en claro la metodología de trabajo y la dinámica del curso.
- *Enseñanza de Herramientas*: Se capacita a los alumnos en el uso de los elementos de sistemas inteligentes que se aplicarán a la asignatura. En los proyectos a realizar se utilizan los lenguajes de programación NQC [3] y PBasic[4], los cuales se explican con ejemplos prácticos y aclarando dudas de configuración e instalación.
- *Conformación de Grupos*: Se motiva al curso en la creación de los grupos de trabajo de tres o cuatro integrantes como máximo. Los alumnos tienen plena libertad para integrarse según sus afinidades.
- *Asignación de Proyectos*: Cada grupo recibirá un proyecto a desarrollar, definido previamente por los profesores. Los proyecto contemplan dos aspectos básicos: hacen uso de sistemas inteligentes y tienen un fuerte componente teórico. Se hace entrega a los alumnos de los Kit de Robótica, Micro Controladores y Manuales que serán necesarios para cada proyecto en particular. Se establece también las fechas de inicio, término y avances de los proyectos.
- *División de tareas*: Los alumnos son motivados a trabajar en equipos y ellos mismos definen las distintas tareas a realizar para la implementación de los proyectos. Trabajan con una lista de tareas.
- *Asignación de Roles*: Los alumnos, según sus preferencias y habilidades, asumen los roles en el desarrollo de los proyectos. Tienen plena libertad en el accionar de esta actividad, siempre guiados por los profesores y monitores correspondientes.
- *Desarrollo del Proyecto*: Los alumnos asisten a los laboratorios en un horario flexible y trabajan en el desarrollo de los proyectos.
- *Presentación*: Los alumnos entregan el documento final, realizan la exposición del proyecto asignado y exponen sus conclusiones. Cada presentación debe incluir un desarrollo teórico y su contextualización en una situación real.

Para el éxito en el desarrollo de los proyectos, los alumnos están siempre apoyados por sus profesores y monitores, como se explica en la siguiente sección. Nos hemos dado cuenta que los alumnos, una vez comenzado los proyectos, empiezan a especializare en las áreas de su interés, sintiéndose muy motivados por aprender, asignándose roles bien definidos según sus cualidades y preferencias. El sentirse los principales actores de sus proyectos los hace entender y comprometerse de mejor manera en la búsqueda de soluciones más creativas.

4. ACTORES DEL MODELO

El modelo contempla la participación de diversos actores: los profesores, los alumnos, los monitores en el tema de sistemas inteligentes, los monitores en aspectos teóricos propios del curso. La figura 2 nos muestra la estructura e interacción de los actores del modelo.

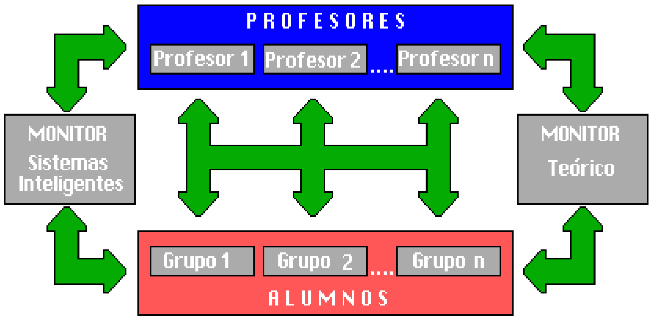

FIGURA 2
ESTRUCTURA E INTERACCIÓN DE LOS ACTORES DEL MODELO

Los *profesores* (que en la mayoría de los casos es sólo uno), son los responsables directos del curso. Estos deben planificar la introducción de los sistemas inteligentes al contexto propio del curso. Su participación más relevante y crítica es la definición de los proyectos grupales que contextualicen los contenidos teóricos del curso en elementos concretos.

El *monitor en sistemas inteligentes* juega un rol muy importante. Será el apoyo directo a los profesores cuando éstos no posean los conocimientos en el área de los sistemas inteligentes. Bajo este escenario, participará como apoyo a los profesores en la definición de los proyectos grupales. Además, tendrá participación directa en las instancias de capacitación de los alumnos en los temas de sistemas inteligentes. Cumple también una función de asistencia permanente a los grupos, en sus proyectos.

El *monitor en aspectos teóricos*, es el ayudante en las temáticas propias del curso. Es el clásico ayudante en los modelos tradicionales de enseñanza.

Para los *alumnos* se adopta la modalidad de trabajo grupal. Estos adquieren un rol protagónico siendo actores proactivos en el desarrollo e implementación de los proyectos asignados.

El modelo se puede extender a escenarios de trabajo multidisciplinarios, donde los grupos de trabajo tendrán participación de alumnos de distintas disciplinas. Para ello, es posible incorporar monitores para cada una de las disciplinas involucradas.

5. NUESTRA EXPERIENCIA

En el primer semestre del año 2001 se incorporó en la malla curricular de la carrera de Ingeniería de Ejecución en Informática la asignatura *Robótica e Interfaces Digitales con el Computador,* una asignatura de carácter electivo, la cual sería dictada a los alumnos de tercer año. Producto de esta nueva asignatura, se implementó un laboratorio de Robótica y MicroControladores, el cual cuenta con computadores actualizados, Kit de robótica Lego, de la línea MindStorms Robotic Systems, sistemas de desarrollo y experimentación de MicroControladores StampBasic 2SX, módulos de transmisión de datos, módulos de memorias, MicroControladores con Java embebido "Javelin" de Parallaxinc y un conjunto de elementos complementarios que permiten a los alumnos desarrollar y probar sus experimentos.

En el desarrollo de esta asignatura en el primer semestre del 2002, se aplicó el modelo antes planteado, siguiendo las distintas etapas antes señaladas:

- *Selección*: Muchos alumnos postularon a la asignatura, los cuales fueron entrevistados por el profesor, con dos propósitos. Primero, ver su motivación frente a un curso de estas características. Y segundo, verificar que cumplieran con los requisitos de formación; en este caso, poseer algún dominio de los lenguajes de programación clásicos, tales como Pascal y C/C++. Se seleccionaron doce alumnos.
- *Presentación metodológica*: Los alumnos seleccionados ya tenían un grado de acercamiento a la dinámica de funcionamiento del curso. Ahora, formalmente se les entregó el programa de la asignatura, explicando su contenido, aclarando todas las inquietudes planteadas, y dando a conocer los proyectos a realizar y la forma de evaluación. También se les dio a conocer el protocolo de trabajo e interacción con el profesor y los monitores.
- *Enseñanza de Herramientas*: Se asignaron los computadores y se instalaron las herramientas de desarrollo. Se hizo participe de esta actividad el monitor especialista, quien capacitó a los alumnos en el uso de la tecnología de sistemas inteligentes.
- *Conformación de Grupos*: Se conformaron cuatro grupos de tres alumnos cada uno. Su constitución se hizo sin la participación del profesor.
- *Asignación de Proyectos*: A cada grupo se le asignó un proyecto de las respectivas áreas: Robótica, Micro Controladores e Internet. El área de robótica contempló el diseño y programación de robots Lego, en su modalidad de robot sigue caminos, robot con sensores IR y de tacto, robot de combate *sumo*, robot busca objetos y soccer robot. La figura 3 muestra el diseño de soccer robots. En el área de MicroControladores se diseñaron y programaron microcontroladores conectados a interfaces analógicas/digitales con el computador, usando transmisión de datos por radio frecuencia Esta tecnología se muestra en la figura 4 Finalmente, en el área de MicroControladores e Internet se diseñaron robots usando microcontroladores controlados a través de Internet, mediante CGI en lenguaje C/C++ , y controlados también mediante PDA. La figura 5 muestra esta tecnología.

- *División de tareas*: Los alumnos tuvieron libertad de organizarse en la asignación de las tareas a realizar durante el desarrollo de los proyectos. El profesor y los monitores controlaban la equidad en cuanto a la carga e trabajo de cada alumno.

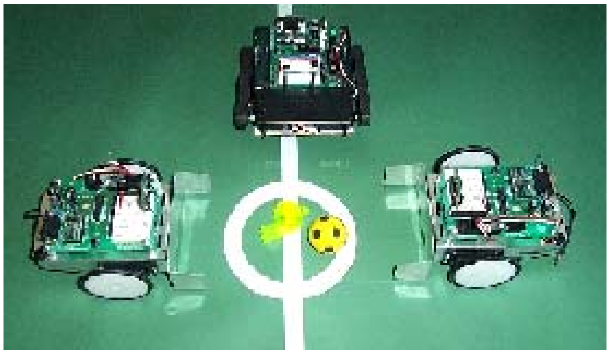

FIGURA 3.
PROYECTO DE SOCCER ROBOTS

FIGURA 4.
TECNOLOGÍA DE MICROCONTROLADORES CONECTADOS A INTERFACES ANALÓGICAS/DIGITALES CON EL COMPUTADOR, USANDO TRANSMISIÓN DE DATOS POR RADIO FRECUENCIA

FIGURA 5.
TECNOLOGÍA DE MICROCONTROLADORES CONTROLADOS POR INTERNET Y PDAS

- *Asignación de Roles*: Cada grupo definió y manejo de manera libre la asignación de los roles y las funciones de sus integrantes. Surgieron líderes naturales en cada grupo, quienes eran los interlocutores principales con los monitores y el profesor.
- *Desarrollo del Proyecto*: En el desarrollo de los proyectos los alumnos trabajaron con mucho entusiasmo y se vio una sana competencia entre los grupos, los cuales trabajaron con mucha creatividad. El profesor y los monitores guiaban el avance de los proyectos en base al cumplimiento de las fechas establecidas.
- *Presentación*: Los grupos realizaron durante el semestre tres presentaciones, en donde dieron a conocer cómo desarrollaron los proyectos, los problemas que se presentaron, la forma en que abordaron las soluciones a los problemas, además de las conclusiones finales contextualizadas a la teoría aplicada.

5. PRÓXIMOS PASOS

La aplicación de este modelo en la asignatura de 'Sistemas Inteligentes' se encuentra en una etapa experimental y de estudio. Nos hemos dado cuenta que los alumnos aprenden de mejor manera los contenidos y se motivan en la generación de soluciones más creativa. Actualmente estamos trabajando en formalizar la aplicación de este modelo pedagógico en otras asignaturas, en áreas no tan cercanas a la tecnología. Específicamente, se está trabajando en la implementación del modelo en asignaturas de las ciencias físicas. También, a mediano plazo, se explorará la aplicación del modelo a grupos interdisciplinarios. Por ejemplo, incorporar alumnos de áreas sociales, psicología, diseño, etc., cada uno aportando desde su perspectiva profesional.

6. CONCLUSIONES

En la aplicación de este modelo hemos percibido dos resultados concretos. Primero, el uso de Robot y MicroControladores (Sistemas Inteligentes) apoyan y facilitan la contextualización y refuerzan lo aprendido en la teoría, permitiendo a los alumnos una experimentación directa con estos elementos didácticos. Segundo, los proyectos asignados a los alumnos, desarrollados en equipos de trabajo y relacionados con problemas reales y específicos (escenario apropiado), apoyan la generación de nuevas ideas, la creatividad, la autocrítica y refuerzan el proceso de enseñanza aprendizaje.

Los alumnos logran terminar con éxito los proyectos asignados, aprenden a trabajar en equipos, comparten ideas, buscan y generan soluciones más creativas y se divierten al trabajar con Robot.

El hecho de que los alumnos planteen sus propias conclusiones, los hace más analíticos y defienden sus planteamientos con fundamentos teóricos prácticos, los cuales han sido contextualizados mediante una didáctica innovadora e integradora.

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INGENIERÍA CIVIL INFORMÁTICA: BASES CONCEPTUALES DEL DISEÑO DE UN CURRICULUM DE CINCO AÑOS

Gustavo A. Donoso M.[1], Oriel A. Herrera G.[2]

Abstract — El diseño de una carrera de Ingeniería Civil Informática hoy en día, debe sustentarse en visiones que orienten el profundo y acelerado proceso de transformación que vive la educación, la tecnología y el campo laboral. Este escenario incierto requiere de un especial esfuerzo de conceptualización, de modo tal que se pueda articular en un conjunto reducido de conceptos los principales aspectos a través de los cuales el diseño curricular reduce la incertidumbre en la formación. Formulamos una base conceptual de seis visiones que permiten reducir la complejidad y orientar el desarrollo. Estas visiones son: progresiva, productiva, conceptual, metodológica, profesional y cristiana del mundo. Este artículo describe cada una de las visiones conceptuales que dan origen a un curriculum de cinco años de Ingeniería Civil Informática en la Universidad Católica de Temuco en Chile. La propuesta permite minimizar los efectos negativos producidos por las circunstancias inciertas que rodean el diseño de un currículum de esta naturaleza.

Index Terms — Educación en Ingeniería, Currículum, Ingeniería Informática.

1. INTRODUCCIÓN

El diseño de una carrera de Ingeniería Civil Informática y, eventualmente, de cualquier Ingeniería Civil, está marcado por la necesidad de reflejar una situación productiva que ocurrirá en cinco o más años. Si hace cinco o más años atrás estuviésemos diseñando una nueva carrera de Ingeniería Civil Informática, la situación educativa, el horizonte tecnológico y las expectativas de trabajo sobre las que ese diseño se basaría serían completamente distintas a las de hoy.

La principal característica que tiene el escenario actual es el de incertidumbre y riesgo en todas y cada una de las áreas que confluyen en el diseño curricular de una carrera de esta naturaleza. Por ejemplo, si actualmente observamos la situación educativa nacional para las Carreras de Ingeniería Civil vemos que ella está siendo afectada por una serie de factores inéditos como son: la proliferación, la masificación, la posibilidad de acreditación, el incremento de programas de postgrado y la educación continua, la complejidad creciente, los nuevos métodos de enseñanza y de aprendizaje, la discusión sobre la duración, entre otros.

Del mismo modo el horizonte tecnológico es sumamente complejo, las nuevas tecnologías tienen ciclos de producción de meses, la innovación es constante y eso hace imposible anticiparse a las características que la oferta tecnológica tendrá en un futuro aun cercano. Aspectos relevantes desde esta perspectiva son que existen, eso sí, áreas con un grado de consolidación en algunos aspectos como son el hardware y software, y también existe una claridad en relación a la importancia actual de las comunicaciones y, en forma más general, de las relaciones entre dispositivos y personas en el acontecer productivo. Del mismo modo, al ser la tecnología un constructo que se desarrolla en capas de funcionalidad, donde la más compleja se construye sobre la más simple; el tema de la complejidad y de la aproximación progresivo a ella es relevante, tanto desde esta perspectiva como desde una perspectiva educativa.

Otro factor relevante está dado por el mercado laboral que presenta el fenómeno de reducción del empleo y aumento de las posibilidades de trabajo. Estas posibilidades, para que se transformen en trabajo efectivo, deben ser aprovechadas y desarrolladas. Esto condiciona el perfil de egreso de un alumno de ingeniería a que posea las potencialidades para el emprendimiento, la gestión, la visión de nuevos negocios, etc.

Así, el presente trabajo describe cómo los elementos anteriores y sus relaciones se organizaron conceptualmente en el diseño curricular de la carrera de Ingeniería Civil Informática de la Universidad Católica de Temuco en Chile [1]. Se presentan las seis visiones que originan el currículum

2. DESCRIPCIÓN DE LAS VISIONES

La concepción del plan de estudios de la Carrera de Ingeniería Civil Informática de la Universidad Católica de Temuco, surge de un trabajo de reflexión profundo que se articula en torno al contexto educativo, disciplinar y productivo asociados a una carrera de esta naturaleza.

El diseño curricular, como se señala en la introducción, busca reducir la incertidumbre en la formación profesional. Así, la conceptualización que lo sustenta se organiza de manera tal que permita responder al escenario riesgoso predominante. Los conceptos claves se agrupan, a su vez, en visiones con objeto de reducir la complejidad y

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transformarlos en elementos que sustenten y orienten la ejecución del proyecto. A continuación se presentan las visiones que orientan tal diseño.

2.1. Visión Progresiva

La Universidad Católica de Temuco, de acuerdo a su realidad estudiantil, capta alumnos que no están situados en los niveles más altos de rendimiento, motivo por el cual declara una preocupación especial por la calidad y oportunidad de la docencia. Estos alumnos, en gran medida, no presentan un adecuado nivel de desarrollo de la capacidad de abstracción requerida por una formación tradicional en ciencias básicas para carreras de ingeniería, motivo por el cual una estrategia importante para sortear esta dificultad está dada por la contextualización de la teoría y por la distribución gradual y sistemática de la complejidad a lo largo del curriculum. Junto a ello una visión progresiva permite incorporar, en magnitudes crecientes, el tema de la complejidad funcional de la tecnología.

Un esquema adecuado para desarrollar los niveles de abstracción está en ir logrando, progresivamente, tal capacidad en torno al aprendizaje contextualizado de las habilidades y conocimientos propios de la especialidad, lo que se completa al cabo de cinco años (ver Figura 1).

Vemos que el ámbito de conocimientos necesarios se va ampliando y haciendo más complejo en la medida que el alumno progresa en el curriculum. Cada año de formación tiene un objetivo claro que el alumno debe cumplir. Este objetivo media y permea la formación en ese año.

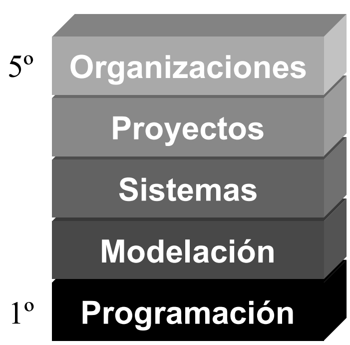

FIGURA 1.
VISION PROGRESIVA. DESCRIBE LOS AÑOS DE FORMACIÓN SEGÚN SU RANGO DISTINTIVO.

Esta visión va integrando en los últimos años los elementos de los años anteriores. Por ejemplo, el modelado de un programa de computador requiere que se haya experimentado previamente con la programación. Del mismo modo, un sistema -que corresponde a soluciones a problemas de ámbitos mucho más complejos que los que da cuenta la programación- no puede diseñarse si no se manejan nociones de abstracción en un cierto nivel. Estose logra teniendo medianamente desarrollada la habilidad de modelación.

Necesariamente los conceptos y habilidades que se adquieren en los primeros años van estableciendo el sustento de la formación en los años posteriores. Este diseño obliga, por lo mismo, a plantearse la posibilidad de exámenes de integración u otros que permitan evaluar el logro del objetivo anual si fuese necesario y factible.

2.2. Visión Productiva

La visión productiva busca interpretar el principal ámbito de trabajo en ingeniería: la toma de decisiones. El diseño en ingeniería, a diferencia de lo que ocurre en otros ámbitos, es un diseño de base científica: "Diseño, entendido como la concepción de un sistema o componente complejo que satisface necesidades dadas y cumple requisitos explícitos. Este diseño se realiza mediante decisiones justificadas científicamente".

Los ámbitos en que se da este diseño son coincidentes con la visión que una organización tiene con respecto a la toma de decisiones, la que se caracteriza por la complejidad y el alcance de ellas.

Así, los conceptos de operacional, táctico y estratégico sustentan la capacidad de diseño en ámbitos progresivamente más complejos.

En el currículum se insertan estos elementos comenzando con un fuerte enfoque en lo operacional. Luego, se enfatizan conceptos a nivel táctico, para trabajar en el último año con un enfoque mayormente estratégico (ver Figura 2).

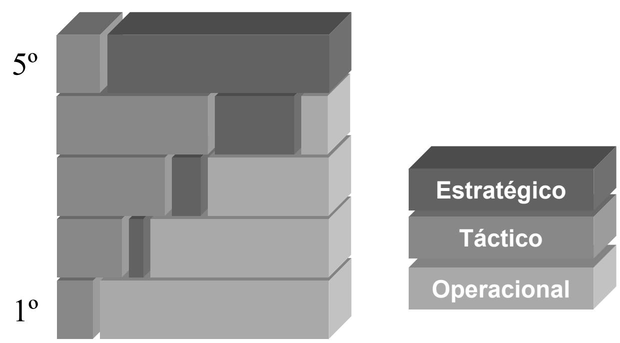

FIGURA 2.
VISION PRODUCTIVA. DISTRIBUYE LOS COMPONENTES DE FORMACIÓN EN LAS TRES ÁREAS DECISIONALES: OPERATIVA, TÁCTICA Y ESTRATÉGICA.

2.3. Visión Conceptual

La informática progresa a pasos inusuales. Desde una informática centrada en el desarrollo de computadoras en las décadas de 1950 y 1960, se pasó a una centrada en el desarrollo de software 1970-1990 para, actualmente, orientarse fuertemente sobre el tema de las comunicaciones, transformando las relaciones del mundo conocido y familiar en un espacio de posibilidades aún bastante inexplorado.

Estos tres ámbitos son los que deben estar presentes en la propuesta curricular, y por tanto en la formación de nuestros alumnos. De hecho, el aspecto incipiente de las redes de comunicación le hemos asignado el acrónimo de *Linkware* para integrarlo a los otros, actualmente conocidos como Hardware y Software.

Al ser las conceptualizaciones en el área Linkware de mayor complejidad, ellas requieren de una base bastante más desarrollada que los ámbitos de Software y Hardware. Estos últimos se trabajan más fuertemente en los primeros años de formación (ver Figura 3).

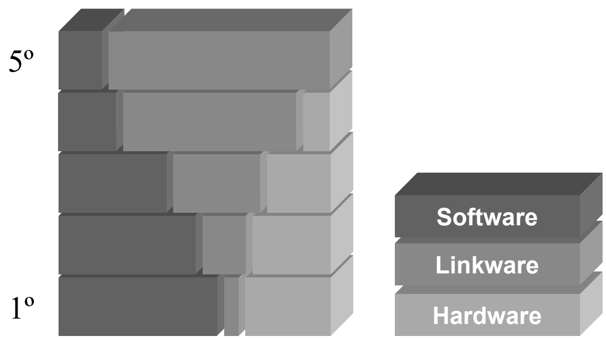

FIGURA 3.
VISION CONCEPTUAL. DISTRIBUYE LOS COMPONENTES DE FORMACIÓN EN LAS TRES ÁREAS CONCEPTUALIZADAS: HARDWARE, SOFTWARE Y LINKWARE.

2.4. Visión Metodológica

Al plantear un análisis macrocurricular, con una formación en cinco años, necesariamente se tiene que pensar que dicha propuesta tiene que ir acompañada de algunos elementos metodológicos transversales que la hagan viable.

Siguiendo con el mismo afán de reducir los conceptos claves a un subconjunto limitado, pensamos que desde el punto de vista metodológico existen dos orientaciones que son relevantes: integración y contextualización.

Integración: el modelo de formación tradicional de ingeniería, ve el curriculum dividido en tres tercios de dos años: ciencias básicas, ciencias de la ingeniería y formación de especialidad. Nuestra propuesta parte de la base del curriculum tradicional y busca su integración en lapso de tiempo más reducido y en un contexto también más próximo (ver Figura 4). A modo de ejemplos de esta integración podemos señalar los siguientes [2].

- Inducción seguida de derivación de algoritmos para ordenar números.
- Conjuntos seguidos de estructuras de datos para almacenarlos.
- Secuencias seguidas de recurrencias.
- Vectores seguidos de cinemática de dos o tres dimensiones.
- Matrices y resolución de ecuaciones seguidas de resolución numérica vía computador.

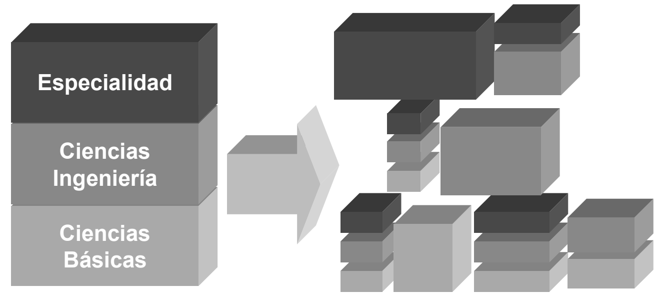

FIGURA 4
INCORPORACIÓN DE LA INTEGRACIÓN AL CURRICULUM TRADICIONAL DE INGENIERÍA

Contextualización: esto corresponde, básicamente, a que una misma situación problemática sea tratada por los diferentes puntos de vista que aportan las ciencias básicas, las ciencias de la ingeniería y los conocimientos de la especialidad. El objeto de lo anterior, del mismo modo que la integración, es abordar los elementos que confluyen en la resolución de un problema de ingeniería, y ver cómo los distintos niveles se mezclan en el diseño de la solución (ver Figura 5).

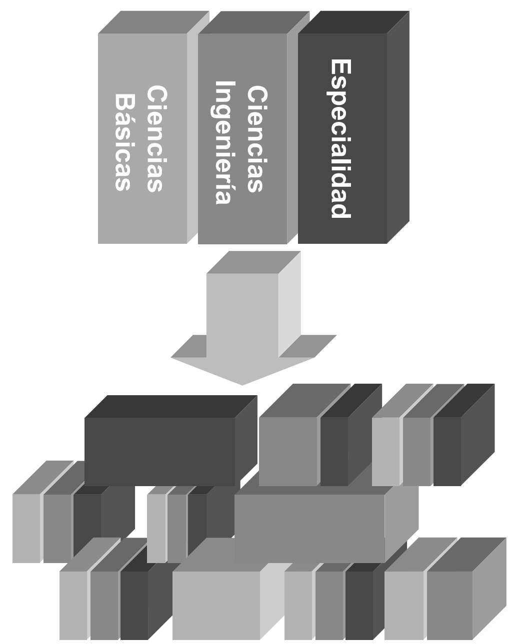

FIGURA 5
INCORPORACIÓN DE LA CONTEXTUALIZACION AL CURRICULUM TRADICIONAL DE INGENIERÍA

La integración y la contextualización en torno a la resolución de problemas que correspondan a situaciones generadoras de desafíos para el alumno, podrían darse, por ejemplo, en los siguientes núcleos temáticos:

- Algebra Booleana - Compuertas Electrónicas - Circuitos.
- Redes - Grafos - Estructuras de datos.

- Comunicaciones - Señales - Funciones sinusoidales.
- Vectores - cinemática - robots móviles.
- Álgebra - Lenguajes de Programación - Objetos.
- Cálculo - Computación de Computaciones - Programas.

Tanto la contextualización como la integración significan un esfuerzo de innovación metodológica que no resulta fácil proyectarlo al diseño en detalle. Esta visión metodológica se debe ir desarrollando paulatinamente, en la medida que las condiciones de entorno así lo permitan.

2.5. Visión Profesional

Esta visión describe los conceptos fundamentales que distinguen a un profesional de Ingeniería de otros profesionales. Se espera que el estudiante sea capaz de manejar conocimiento y demostrar habilidades que permitan, por una parte, el modelado de una realidad y por otra el diseño de soluciones en el área [3]. Estos conceptos se resumen en:

- *modelamiento científico*: Entendido como la concepción de modelos matemáticos y otros capaces de representar sistemas determinados. Se espera que el estudiante, a nivel de licenciatura, sea capaz de formular un modelo científico de una realidad que tenga una complejidad acorde a lo que se espera de él en ese nivel.
- *diseño*: Entendido como la concepción de un sistema o componente complejo que satisface necesidades dadas y cumple requisitos explícitos. Este diseño se realiza mediante decisiones justificadas científicamente. Bajo esta visión se espera que el estudiante, al egreso, sea capaz de formular y gestionar un proyecto de diseño que permita dar solución a un problema complejo de carácter organizacional y/o científico.

2.6. Visión Humanista-Cristiana del Mundo

Establece los conceptos básicos que la visión de la Universidad le entrega a los egresados. Se espera que el estudiante presente una actitud profesional y de vida acorde a los principios que sustenta nuestra Universidad. Esta visión se aprecia en dos dimensiones:

- *Dimensión Humana*: Entendida como el compromiso que cada uno tiene consigo mismo. Implica la formación de la autoestima y el carácter testimonial del ejemplo personal. Se espera, al egreso, que el profesional tenga una alta autoestima personal y profesional, autoestima tal que se traduzca en una disposición permanente de solidaridad y en una calidad humana sobresaliente.
- *Dimensión Social:* Entendida como la vinculación del hombre con su medio y el compromiso que aquello determina. Se espera que el egresado sea un aporte a la sociedad, tanto del punto de vista humano como profesional.

3. CONCLUSIONES

En el diseño curricular descrito se busca integrar las distintas visiones que, a nuestro entender, confluyen en la formación de un Ingeniero Civil Informático. Esto permite establecer una imagen general de la formación, lo que ayuda a quienes participan del proceso de enseñanza y aprendizaje, a tener mayor claridad en las características del proceso, tanto desde la perspectiva de la enseñanza como del aprendizaje.

Las definiciones asociadas a las seis visiones propuestas permiten que la claridad anterior pueda ser expresada en términos concretos. Así, los conceptos vertidos tienen un significado claro en todas las etapas de la formación.

Creemos que lo establecido, si bien es un resultado perfectible, permite evaluar y minimizar los efectos negativos producidos por las circunstancias inciertas que rodean el diseño de una carrera de esta naturaleza. Del mismo modo, a la luz de las necesidades educativas actuales, pensamos que visiones generales como éstas corresponden a un primer paso en la dirección que lleve a procesos educativos de mejor calidad.

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PROYECTO COVIE: UN MODELO DISTRIBUIDO DE APRENDIZAJE DE LA PROGRAMACIÓN CON APOYO DE LA RED

Ana María Ferraro de Velo[1], Gloria Bianchi[2] y Juan Pablo Barani[3]

Resumen *- Las Tecnologías de la Información y la Comunicación integradas a la Educación permiten construir ambientes de aprendizaje enriquecidos. Esta integración contempla estilos de aprendizaje centrados en el estudiante más que en el profesor.*

En las aulas colaborativas e interactivas, las cuales se desarrollan según el espíritu de las altas tecnologías, se combinan el trabajo individualizado con el trabajo en equipo. Para ello, los docentes estimulan el desarrollo de aprendizajes investigativos y explorativos que permiten ubicar, seleccionar y procesar los conocimientos, de modo que los alumnos puedan pasar de lo factual al pensamiento crítico y a la toma de decisiones.

El proyecto CoViE se basa en la hipótesis que una educación semipresencial que combina la formación con apoyo de la red con la educación presencial, y además compagina la auto educación con la interacción grupal, es la más eficaz de las metodologías a nuestro alcance en el contexto dentro del cual nos desenvolvemos.

Términos de búsqueda *– Educación semipresencial, Internet, Programación, Proyecto educativo.*

INTRODUCCIÓN

Las Tecnologías de la Información y la Comunicación integradas a la Educación permiten construir ambientes de aprendizaje enriquecidos. Esta integración contempla estilos de aprendizaje centrados en el estudiante más que en el profesor. La información integrada y multidisciplinaria, a la que los estudiantes pueden acceder según su propio interés y motivación, en el marco de un modelo distribuido de aprendizaje, vincula las aulas con los centros de trabajo, con los negocios, los hogares, los espacios comunitarios y la "aldea global". El estudio autónomo y el autoaprendizaje ocupan un papel primordial.

En las aulas colaborativas e interactivas, las cuales se desarrollan según el espíritu de las altas tecnologías, se combinan el trabajo individualizado con el trabajo en equipo. Para ello, los docentes estimulan el desarrollo de aprendizajes investigativos y explorativos que permiten ubicar, seleccionar y procesar los conocimientos, de modo que los alumnos puedan pasar de lo factual al pensamiento crítico y a la toma de decisiones.

Al planificar las estrategias didácticas y actividades de aprendizaje se aplican criterios de selección de los medios según sus cualidades. La pauta recomendable es utilizar la combinación de los medios que permitan trabajar mejor las variadas facetas de cada tema, así como desarrollar una conciencia en los jóvenes sobre las potencialidades y convenciones de cada uno de ellos. Si bien los medios no se emplean para sustituir la experiencia directa, son el soporte óptimo de una metodología rediseñada acorde a las necesidades actuales.

El propósito de esta investigación es identificar las técnicas y herramientas óptimas que permitan acompañar al alumno en el proceso de organizar la realidad y la información que lo rodea, para lograr hacer un uso productivo de ellas y construir su propio conocimiento, siempre teniendo en cuenta que es tema de exploración permanente la incidencia de las TICs y el lenguaje virtual en la pedagogía y la psicología del aprendizaje, así como las posibilidades y limitaciones que acarrea el uso de determinadas tecnologías cuando se colocan al servicio de la educación.

Esto nos lleva al problema de la formación docente. Enseñar en un curso que utiliza la red es muy diferente a hacerlo en la forma tradicional. Implica un período de capacitación para lograr la suficiente aptitud que permita manejar el recurso y aprovechar las ventajas que el mismo brinda. En esta investigación, el punto de partida es combinar las características de la educación presencial con el apoyo de la red. Además, estimamos que se debe trabajar con las dimensiones afectivas de la enseñanza, las que se suelen pasar por alto en el momento en que se sobrevalora el aporte de la informática a la educación.

El proyecto se basa en la hipótesis de que una educación que combina la formación con apoyo de la red con la educación presencial, y además compagina la autoeducación con la interacción grupal, es la más eficaz de las metodologías a nuestro alcance en el contexto dentro del cual nos desenvolvemos.

Por otra parte, el trabajo educativo con apoyo de la red requiere de un gran esfuerzo de gestión y administración: calendario de actividades, preparación de materiales, conformación y dinámica de trabajo de los grupos, elección de temas para los proyectos y, sobre todo, formación de los profesores y nuevas competencias de los alumnos.

La función social y organizativa del docente es un elemento fundamental en su labor formativa y en algunos momentos del curso puede llegar a ser crucial para el éxito del mismo, puesto que los factores motivacionales están

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jugando un papel decisivo en el desarrollo de este tipo de cursos.

PRINCIPIOS DIDÁCTICOS

Se plantean en el proyecto algunos principios didácticos que el docente, a través de la red, deberá tener en cuenta a la hora de proponer el trabajo en grupo:

- Diseñar actividades basadas en la cooperación, que favorezcan la interdependencia entre los participantes, desarrollando tanto la empatía como la autonomía.
- Favorecer la implicación activa de los participantes en su propio aprendizaje partiendo de sus conocimientos previos y mediante la autoevaluación como seguimiento de sus progresos y la búsqueda de nuevas estrategias de resolución de problemas.
- Desarrollar el pensamiento crítico, mediante el análisis crítico y creativo de la información.
- Aprovechar los recursos del medio, del entorno sociocultural, valorando como positiva la diversidad, sobre todo en el desarrollo de soluciones a los problemas planteados.
- Establecer procesos y espacios para la comunicación y el diálogo que permitan el contraste de ideas y actitudes y favorezca la construcción colectiva del conocimiento.

ACTIVIDADES

Es fundamental la planificación precisa y la programación previa de los cursos con esta modalidad, porque en estos no cabe la improvisación o, al menos, ésta tiene un espacio muy reducido si lo comparamos con el que puede admitirse en la formación presencial.

Una de las claves metodológicas de esta formación es el aprendizaje colaborativo, por lo que las actividades en grupos cooperativos son el punto central de un modelo formativo, interactivo, flexible y autónomo. El docente se convierte en facilitador y dinamizador y los participantes asumen la responsabilidad de su propio aprendizaje.

A lo largo del curso los alumnos tienen la posibilidad de valorar los contenidos y actividades que se van proponiendo, y se propician las actividades de autoevaluación individual y de equipo. Su objetivo fundamental es que cada uno pueda medir sus progresos y reconocer sus dificultades y posibilidades, permitiendo así una mejor autorregulación del aprendizaje.

Las actividades que se consideran relevantes dentro de este modelo son:

- Ambientación con el modelo
- Desarrollo evolutivo de grupos cooperativos
- Evaluación, autoevaluación y coevaluación
- Recuperación de información, y dentro de la misma
- Actividades de análisis crítico
- Debate
- Producción de materiales

EVALUACIÓN

La evaluación que se lleva a cabo durante el curso tiene las siguientes características:

- **Integral:** abarca conocimientos, habilidades, actitudes y valores.
- **Continua**: se realiza al iniciar el proceso, durante el mismo y al finalizar el curso.
- **Distribuida**: a cargo de todos los participantes de la experiencia: el profesor, los ayudantes de trabajos prácticos, los alumnos entre sí (coevaluación) y de sí mismos (autoevaluación).

Las actividades para evaluar en los alumnos sus habilidades y conocimientos son las siguientes:

- La participación activa en las sesiones de clase: En el curso los alumnos discuten los conceptos de la clase y se aclaran las dudas, con moderación del profesor. Posteriormente, el curso se divide en equipos de 3-4 participantes quienes discuten y resuelven los problemas que se les plantean, entregando su solución al final de la clase. Uno de los equipos se encarga de resolver los problemas frente a la clase.
- Resolución de problemas de tarea y cuestionarios ad-hoc previos a las clases, con entrega por escrito antes de la fecha establecida por el profesor, incluyendo la autoevaluación crítica de la misma. Se evalúa tanto el procedimiento aplicado como el resultado del problema.
- Trabajos en el laboratorio virtual: los alumnos tienen acceso a la dirección virtual del tema, resuelven los ejercicios y responden a las preguntas planteadas por el profesor. Las entregas son pautadas y puntuales a través de la red.
- Asistencia a los talleres de resolución de problemas, para resolver ejercicios sobre el tema y colaborar con sus compañeros de curso.
- Trabajos prácticos: Al iniciar el curso se conforman grupos de 4-5 alumnos que deben trabajar conjuntamente durante todo el cuatrimestre para producir un sistema con carácter real. El trabajo práctico se divide en dos etapas bien diferenciadas. En la primera, a cada grupo se le asigna la realización de un módulo específico que forma parte de un sistema de mayor escala. En la segunda etapa, el grupo debe tomar el resto de los módulos realizados por sus compañeros e integrarlos en el sistema final. Al finalizar cada etapa, el grupo deberá presentarse en las fechas preestablecidas a fin de evaluar el trabajo realizado hasta el momento.

EL AULA VIRTUAL

El aula virtual requiere la implementación de una comunidad virtual educativa a través de la cual es posible centralizar el aprendizaje en el alumno, reconociendo y estimulando su interacción con los demás integrantes de la misma.

El aula virtual nos provee los siguientes servicios:

- Brinda información administrativa y académica correspondiente a los cursos y aquella generada durante el desarrollo de los mismos.
- Proporciona servicios tecnológicos adecuados para la comunicación que permiten interactuar a los docentes con los alumnos y viceversa, proveyendo el medio para el acceso al software, las publicaciones, la ejercitación, el material didáctico, la bibliografía de referencia y los foros de discusión.
- Favorece y permite captar las respuestas y soluciones de los alumnos a las consultas y trabajos generados por los miembros de la comunidad.

Actualmente los integrantes de la Comunidad Virtual son:

- **Docentes:** Llevan adelante el control y la supervisión de sus cursos y mantienen contacto diario con sus alumnos.
- **Alumnos:** Tienen acceso a bibliografía, material didáctico, ejercitación obligatoria y adicional, enunciados de trabajos prácticos, software de distribución gratuita, etc.

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LOS DIAGRAMAS Y MAPAS DE PROBLEMAS EN EL APRENDIZAJE DE LAS CIENCIAS BÁSICAS

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Abstract — *En el ámbito de la formación y el ejercicio profesional de la ingeniería, las representaciones esquemáticas de cualquier índole constituyen una valiosa herramienta para la comprensión y aplicación de los principios fundamentales, por su característica de representar en forma gráfica un proceso simple o complejo, resumir información o plantear el algoritmo a seguir para un cálculo determinado. La resolución de problemas en las ciencias básicas constituye una efectiva estrategia didáctica, puesto que permite la integración de conocimientos, el desarrollo de habilidades y la adopción de actitudes, tales como la comprensión de la lectura, la interpretación de esquemas y la toma de decisiones, elementos indispensables para el desarrollo profesional de un ingeniero. En el presente trabajo se describen diferentes tablas, gráficas, diagramas de cálculo y esquemas de proceso utilizados en la interpretación y planteamiento de la resolución de problemas de química general por estudiantes de la carrera de ingeniería química en el Instituto Politécnico Nacional-México*.

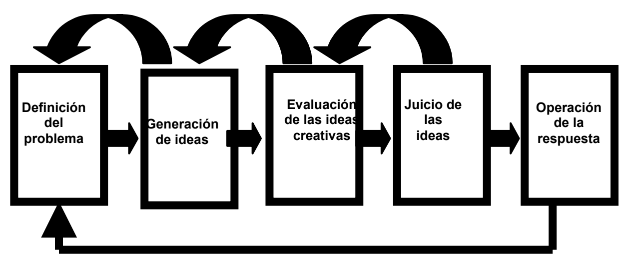
Index Terms — *Auxiliares didácticos, diagramas, esquemas, resolución de problemas.*

INTRODUCCIÓN

En el ámbito académico de las escuelas de ingeniería, la resolución de problemas se fundamenta en la comprensión de los conceptos involucrados para su aplicación efectiva en la búsqueda de respuestas, mediante ciertas habilidades que han sido desarrolladas y la actitud de superación del reto. De esta forma, el individuo memoriza información y acumula experiencia que le serán de utilidad para comprender y resolver futuros problemas, similares o relacionados. Así, la recuperación consciente y voluntaria de la experiencia del individuo se convierte en un factor determinante para la resolución eficaz de cualquier tipo de problema sea académico, técnico, científico, profesional, socioeconómico, etc.

En este contexto, la visualización y la esquematización son técnicas de representación gráfica que impactan positivamente en la memorización y otras habilidades superiores del pensamiento involucradas en el aprendizaje, generándose una relación directa entre visualización-memoria-razonamiento-aprendizaje-aplicación. Hoy en día, la visualización o razonamiento a través de imágenes está recibiendo atención como un método alternativo de pensamiento que permite practicar la imaginación, hacer imágenes mentales y representar nuestras ideas de manera gráfica. Así, el proceso de razonamiento se mejora cuando se esquematizan ideas y se elaboran diagramas respecto a relaciones entre ideas, datos y conceptos; de manera similar, la esquematización ayuda para comunicar ideas e información a otras personas [1].

Además de trazar objetos, imágenes mentales o conceptos, los esquemas y diagramas permiten resumir información, así como representar procesos y relaciones a través de diagramas de flujo y otros tipos de cartas; en muchos aspectos, elaborar un esquema ayuda al razonamiento para contestar una pregunta o prever una solución, lo cual es una herramienta esencial para todo ingeniero concebido como un eficiente resolvedor de problemas y eficaz tomador de decisiones. Un diagrama de flujo es un esquema que conecta ideas, conceptos y/o tareas de manera secuencial y opcional; de esta manera, el proceso mismo de resolución creativa de problemas puede visualizarse mediante el siguiente diagrama de flujo:



DESARROLLO

Con el propósito fundamental de promover la formación integral de los futuros profesionales de la ingeniería, en concordancia con el perfil demandado por el mercado ocupacional, las instituciones de educación superior han realizado reformas curriculares para privilegiar el desarrollo de las habilidades intelectuales y emocionales, así como la adopción de actitudes de valor, por encima de la simple

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asimilación de los conocimientos generales y particulares de cada especialidad.

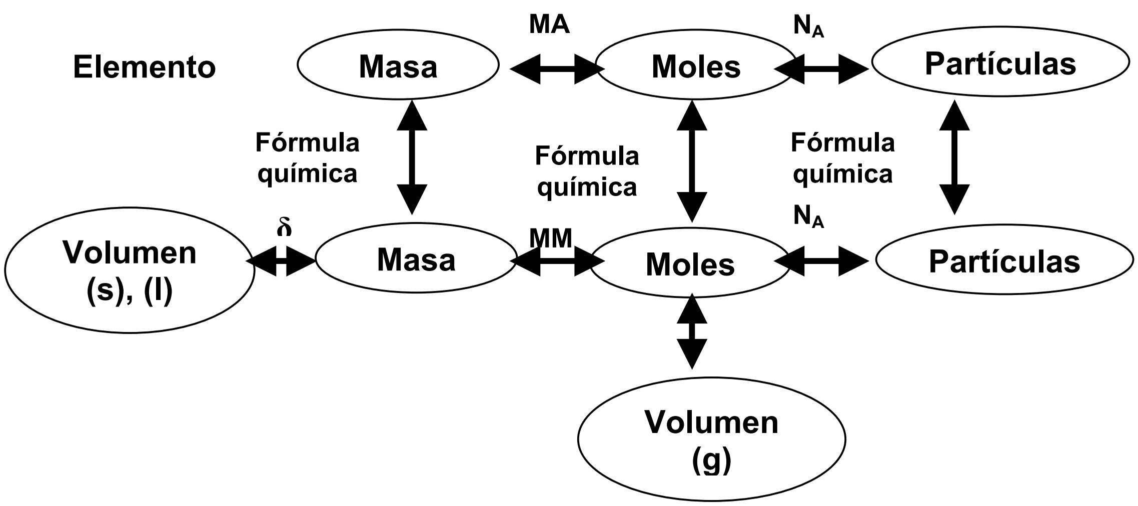
En este contexto, la resolución creativa de problemas ha demostrado ser una estrategia didáctica efectiva que permite la integración de conocimientos y el desarrollo de otras habilidades como la interpretación de esquemas y la toma de decisiones, indispensables para la formación integral y el ejercicio profesional del ingeniero. Así, la actividad tradicional de resolución de problemas en los diferentes cursos ha evolucionado para hacer énfasis en el proceso mismo de resolución, desde los aspectos de interpretación y validación de la información, hasta la verificación de la respuesta, pasando por el planteamiento previsto para la resolución [2].

En el caso particular de la asignatura de Química General correspondiente a los dos primeros semestres del plan de estudios de la carrera de Ingeniero Químico Industrial, impartida en la Escuela Superior de Ingeniería Química e Industrias Extractivas del Instituto Politécnico Nacional (ESIQIE-IPN) de México, los programas de estudio consideran los temas de Estequiometría, Reacciones en Solución y Equilibrio Químico, entre otros, los cuales permiten desarrollar las habilidades de:

- comprender e interpretar lo que se lee u observa,
- plantear **esquemas** que representen el problema planteado,
- establecer **diagramas de flujo y algoritmos** que correspondan a la secuencia de cálculos prevista para la resolución, así como
- diseñar **tablas y gráficas** que permitan validar la consistencia lógica de los resultados obtenidos.

Producto del trabajo cotidiano y la actualización académica, la experiencia docente ha permitido diseñar, recopilar, adaptar y recomendar la utilización de diferentes auxiliares didácticos como esquemas, mapas de problemas, diagramas de cálculo, tablas de datos y resultados, etc., que facilitan la traducción entre los lenguajes verbal, escrito, matemático, científico, coloquial y pictográfico, para su aplicación en la resolución creativa de problemas de química general.

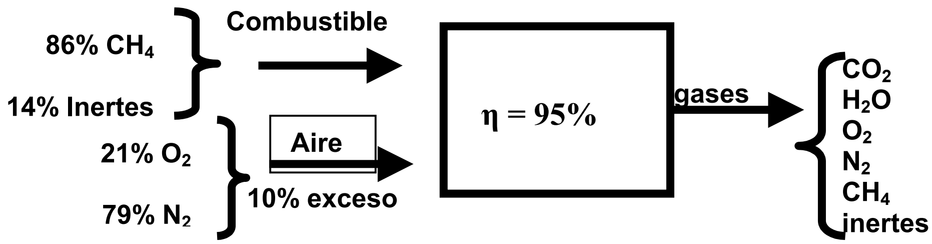
La metodología que se aplica está basada en el planteamiento, comprensión y resolución creativa y crítica de problemas paradigmáticos relacionados con los diferentes conceptos y aplicaciones de los temas señalados, realizando el análisis de las ventajas y limitaciones de utilizar los diferentes auxiliares didácticos mencionados y su posterior aplicación en problemas de reforzamiento, incluyendo problemas conceptuales e integradores de los diversos temas, mediante el trabajo individual o en equipo.



ESQUEMA 1
DIAGRAMA DE CÁLCULO PARA REALIZAR CONVERSIONES DE CANTIDADES DE SUSTANCIA

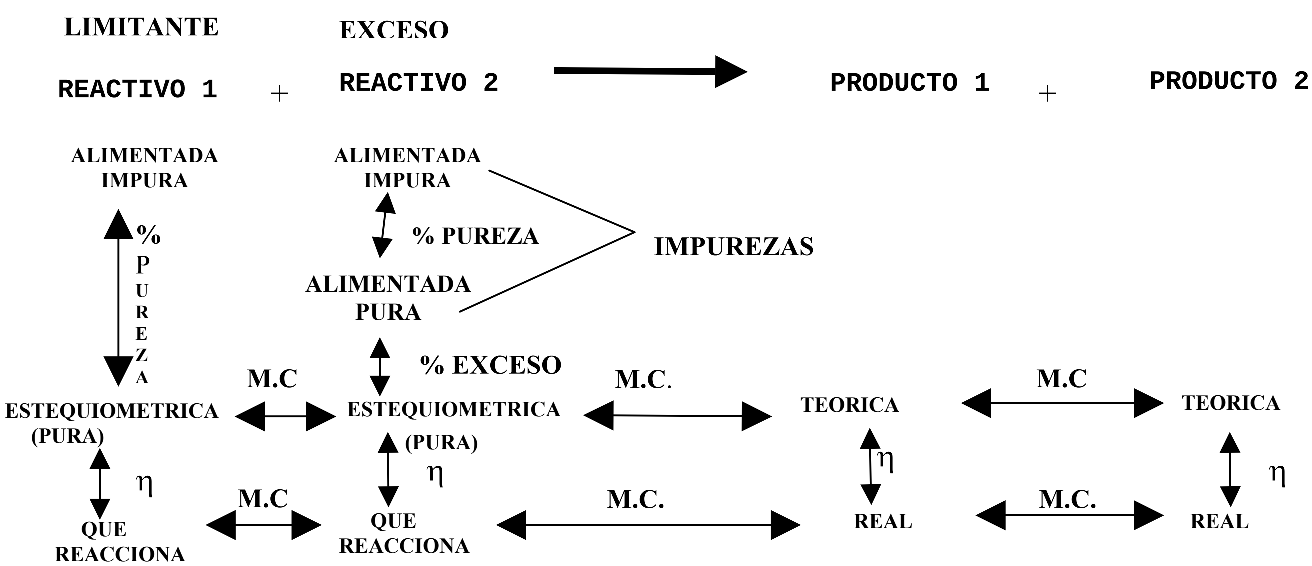
Este diagrama representa la relación entre diferentes conceptos fundamentales de la estequiometría y se puede utilizar para identificar los cálculos necesarios para expresar una cantidad de sustancia en diferentes unidades equivalentes entre sí, mediante la aplicación del método de los factores de conversión deducidos a partir de conceptos y/o el análisis de la información cualitativa y cuantitativa de la fórmula química de cada sustancia. Cabe reiterar que para realizar la conversión o "paso" entre cada concepto, se requiere un factor que modifique la unidad dimensional o la especie de la cantidad conocida.

$$CH_4 + 2\,O_2 \rightarrow CO_2 + 2\,H_2O$$



ESQUEMA 2
DIAGRAMA DE BLOQUES PARA UN PROCESO (REACTOR)

Este tipo de esquemas son convenientes para representar problemas que involucran diversos cálculos estequiométricos relacionados con las cantidades de reactivos y productos de una reacción, con base en los datos de composición, rendimiento y exceso de reactivo que se establezcan. Para esto, cada **bloque** representa a un equipo y mediante **líneas** con flechas se identifican cada una de las sustancias que intervienen en el proceso; también es recomendable la adopción de una **simbología** alfanumérica que identifique a los parámetros (masa, moles, volumen, temperatura, etc) de cada sustancia, así como indicar la composición porcentual que se conozca de las mezclas utilizadas (minerales, soluciones, residuos, etc.).[3]



ESQUEMA 3
DIAGRAMA DE CÁLCULOS ESTEQUIOMÉTRICOS PARA UN PROCESO

Este tipo de diagramas permite establecer o seleccionar el algoritmo de cálculo que debe seguirse con referencia a las cantidades de reactivos y productos de una reacción, de conformidad con los datos establecidos de composición, rendimiento y exceso de reactivo. Para esto, debe identificarse con antelación cuál es el reactivo limitante, puesto que a partir de la cantidad de sustancia de este reactivo se determinan las cantidades de reactivo en exceso necesario y de producto obtenido, así como las cantidades remanentes de cada sustancia por concepto de la correspondiente conversión de reacción.

$$CH_4 + 2\,O_2 \rightarrow CO_2 + 2\,H_2O$$

Sustancia	Alimentación	Reacción (-)	Producción (+)	Salida
CH_4			0	
Inertes		0	0	
O_2			0	
N_2		0	0	
CO_2	0	0		
H_2O	0	0		
Total	A	-B	+B	A

ESQUEMA 4
TABLA DE DATOS, CÁLCULOS Y RESULTADOS

Este tipo de auxiliar didáctico permite resumir los datos del problema, condiciones establecidas, cálculos realizados e incógnitas determinadas con relación a las cantidades de sustancias iniciales y finales de un proceso químico, facilitando la comprobación de los resultados así como la toma de decisiones o la realización de cálculos posteriores a partir de los mismos, tales como aspectos de impacto ambiental, economía, seguridad, disponibilidad, etc.

CONCLUSIONES Y RECOMENDACIONES

Cuando se trabaja con cantidades, el pensamiento verbal se vuelve complicado, mientras que el pensamiento matemático permite resolver con facilidad el problema. La visualización refuerza el pensamiento matemático, pues desarrolla un sentido para apreciar tamaños y cantidades, así como su relación entre ellos.

Se sabe que la mente recuerda mejor aquellas imágenes no usuales o acostumbradas, por lo cual es necesario diseñar y utilizar diferentes esquemas y diagramas recordables por los alumnos, de acuerdo a su propio estilo de aprendizaje.

Debido al manejo de símbolos codificados, la lectura de diagramas de proceso y planos de ingeniería está ligada de manera íntima con el análisis que realiza el hemisferio cerebral izquierdo, en tanto que la visualización y la esquematización involucran al pensamiento creativo que radica en el hemisferio cerebral derecho. Así, dichas actividades son necesarias y complementarias para el desarrollo de la habilidad de resolución de problemas y toma de decisiones, a efecto de promover la formación integral del futuro profesional de la ingeniería, en cualquier disciplina.

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IMPACTO SOCIAL DEL INGENIERO QUÍMICO

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Abstract — *Durante la última década, los planes de estudio de las carreras de ciencias e ingeniería han privilegiado el desarrollo de habilidades y la adopción de actitudes de valor por encima de la asimilación de los conocimientos. Uno de estos aspectos enfatizados es el relativo con el desarrollo de la habilidad para tomar decisiones en un contexto determinado, con el propósito de que esta capacidad pueda transferirse a la vida diaria profesional y formar así mejores ciudadanos. En este contexto, ha constituido un reto para profesores y estudiantes el diseño y selección de problemas y casos de estudio para la toma de decisiones en situaciones propias de la profesión en estudio. Los cursos de ciencias básicas en las carreras de ingeniería ofrecen excelentes oportunidades para desarrollar las habilidades de resolución de problemas y la toma de decisiones a través del análisis de los datos, condiciones y resultados de ejemplos y ejercicios relacionados con aspectos industriales, ambientales, sociales y económicos en los procesos químicos. Se describen los criterios empleados para la selección y diseño de problemas de química general relacionados con la toma de decisiones, utilizados en la formación integral de estudiantes de ingeniería química en la ESIQIE – IPN.*

Index Terms —.*Ingeniería química, química general, resolución de problemas, toma de decisiones.*

INTRODUCCIÓN

La ingeniería química se puede definir como la profesión técnica relacionada con la aplicación de las ciencias naturales para la producción de sustancias químicas a escala comercial y con los procesos industriales que convierten a las materias primas y la energía en productos con mayor valor económico, mediante cambios químicos, físicos y térmicos.

Con el objetivo de lograr el óptimo aprovechamiento de los recursos naturales, en beneficio de la sociedad y el desarrollo sustentable de la misma, la ingeniería química requiere la formación de profesionales con cultura científico-tecnológica y conciencia social que consideren la comprensión e integración de los conocimientos de la especialidad, el desarrollo de las habilidades intelectuales necesarias para aplicar dichos conocimientos, así como la adopción de actitudes para su interacción social y profesional.

En el contexto mundial actual de acelerado avance científico-tecnológico, libre mercado y economías globalizadas, los planes de estudio de las carreras de ciencias e ingeniería han privilegiado el desarrollo de las habilidades y la adopción de actitudes por encima de la asimilación de conocimientos, para formar profesionales calificados y dispuestos a asumir una amplia variedad de actividades interdisciplinarias involucradas en la elaboración de cualquier producto que haga mejor o más fácil nuestra vida cotidiana.

Se considera que las habilidades más necesarias para el quehacer diario del ingeniero en cualquier especialidad son aquellas que le permiten resolver problemas y tomas decisiones de manera eficiente, entendiendo por problema una situación novedosa que es necesario afrontar con base en el experiencia, para la cual no se tiene una solución o respuesta inmediata, en tanto que la toma de decisión puede definirse como el proceso sistémico cuyo objetivo es la validación de una respuesta o la definición de un curso de acción para alcanzar un propósito determinado.

En décadas pasadas, los ingenieros fundamentaban sus decisiones en consideraciones de carácter técnico y económico, conforme su experiencia profesional y los criterios establecidos por la economía y la administración industrial. Hoy en día, con base en la ética profesional y responsabilidad con la sociedad, las decisiones efectivas deben estar fundamentadas en aspectos sociales, económicos, políticos, ambientales y tecnológicos, procurando el mejor conjunto de ellos conforme la experiencia propia de cada profesional.

DESARROLLO

En los modelos educativos promovidos por organismos internacionales como la UNESCO, se enfatiza la necesidad de la formación integral de los futuros profesionales a través de los aprendizajes de conocer, hacer, convivir y ser. Así, en el aprender a hacer se plantea aplicar con eficiencia y eficacia los conocimientos para resolver problemas y tomar decisiones en el ámbito laboral, en tanto que en el aprender a ser se busca resolver los problemas propios, tomar decisiones y responsabilizarse de la vida propia en los ámbitos personal, familiar y social. [1]

Con el propósito de promover el desarrollo de la habilidad para tomar decisiones en un contexto determinado, a efecto de que esta capacidad pueda transferirse a la vida

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diaria y profesional, los cursos de ciencias básicas de las carreras de ingeniería ofrecen la oportunidad de practicarla a través del análisis y validación de los datos, condiciones y respuestas de problemas relacionados con aspectos sociales, industriales, ambientales y económicos.

Algunas de las técnicas recomendadas por las teorías administrativas para la toma de decisiones son realizadas por individuos y otras por equipos de trabajo; unas de ellas son idóneas para seleccionar ideas, instrumentar acciones o validar resultados.

En el caso de tener dos o más opciones en igualdad de características de los resultados, se recomienda seleccionar aquella opción menos problemática o riesgosa, sin ignorar las consecuencias a largo plazo; para este caso se recomienda la elaboración de una tabla que contenga los criterios mínimos que deben ser satisfechos por la mejor opción. De manera similar, la elaboración de una matriz de ventajas y desventajas constituye una herramienta útil para identificar las soluciones u opciones más promisorias [2].

Los cursos de Química General para la carrera de ingeniería química permiten ejercitar la toma de decisiones en la resolución de problemas y estudio de casos relacionados con la selección de materias primas y procesos industriales, así como cálculos estequiométricos relacionados con aplicaciones en contextos definidos, haciendo énfasis en las diferentes características de los problemas académicos y de la vida real en el ejercicio de la profesión [3]:

CARACTERÍSTICA	ACADÉMICO	VIDA REAL
ENFOQUE	UNIDISCIPLINARIO	MULTIDISCIPLINARIO
DEFINICIÓN	COMPLETA	ESCASA
RESOLUCIÓN	ALGORITMO	HEURÍSTICA
FUNDAMENTO	CONOCIMIENTOS	EXPERIENCIA

CARACTERÍSTICAS DE PROBLEMAS

CARACTERÍSTICA	ACADÉMICO	VIDA REAL
RESPUESTA	ÚNICA	MÚLTIPLES
EVALUACIÓN	INMEDIATA	POSTERIOR
CRITERIOS	CORRECTA/	BENEFICIOS/RIESGOS
	INCORRECTA	VALORES/PREJUICIOS

CARACTERÍSTICAS DE LAS DECISIONES

En el caso particular de la Escuela Superior de Ingeniería Química e Industrias Extractivas del Instituto Politécnico Nacional (ESIQIE-IPN) de México, que es la institución pública mexicana que atiende la mayor matrícula de ingeniería química en el nivel de licenciatura, los contenidos programáticos de Química General consideran los temas de Estequiometría, Reacciones en Solución y Equilibrio Químico, entre otros, los cuales ofrecen la oportunidad de diseñar y/o seleccionar problemas que involucren una toma de decisión basada en los cálculos realizados, la respuesta obtenida y el conjunto de criterios establecidos (económico, ambiental, social, etc.

Problema 1. Los líquidos blanqueadores de uso doméstico se preparan a partir de la disolución de hipocloritos, en los cuales el elemento activo es el cloro liberado. Si dispones de hipoclorito de sodio cuyo costo es \$18/kg y de hipoclorito de calcio cuyo costo es \$22/kg, determina cuál sustancia es la recomendable desde el punto de vista económico para preparar líquidos blanqueadores cuya concentración sea 6% de cloro libre.

Análisis.- Este tipo de problemas involucra una decisión de carácter económico, con base en la determinación del costo unitario óptimo determinado por la cantidad de reactivo necesario y el monto de la inversión económica que debería realizarse. La carencia de una base de cálculo determinada, permite utilizar las alternativas de una cantidad de producto a elaborar o un monto económico común para realizar la comparación y toma de decisión.

Problema 2. La dosis letal de HCN es 300mg/kg de aire inhalado. El acrilán tiene la fórmula empírica CH_2CHCN, donde el HCN representa el 50.9% en masa. Una oficina tiene una alfombra de acrilán que mide 12 por 15 pies, la cual contiene 30 oz. de acrilán/yarda^2. Considerando que un incendio provocara que se consumiese el 50% de la alfombra y que el rendimiento del HCN fuese del 20%, ¿se generará la dosis letal de HCN en dicha oficina?

Análisis.- Con base en los resultados numéricos derivados de los cálculos estequiométricos y el planteamiento de la pregunta **¿qué pasaría sí....?**, se puede realizar una discusión en el grupo respecto al concepto de dosis letal y la conveniencia de utilizar este tipo de materiales en el hogar, empleo de retardadores de fuego, extintores de incendio, etc.

Problema 3. La concentración de las bebidas alcohólicas se expresa en °G.L. que representa el % volumen de etanol en cada bebida. Una lata de cerveza contiene 355mL de bebida y reporta 6.0°G.L., en tanto que una "cuba libre" se prepara con una medida de 30mL de ron de 40.0°G.L. Determina en cuál bebida es menor la ingesta de alcohol.

Análisis.- La determinación de la cantidad real de etanol que se ingiere en cada medida de una bebida alcohólica, permitirá aclarar la falsedad del concepto de "bebida de moderación" que la mercadotecnia asigna a la cerveza, así como establecer el conjunto de características fisicoquímicas y biotecnológicas que servirían de base para establecer la dosis recomendada de una bebida alcohólica en particular.

Problema 4. Se sabe que las infusiones de café o té contienen 0.05mg/mL de cafeína, en tanto que las bebidas de chocolate y la coca-cola contienen 0.6mg y 5.0mg/oz fluida, respectivamente; el contenido de cafeína en el café "descafeinado" es equivalente al chocolate. Las dosis diarias superiores a 1.0g de cafeína pueden causar síntomas alarmantes en el ser humano. Determina las combinaciones posibles de tazas de café, vasos de chocolate y/o latas de coca-cola que pueden ingerirse diariamente sin rebasar la dosis permitida.

Análisis.- La búsqueda de la información necesaria, y los cálculos realizados, permitirá identificar diferentes opciones de respuesta para un mismo problema, cuya discusión en el grupo podría llevar a una recomendación consensuada o al enriquecimiento del problema por la inclusión de restricciones adicionales para la respuesta óptima.

Problema 5. Los solventes arrojados en operaciones industriales son contaminantes importantes si no se disponen en forma apropiada. El reporte del gas de desperdicio de una planta de fibras sintéticas indica 40%mol de CS_2, 10% de SO_2 y 50% de H_2O, sugiriéndose quemarlo con exceso de aire y cuyos gases de combustión serán arrojados por una chimenea. Si el reglamento local establece que ningún gas de combustión puede rebasar el 2%mol de SO_2 en base seca, calcula el % mínimo de aire en exceso. ¿Con esta medida se evitará la contaminación por lluvia ácida?

Análisis.- De manera independiente al resultado numérico que se obtenga en el proceso de resolución de este problema, la discusión en el grupo debería enfocarse en torno a problemática de la lluvia ácida por razón del SO_2 que se libera en algunos procesos industriales y la efectividad de este tipo de acciones de diluir los contaminantes, planteadas en algunos textos de ingeniería.

CONCLUSIONES Y RECOMENDACIONES

La efectividad de la respuesta a un problema de ingeniería y de la decisión correspondiente, dependerá de la calidad de la información suficiente, oportuna y relevante que se tenga, así como del conjunto de criterios o restricciones que se establezcan. Los criterios actuales de toma de decisiones en el ámbito de la ingeniería exigen considerar el contexto social, entendido como las implicaciones e impacto a los individuos y al medio ambiente.

La herencia cultural influye en el proceso de toma de decisión. Las civilizaciones occidentales son sistemas competitivos en los cuales se argumentan puntos de vista antagónicos en la vida diaria; en contraste, las sociedades orientales tiene larga tradición cultural de trabajo en equipo y colaboración.

Constituye un reto a resolver por los profesores de los cursos de ciencias básicas y ciencias de la ingeniería el diseño, selección y recopilación de problemas y casos de estudio que involucren la toma de decisión por parte de los estudiantes, en situaciones propias de la vida diaria y la profesión en estudio.

La mayoría de los problemas relacionados con los aspectos sociales y tecnológicos no tienen respuesta única, por lo cual es necesario evaluar las diversas soluciones y sus consecuencias para tomar la mejor decisión de acuerdo a los criterios y condiciones establecidos. Cada una de las etapas del proceso de resolución creativa de problemas involucra una toma de decisión en torno al objetivo de cada una de ellas.

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EL TRABAJO EXPERIMENTAL Y LA FORMACIÓN CIENTÍFICA BÁSICA

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Abstract — *El aprendizaje de las ciencias en los diferentes niveles educativos del país, se ha caracterizado por ser principalmente memorístico y aunque algunos cursos son del tipo teórico/práctico, generalmente las clases de laboratorio están integradas por una serie de prácticas que se realizan como recetas, son rígidas y en muchas ocasiones no existe una continuidad entre ellas. Lo anterior trae como consecuencia que el proceso de enseñanza-aprendizaje no alcance sus objetivos porque resulta poco atractivo para los alumnos. Para contrarrestar esa inercia, en la formación en el área de ingeniería, es recomendable que desde los primeros cursos se cuente con laboratorios que les proporcionen a los estudiantes una formación sólida, con principios metodológicos que les ayuden a resolver problemas en su desarrollo profesional. En este trabajo se plantea un curso de laboratorio de ciencias, en el que los participantes desarrollen su capacidad de aprendizaje, adquiriendo a la vez una formación metodológica y crítica.*

Index Terms — *Asignaturas teórico-experimentales, formación científica, ingeniería química, trabajo experimental.*

INTRODUCCIÓN

En la actualización de los planes y programas de estudio de las carreras de ingeniería se debe contemplar la necesidad de proporcionar a los estudiantes una formación sólida en métodos y mediciones experimentales, ya que se espera que los egresados de esas áreas tengan la capacidad de resolver numerosos problemas.

En ese orden de ideas, los cursos de laboratorio pueden ser el medio para adquirir muchas de las habilidades relacionadas con su trabajo futuro.

Análisis del proceso de aprendizaje

Tradicionalmente en la enseñanza de la ingeniería al nivel de licenciatura o equivalente, primero se ofrece una sólida preparación en las ciencias básicas y de la ingeniería y posteriormente se incorporan cursos de especialidades complementarias.

Al tratar de actualizar la formación y conseguir una preparación más amplia para el educando se han incorporado asignaturas adicionales en el plan de estudios, para el tratamiento de diversos aspectos de actualidad que complementen su educación.

En otros planes de estudios se cuenta con varios módulos opcionales de aplicación, estructurados para una especialidad y orientados hacia determinada área de trabajo que el estudiante seleccione con base en su interés.

Ante estas posibilidades la mayoría de las instituciones relacionadas con la educación y el ejercicio de la ingeniería consideran que el primer enfoque es el que permite alcanzar mejores resultados, facilitando la vigencia de los conocimientos y la necesaria actualización profesional.

A pesar de las diferentes orientaciones, en todos los planes y programas de estudio de las carreras de ingeniería las asignaturas de carácter teórico-experimental ocupan un sitio preponderante, por ser éstas las que representan la interdependencia de las ciencias y la tecnología, misma que es uno de los objetivos de toda especialidad de ingeniería.

Generalmente los cursos experimentales de las materias teórico-prácticas están formadas por un conjunto de reglas que se utilizan como un medio para comprobar y reafirmar lo establecido por la teoría, sin considerar que puede ser un mecanismo para generar nuevos conocimientos, habilidades y actitudes mediante el trabajo metodológico de la experimentación.

En los primeros semestres de estudios de las carreras científico-tecnológicas se presenta además otra problemática, altos índices de reprobación y deserción. Analizar la razón de esto resulta complejo ya que inciden varios factores en ello.

Es conocido que cada vez hay más alumnos con falta de interés y vocación por las carreras científico-tecnológicas, y que tienen fuertes deficiencias metodológicas y conceptuales derivadas de los cursos de los anteriores niveles de educación. Por otro lado las asignaturas están elaboradas con contenidos programáticos excesivos y en ocasiones repetitivos en un bloque de asignaturas seriadas. Debido al calendario escolar y a la rigidez de los programas existe una desvinculación y/o desfasamiento entre los contenidos programáticos de la teoría y el laboratorio.

Por otro lado, la masificación de los procesos educativos en el nivel de referencia trae como consecuencia la escasez de recursos económicos y materiales en las instituciones.

En el primer semestre de estudios de las tres especialidades ofrecidas en la Escuela Superior de Ingeniería Química e Industrias Extractivas (ESIQIE) del Instituto Politécnico Nacional (IPN) se imparten tres asignaturas de carácter teórico-práctico, cuyos programas de prácticas de laboratorio se basan en el objetivo de comprobar y reafirmar

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los conceptos y aplicaciones tratados en las sesiones de teoría, considerando un conjunto de experimentos guiados, en relación con algunos temas del programa de la asignatura..

DESARROLLO

El presente trabajo propone un programa de actividades para un *Laboratorio de Ciencias Básicas* para los estudiantes de primer semestre en la ESIQIE, sustentado en el hecho comprobado de que el trabajo en el laboratorio es un mecanismo idóneo para que el alumno adopte y desarrolle una metodología científica-básica.

Los objetivos generales del presente trabajo incluyen el dominio de diferentes tipos de lenguajes; matemático, gráfico, químico, escrito, se espera que genere interés y se adquiera la habilidad para consultar fuentes bibliográficas en otros idiomas y con la información recabada se tenga la capacidad para analizarla, discriminarla y sintetizarla.

Es importante que los estudiantes tengan criterio para ponderar la influencia de los factores (toxicidad, disponibilidad material, economía, tiempo, ecología) que intervienen en un fenómeno fisicoquímico en particular, y que utilicen su creatividad en el diseño de experimentos para fines específicos.

En el trabajo experimental se necesita la aplicación de criterios y habilidades para seleccionar y manipular equipo, instrumental y reactivos de laboratorio; se debe manifestar una actitud crítica para analizar, interpretar y comunicar resultados, así como adoptar hábitos de puntualidad, orden, limpieza y seguridad.

El programa de actividades del *Laboratorio de Ciencias Básicas* está diseñado considerando estos objetivos *y* el propósito de disminuir los efectos negativos de los factores que inciden en el aprovechamiento de los alumnos y en el problema de la deserción. Este se compone de seis sesiones de dos horas cada una, las cuales se describen enseguida.

La primera actividad a desarrollar tiene como objetivo adquirir dominio en el lenguaje químico. Se pretende que identifique las principales funciones químicas en el área de la Química Inorgánica, al mismo tiempo debe conocer los acuerdos internacionales sobre las reglas de nomenclatura de dichos compuestos aprobado por la UIPAC [1]. Además debe interpretar la información gravimétrica y molar que proporciona una fórmula química [2].

Las actividades que están vinculadas para el logro del objetivo anterior pueden ser la búsqueda del contenido de compuestos inorgánicos en las etiquetas de los productos de uso comercial, como medicamentos, limpiadores, artículos de belleza, alimentos, etc. y la clasificación de acuerdo a sus funciones químicas.

Las relaciones cuantitativas y cualitativas se pueden analizar en recetas de cocina.

En la segunda sesión se propone el desarrollo de lenguaje algebraico y gráfico [3]. Con datos experimentales se puede medir la incertidumbre, construir gráficas e interpretar los modelos matemáticos relacionados. En la resolución de problemas generales en la Ingeniería se pueden diseñar diagramas de flujo con simbología relacionada.

La experiencia propuesta es elaborar una estadística de consumo personal diario de agua por los integrantes de una familia. Con la información meteorológica obtenida de los diferentes medios de comunicación construir gráficas de la temperatura promedio en la zona durante un mes [4].

En la tercera sesión se desarrolla la habilidad de lectura de textos científicos en el área de la Química. El objetivo es clasificar las diferentes fuentes de información y encontrar la forma de acceso a las publicaciones periódicas, manuales y catálogos. Otro objetivo es leer, analizar y sintetizar el material de ciencias básicas e ingeniería de que se dispone en los idiomas español e inglés [5 y 6].

Para lo anterior se sugiere hacer la búsqueda de las propiedades físicas y químicas de algunas sustancias en manuales y catálogos, y consultar los artículos publicados en las revistas científicas de circulación nacional e internacional [7 y 8].

En la cuarta actividad se plantea la comunicación escrita. En este punto se tiene como objetivo analizar la estructura de reportes técnicos en cuanto a formato, sencillez, claridad, limpieza, lenguaje adecuado, etc. Es necesario también hacer una revisión de otros tipos de reportes escritos, como son las bitácoras de laboratorio y los informes técnicos.

Por lo que se proyecta una revisión y análisis de la estructura de las tesis de licenciatura de diferentes carreras y la realización de un ensayo para cada apartado en el formato de reporte técnico [9, 10 y 11].

El tema de la quinta sesión es el trabajo en el laboratorio de Química y los objetivos son que obtenga los hábitos generales de trabajo en un laboratorio como son puntualidad orden y limpieza, que conozca los riesgos que se presentan en esa área, así como las medidas de seguridad necesarias.

Se les pedirá que elaboren y presenten un programa audiovisual con notas relacionadas con los tópicos mencionados y que dramaticen una situación de emergencia en un laboratorio [4].

En la última sesión se propone como tema las técnicas de separación y purificación. En ésta se deberán establecer criterios para la composición de mezclas de sustancias líquidas y sólidas, se analizarán las propiedades físicas y químicas de las sustancias para seleccionar la técnica adecuada de separación o purificación, se diseñará el experimento apropiado para aplicar la técnica elegida y se seleccionará el equipo y reactivos necesarios para el experimento [12]. La experiencia sugerida para lograr los objetivos son; determinar el contenido de alcohol en una bebida alcohólica comercial y determinar la concentración de una solución desconocida a partir de soluciones patrón [13].

CONCLUSIONES

El diseño de las actividades se realizó con la idea de propiciar una formación integral de los estudiante al reforzar una actitud metodológica y critica, para que tengan un adecuado desempeño en todas las asignaturas teórico-experimentales. A su vez, se puede dar atención a un alto número de alumnos sin que esto represente una considerable inversión económica en reactivos.

Por otro lado, este programa es independiente y por lo tanto no se presenta desfasamiento con la teoría al no estar vinculado al avance programático de ésta en las diferentes asignaturas involucradas, sin embargo, muestra interdisciplinariedad lo cual fortalecerá las actitudes metodológicas del estudiante, reflejándose este aspecto en una reducción de la pérdida de recursos institucionales derivada de la deserción estudiantil por razones de irregularidad académica.

El trabajo de laboratorio es una actividad que se puede realizar con éxito cuando se ha tenido una formación metodológica sólida. Es necesario que el tiempo que emplean los estudiantes en las actividades experimentales sea de gran valor parar su formación y los prepare para resolver problemas en su futura vida profesional.

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ESTRATEGIAS INTEGRADORAS PARA PROMOVER EL APRENDIZAJE DE LAS CIENCIAS

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Abstract *— La resolución de los problemas que plantea la sociedad, demanda la participación de profesionales que se desenvuelvan de manera interdisciplinaria y que estén inmersos en la dinámica del desarrollo acelerado del conocimiento. Las diversas áreas de la Ciencia, han visto disminuida su matrícula escolar en instituciones de educación superior por razones conocidas: aparente dificultad, desvinculación del contexto social, poco atractivo, etc. En la ESIQIE-IPN (México), se ofrecen licenciaturas del área tecnológica que demandan un alto desempeño en las asignaturas de Ciencias. Se presentan los resultados de una serie de estrategias desarrolladas por un grupo de profesores para los estudiantes del primer año, cuyo objetivo principal fue promover el acercamiento de los alumnos hacia las asignaturas menos atractivas para ellos y mejorar su desempeño académico.*

Index Terms — Aprendizaje de las ciencias básicas, desarrollo de habilidades, formación integral, ingeniería química

PRESENTACIÓN

Se sabe que la enseñanza de las Ciencias Básicas en los niveles del bachillerato y superior se realizó durante mucho tiempo con un enfoque centrado en el profesor, bajo el punto de vista de que es necesario presentar, como sinónimo de enseñar, la mayor cantidad posible de los conocimientos desarrollados en cada disciplina científica, como signo de buena calidad académica para la futura vida profesional.

De tal forma, el proceso favorecido es el de enseñaza y el alumno se limita a tomar apuntes y, esporádicamente, solicitar explicaciones de lo expuesto durante la clase.

Con el explosivo crecimiento del conocimiento científico y tecnológico, se ha observado que dicha práctica educativa no es operante por requerir un mayor número de horas–clase en todas y cada una de las asignaturas del plan de estudios, con el único propósito de poder exponer todos los conocimientos de frontera.

Esta situación ha propiciado que los alumnos encuentren poco atractivas las sesiones de clase, prejuzguen a muchos profesores y rechacen aprender los contenidos de las diferentes asignaturas, generándose sentimientos de malestar que se manifiestan a través de diversas actitudes y expresiones de disgusto, aburrimiento y desinterés que conducen a la falta de atención reprobación y por último a la deserción.:

Este conjunto de factores es característico, aunque no exclusivo, del proceso de enseñanza–aprendizaje de las Ciencias Básicas en las carreras del campo de la Ingeniería, a pesar de la importancia que representan como elemento fundamental para la comprensión, integración, dominio y aplicación de los conocimientos tecnológicos de cada especialidad [1].

Sin embargo, es necesario crear conciencia en los estudiantes sobre la importancia que las diferentes disciplinas de la Ingeniería tienen en la formación del profesional que atenderá los requerimientos de la sociedad relacionados con el uso adecuado de la energía y los recursos naturales, el desarrollo de nuevos materiales y la recuperación y conservación del medio ambiente.

Los nuevos procesos educativos de las Ciencias Básicas en las carreras de Ingeniería plantean opciones metodológicas para que el ejercicio de la docencia propicie el aumento del interés de los alumnos por dichas ciencias y la adopción consciente de su corresponsabilidad en su propia formación profesional.

Entre otras opciones, se ha encontrado que la interacción profesor-alumno, la asesoría personalizada, la resolución de problemas contextualizados al entorno [2], la participación en proyectos de investigación y la vinculación con personal académico de otras instituciones, permiten revertir la imagen distorsionada de las Ciencias Básicas y favorecer el aprendizaje significativo [3] y el desarrollo de habilidades y actitudes, elementos fundamentales de la formación integral [5]

Entre dichas habilidades y actitudes, reconocidas como elementos permanentes del desarrollo profesional, destacan la comunicación y el trabajo en equipo, la resolución de problemas y la toma de decisiones, el autoaprendizaje, la creatividad, la innovación y el liderazgo [4].

DESARROLLO

La Escuela Superior de Ingeniería Química e Industrias Extractivas (ESIQIE) del Instituto Politécnico Nacional (IPN) tiene como objetivo la formación de recursos humanos en las áreas de la Ingeniería Química y la Ingeniería Metalúrgica.

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Los planes de estudio de sus carreras consideran dos semestres de tronco común, a cargo del Departamento de Ciencias Básicas (DCB).

El trabajo en este periodo tiene como objetivo el homogeneizar los conocimientos de los alumnos de nuevo ingreso y desarrollar metodologías de trabajo necesarias para el estudio de cada especialidad.

Como Departamento responsable de sentar las bases de la formación de los estudiantes, se requiere hacer énfasis en la educación integral y el desarrollo profesional, por lo que se considera la cobertura de los aspectos del ***saber*** (conocimientos), del ***hacer*** (habilidades) y del ***ser*** (actitudes).

De esta forma, toda actividad de enseñanza–aprendizaje debería involucrar la realización de esfuerzos mentales, físicos y actitudinales tanto para estudiantes como para profesores.

Al respecto, se han identificado algunas actividades auxiliares que requieran la realización de dichos esfuerzos, así, el *esfuerzo mental* predomina en acciones simples como: formular interrogantes, descifrar acertijos, encontrar elementos ocultos, realizar cálculos aproximados, inventar historias y problemas y modificar condiciones en problemas conocidos; el *esfuerzo físico* está presente y destaca en acciones como: leer en voz alta, escribir un texto, realizar búsquedas bibliográficas y realizar experimentos u observaciones. Por su parte, el *esfuerzo actitudinal* predomina al: participar en competencias y juegos y al trabajar en equipo.

En este contexto, las diferentes Academias del Departamento de Ciencias Básicas de la ESIQIE-IPN, han diseñado y ensayado diversas actividades curriculares y extracurriculares de apoyo al proceso de aprendizaje con el propósito fundamental de que los alumnos establezcan relaciones entre los contenidos de las asignaturas y su entorno, a la vez de desarrollar habilidades y actitudes que complementen su formación.

Con el propósito de establecer un vínculo entre los conocimientos teóricos y el entorno, se propicia la participación en proyectos de investigación bibliográfica y de campo en las diversas áreas de las Ciencias Básicas, Ingeniería y Educación, con la presentación de los resultados obtenidos en los foros académicos adecuados.

Para esto, los alumnos seleccionan un tema de su interés, realizan la correspondiente búsqueda de información bibliográfica, clasifican, analizan y reportan sus conclusiones mediante un informe escrito.

En el caso de investigaciones de campo, los alumnos diseñan además su instrumento de recolección de información, lo aplican, analizan los datos y exponen sus conclusiones en forma gráfica y/o escrita.

Debido al nivel de estudios en que se encuentra el DCB, a la fecha no se han realizado investigaciones experimentales, sin embargo, algunos temas tratados a nivel de investigación bibliográfica y de campo han servido como tema de Tesis profesional cuando los retoman en semestres avanzados.

Este tipo de actividades tiene por objetivo que los alumnos participantes observen cambios positivos en su autoestima, orientación vocacional, relaciones humanas y desempeño académico.

Otro conjunto de actividades extracurriculares para el desarrollo de habilidades, se realiza por sugerencia de los profesores y como elemento complementario de la evaluación.

Estas actividades se orientan a fortalecer la creatividad, capacidad de organización, trabajo en equipo y espíritu de competencia.

Entre ellas se encuentra el diseño de juegos académicos de destreza, armado de rompecabezas, resolución de acertijos lógicos, escritura de cuentos y ensayos, diseño y presentación de experiencias de cátedra, resolución de problemas integradores y la propuesta de usos alternativos de objetos comunes.

Con este conjunto de actividades, además de disfrutar su aspecto lúdico, los alumnos tienen la oportunidad de mejorar su capacidad de análisis y creatividad, al diseñar y proponer otras actividades similares.

El reconocimiento de las diferentes capacidades de los estudiantes, requiere de actividades que propicien su desarrollo, para esto se promueve su participación en exposiciones de profesiones y Ferias de Ciencias.

Los alumnos que deciden incorporarse en estas exposiciones, diseñan, ensayan y/o presentan actividades experimentales orientadas a despertar el interés vocacional, mejorar la imagen de las Ciencias, divulgar el conocimiento científico–tecnológico, destacar la importancia del quehacer científico y su impacto en la sociedad y facilitar el acercamiento de los niños a la Ciencia.

En el caso de la feria de carreras ofrecidas por el IPN, los alumnos realizan demostraciones recreativas para atraer la atención de los visitantes y mostrar aspectos agradables de las Ciencias y la Ingeniería.

En la Feria de Ciencias, orientada a rescatar el interés por las diferentes ramas del conocimiento científico entre la población de educación básica, los alumnos conducen la realización de actividades sencillas por parte de los niños visitantes, las cuales implican poner en juego los sentidos y el razonamiento.

Estas actividades de divulgación se presentan en festivales institucionales, durante la Semana Nacional de la Ciencia y la Tecnología, así como en los congresos nacionales de educación de la Sociedad Química de México.

Estas actividades están orientadas a mejorar la matrícula de nuevo ingreso a la Institución, la imagen de la misma ante la comunidad y a que los alumnos involucrados en estos eventos canalicen sinérgicamente su entusiasmo y disposición, mejorando su capacidad de organización, espíritu de responsabilidad, vocación profesional y habilidad de comunicación.

Con el propósito de mejorar la capacidad de organización, relaciones humanas y responsabilidad en el cumplimiento de las actividades comprometidas, se recomienda la participación en las secciones estudiantiles de las agrupaciones gremiales afines para que los estudiantes colaboren en la organización de las diferentes actividades académicas (congresos, cursos cortos, visitas industriales, conferencias técnicas, etc.) y sociales (conferencias culturales, excursiones) que realizan las secciones estudiantiles del Instituto Mexicano de Ingenieros Químicos (IMIQ), la Sociedad Química de México (SQM), la Sociedad de Ingenieros en Plásticos (SIP), la Sociedad Polimérica de México (SPM), la Sociedad Química Cosmetológica (SQC), etc.

El desempeño de los alumnos participantes, les permite ocupar cargos directivos a nivel institucional y nacional, facilitando su ingreso al mercado ocupacional por su interacción frecuente con los profesionales del ramo.

En otro bloque de actividades extracurriculares, se motiva a los estudiantes para que organicen eventos académicos y culturales como ciclos de conferencias y competencias académico–deportivas, dirigidas a la propia comunidad estudiantil.

En la realización de estas actividades, los estudiantes ponen en juego su capacidad de organización y corresponsabilidad, a la par de promover el espíritu de competencia entre los participantes.

CONCLUSIONES Y RECOMENDACIONES

El desarrollo de habilidades de los estudiantes de Ingeniería puede fomentarse a través de estrategias de enseñanza–aprendizaje, dentro y fuera del salón de clase, mediante actividades complejas (desarrollo de proyectos y organización de eventos) y puntuales (escritura de ensayos, diseño de juegos, resolución de problemas, participación en competencias, etc.). Para alcanzar una formación integral de los estudiantes de nivel superior, más que seguir incluyendo asignaturas que saturan los programas de estudio, es altamente recomendable instrumentar estrategias de enseñanza-aprendizaje que involucren la realización de actividades curriculares y extracurriculares orientadas al desarrollo de habilidades y actitudes. La experiencia ha mostrado excelentes resultados en la mejora de la autoestima de los estudiantes que han participado en las diferentes actividades, se han fortalecido los canales de comunicación entre profesores y alumnos y éstos se han percatado de que es posible establecerlos entre sus compañeros y con estudiantes más jóvenes. Ambas situaciones de mejora han permitido a los alumnos, sentirse menos presionados o agredidos en un ambiente al que han accedido por razones de estudio, en una época en que están sujetos a muchos cambios

La participación de los alumnos de nivel superior en eventos de difusión y divulgación dirigidos a jóvenes y niños ha mostrado excelentes resultados, en razón de la afinidad y confianza mutua que facilitan la comunicación entre ellos.

Es posible establecer vínculos de cooperación entre estudiantes de diversas instituciones educativas a través de la realización de conferencias, cursos, visitas, congresos, concursos, etc, organizados por ellos mismos.

La realización de algunas de estas actividades, permite consolidar la vocación de los estudiantes, sobre todo en momentos en que el exceso de información, hace más atractivas las licenciaturas relacionadas con la electrónica, las comunicaciones y la computación.

Con el propósito, entre otros, de hacer más atractivo el estudio de las Ciencias Básicas, es necesario que los profesores fortalezcan sus habilidades y actitudes para diseñar, seleccionar y asesorar aquellas actividades en que participarán los estudiantes.

Los profesores involucrados en el diseño de estas actividades, encontrarán un mayor número de elementos que permiten evaluar de forma integral el aprendizaje de sus estudiantes.

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Con este conjunto de actividades, además de disfrutar su aspecto lúdico, los alumnos tienen la oportunidad de mejorar su capacidad de análisis y creatividad, al diseñar y proponer otras actividades similares.

El reconocimiento de las diferentes capacidades de los estudiantes, requiere de actividades que propicien su desarrollo, para esto se promueve su participación en exposiciones de profesiones y Ferias de Ciencias.

Los alumnos que deciden incorporarse en estas exposiciones, diseñan, ensayan y/o presentan actividades experimentales orientadas a despertar el interés vocacional, mejorar la imagen de las Ciencias, divulgar el conocimiento científico–tecnológico, destacar la importancia del quehacer científico y su impacto en la sociedad y facilitar el acercamiento de los niños a la Ciencia.

En el caso de la feria de carreras ofrecidas por el IPN, los alumnos realizan demostraciones recreativas para atraer la atención de los visitantes y mostrar aspectos agradables de las Ciencias y la Ingeniería.

En la Feria de Ciencias, orientada a rescatar el interés por las diferentes ramas del conocimiento científico entre la población de educación básica, los alumnos conducen la realización de actividades sencillas por parte de los niños visitantes, las cuales implican poner en juego los sentidos y el razonamiento.

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Con el propósito de mejorar la capacidad de organización, relaciones humanas y responsabilidad en el cumplimiento de las actividades comprometidas, se recomienda la participación en las secciones estudiantiles de las agrupaciones gremiales afines para que los estudiantes colaboren en la organización de las diferentes actividades académicas (congresos, cursos cortos, visitas industriales, conferencias técnicas, etc.) y sociales (conferencias culturales, excursiones) que realizan las secciones estudiantiles del Instituto Mexicano de Ingenieros Químicos (IMIQ), la Sociedad Química de México (SQM), la Sociedad de Ingenieros en Plásticos (SIP), la Sociedad Polimérica de México (SPM), la Sociedad Química Cosmetológica (SQC), etc.

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En la realización de estas actividades, los estudiantes ponen en juego su capacidad de organización y corresponsabilidad, a la par de promover el espíritu de competencia entre los participantes.

CONCLUSIONES Y RECOMENDACIONES

El desarrollo de habilidades de los estudiantes de Ingeniería puede fomentarse a través de estrategias de enseñanza–aprendizaje, dentro y fuera del salón de clase, mediante actividades complejas (desarrollo de proyectos y organización de eventos) y puntuales (escritura de ensayos, diseño de juegos, resolución de problemas, participación en competencias, etc.). Para alcanzar una formación integral de los estudiantes de nivel superior, más que seguir incluyendo asignaturas que saturan los programas de estudio, es altamente recomendable instrumentar estrategias de enseñanza-aprendizaje que involucren la realización de actividades curriculares y extracurriculares orientadas al desarrollo de habilidades y actitudes. La experiencia ha mostrado excelentes resultados en la mejora de la autoestima de los estudiantes que han participado en las diferentes actividades, se han fortalecido los canales de comunicación entre profesores y alumnos y éstos se han percatado de que es posible establecerlos entre sus compañeros y con estudiantes más jóvenes. Ambas situaciones de mejora han permitido a los alumnos, sentirse menos presionados o agredidos en un ambiente al que han accedido por razones de estudio, en una época en que están sujetos a muchos cambios

La participación de los alumnos de nivel superior en eventos de difusión y divulgación dirigidos a jóvenes y niños ha mostrado excelentes resultados, en razón de la afinidad y confianza mutua que facilitan la comunicación entre ellos.

Es posible establecer vínculos de cooperación entre estudiantes de diversas instituciones educativas a través de la realización de conferencias, cursos, visitas, congresos, concursos, etc, organizados por ellos mismos.

La realización de algunas de estas actividades, permite consolidar la vocación de los estudiantes, sobre todo en momentos en que el exceso de información, hace más atractivas las licenciaturas relacionadas con la electrónica, las comunicaciones y la computación.

Con el propósito, entre otros, de hacer más atractivo el estudio de las Ciencias Básicas, es necesario que los profesores fortalezcan sus habilidades y actitudes para diseñar, seleccionar y asesorar aquellas actividades en que participarán los estudiantes.

Los profesores involucrados en el diseño de estas actividades, encontrarán un mayor número de elementos que permiten evaluar de forma integral el aprendizaje de sus estudiantes.

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LO BLANCO Y LO NEGRO DEL PROCESO EDUCATIVO

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Abstract — *Cuando se pretende realizar el análisis de los diferentes momentos, componentes o de todo el proceso educativo, resulta más fácil y conveniente enmarcarlo dentro de algún modelo educativo proporcionado u oficializado, pero es precisamente lo opuesto lo que permite cuestionar sobre los elementos que siempre están presentes y establecen los límites del análisis. En este trabajo se presenta una introspección de los límites de cinco elementos de dicho proceso: poder (autoridad-libertad), individuo (persona-sociedad), contenido (formación-información), trabajo (esfuerzo-interés) y contexto (idealidad-realidad), sin inducir o cuestionar el grado positivo o negativo de los mismos. Para sustentar lo anterior se citan diversos valores educativos que validan el principio axiológico del presente trabajo, así como la concepción de los actores principales alumno-profesor, como individuos con fortalezas y debilidades que se reflejan en su proceder y, por consecuencia, en el proceso educativo.*

Index Terms — *Actitudes, educación integral, educación superior, valores.*

DESARROLLO

Esta investigación cualitativa, expone las definiciones de los supuestos axiológicos que enmarcan a cinco antinomias en cualquier componente y momento del proceso educativo, permitiendo además definir una concepción sobre la participación de los dos actores principales en el mismo.

Conciencia Histórica.

Permite orientar acciones al aceptar la identidad y la unidad nacional, como parámetros de reflexión sobre la cultura, en un contexto específico, eliminado manifestaciones de xenofobia, patriotismo intolerante o nacionalismo a ultranza.

Conciencia moral.

Importancia de descubrir que la conducta es el producto de la reflexión y decisión personal, pero lo suficientemente clarificada para garantizar la base racional y evitar la anarquía y el autoritarismo.

Servicio.

Entrega que antepone interés o comodidades para hacer de la tarea un trabajo solidario y compromiso de colaboración.

Humanismo.

Perfeccionamiento del hombre al identificar sus alcances, contradicciones y absurdos en el respeto de las reglas de la naturaleza, al buscar el fin último de integrarse a la misma.

Apertura al cambio.

Ser más humano y plural en las relaciones sociales, a través de la reflexión y análisis de la existencia de nuevas formas de vida y pensamiento.

Vocación.

Inclinación, cauces técnicos, científicos y legales que permiten ejercer una profesión, entendida como el procedimiento que garantiza un desempeño más articulado.

Integración social.

Interpretación de la persona dentro de la totalidad, la cual se alcanza en la medida que se equilibran en sus justas relaciones lo personal y lo colectivo, en un clima de libertad y participación democrática.

Transmisión de cultura.

Se convierte en valor cuando como ciencia y técnica, con buen juicio, integra lo particular con lo general de nuestras raíces.

Tolerancia.

Entendida como el desarrollo del respeto en la convivencia con los otros que piensan, sienten y actúan de manera diferente a la propia.

Comunicación.

Llega a ser un valor cuando su manifestación es un dialogo abierto para comprender y escuchar a los demás, favoreciendo el encuentro entre los participantes.

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Autoformación.

Implica continuar aprendiendo después de la permanencia en un sistema escolarizado y formal, a través de la preparación, reflexión e incorporación de saberes, valores y actitudes que favorezcan el desarrollo humano.

Si el planteamiento del análisis se realizara buscando solo el significado y la contraparte de estos valores, entonces estaríamos en una posición interpretativa. Por el contrario, la idea principal es presentar estos valores educativos como medidas de reflexión y sugerencias de resolución.

El reconocer alcances, recursos y sobre todo límites de acción, nos facilita la opción de decidir con firmeza y enfatizar una crítica que construya decisiones que favorezcan la educación, al permitir definir los procedimientos y/o características que deben prevalecer cuando nos enfrentamos a algún problema o disyuntiva de nuestro quehacer educativo.

En este encuadre las antinomias se expondrán comparativamente para reconocer su rango de acción entre cada par, sin embargo aunque el título del trabajo expresa un punto blanco y su extremo negro, en ningún momento se desean establecer como parámetros de consideración drástica, mucho menos dogmática.

Sociedad-persona

La primera nos fija patrones de comportamiento, ciertos códigos de valores, requerimientos que considera suficientes para el bien común o simplemente usos y costumbres que nos permiten ejercer acciones democráticas o solidarias; sin embargo cada uno de nosotros como persona tiene derechos sustentados en criterios, intereses y afanes, ponderables aún en contra de la misma colectividad.

Libertad-autoridad

Nacemos con la libertad de acción y son los factores condicionantes externos los que acotan esta facultad de decisión y acción, presentándose así un límite máximo que es la autoridad, la cual debe estar estructurada con fundamentos ontológicos, éticos y jurídicos que impliquen orden y mandato, mismos que, al no existir los anteriores fundamentos, se pueden convertir en abuso y arbitrariedad.

Idealidad-realidad

Al enfrentarse ambas como un dilema, se genera un conflicto de adecuación y confrontación de supuestos. Esto en razón de que la primera se manifiesta a través de un modelo único que rige el actuar en todos los rubros Institucionales, en tanto que la segunda se relaciona con la manifestación histórico-social de tal modelo, en un momento y espacio.

Formación-información

En referencia a la primera se define como el resultado de una experiencia vital y una orientación axiológica, que adecue los conocimientos en forma objetiva, sustentado en sus creencias y fines personales y sociales, cuidando de no caer en el adoctrinamiento o dogmatismo. Por el contrario, la segunda pretende crear un cientificismo intolerante al presuponer que el saturar de saberes es el objetivo principal, no importando la aportación o acercamiento de este conocimiento a la realidad social.

Esfuerzo-interés

Este último par antagónico se considera el más subjetivo de todos, puesto que involucra aspectos de motivación como elemento intrínseco de cada persona, hecho que ocasiona que sea la decisión del individuo el peso mayor al momento de sopesar sus metas, objetivos, simpatías y necesidades. Su selección estará enfocada a favorecer su entorno cultural, social y económico y en la mayoría de las veces será la que le represente menor esfuerzo.

ANÁLISIS

Si la referencia es una institución educativa, cómo responderíamos a la pregunta: ¿hasta dónde nuestra conducta es egoísta y hasta dónde es colectiva?. Está claro que existe todo un contexto personal y una formación que obligan a definir la respuesta con base en nuestra conciencia histórica y moral, además de otros valores como la apertura al cambio, la transmisión de cultura, etcétera.

Y el pensamiento trabajaría entonces entre un extremo personal y otro extremo social, efecto que como opuesto nos permitiría vislumbrar a cual le va a dar mayor importancia a satisfacer mis intereses, sin ponderarlos requerimientos como Institución, o es más significativo el sacrificar mi persona por el bien común.

También podríamos considerar que en el ámbito académico, se pueden presentar los extremos de una libertad excesiva que se puede convertir en libertinaje donde hago lo que quiero sin respeto ni tolerancia y una autoridad impuesta y sin valor alguno que pierde el control de las acciones. En cualquiera de estos casos, el compromiso social, la vocación de servicio y la apertura a los cambios están lejos de aparecer.

En cuanto a los contenidos, la referencia cotidiana sería el establecer un cúmulo de datos, teorías, etcétera, que yo Profesor vacié a los estudiantes para que la repitan como tal, es decir mi punto límite es la información; o mejor reflexiono sobre lo que le será significativo, lo que manejará y empleará en su formación, que es nuestro otro extremo, evidenciando los valores educativos, de transmisión de cultura, conciencia histórica, vocación, y sobretodo inculcando la autoformación y el humanismo.

El mismo efecto sucede cuando se revisa el modelo educativo de nuestra Institución que de manera ideal nos presenta la misión y la visión que se debe buscar y sucede que cuando observamos nuestra realidad, visualizamos una serie de incongruencias, carencias, ineficiencias, que además de desmerecer nuestro interés, desaniman en ocasiones nuestro esfuerzo. Pero esto es factible de acomodarse después de sopesarlos bajo los valores de tolerancia, servicio, vocación, comunicación y autoformación.

CONCLUSIONES

Sería interminable complejo y aparentemente indescifrable el analizar cada uno de los componentes y momentos del proceso educativo, lo que esta experiencia nos marca es un camino que nos permite, establecer que estos aspectos son factibles de resolverse; a través de la representación de una red de posibilidades, con la conciencia de los límites y niveles a los que nos enfrentamos.

Esta conciencia siempre deberá estar regida por principios axiológicos que facilitan nuestro actuar y encuadrada en principios pedagógicos señalados como antinomias por su antagonismo referencial, pero que nos permiten reconocer los límites de nuestra práctica.

En una revista llamada tiempo libre apareció un día del maestro un artículo titulado "hoy, educar es diferente", y que escribe: "Educar hoy es diferente, no porque halla cambiado el objetivo fundamental...........sino porque hay que tomar en cuenta los distintos elementos de nuestro tiempo, que antes no existían y que han venido a imponerse en el mundo de la modernidad"...... exige prepararse más y mejor, identificar una jerarquía de valores y –hacerlos valer- por la congruencia de la propia vida......." (Paz Fernández, 1998).

Por último "Educamos más por lo que somos que por lo que hacemos y decimos, porque la educación es una forma de vida, no sólo una profesión o actividad". (Blanco, 1997).

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UNA METODOLOGIA PARA EL ANALISIS Y OPTIMIZACION DE MODELOS QUE EVALUAN LA CALIDAD DE LA ENSEÑANZA

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Resumen-- *El presente trabajo está encuadrado dentro de los campos de la calidad total, y de la educación superior, y dentro de esta, específicamente en lo que hace a la formación de Ingenieros. Se ha diseñado una metodología que permite analizar y optimizar Modelos que Evalúan la Calidad de la Enseñanza. Dicha metodología, se ha aplicado al análisis y optimización del Sistema SECAI (Sistema de Evaluación de la Calidad de las Enseñanzas de la Ingeniería, desarrollado en el marco del Programa Columbus de la Comunidad Europea), utilizando los datos emergentes de la aplicación de SECAI a la evaluación de nueve Carreras de Ingeniería de cinco Universidades de diferentes países. La metodología diseñada se ha obtenido utilizando una estrategia de análisis mixta entre experimentación y métodos estadísticos, lo cual ha hecho posible definir criterios suficientemente científicos y estables, que han permitido obtener un Modelo Optimizado, cuya aplicación a las nueve Carreras de las cinco Universidades antes mencionadas, ha arrojado resultados análogos a los obtenidos con el Modelo SECAI Original, mejorando su eficiencia sin disminuir su eficacia.*

En este trabajo se ha diseñado una metodología para analizar y optimizar modelos que son utilizados para evaluar la calidad del proceso de enseñanza aprendizaje de Instituciones Universitarias, pero nada impide extender su aplicación a procesos o sistemas que no tengan nada que ver con la educación superior.

El modelo elegido para analizar y optimizar ha sido el Modelo SECAI (Sistema de Evaluación de la Calidad de la Enseñanza de Ingeniería) desarrollado en el marco del programa COLUMBUS DE LA COMUNIDAD EUROPEA. Por un grupo de expertos en evaluación de la enseñanza de la Ingeniería, procedente de los siguientes centros:

- IMPERIAL COLLEGE OF SCIENCE – INGLATERRA
- INSTITUTO TECNOLOGICO DE MONTERREY – MEXICO
- POLITÉCNICO DE TORINO – ITALIA
- PONTIFICIA UNIVERSIDAD JAVERIANA DE BOGOTA – COLOMBIA
- TESCHNISCHE HOCHSCHULE – DARMSTAD – ALEMANIA
- UNIVERSIDAD CATOLICA DE VALPARAISO – CHILE
- UNIVERSIDAD DE RIO DE JANEIRO – BRASIL
- UNIVERSIDAD POLITÉCNICA DE MADRID – ESPAÑA
- UNIVERSIDAD NACIONAL DE MAR DEL PLATA – ARGENTINA

Analizando los conceptos y fundamentos que han servido como base para el diseño y estructuración del Modelo SECAI, rápidamente se advierte que estos responden a los conceptos y fundamentos del Control de Calidad Total aplicado en la industria, naturalmente, con las adaptaciones pertinentes al campo de aplicación para el que ha sido diseñado, esto es, la enseñanza superior.

En este modelo se define Calidad de la Enseñanza de la siguiente manera:

"La enseñanza es de calidad en la medida en que se logran los objetivos previstos y estos son adecuados a las necesidades de la sociedad y de los individuos que se benefician de ella".

Esta definición nos conduce al diseño del plan de estudios y especialmente, a los objetivos formativos, su pertinencia y su realismo.

En función de esto, los expertos de SECAI han considerado como una buena base a la hora de establecer una estrategia de evaluación de la calidad de la enseñanza, centrar ésta, en la institución, que ofrece un programa de estudios, su misión, sus fines, el contexto social al que debe servir, el proceso interno de enseñanza - aprendizaje que desarrolla y la concordancia entre logros, objetivos previstos y recursos utilizados.

Con todo esto, llegamos al concepto de "Calidad Global de la Enseñanza", equivalente al de "Calidad Total" utilizado en las empresas industriales, puesto que se plantean, ahora, varios componentes de la calidad de la enseñanza:

- *Calidad del plan de estudios*
- *Calidad del proceso de enseñanza*
- *Calidad de resultados inmediatos*
- *Calidad de integración*
- *Calidad de servicio o de resultados a medio y largo plazo*

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Para evaluar cada uno de los componentes de calidad antes definidos, se utilizan indicadores de calidad.

Estos indicadores deberán ser cuantitativos y cualitativos.

Es de destacar que si bien la utilización de Indicadores cualitativos es insoslayable, su valoración objetiva resulta extremadamente difícil.

El Modelo SECAI se estructura en un conjunto de 94 indicadores a través de los cuales se pretende evaluar los siguientes factores de calidad:

1. Plan de Estudios
2. Condiciones de ingreso de los estudiantes (entrada proceso)
3. Proceso de enseñanza – aprendizaje
4. Resultados inmediatos
5. Integración de los graduados

Cada indicador es valorado con una escala de 1 a 5, utilizándose el cero cuando no se puede valorar o calificar por falta de datos u otras razones, vale decir: 5 → MUY ALTA, 4 → ALTA, 3 → MEDIA, 2 → BAJA, 1 → MUY BAJA, 0 → SIN CALIFICACION POR FALTA DE DATOS U OTRAS RAZONES.

Además, con el objeto de que el auditor o evaluador pueda emitir un juicio globalizado acerca de cada factor o subfactor, se utilizan índices de calidad cuya valoración es también de 1 a 5, valoración que no tienen porqué coincidir con el valor medio de las valoraciones o calificaciones otorgadas a los indicadores de su grupo, ya que eso supondría atribuir el mismo peso a cada uno, lo cual no tiene ningún, fundamento, ni teórico, ni práctico.

En resumen, este Modelo en su versión original, está compuesto por cinco factores, 6 subfactores, 94 indicadores, 9 subindices de calidad y 5 índices de calidad.

A continuación se presenta una planilla resumen utilizadas para las evaluaciones internas y externas:

Cuadro I:

Planilla de Resumen

CRE-COLUMBUS				**SISTEMA DE EVALUACION DE LA CALIDAD DE LAS ENSEÑANZAS DE INGENIERIA (SECAI)**								**INSTITUCION (CODIGO)** / **HOJA DE RESUMEN DE EVALUACION**					
PLAN DE ESTUDIOS				**I. ESTUDIANTES**		**PROCESO DE ENSEÑANZA**								**RESULTADOS**		**INTEGRACION**	
PARTICIPACION		**CONTENIDO**				**GESTION**		**PROFESORES**		**INSTALACIONES**		**F. DIDACTICOS**					
11001		13001		20001		31001		32101		33101		34001		40001		50001	
11002		13002		20002		31002		32102		33102		34002		40002		50002	
11003		13003		20003		31003		32103		33103		34003		40003		50003	
METODOLOGIA		13004		20004		31004		32104		33104		34004		40004		50004	
12001		13005		20005		31005		32105		33105		34005		40005		50005	
12002		13006		20006		31006		32106		33106		34006				50006	
12003		13007				31007		32107		33107		34007				50007	
12004		**P.EN MARCHA**				31008		32108		**EQUIPOS**		34008				50008	
12005		14001				31009		32109		33201		34009					
12006		14002				31010		32110		33202		34010					
12007		14003				**P. SERVICIOS**		32111		33203		34011					
		14004				32201		32112		33204		34012					
		14005				32202				33205		34013					
						32203				33206		34014					
						32204		I_{321}		I_{331}							
I_{11}		I_{13}						I_{322}		I_{332}		I_{34}					
I_{12}		I_{14}				I_{31}		I_{32}		I_{33}							
$I_1 =$				$I_2 =$		$I_3 =$								$I_4 =$		$I_5 =$	

En función de lo expresado y dado que efectivamente, el Modelo SECAI ha sido diseñado teniendo en cuenta los conceptos y fundamentos del Control de Calidad Total en la Industria, se decidió tener en cuenta estos mismos fundamentos y conceptos para analizarlo y optimizarlo, por cuanto, en nuestra opinión, existía una súperabundancia de indicadores.

Básicamente el Control de Calidad Total en la Industria se define como:
"El conjunto de esfuerzos efectivos de los diferentes grupos de una organización para la integración del desarrollo, del mantenimiento y la superación de la calidad de un producto, con el fin de hacer posibles fabricación y servicio a satisfacción del consumidor y al nivel más económico".

Por otra parte, en el Control de Calidad Total se deben seguir los siguientes cuatro pasos:

1. *Control de Calidad en toda la organización, con la participación de todos los miembros de la misma.*
2. *Educación y capacitación en Control de Calidad para todo el personal*
3. *Auditoría de Control de Calidad Interna y externa.*
4. *Utilización de Métodos Estadísticos*

En función de todo esto, el fundamento del concepto de Calidad Total es que: *"el control debe iniciarse con el diseño del producto, y no termina sino cuando este llega a manos del consumidor y lo satisface".*

En la elaboración del Modelo SECAI se han tenido en cuenta todos estos pasos y fundamentos, excepto el 4, es decir, la utilización de métodos estadísticos, métodos que nosotros utilizaremos para analizar y optimizar el Modelo SECAI.

Veamos que es lo que se hace en la industria.

En primer lugar diremos que las características de calidad de un producto, proceso o sistema, cualesquiera sean estos, son dos:

- *Características de calidad reales*
- *Características de calidad sustitutas*

Por ejemplo, en un buen automóvil de turismo, las características de calidad reales o atributos que los consumidores exigen son los siguientes :

- *Buen diseño*
- *Facilidad de conducción*
- *Confort*
- *Buena aceleración*
- *Estabilidad a altas velocidades*
- *Durabilidad*
- *Seguridad*
- *Facilidad de reparación*

Como se puede ver, las características de calidad reales son generalmente subjetivas y por lo tanto muy difíciles de medir, y aquí surge el problema fundamental a resolver, que es: como lograr estas características, que son las que demanda el consumidor. Las empresas que mejor logran esto, son las que ganan el mercado.

Las características de calidad sustitutas son, en cambio, aquellas que se pueden medir y las que hay que definir para poder lograr las características de calidad reales.

En el caso del automóvil, las características de calidad sustitutas serían, por ejemplo :

- *las materias primas*
- *la resistencia de los materiales*
- *los procesos de fabricación y maquinado*
- *las tolerancias*
- *los tratamientos térmicos*
- *etc.*

Características éstas que rápidamente se advierte que son medibles, y por tanto, objetivas.

Ahora bien, el proceso a seguir para obtener las características reales a partir de las sustitutas, es el siguiente :

- *Definir las características de calidad reales para un producto dado.*
- *Resolver el problema de como medir tales características y como fijar las normas de calidad para el producto.*
- *Determinar las características de calidad sustitutas*
- *Establecer la relación entre las características de calidad reales y las sustitutas mediante estadísticas y análisis de calidad.*

En general, una vez definidas las características de calidad reales (mediante encuestas, estudios de mercado, etc.) y las posibles características de calidad sustitutas (mediante el concurso de especialistas) que nos permitirán alcanzar dichas características reales, se debe realizar un análisis de calidad estadístico para determinar cuales de estas características sustitutas seleccionadas, son las que nos permitirán alcanzar las reales, e incluso no habrá que extrañarse si algunas de ellas no tiene ninguna o escasa relación con las reales.

Para poder realizar este análisis, normalmente se diseña un modelo que recurre a indicadores de tipo cuantitativo y cualitativo, y en general, se puede decir que los indicadores cualitativos representarán características de calidad reales, mientras que los indicadores cuantitativos se referirán a características de calidad sustitutas, aunque alguno de ellos puede representar una característica de calidad real.

Por lo tanto el problema básico consiste en diseñar una metodología que nos permita determinar el grado de correlación que existe entre estos indicadores.

Diseñada esta metodología, estaremos en poder de una herramienta que nos permitirá, en primer lugar, optimizar el modelo, y en segundo lugar, efectuar su validación.

El problema ya complejo de determinar la calidad de un proceso, sistema o producto industrial, se vuelve – en el caso de una Universidad – altamente complejo, por cuanto el sistema universitario, es uno de los sistemas más complejos que existen, pues está sometido a una serie de condiciones y presiones a los que obviamente no está sometida una fabrica de automóviles y dado que en el caso de la Universidad, el producto son personas, el problema se vuelve más complejo aún, por cuanto las características de calidad reales, se hacen más difíciles de definir y naturalmente, mucho más difíciles de medir y objetivizar, y muchas de las que llamaríamos características de calidad sustitutas, definidas por indicadores cuantitativas que se utilizan normalmente a la hora de evaluar Instituciones Universitarias, ni tienen relación, ni presentan ayuda alguna para definir las características de calidad reales del "producto" ni del sistema, aunque puedan medir la eficiencia de este, que en última instancia podría considerarse como una características de calidad real de él, pero sin que tenga nada que ver en las características de calidad reales del "producto", que es lo que finalmente importa

METODOLOGÍA PARA EL ANÁLISIS Y OPTIMIZACIÓN DEL MODELO

La metodología de análisis y optimización se ha basado en la aplicación de dos métodos estadísticos en conjunción con el método de "juicio de expertos", habiéndose utilizado los resultados de la aplicación de SECAI a nueve carreras de cinco Universidades, que son las siguientes:

1. UNIVERSIDAD: P.J.B.C.
   CARRERA: Ingeniería Electrónica
2. UNIVERSIDAD: N.M.P.A.
   CARRERA: Ingeniería Eléctrica y Electrónica
3. ESCUELA: P.N.Q.E.
   CARRERA: Ingeniería Eléctrica y Electrónica
4. UNIVERSIDAD: P.M.E.
   CARRERA: Ingeniería Técnica Aeronáutica
5. UNIVERSIDAD: C.V.CH.
   CARRERA: Bioquímica
   CARRERA: Ingeniería Eléctrica
   CARRERA: Ingeniería Mecánica
   CARRERA: Ingeniería Química
   CARRERA: Ingeniería Industrial

OBJETIVO DE LA OPTIMIZACIÓN

El objetivo de la optimización es reducir el numero de indicadores sin que pierda eficacia el modelo en cuanto a los resultados de la evaluación y en lo que respecta a la información que suministra para abordar futuros procesos de mejoras de la calidad.

METODOLOGIA

Para lograr este objetivo se ha seguido un desarrollo metodológico basado en dos hipótesis fundamentales:

1. *El modelo original de 94 indicadores elaborado durante un largo periodo, en el que han intervenido un gran número de expertos y docentes, incluye la totalidad de los factores que influyen en la calidad de la enseñanza.*
2. *Es posible reducir el número de indicadores sin que exista perdida de información significativa para la evaluación de la calidad, mejorando la eficiencia del modelo sin pérdida de eficacia.*

Para realizar el análisis y optimización del modelo, se contó con las evaluaciones internas (CEI) y externas (CEE) de las nueve carreras, plasmadas en las respectivas Planillas Resumen. Además se contó con un análisis del modelo, efectuado por 40 expertos, docentes y Directivos de Centros Universitarios. Dicho análisis se había efectuado dos años después de haberse diseñado SECAI y habiéndose evaluado ya varias carreras de Ingeniería de distintas Universidades de varios países, con el objeto de reducir el número de indicadores.

Muchos de estos expertos habían actuado como evaluadores externos de SECAI, y por tanto conocían muy bien el modelo.

Como resultado de este análisis, los 40 expertos concluyeron en que, efectivamente, los indicadores eran demasiados y por tanto recomendaron reducirlos ya fuese eliminando algunos no demasiado importantes o agrupándolos en la forma más conveniente.

De esta acción surge una propuesta de modelo optimizado, basada exclusivamente en el juicio de expertos, que reduce los 94 indicadores a sólo 69.

En función de todo esto, el desarrollo metodológico y los instrumentos, para realizar el análisis y optimización, motivo de este trabajo, se representa en el siguiente esquema:

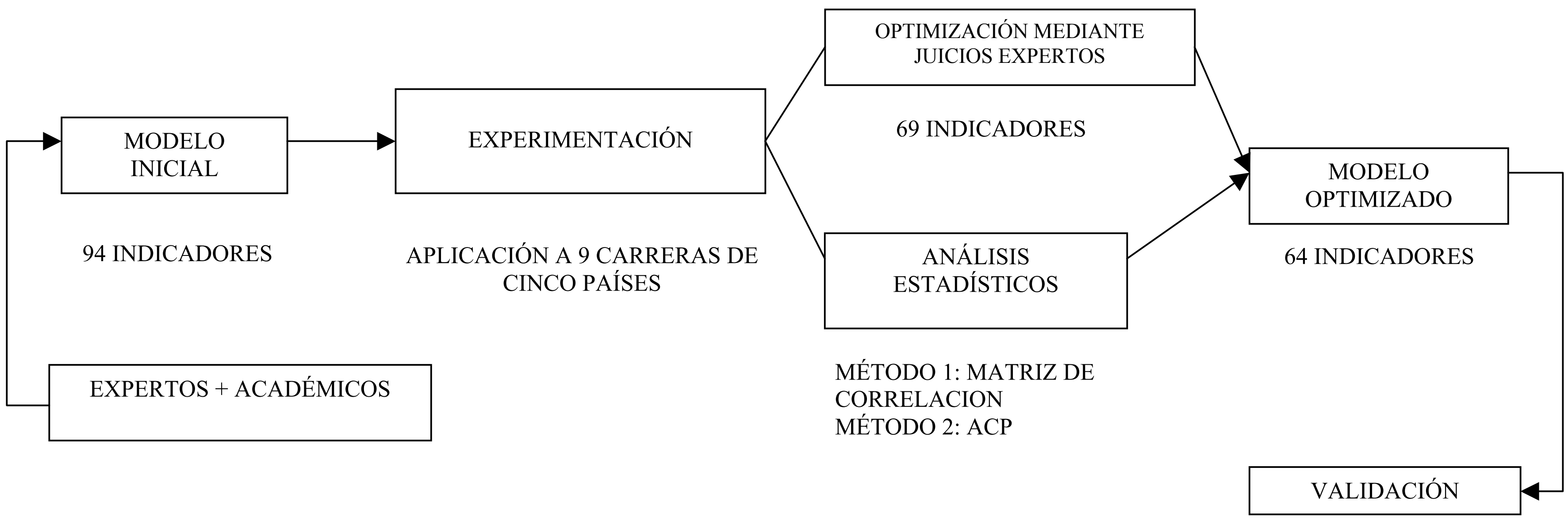


FIGURA I:
Desarrollo Metodológico e Instrumentos

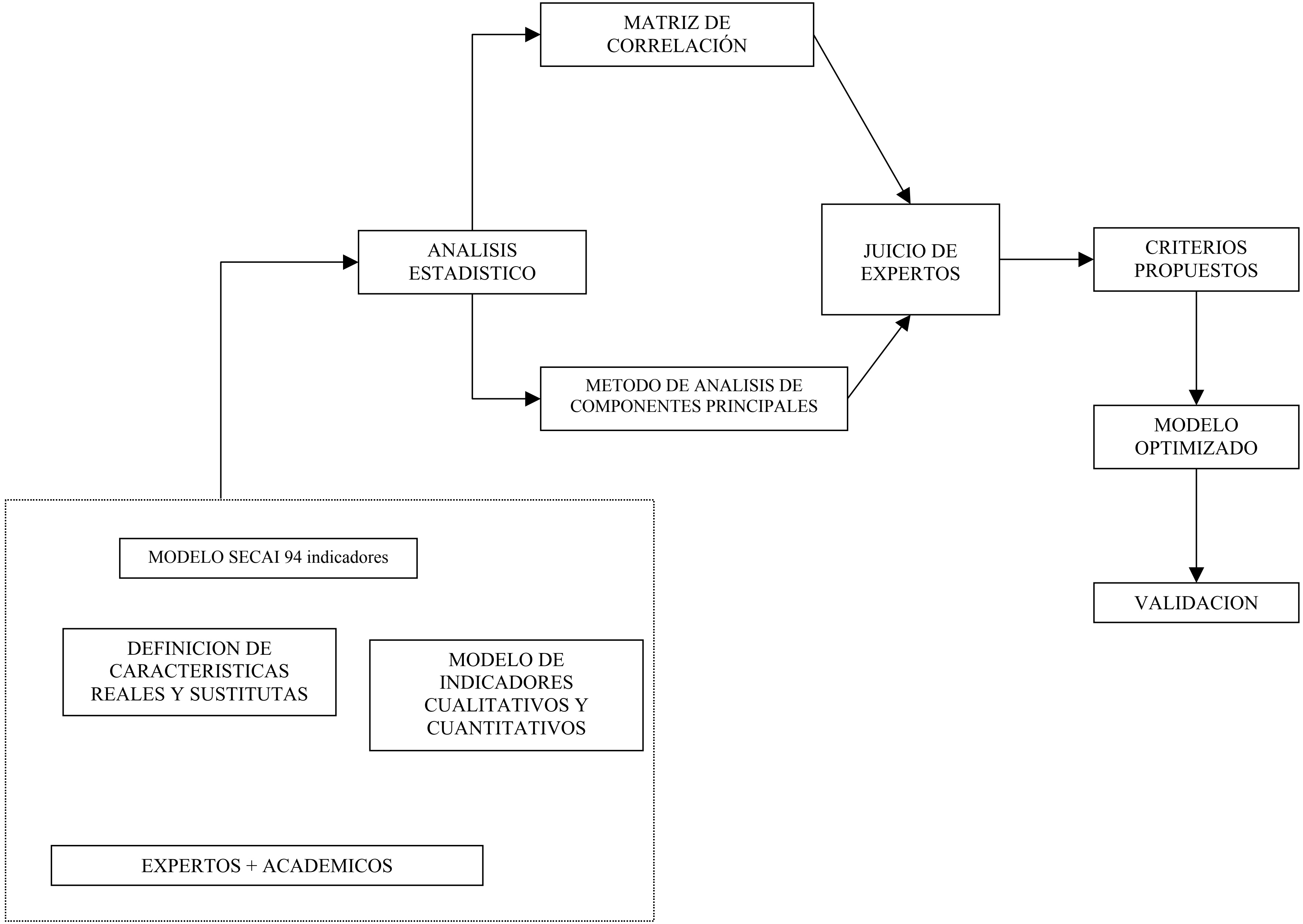


FIGURA II
Metodología seguida para la Optimización

ANÁLISIS ESTADÍSTICO

Si tanto una prueba paramétrica como una no – paramétrica son aplicables al mismo conjunto de datos, se debe evitar, la prueba no – paramétrica "rápida y fácil", y efectuar la técnica paramétrica más eficiente.

Teniendo en cuenta esto, en nuestro caso, dada la forma de calificación adoptada, si bien el nivel de medición es ordinal, los datos pueden ser procesados intervalarmente y se puede suponer un comportamiento paramétrico.

Este concepto es el que nos permite construir las matrices de correlación. Una con la valoración de los indicadores resultado de la evaluación interna y otra con la valoración de los indicadores resultado de la evaluación externa.

MATRIZ DE CORRELACIÓN

Como primer paso hacia la optimización del modelo, se analiza la correlación existente entre los 94 indicadores.

Construimos la matriz de correlación con todos los indicadores (94 x 94), cuyo fundamento es el siguiente:

Supongamos los indicadores x, y, z. La correlación entre los indicadores x e y se expresa como : r (x,y). Este coeficiente de correlación tomará valores entre 1 y -1. Si r (x,y) se acerca a cero, esto implica que ambos indicadores no están correlacionados. En cambio, si tiende a uno, la correlación es alta. Naturalmente r (x,x), r (y,y) y r (z,z) serán igual a 1.

	x	**y**	**Z**
x	1	ρ (x,y)	ρ (x,z)
y	ρ (y,x)	1	ρ (y,z)
z	ρ (z,x)	ρ (z,y)	1

Para determinar que indicadores están correlacionados se realiza un test de hipótesis. La hipótesis a probar es: "los indicadores no están correlacionados"

Esto es equivalente a decir que el coeficiente de correlación es igual a cero, vale decir, r = 0.

Se fija un nivel de significación "p" para la prueba de 5%.

El nivel de significación "p" es la probabilidad de rechazar la hipótesis propuesta siendo esta verdadera.

Si el nivel de significación "p" es menor o igual que 0,05, se rechaza la hipótesis. Lo cual implica que los indicadores están correlacionados.Por lo tanto, se adopta como primer criterio, trabajar con un nivel de confianza del 95% para seleccionar los indicadores que están correlacionados, lo cual, en primera instancia, nos permitiría eliminar todos aquellos indicadores que presentan una correlación con un nivel de confianza mayor o igual al 95%. A modo de ejemplo presentamos la primer página de la matriz de correlación resultado de evaluación interna:

MATRIZ I

Matriz de Correlación Evaluaciones Internas

Sample Correlations

	A11001	A11002	A11003	A12001	A12002	A12003
A11001	1.0000	0.7003	0.7802	0.4605	0.2649	0.4318
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0000	0.0356	0.0131	0.2122	0.4909	0.2458
A11002	0.7003	1.0000	0.7559	0.6576	0.2671	0.6786
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0356	0.0000	0.0185	0.0542	0.4872	0.0445
A11003	0.7802	0.7559	1.0000	0.3107	0.1331	0.7357
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0131	0.0185	0.0000	0.4158	0.7329	0.0239
A12001	0.4605	0.6576	0.3107	1.0000	0.4391	0.5871
	(9)	(9)	(9)	(9)	(9)	(9)
	0.2122	0.0542	0.4158	0.0000	0.2370	0.0965
A12002	0.2649	0.2671	0.1331	0.4391	1.0000	0.0486
	(9)	(9)	(9)	(9)	(9)	(9)
	0.4909	0.4872	0.7329	0.2370	0.0000	0.9013
A12003	0.4318	0.6786	0.7357	0.5871	0.0486	1.0000
	(9)	(9)	(9)	(9)	(9)	(9)
	0.2458	0.0445	0.0239	0.0965	0.9013	0.0000
A12004	0.2979	0.1443	0.0955	0.6170	0.8552	0.1650
	(9)	(9)	(9)	(9)	(9)	(9)
	0.4362	0.7110	0.8070	0.0768	0.0033	0.6715
A12005	0.7859	0.6929	0.9166	0.4031	0.4452	0.6701
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0120	0.0385	0.0005	0.2821	0.2298	0.0483
A12006	0.1860	0.3154	-0.0542	0.6317	0.8635	0.0819
	(9)	(9)	(9)	(9)	(9)	(9)
	0.6318	0.4083	0.8899	0.0680	0.0027	0.8340
A12007	0.8341	0.7071	0.8185	0.2325	0.1202	0.5808
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0052	0.0331	0.0070	0.5472	0.7581	0.1010
A13001	0.8466	0.6108	0.8254	0.3113	0.1187	0.4800
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0040	0.0806	0.0061	0.4148	0.7611	0.1910
A13002	0.4423	0.7500	0.8504	0.3699	0.1457	0.8571
	(9)	(9)	(9)	(9)	(9)	(9)
	0.2332	0.0199	0.0037	0.3272	0.7084	0.0031
A13003	0.6266	0.6250	0.7323	0.3288	0.2428	0.7143
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0709	0.0719	0.0249	0.3876	0.5290	0.0306

Coefficient (sample size) significance level

MATRIZ II

Matriz de Correlación Evaluaciones Externas

Sample Correlations

	A11001	A11002	A11003	A12001	A12002	A12003
A11001	1.0000	0.7750	0.5518	0.7836	0.2229	0.6877
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0000	0.0142	0.1235	0.0125	0.5642	0.0406
A11002	0.7750	1.0000	0.5287	0.7836	0.3001	0.4779
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0142	0.0000	0.1434	0.0125	0.4326	0.1932
A11003	0.5518	0.5287	1.0000	0.1163	-0.1127	0.2704
	(9)	(9)	(9)	(9)	(9)	(9)
	0.1235	0.1434	0.0000	0.7657	0.7729	0.4816
A12001	0.7836	0.7836	0.1163	1.0000	0.3887	0.6970
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0125	0.0125	0.7657	0.0000	0.3012	0.0369
A12002	0.2229	0.3001	-0.1127	0.3887	1.0000	-0.2479
	(9)	(9)	(9)	(9)	(9)	(9)
	0.5642	0.4326	0.7729	0.3012	0.0000	0.5202
A12003	0.6877	0.4779	0.2704	0.6970	-0.2479	1.0000
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0406	0.1932	0.4816	0.0369	0.5202	0.0000
A12004	0.0978	0.0578	-0.4237	0.3903	0.7536	-0.0456
	(9)	(9)	(9)	(9)	(9)	(9)
	0.8023	0.8825	0.2558	0.2990	0.0190	0.9072
A12005	0.8499	0.7609	0.5762	0.6767	0.2779	0.5990
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0037	0.0173	0.1044	0.0453	0.4690	0.0883
A12006	0.1423	0.1023	-0.4803	0.4590	0.7291	0.1203
	(9)	(9)	(9)	(9)	(9)	(9)
	0.7149	0.7934	0.1907	0.2140	0.0258	0.7579
A12007	0.7609	0.6275	0.5762	0.3765	-0.1186	0.4746
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0173	0.0704	0.1044	0.3179	0.7611	0.1968
A13001	0.7465	0.5339	0.3628	0.6516	0.0162	0.7622
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0209	0.1387	0.3373	0.0572	0.9670	0.0170
A13002	0.5164	0.6132	0.5433	0.4047	-0.3764	0.7524
	(9)	(9)	(9)	(9)	(9)	(9)
	0.1546	0.0791	0.1306	0.2800	0.3181	0.0193
A13003	0.8106	0.8944	0.4074	0.8627	0.3260	0.6777
	(9)	(9)	(9)	(9)	(9)	(9)
	0.0080	0.0011	0.2764	0.0028	0.3920	0.0449

Coefficient (sample size) significance level

A los efectos de dar una explicación rápida de lo que significa esta sucesión de números, tomemos por ejemplo, el indicador 12005 y el 11003 de la matriz de las evaluaciones internas. Debajo de éste, aparecen los siguientes valores:

0,9166 que es el factor o coeficiente de correlación
(9) que es el número de datos
0,0005 que es el nivel de significación

Por tanto, el propio programa, nos da el coeficiente de correlación, el nivel de significación y consecuentemente el nivel de confianza con que se trabaja, que para el caso elegido en el ejemplo será:

(100 x 1) – (0,0005 x 100) = 99,95%
100 – 0,05 = 99,95% que es el nivel de confianza.

Por otra parte, dado que la decisión ha sido trabajar con un nivel de confianza del 95%, esto implica (Loter Sachs: Estadística Aplicada, Tabla 5.13 pág. 358- Ed. Labor-1978) que para 9 datos corresponde un coeficiente o factor de correlación de 0,666. Por encima de este valor hay significación correlativa, por debajo no la hay. Por tanto, si se iguala o supera el valor tabulado (0,666), para 9 datos y test bilateral (que es nuestro caso), se rechaza la hipótesis nula y se acepta la alternativa.

En función de todo esto, de la matriz de correlación se seleccionaron todos aquellos indicadores con un nivel de significación menor o igual a 0,05 (nivel de confianza igual o mayor que el 95%) y con un factor de correlación igual o mayor a 0,666.

La ejecución de dicha matriz a través del software Statgraph Plus ha originado más de 100 páginas, para cada una de ellas (evaluación interna y externa). Del análisis de los resultados finales de la prueba de hipótesis, tanto para los valores correspondientes a las evaluaciones internas como para los correspondientes a las evaluaciones externas, surge -como era de esperar- que existe un excesivo número de correlaciones, cosa que hace casi imposible, en esta etapa, la definición de algún criterio coherente y estable para la eliminación y/o agrupación de los indicadores correlacionados. Por tanto, y a los efectos de lograr las condiciones necesarias para la toma de decisiones referente a la eliminación y agrupación de indicadores, que nos permita lograr la optimización buscada, hacemos ahora, un análisis estadístico utilizando el método de Análisis de Componentes Principales.

ANALISIS DE COMPONENTES PRINCIPALES (ACP)

A diferencia de los resultados obtenidos por la matriz de correlación en forma general, aplicamos ahora el método de ACP, donde los resultados se restringirán en forma individual a cada uno de los factores del Modelo SECAI.

La base de datos es la misma, es decir, la planilla resumen de evaluación de cada carrera.

El ACP es uno de los métodos más utilizados en el análisis multivariable. Consiste en una técnica de reducción de la información disponible sobre un conjunto de elementos, en los cuales se han tomado diversas observaciones. Condensa la matriz de correlación entre las variables, en unos "componentes principales" de la variabilidad total. Vale decir, el ACP es una técnica estadística que permite transformar un conjunto de variables intercorrelacionadas en otro conjunto de variables no correlacionadas, denominadas factores. Estos factores son combinación lineal de las variables originales.

Esta técnica se basa en el análisis de las matrices de varianza y covarianza con el fin de describir sus variables o componentes principales, es decir, las que tienen un mayor poder explicativo de la variación total del sistema.

Se fundamenta, según **C. Taylor**, en suponer que la matriz de varianza – covarianza es el reflejo de una estructura subyacente. De donde la variabilidad del sistema, puede ser explicada en su mayor parte por un número menor de variables componentes principales.

Según el procedimiento desarrollado por **Hotelling**, el primer componente principal que se extrae es el que resume lo mejor posible la información contenida en la matriz de datos original, vale decir, el que contribuye mejor a explicar la varianza total.

El segundo componente principal es el que resume lo mejor posible la información restante, es decir, el que aporta un máximo de la varianza residual resultante, siendo independiente del primero.

La secuencia puede continuar, extrayéndose factores hasta explicar la varianza total.

Algebraicamente las componentes principales (CP) son una aplicación de los autovalores y autovectores, vale decir, la varianza máxima explicada por cada indicador y los factores ortogonales de cada variable o indicador.

Los componentes principales (CP) presentan las siguientes propiedades matemáticas:

1- *Son ortogonales, es decir, no correlacionadas o independientes entre si.*
2- *Representan una transformación de las variables originales en las que se alcanza su máxima varianza posible.*

En función de todo esto, el ACP se utiliza para:

- *Reducir un conjunto de variables (o indicadores) a la síntesis de unas pocas destacadas.*
- *Mostrar que variables (indicadores) pueden ser omitidas en un sistema sin alterar la información básica.*

El cálculo de las componentes principales (CP) se realizó utilizando el Software estadístico MINITAB.

Para seleccionar los CP, se analiza la varianza acumulada y se considera el número de CP que explican, en nuestro caso, el 95% de la variación del sistema.

De esta manera, se pueden extraer indicadores posibles de ser eliminados o reagrupados, con el nivel de confianza que se desee.

A los efectos de dar una rápida explicación de la información suministrada por el software, veamos la primer página de la matriz de covarianza del Método de Análisis de Componentes Principales, factor por factor, de las Evaluaciones Internas.

Análisis de Componentes Principales

Evaluación Interna

Principal Component Analysis
Eigenanalysis of the Covariance Matrix

Eigenvalue	2.0941	0.3430	0.0906
Proportion	0.828	0.136	0.036
Cumulative	0.828	0.964	1.000

Variable	PC1	PC2	PC3
11001	-0.731	0.676	0.092
11002	-0.624	-0.718	0.310
11003	-0.276	-0.169	-0.946

Principal Component Analysis
Eigenanalysis of the Covariance Matrix

Eigenvalue	7.5036	2.8109	1.0648	0.4450	0.2913	0.2043	0.0413
Proportion	0.607	0.227	0.086	0.036	0.024	0.017	0.003
Cumulative	0.607	0.834	0.921	0.957	0.980	0.997	1.000

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7
12001	0.280	-0.300	0.490	0.415	0.494	0.394	-0.142
12002	0.572	0.122	-0.375	0.354	0.283	-0.463	0.311
12003	0.057	-0.544	0.477	0.028	-0.393	-0.475	0.303
12004	0.570	0.121	0.219	-0.736	0.073	0.169	0.192
12005	0.103	-0.293	-0.102	-0.274	0.231	-0.443	0.754
12006	0.505	0.042	-0.102	0.257	-0.680	0.245	0.380
12007	0.022	-0.705	-0.568	-0.133	0.018	0.347	0.204

Como se puede ver, en esta matriz aparecen tres valores:

- *Eingenvalue: que son los autovalores*
- *Proportion: que es la varianza proporcional*
- *Cumulative: que es la varianza acumulada*

El primer problema (cuántas variables se pueden eliminar) se resuelven mediante el Eingenanalisys de la matriz de covarianza. Por ejemplo: si analizamos los tres primeros indicadores, 11001, 11002 y 11003, vemos que el primer valor de varianza acumulada es 0,828; el segundo 0,964 = 0,828 + 0,136, y el tercero es 1 = 0,828 + 0,136 + 0,036. Por lo tanto entre el primer valor 0,828 y el segundo 0,136 tenemos el 96,4% de la varianza explicada.

Puesto que la decisión ha sido trabajar con un nivel de confianza del 95% (vale decir, tenemos que elegir la cantidad de componentes que expliquen el 95% de la varianza total de los datos), utilizando sólo dos componentes principales, ya tenemos explicada la mayor varianza o el mayor porcentaje de la variación de los datos deseado. Y por lo tanto, se puede eliminar una variable.

El segundo problema (cuáles son las variables que explican el mayor porcentaje de la varianza), se resuelve analizando las componentes principales (PC1, PC2 y PC3) de los indicadores bajo análisis, en este caso el 11001, 11002 y 11003, y seleccionando de cada columna el indicador que presente el mayor coeficiente en valor absoluto, que a su vez indica la mayor correlación.

Por ejemplo: en la columna de la componente principal 1 (PC1) vemos que el mayor coeficiente lo tiene el indicador 11001 (0,731). Ese indicador queda seleccionado. Pasamos ahora a la columna de la componente principal 2 (PC2) y vemos que el mayor coeficiente lo tiene el indicador 11002 (-0,718), por lo tanto este indicador queda seleccionado. Dado que se había determinado que con sólo dos indicadores tendríamos explicados el mayor porcentaje de los datos deseado, los indicadores 11001 y 11002 son los que quedan, pudiéndose eliminar o reagrupar el indicador 11003.

Si pasamos al grupo de indicadores del 12001 al 12007 y analizamos la varianza acumulada, vemos que con cuatro variables tendremos explicado el 95,7% de la varianza total, y por lo tanto, podremos eliminar o reagrupar tres indicadores.

Los que quedan son el 12001, 12002, 12004 y 12007, pudiéndose eliminar o reagrupar los indicadores 12003, 12005 y 12006.

Realizado este trabajo con cada uno de los factores del Modelo Original (94 indicadores) tanto para las evaluaciones internas como para las externas, resultó que en principio se podrían eliminar 36 indicadores en el caso de las evaluaciones internas y 34 indicadores en el caso de las evaluaciones externas.

Asimismo, entre las evaluaciones internas y externas, aparentemente, se podrían eliminar o reagrupar 51 indicadores, habiéndose reducido el Modelo de 94 indicadores, en tal caso, a sólo 43 indicadores, lo cual a primera vista no parece recomendable, puesto que una reducción tan significativa de indicadores redundaría en una pérdida de información demasiado importante.

A continuación se tratará de llegar a un Modelo Final Optimizado mediante la eliminación y agrupación de los indicadores originales (94), en función del trabajo estadístico realizado, de la experiencia, y del extraordinario marco de referencia y contrastación que representa el juicio de expertos de SECAI concretado en el modelo reducido de 69 indicadores.

De la comparación entre la Versión Reducida del Modelo SECAI (69 indicadores) y los resultados, consecuencia de la aplicación del Método de Análisis de Componentes Principales (ACP) al Modelo Original de SECAI (94 indicadores), surge claramente que existe una notable diferencia (como no podía ser de otra manera) entre la eliminación de indicadores propuesta por los expertos de SECAI y la propuesta por este Método Estadístico (ACP).

Por tanto, se hace necesario realizar el siguiente análisis de congruencia en base a conceptos técnicos y de experiencia, teniendo en cuenta las correlaciones establecidas por las matrices de correlación, por el Método de Análisis de Componentes Principales y por el juicio de expertos de SECAI.

ANÁLISIS EN BASE A CONCEPTOS TÉCNICOS Y EXPERIENCIA

Para realizar este análisis se tuvo en cuenta los siguientes elementos y criterios:

Elementos:

- *Eliminación de indicadores propuesta por el Método de ACP tanto en las evaluacines internas como en las externas.*
- *Correlación entre indicadores definida por la matriz de correlación (94 x 94) con un nivel de confianza del 95% para las evaluaciones internas y externas.*
- *Juicio de expertos de SECAI.*
- *La experiencia profesional*

Criterios:

Indicadores que se eliminan:

Todos aquellos Indicadores que por indicación del método de Análisis de Componentes Principales (ACP), aparezcan como susceptibles de ser eliminados, tanto en las evaluaciones internas como en las externas, y que además, así lo proponga el Juicio de Expertos de SECAI, serán eliminados.

También se eliminarán aquellos indicadores que aunque el Juicio de Expertos de SECAI no haya contemplado la posibilidad de eliminarlos, aparezcan como posibles de ser eliminados, por la aplicación del método de ACP, en ambas evaluaciones (Internas y Externas) y que la experiencia indique que pueden eliminarse sin distorsionar el modelo.

Indicadores que se agrupan:

Se agruparán todos aquellos Indicadores que presenten las condiciones de correlación establecidas, es decir: que estén correlacionados con un nivel de confianza igual o mayor al 95% en ambas evaluaciones (Matriz de Correlación. Evaluaciones Interna y Externa) y que además, así lo aconseje el Juicio de Expertos de SECAI.

También se agruparán aquellos Indicadores que, aunque el Juicio de Expertos de SECAI no haya contemplado la posibilidad de agruparlos, presenten las condiciones de correlación establecidas, y su agrupación, de acuerdo a la experiencia, parezca lógica y no distorsione la estructura del modelo.

Indicadores que se mantienen:

Se mantendrán todos aquellos Indicadores, que por la aplicación del método de Análisis de Componentes Principales (ACP), aparezcan como no eliminables en ambas evaluaciones, y así lo aconseje el Juicio de Expertos de SECAI.

También se mantendrán aquellos Indicadores, que apareciendo como susceptibles de ser eliminados, por la aplicación del método de ACP a una de las evaluaciones (Interna o Externa), aparezcan como no eliminables en la otra, y el Juicio de Expertos de SECAI aconseje mantenerlos.

En función de estos elementos y criterios se procedió al análisis de congruencia antes mencionado, indicador por indicador, llegándose a la versión optimizada, cuya estructura se presenta en el siguiente cuadro (Cuadro II) comparándola con la versión original del Modelo SECAI (94 indicadores).

Cuadro: II
Comparación Global de la Versión SECAI (94 indicadores) y la Versión Optimizada (64 indicadores)

Versión SECAI (94 Indicadores)		Versión Optimizada (64 Indicadores)	
Factores y Subfactores	Indicadores	Factores y Subfactores	Indicadores
I_1. Plan de Estudios	22	I_1. Plan de Estudios	16
I_{11}. Participación	3	I_{11}. Proceso de elaboración	6
I_{12}. Metodología	7	I_{12}. Contenido	7
I_{13}. Contenidos	7	I_{13}. Puesta en Marcha	3
I_{14}. Puesta en Marcha	5		
I_2. Ingreso de Estudiantes	6	I_2. Ingreso de Estudiantes	4
I_3. Proceso de Enseñanza Aprendizaje	53	I_3. Proceso de Enseñanza	35
I_{31}. Gestión Académica	10	I_{31}. Gestión Académica	8
I_{32}. Rec. Humanos	16	I_{32}. Recursos Humanos	11
I_{321}. Profesores	12	I_{321}. Profesores	8
I_{322}. P. Servicios	4	I_{322}. P. Servicios	3
I_{33}. Recursos Materiales	13	I_{33}.Instal. y Equipamiento	6
I_{331}. Instalaciones	7	I_{34}. Factores Didácticos	10
I_{332}. Equipamiento	6		
I_{34}. Factores Didácticos	14		
I_4. Resultados Inmediatos	5	I_4. Resultados Inmediatos	5
I_5. Integración	8	I_5. Integración	4
Total.	94	Total.	64

Vemos que la versión optimizada comporta un modelo compuesto por 5 factores, 9 subfactores y 64 indicadores.

APLICACIÓN DEL MODELO OPTIMIZADO (64 INDICADORES) A LAS CARRERAS YA EVALUADAS CON EL MODELO ORIGINAL (94 INDICADORES)

Obtenido el Modelo Optimizado de Indicadores, aparentemente, lo que se debería hacer, es efectuar una nueva evaluación, tanto interna como externa, con este modelo optimizado. Pero en realidad esto no seria correcto, ya que una carrera o institución una vez evaluada, ya no es el misma, y por tanto, a los efectos de verificar si con el modelo optimizado se obtienen resultados equivalentes a los obtenidos con el modelo original, dicha nueva evaluación no seria de mucha utilidad.

Por tanto, la decisión tomada, fue la de evaluar cada una de las nueve carreras, con los nuevos indicadores, dándole a cada uno de ellos como calificación resultante, el promedio de las calificaciones de cada uno de los indicadores originales que se han agrupado en cada uno de los nuevos indicadores. De la misma manera, los índices de calidad finales de cada factor, se calificarán con el promedio de los valores correspondientes a los indicadores que califican a dicho factor.

A los efectos de poder realizar las comparaciones pertinentes, este trabajo se realizó con el modelo optimizado (64 indicadores) y con el modelo reducido de SECAI (69 indicadores).

A tal efecto se confeccionaron seis planillas resumen para cada una de las carreras evaluadas: Dos planillas correspondientes a la Evaluación Interna y a la Externa, efectuadas con el modelo original (94 indicadores) por los expertos designados por SECAI. Dos planillas correspondientes a la Evaluación Interna y Externa efectuadas con el modelo reducido de SECAI (69 indicadores) con la calificación de cada uno de los nuevos indicadores e índices obtenida como se indica más arriba. Dos planillas correspondientes a las Evaluaciones Internas y Externas efectuadas con el modelo optimizado (64 indicadores), con la calificación de cada uno de los nuevos indicadores e índices obtenida como se indica más arriba.

A modo de ejemplo y por razones de espacio, se presenta sólo la "Planilla Comparación de los Indices obtenidos con el modelo SECAI Original (94 indicadores) y los obtenidos con los Modelos SECAI Reducido (69 indicadores) y el Modelo Optimizado producto de este trabajo (64 indicadores), y los diagramas de barras representativos de las Evaluaciones Internas y Externas obtenidos con los tres modelos, exclusivamente para dos de las carreras evaluadas, de diferentes universidades.

Cuadro III:

Comparación de los índices obtenidos con el modelo SECAI (94 indicadores)
y los obtenidos con los modelos SECAI reducido (69 indicadores) y Optimizado (64 indicadores)

P.J.B.C.

Carrera: Ingeniería Electrónica

INDICE	(1) EVAL. INT. SECAI (94 ind.)	(2) EVAL.INT. SECAI (69 Ind.)	(3) EVAL. INT. MOD. OPTIM. (64 Ind.)	DIFERENCIA (1) - (2)	DIFERENCIA (1) - (3)	DIFERENCIA (2) - (3)	(4) EVAL. EXT. SECAI (94 ind.)	(5) EVAL. EXT. SECAI (69 ind.)	(6) EVAL. EXT. MOD. OPTIM (64 ind.)	DIFERENCIA (4) - (5)	DIFERENCIA (4) - (6)	DIFERENCIA (5) - (6)
I_{11}	4	4,5	4,25	0,5=12,5%	0,25=6,25%	0,25=5,5%	3,67	4,33	3,75	0,66=18%	0.08=2.1%	0,58=13,4%
I_{12}	4	4,28	4,28	0,28=7%	0,28=7%	0=0%	4,43	4,28	4,2	0.15=3.4%	0.23=5.2%	0.08=1.9%
I_{13}	4	4,16	4,16	0,16=4%	0,16=4%	0=0%	3,85	4,16	4,16	0.31=8%	0.31=8%	0=0%
I_{14}	4						4,2			---	---	---
I_{1}	4	4,3	4,23	0,3=7,5%	0,23=5,75%	0,07=1,6%	4,04	4,25	4	0.26=6.4%	0.04=0.99%	0.3=7%
I_{2}	4	4	4	0=0%	0=0%	0=0%	4,17	4	4	0.17=4%	0,17=4%	0=0%
I_{31}	4	3,6	3,6	0,4=10%	0,4=10%	0=0%	3,8	3,7	3,7	0.1=2.6%	0.1=2.6%	0=0%
I_{321}	3	3,28	3,19	0,28=9,3%	0,19=6%	0,09=2,7%	2,67	2,77	2,62	0,1=3,7%	0.05=1.87%	0,15=5,4%
I_{322}	4	4,5	4,5	0,5=12.5%	0,5=12.5%	0=0%	4,75	4,8	4,8	0.05=1%	0.05=1%	0=0%
I_{32}	4	3,89	3,85	0,11=2,75%	0,15=3,75%	0,04=1%	3,71	3,8	3,72	0.09=2,4%	0.01=0.27%	0,08=2,1%
I_{331}	4						4,29			---	---	---
I_{332}	4						4,67			---	---	---
I_{33}	4	3,75	3,75	0,25=6,25%	0,25=6,25%	0=0%	4,48	4,5	4,5	0,02=0,44%	0.02=0.44%	0=0%
I_{34}	4	3,65	3,75	0,35=8.75%	0,25=6,25%	0,1=2,6%	4	3,65	4,25	0.35=8.7%	0.25=6.25%	0.6=14%
I_{3}	4	3,72	3,73	0,28=7%	0,27=6,75%	0,01=0,26%	4	3,9	4	0,1=2,5%	0=0%	0,1=2,5%
I_{4}	4	3,6	3,6	0,4=10%	0,4=10%	0=0%	3,6	3,6	3,6	0=0%	0=0%	0=0%
I_{5}	4	3,88	3,88	0,12=3%	0,12=3%	0=0%	4	4	4	0=0%	0=0%	0=0%

GRAFICO I: P.J.B.C. - CARRERA INGENIERIA ELECTRONICA
EVALUACION INTERNA

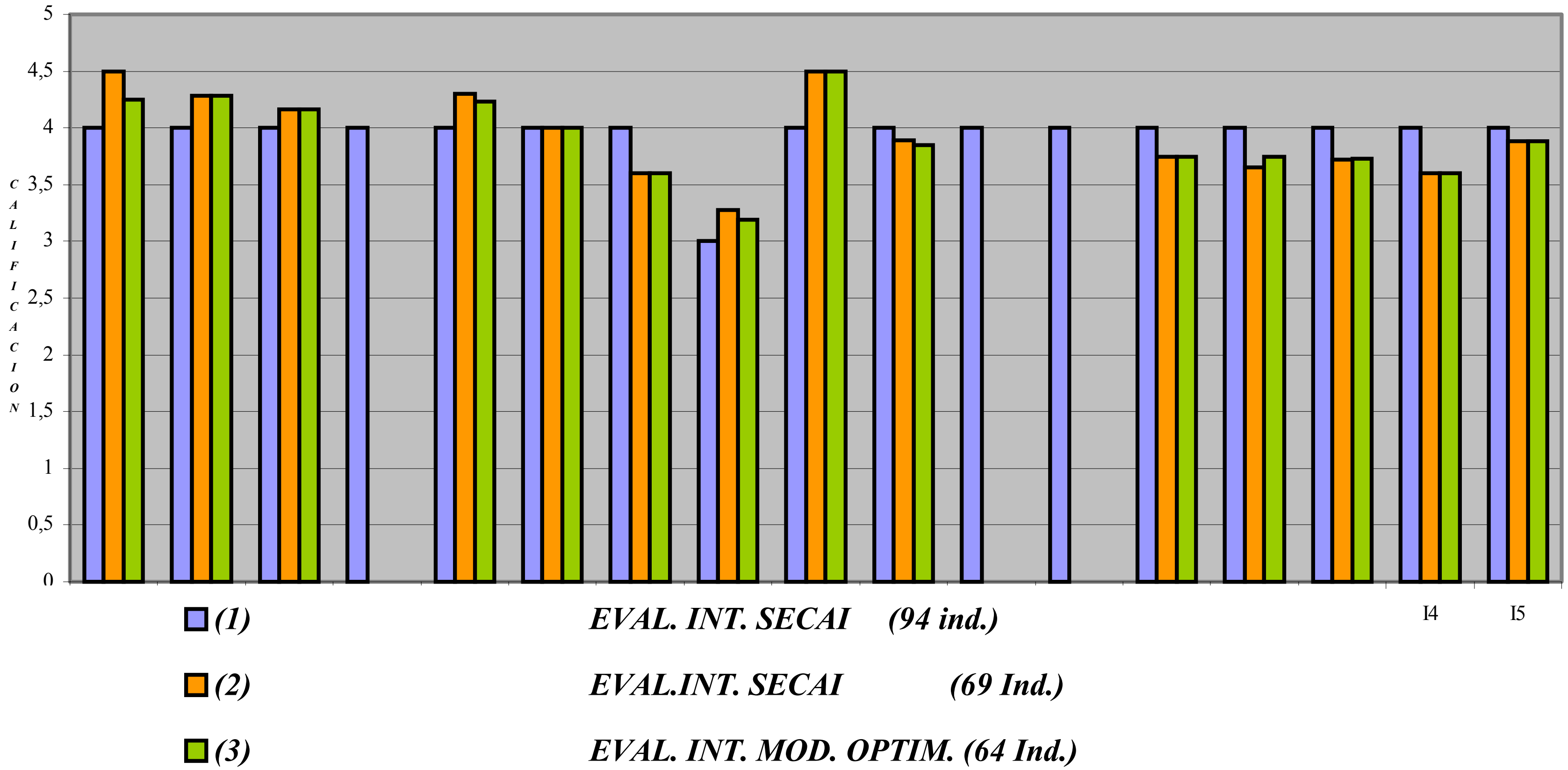
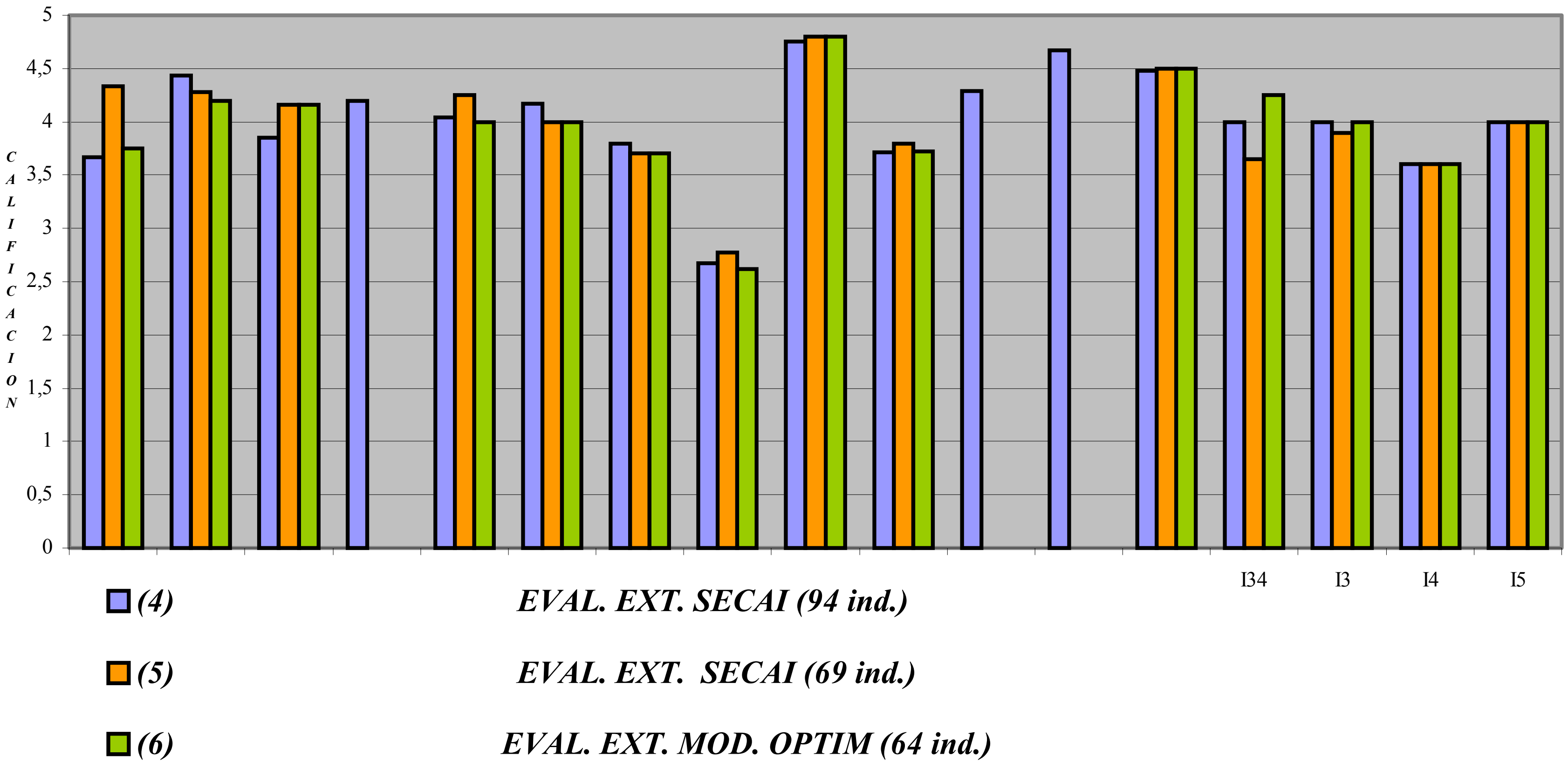


GRAFICO II: P.J.B.C. - CARRERA INGENIERIA ELECTRONICA
EVALUACION EXTERNA



Cuadro IV:

Comparación de los índices obtenidos con el modelo SECAI (94 indicadores)
y los obtenidos con los modelos SECAI reducido (69 indicadores) y Optimizado (64 indicadores)

P.M.E.

Carrera: Ingeniería Técnica Aeronáutica

INDICE	(1) EVAL. INT. SECAI (94 ind.)	(2) EVAL.INT. SECAI (69 Ind.)	(3) EVAL. INT. MOD. OPTIM. (64 Ind.)	DIFERENCIA (1) - (2)	DIFERENCIA (1) - (3)	DIFERENCIA (2) - (3)	(4) EVAL. EXT. SECAI (94 ind.)	(5) EVAL. EXT. SECAI (69 ind.)	(6) EVAL. EXT. MOD. OPTIM (64 ind.)	DIFERENCIA (4) - (5)	DIFERENCIA (4) - (6)	DIFERENCIA (5) - (6)
I_{11}	1,66	1,75	1,75	0.09=5%	0.09=5%	0=0%	1,66	1,5	1,5	0.16=9.6%	0.16=9.6%	0=0%
I_{12}	1,85	2,4	2,5	0.55=29.7%	0.65=35%	0.1=4%	1,66	2,8	2,8	1.14=68%	1.14=68%	0=0%
I_{13}	2,42	2,33	2,33	0.09=3.7%	0.09=3.7%	0=0%	2,8	2,33	2,33	0.47=16.8%	0.47=16.8%	0=0%
I_{14}	2,2			---	---	---	2,2			---	---	---
I_1	2,03	2,16	2,19	0.13=6%	0.16=7%	0.03=1.37%	2,08	1,87	1,87	0.21=10%	0.21=10%	0=0%
I_2	2	1,66	1,66	0.34=17%	0.34=17%	0=0%	2,33	2,25	2,25	0.08=3.4%	0.08=3.4%	0=0%
I_{31}	3	3	2,9	0=0%	0.1=3.3%	0.1=3.3%	2,8	2,8	2,7	0=0%	0.1=3.6%	0.1=3.6%
I_{321}	3	3	2,93	0=0%	0.07=2.33%	0.07=2.33%	3,7	3,68	3,64	0.02=0.54%	0.06=1.6%	0.04=1.1%
I_{322}	3,25	3,33	3,33	0.08=2.4%	0.08=2.4%	0=0%	3	3,16	3,16	0.16=5%	0.16=5%	0=0%
I_{32}	3,12	3,16	3,13	0.04=1.28%	0.01=0.32%	0.03=0.95%	3,35	3,4	3,4	0.05=1.47%	0.05=1.47%	0=0%
I_{331}	3			---	---	---	2,85			---	---	---
I_{332}	3,25			---	---	---	2,83			---	---	---
I_{33}	3,12	2,83	2,83	0.29=9.3%	0.29=9.3%	0=0%	2,84	2,83	2,83	0.01=0.35%	0.01=0.35%	0=0%
I_{34}	2,85	2,88	3,05	0.03=1.04%	0.2=6.5%	0.17=5.6%	2,71	2,96	3,15	0.25=9.2%	0.44=16%	0.19=6%
I_3	2,99	2,97	2,98	0.02=0.66%	0.1=0.33%	0.01=0.33%	2,99	3	3,02	0.01=0.33%	0.03=0.99%	0.02=0.66%
I_4	2,33	2,33	2,33	0=0%	0=0%	0=0%	2,33	2,33	2,33	0=0%	0=0%	0=0%
I_5	3,16	3,13	3,13	0.03=0.94%	0.03=0.94%	0=0%	3,8	3,75	3,75	0.05=1.3%	0.05=1.3%	0=0%

GRAFICO III: P.M.E. - CARRERA INGENIERIA TECNICA AERONAUTICA
EVALUACION INTERNA

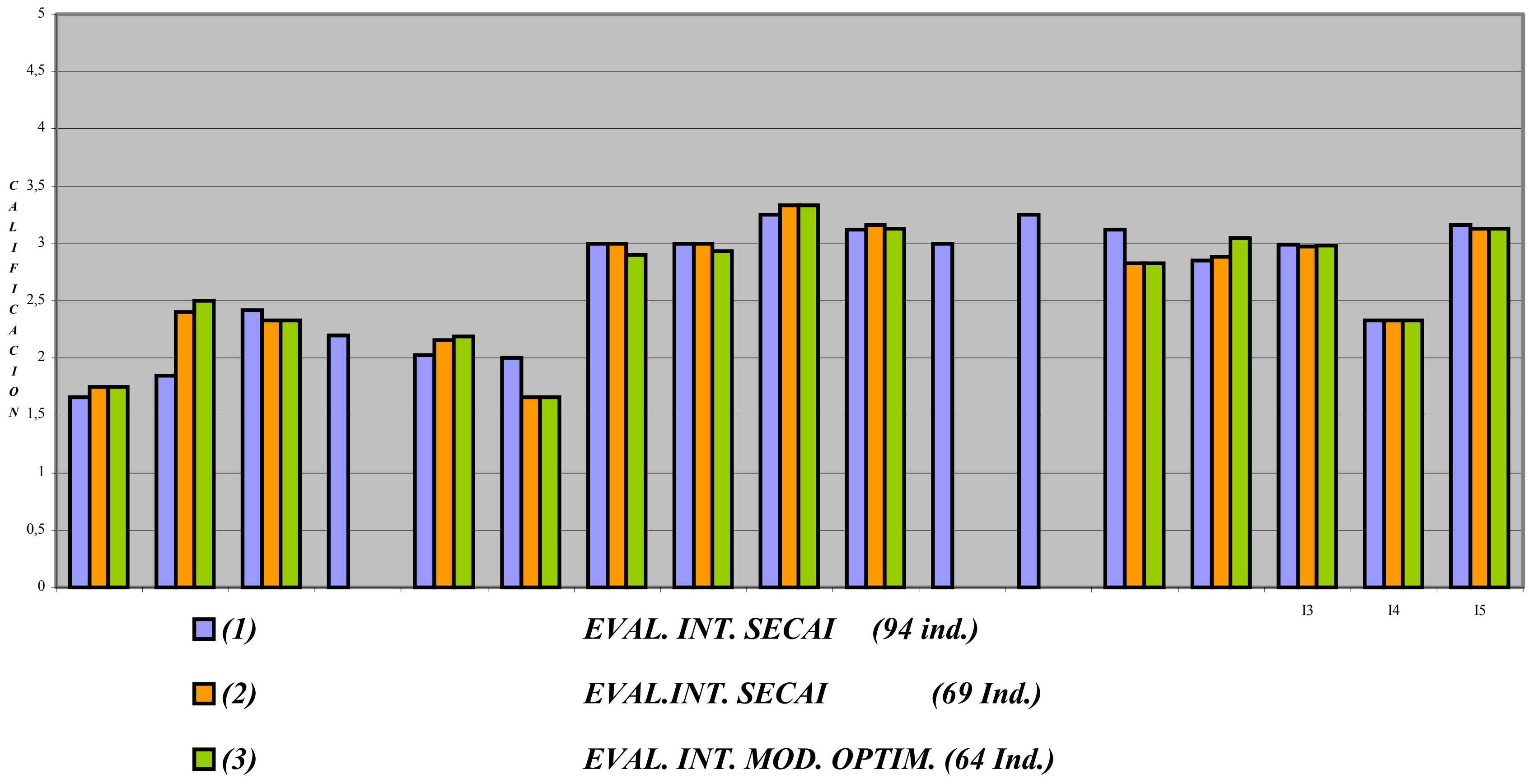
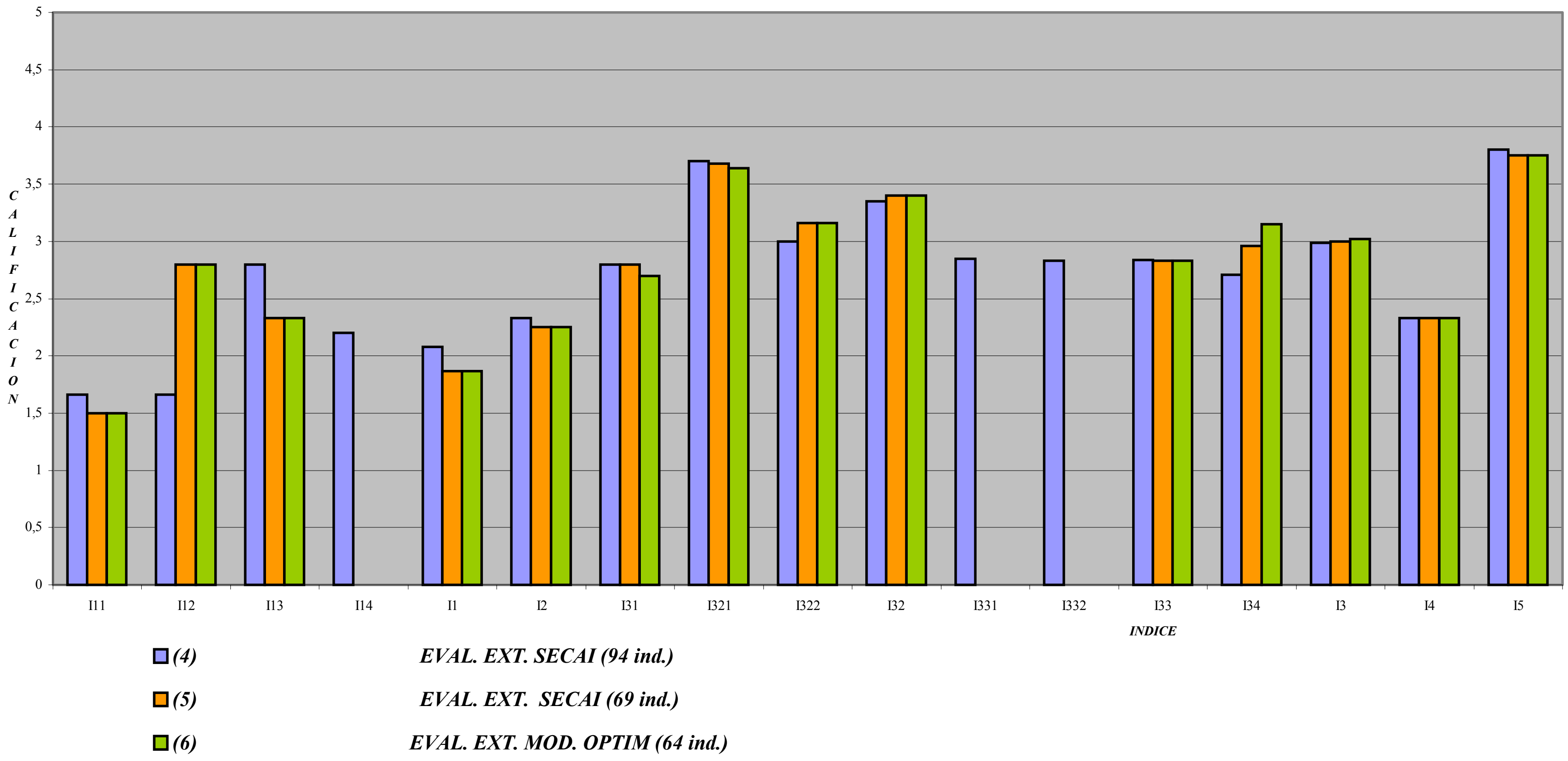


GRAFICO IV P.M.E. - CARRERA INGENIERIA TECNICA AERONAUTICA
EVALUACION EXTERNA



COMPARACIÓN ENTRE LOS INDICES DE CALIDAD OBTENIDOS CON LA UTILIZACION DE LOS INDICADORES DEL MODELO ORIGINAL, LOS OBTENIDOS CON EL MODELO REDUCIDO Y LOS OBTENIDOS CON EL MODELO OPTIMIZADO

De la comparación de cada una de las planillas de evaluación generadas por el Comité de Evaluación Interna y el Comité de Evaluación Externa, con cada una de las planillas de evaluación generadas con los nuevos indicadores, se ve claramente que los valores correspondientes a cada uno de los índices tanto en la Evaluación Interna como en la Evaluación Externa, realizadas con el Modelo SECAI (94 indicadores), coinciden casi en forma exacta con los valores de los índices obtenidos tanto con el Modelo Reducido de SECAI (69 indicadores) como con el Modelo Optimizado (64 indicadores), producto de esta trabajo.

Por tanto, la decisión de asignar a cada uno de los nuevos indicadores el promedio del valor de los indicadores obtenidos con el Modelo Original de SECAI que los componen, parece ser aceptable.

En general las diferencias entre los índices de los dos Modelos SECAI y los del Modelo Optimizado no son sustantivas, salvo en algunos casos, y siempre localizadas en los índices I_{11}, I_{12} e I_{13}, puesto que al haberse modificado la estructura del Modelo Original, el Indice I_{11} tanto en el Modelo Reducido de SECAI como en el Modelo Optimizado producto de esta trabajo, califica al subfactor "Proceso de Elaboración", que es la conjunción de los subfactores: "Participación" (Indice I_{11}) y "Metodología" (Indice$_{12}$) del Modelo Original de SECAI.

Asimismo, en el Modelo Original de SECAI, los Indices I_{12} e I_{13}, califican a los subfactores "Metodología" y "Contenido" respectivamente, mientras que, tanto en el Modelo Reducido de SECAI como en el Modelo Optimizado, producto de este trabajo, califican a los subfactores "contenido" y "puesta en marcha" respectivamente.

El resto de las diferencias se deben, en general, a que tanto en el Modelo Reducido de SECAI como en el Modelo Optimizado, el índice de cada factor es el promedio de las calificaciones otorgadas a cada indicador perteneciente a dicho factor, mientras que en el Modelo Original de SECAI, el índice de cada factor no siempre coincide con el promedio de los valores asignados a los indicadores de ese factor, y cuanto más se aparta de éste, mayor es la diferencia.

CONCLUSIÓN

- No existen "indicadores de calidad" absolutos ni indiscutibles, y mucho menos un modelo de aplicación universal que pueda ser irrefutable.
- Tal como ocurre en todos los procesos para definir u obtener la calidad requerida de un producto final, conseguir ésta, es algo sumamente difícil, por cuanto las características de calidad reales – que son las que definen la calidad del producto, proceso o sistema – son altamente subjetivas y por tanto muy difíciles de medir.
- Se ha logrado desarrollar una metodología para el análisis y optimización de modelos para evaluar la calidad de las enseñanzas.
- Dicha metodología ha sido desarrollada teniendo como referencia los procedimientos – con las adaptaciones correspondientes al caso y ámbito de estudio – utilizados para determinar la calidad de productos, procesos y sistemas industriales, que en general, consiste en realizar un análisis estadístico de calidad utilizando métodos estadísticos que correlacionan y comparan las variables en juego.
- Se han utilizado dos métodos estadísticos (Matriz de Correlación y el Método de Análisis de Componentes Principales) y un Método basado en el Juicio de Expertos:
- Ha quedado puesto de manifiesto que, en este problema, la utilización de métodos estadísticos conjuntamente con el Método de Juicio de Expertos, se manifiesta como una estrategia muy adecuada para el análisis y optimización de modelos que evalúan la calidad de la enseñanza.
- En función de los resultados obtenidos y su comparación con los dos Modelos SECAI, el Modelo Optimizado desarrollado en este trabajo, facilita la aplicación de SECAI mejorando su: eficiencia sin disminuir su eficacia.

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INFLUENCIA DE LA GLOBALIZACION EN EL MEJORAMIENTO DE LA CALIDAD DE LA ENSEÑANZA EN MEXICO EN EL AREA DE COMPUTO

Joaquín Flores Paredes, Masiel Estibalis Gutierrez Estrada y Antonio Trejo Lugo

RESUMEN

El contexto en el que se desarrolla actualmente la educación superior en general, está dominado por la competencia a escala mundial.

Esto se acentúa particularmente cuando se trata de carreras en el área de cómputo y similares, donde ser competitivo es una condición determinante para participar en el mercado laboral con mejores posibilidades de éxito. En esta área ser competitivo requiere el conocimiento de las nuevas tecnologías, del desarrollo de habilidades para el diseño, construcción, uso y mantenimiento de herramientas útiles para los servicios informáticos y de telecomunicaciones.

1.INTRODUCCION

Las comunicaciones entre personas tienden a hacerse cada día más independientes del lugar donde se encuentran las mismas. Con lo cual se nota una tendencia hacia accesos inalámbricos, hacia las redes que ofrecen los diferentes servicios. Probablemente seguirán proliferando estos sistemas con accesos que dan al usuario cada día una mayor movilidad.

La convergencia de la tecnología de la información y las comunicaciones es muy importante.

La tecnología de fibra óptica facilita las capacidades de transmisión de alto ancho de banda por tal motivo se puede decir que la informática del presente nada tiene que ver con la que llegara en u futuro muy cercano, ya que según estudios, en un corto periodo de tiempo nos comunicaremos como ordenadores; de hecho las telecomunicaciones y la informática estarán tan unidas que serán indistinguibles.

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Los avances en tecnologías digitales y en las transmisiones por fibra óptica permiten hablar ahora de velocidades de transmisión y de conmutación menores de una mil millonésima de segundo.

A través de estas redes de alta capacidad y los servicios que en ellas serán ofrecidos se estará en posibilidad de "integrar todos los servicios", de tener "transferencias de información totalmente digitales", de empezar a construir la "supercarretera de información y de que todo esto forme la base de la "sociedad de la información" del futuro.

Las comunicaciones a diferencia de otras disciplinas son por naturaleza de influencia global.

El mercado es claramente global y ahora vemos organizaciones cambiando la dirección de su mercado. Mucho se ha escrito de la estructura de las nuevas organizaciones, pero en esencia se puede decir que los términos globalización, virtualidad, movilidad y flexibilidad es la forma en que se definen las nuevas organizaciones.

Desde los inicios de la informática, los desarrollos y las nuevas tecnologías no ha parado de sucederse a un ritmo frenético, un ejemplo de ello, y tomándolo de forma comparativa, fue la introducción de la radio que le tomo 38 años llegar a 50 millones de usuarios; a la televisión 13 y a Internet 4 años, lo que nos da una idea, en cuanto a tiempo, de la forma en que llegan los avances.

Las necesidades fundamentales no han cambiado, sin embargo si lo han hecho los medios por los cuales se ofrecen productos y servicios porque las exigencias de los usuarios y sus comparaciones entre productos, han sido parte del impulso del avance tecnológico.

Las computadoras fueron creadas para la resolución rápida de centenares de tareas distintas.

Podemos asegurar que la informática ha

ayudado y ha participado en la evolución de prácticamente cualquier actividad profesional o domestico.

Y así, la información a traído consigo el Internet, que es una enorme red, donde puedes buscar información y algunas ventajas son:

En educación: hasta hace algunos años, la educación basada en sus conocimientos únicamente en los libros, Internet se ha convertido en el apoyo de todas las personas que se desenvuelven en el ámbito educativo.

En empresas: ahora con el Internet, puedes ingresar al sitio, buscar lo que necesitas, y si la pagina te lo permite organizar o hacer tratos, apartados, visitas, pagos, etc., creando lo que ahora llamamos comercio electrónico.

2.DESARROLLO

Los retos de la educación superior son numerosos y complejos, son derivados de las diversas demandas de la nueva sociedad, la cual no es ajena a la velocidad y el alcance de los avances de la ciencia y la tecnología en todas sus expresiones, pero principalmente en telecomunicaciones y la informática, que se han convertido en un poderoso motor que ha venido a transformar todo de una manera vertiginosa

México es el país que ha requerido por necesidad un acelerado desarrollo y fortalecimiento de la Educación Superior, pues hay que considerar que con el Tratado de Libre Comercio con Estados Unidos y Canadá se han fortalecido los intercambios de programas de estudios, se han celebrado convenios de vinculación, transferencia de tecnología educativa y científica entre las diversas Universidades e Instituciones de Educación Superior, por lo que los profesionistas de este país, nos veremos precisados a ingresar a la cultura de la actualización profesional, como medio de lograr la certificación profesional que se tendrá que exigir para el ejercicio de las profesiones.

En el Plan Nacional de Educación 2000–2006 se plantea, entre sus objetivos principales el de "impulsar el desarrollo con equidad de un sistema de Educación Superior de buena calidad" considerando las necesidades de transformar el actual sistema cerrado en uno abierto, flexible, innovador y dinámico, que permita la ampliación y diversificación de las oportunidades y oferta educativa, pues se requiere de nuevas estructuras para su planeación y coordinación a nivel nacional.

Se busca con ello que las acciones en materia de Educación Superior sean congruentes con el Plan Nacional de Educación del Gobierno Federal con las políticas y programas de desarrollo de los estados, a fin de conformar un sistema de Educación integrado y flexible que contribuya con mayor oportunidad y niveles crecientes de calidad al progreso económico, social, cultural, científico y tecnológico de cada estado y del conjunto del país.

La demanda de personal capacitado y entrenado está creciendo súbitamente, por lo que en la formación de los estudiantes se debe de lograr no solo transferir conocimientos y habilidades, sino lograr alcanzar las destrezas de competencia profesional, es decir, que el egresado sea capaz de responder a los retos laborales mediante la certificación de dichas competencias profesionales, por ello es necesario preparar el escenario para poder responder eficientemente a dichos retos, y buscar las causas y mecanismos que logren realizar una verdadera vinculación entre la Universidad y el aparato productivo, con mecanismos tales como la investigación científica y tecnológica.

En el área de cómputo la tecnología esta siendo ofrecida a los estudiantes universitarios por algunas grandes empresas líderes en su área respectiva a nivel mundial, quienes organizan concursos y ofrecen certificaciones con las cuales quieren incentivar la creatividad de los estudiantes en estas áreas. Algunas de ellas destinan una parte importante de su presupuesto a generar proyectos educativos en el área de cómputo, para beneficio de la misma empresa y de los estudiantes a quienes van dirigidos tales proyectos.

Lo anterior ha generado un gran cambio en instituciones universitarias privadas las cuales buscan ser competitivas y proporcionar a la vez a sus estudiantes una alta calidad educativa actualizada a la nueva tecnología, para ejemplificar lo anterior tomaremos como ejemplo a la universidad de Cuautitlan Izcalli que es una Universidad privada con apenas 10 años de haber sido fundada la cual se ubica en el municipio de Cuautitlan Izcalli en el Estado de México en la cual entre otras se ofrecen las licenciaturas de Ingeniero en Computación y Sistemas Digitales e Informática Administrativa la cual ha implementado diversos programas educativos.

Por todo esto es que desde sus inicios la Universidad de Cuautitlán Izcalli se ha caracterizado por realizar diversos esfuerzos con el fin de permanecer a la vanguardia de los cambios científicos tecnológicos, sociales y culturales establecidos en el entorno, tratando siempre de responder satisfactoriamente a las demandas que como institución de educación superior le competen. En estos esfuerzos, se ha distinguido por buscar permanentemente la calidad en la educación ofreciendo a los estudiantes todos los elementos que les permitan convertirse en profesionistas capaces de ser, hacer, convivir, pensar y transformar su realidad.

En este marco la Universidad de Cuautitlan Izcalli plantea la necesidad de construir métodos e instrumentos que le permitan dar respuesta con una mayor calidad y pertinencia a las exigencias del entorno, y asume el compromiso de incorporarse al esfuerzo de transformaciones y cambio que requiere el país. En este aspecto y para atender la creciente demanda de educación superior existente en el estado y en las entidades concurrentes ha venido ampliando su oferta educativa.

La Universidad de Cuautitlan Izcalli, consiente de su papel social, ha instrumentado una serie de mecanismos, tal es el caso del proyecto con la empresa de Cisco Systems que es líder mundial en redes para Internet con la cual el 29 de Enero del 2001 se firma el convenio para poder impartir el proyecto "CISCO NETWORKING ACADEMY PROGRAM" en base a los lineamientos establecidos por la empresa, a partir de ese día la Universidad forma parte como academia regional.

El 25 de Febrero del 2001, se seleccionan dos instructores: Ing. José Joaquín González Cedeño (Contacto Principal del Proyecto) e Ing. Norma Grajales Ojeda, quiénes fueron capacitados para poder impartir el proyecto en la Universidad de Cuautitlán Izcalli asistiendo a su capacitación con su "ACADEMIA REGIONAL".

El 26 de Febrero del 2001, la Coordinación de Ingeniería en Computación y Sistemas Digitales e Informática Administrativa a cargo del Ing. Antonio Trejo Lugo junto con los dos instructores seleccionados establecen las políticas para coordinar el proyecto "CNAP".

El 14 de mayo del 2001, se crean 5 grupos que incursionarán por primera vez en el proyecto, se dan de alta un total de 60 alumnos, de los cuales logran graduarse 52 alumnos quienes obtienen su constancia por haber aprobado el modulo I versión 2.1 en español.

El 17 de Septiembre del 2001, se crean 2 grupos que continúan con el Modulo II versión 2.1 en español, se dan de alta un total de 17 alumnos de los cuales logran graduarse 12 alumnos quienes obtienen su constancia por haber aprobado.

El 14 de Enero del 2002, a esta fecha se obtiene experiencia en la implantación del programa y se realizan los ajustes académicos para los siguientes grupos.

El 15 de Enero del 2002, se crean 4 grupos que empezarán con el Modulo I versión 2.1 en español, se dan de alta un total de 52 alumnos de los cuales logran graduarse 51 alumnos quienes obtienen su constancia por haber aprobado.

El 01 de Febrero del 2002, se crea 1 grupo que continua con el Modulo II versión 2.1 en español, se dan de alta un total de 13 alumnos de los cuales logran graduarse 12 alumnos quienes obtienen su constancia por haber aprobado.

El 01 de Febrero del 2002, en esta misma fecha se crea 1 grupo que continua con el modulo III versión 2.1 en español, se dan de alta un total de 7 alumnos de los cuales todos se gradúan obteniendo su constancia por haber aprobado.

El 01 de Mayo del 2002, se crean 2 grupos que empezarán con el Modulo I versión 2.12 en español, se dan de alta un total de 28 alumnos de los cuales 26 alumnos se gradúan obteniendo su constancia por haber aprobado.

El 01 de Mayo del 2002, en esta misma fecha se crean 4 grupos que continúan con el modulo II versión 2.12 en español, se dan de alta un total de 50 alumnos de los cuales 46 alumnos se gradúan obteniendo su constancia por haber aprobado.

El 24 de Mayo del 2002, se crea un 1 grupo que continua con el modulo IV versión 2.12 en español, se dan de alta un total de 7 alumnos de los cuales todos se gradúan en la fecha del "24 de Agosto del 2002" obteniendo su constancia por haber aprobado y formado La PRIMERA GENERACION del proyecto "CISCO NETWORKING ACADEMY PROGRAM", Felicidades.

El 06 de Junio del 2002, se crea 1 grupo que continua con el modulo III versión 2.12 en español, se dan de alta un total de 11 alumnos de los cuales todos se gradúan obteniendo su constancia por haber aprobado.

El 31 de Julio del 2002, la Universidad de Cuautitlán Izcalli es seleccionada entre varias instituciones de México por la International Youth Foundation y Cisco Learning Institute, para firmar un convenio en el cual otorga a 100 alumnos (75 mujeres y 25 hombres) beca para poder cursar el proyecto "CNAP" en el lapso de un año.

El 08 de Agosto del 2002, se seleccionan dos intructores: Ing. Sofía Chávez e Ing. Elva Bernal quienes serán capacitadas en la "ACADEMIA REGIONAL" para poder impartir el proyecto en la Universidad de Cuautitlán Izcalli y sumarse al grupo de instructores autorizados para dar dicho programa. Conformando el total de 4 instructores dentro de la Universidad de Cuautitlán Izcalli.

El 21 de Agosto del 2002, "CISCO LEARNING INSTITUTE" solicita la información de dos alumnas con mejor promedio para seleccionar a una sola e invitar al evento "CISCO Networkers 2002 " en septiembre GRATUITAMENTE.

El 24 de Agosto del 2002, se crea 1 grupo que continua con el modulo IV versión 2.12 en español, se dan de alta un total de 11 alumnos los cuales van en busca de aprobar y formar parte de la segunda generación.

El 01 de Septiembre del 2002, a esta fecha la Universidad de Cuautitlán Izcalli ha proporcionado el proyecto "CISCO NETWORKING ACADEMY PROGRAM" a 140 alumnos.

El 02 de Septiembre del 2002, la coordinación de Ingeniería en Computación y Sistemas Digitales e Informática Administrativa conjuntamente con los instructores del proyecto plantean propuestas y ajustes académicos para todo grupo que empiece y continúe con el programa.

El 05 de Septiembre del 2002, la Universidad de Cuautitlán Izcalli publica convocatoria de becas la cual podrás observar en la liga correspondiente.

Actualmente la Universidad de Cuautitlan Izcalli esta llevando acabo los convenios para Implementar el programa de Centro Educacional Académico Autorizado Sun (AASEC).

Debido a la transformación que la industria de tecnología vive día a día Sun Microsystems de México líder de tecnología, implementa un programa para compartir con la Academias Regionales y locales inscritas en el convenio Cisco Networking Academy.

En este programa, los estudiantes tienen la oportunidad de obtener entrenamiento certificado en tecnología Sun en la curricula de sus estudios universitario así como aprender a construir, diseñar y mantener las redes computacionales.

Logrando con esto proporcionar a los alumnos un nivel competitivo que los distinga y que sea acorde a las necesidades del mercado.

Sun proporcionará a las Instituciones académicas materiales de cursos desarrollados por Sun así como la capacitación de los maestros y planes de estudios de la más alta calidad. Creando con esto un conjunto de esfuerzos, dado que las escuelas proveerán una nueva área de estudio a sus alumnos y presentará tecnologías de última generación.

Fundamentos de Solaris 8 SA-118 (40 horas)
Administración 1 Solaris 8 SA-238 (40 horas)
Administración 11 Solaris 8 SA-288 (40 horas)

Programación Java para programadores SL-110 (40 horas)
Migración de programas orientados con tecnología Java SL-210 (40 horas)
Lenguaje de programación Java SL-275 (24 horas)

La intención de incorporar nuestros esfuerzos educacionales al proyecto de Cisco Networking Academy desempeña un papel importante en el suministro de educación que se dará de manera mas contundente a nivel nacional para el desarrollo social de México.

La iniciativa académica de conjuntar a Cisco & Sun, está diseñada para introducir a los alumnos a las tecnologías Sun así como enseñar a los estudiantes a diseñar, construir y mantener las redes computacionales. De esta forma se dotara de habilidades en los campos de estudio elegidos por ambas partes. Sun proporcionará a instituciones académicas seleccionadas materiales de cursos desarrollados por Sun para este propósito. Al establecer este contacto, Sun busca crear una sinergia con instituciones académicas, dado que las escuelas proveerán una nueva área de estudio a sus alumnos y Sun presentará tecnologías a la siguiente generación de usuarios.

El programa de Sun & Cisco mejoran las experiencias de los alumnos al:

- Dar acceso a los estudiantes a:

  Las tecnologías Sun más recientes

  Capacitación y planes de estudio de la más alta calidad

  Guías de curso tendientes a la certificación

  Cursos que pueden ser integrados a programas de obtención de grados post-universitarios.

Otro de las formas en que la institución está tratando de mantener preparados a sus alumnos en esta área es mediante la participación en eventos como los organizados por The Association for Computing Machinery
la cual tiene el objetivo de consolidar su crecimiento y difusión en México; este se ha dado gracias al surgimiento de otros capítulos en diversas sedes del país y a la cada vez más numerosa participación de la comunidad universitaria en los eventos que la sociedad auspicia, tales como el ACM Central American Programming Contest 2002, eliminatoria oficial del ACM Collegiate Programming Contest 2003, ambos concursos de programación con proyección mundial.

Los proyectos anteriores han traído como consecuencia una mayor demanda de alumnos hacia la institución.

MODELO DEL INSTRUCTOR EXPLICITO EN UN SISTEMA TUTORIAL INTELIGENTE

Constanza R. Huapaya[1], Graciela M. Arona[1] y Francisco A. Lizarralde[1]

Abstract *—Los Sistemas Tutoriales Inteligentes (STI) son uno de los resultados más importantes producidos por la Inteligencia Artificial en Educación. Su creación es de alta complejidad, tanto pedagógica como computacional. Las herramientas de autoría son una alternativa eficaz para su implementación. El objetivo de este trabajo es definir un modelo del instructor, a fin de acrecentar la eficacia del sistema. El autor, experto en teorías cognitivas y diseño instruccional crea un STI. Este producto puede ser utilizado por instructores de distintos niveles de experticia. Son ellos quienes efectivamente lo usan en un aula con un grupo de estudiantes en diferentes sesiones. Se ha estudiado la interacción sistema-instructor para abstraer las características más relevantes. En especial, un instructor de temas de ingeniería podría ser asistido por un STI a fin de establecer los objetivos instruccionales de una sesión, evaluar el estado de conocimiento de sus alumnos, y valorar el éxito de su gestión.*

Palabras clave — Inteligencia Artificial en Educación, Modelo del Instructor, Sistemas Tutoriales Inteligentes.

INTRODUCCION

La enseñanza puede ser entendida como un tipo especial de comunicación humana. Los maestros construyen la riqueza de esa comunicación a partir de su práctica cotidiana. A fin de mejorar la enseñanza, la comunidad de Inteligencia Artificial en Educación investiga teorías, metodologías y técnicas con la finalidad de construir herramientas que asistan al maestro en su actividad diaria. El principal foco de interés actual de esta investigación se basa en la imitación de la actividad adaptativa y comunicacional de un maestro humano.

SISTEMAS TUTORIALES INTELIGENTES

Para alcanzar el objetivo enunciado, se construyen ambientes de enseñanza, como los Sistemas Tutoriales Inteligentes [1]-[2], cuyo objetivo es transformarse en “maestros computacionales”. El término "inteligente" en STI se refiere a la habilidad del sistema para saber qué enseñar, cuándo enseñarlo, y cómo enseñarlo.

Un STI debe mostrar capacidad de entendimiento, aprendizaje, razonamiento y resolución de problemas. Además, debe ser capaz de identificar las fortalezas y debilidades de un aprendiz, y establecer un plan instruccional para adaptarse a cada estudiante real. Asimismo, manipula información sobre el proceso de aprendizaje de cada estudiante (como estilo de aprendizaje preferido y conceptos erróneos adquiridos). La instrucción debe ajustarse a las necesidades del estudiante, i.e., tiene que *adaptarse* a cada uno de ellos [3]. La capacidad de adaptarse diferencia a los STIs de las herramientas tradicionales como los CAIs (Computer Aided Instruction).

No obstante, la construcción de STIs reales todavía es ardua y costosa [4]. Es necesario profundizar el análisis del conocimiento experto involucrado en un STI a fin de ser capturado en un sistema computacional.

Durante los últimos veinte años se ha trabajado sobre la siguiente arquitectura básica (ver figura 1): un STI posee componentes para modelizar el conocimiento a enseñar (plasmado en el **modelo del dominio**), el seguimiento de la actividad del estudiante (o **modelo del estudiante**), el conocimiento pedagógico (que será plasmado en un **plan instruccional**), y la **interfaz** de comunicación (con el estudiante y con el profesor) .

Una vez elegido el tópico que un estudiante determinado debe aprender, comienza una sesión tutorial donde el STI entrega el material instruccional siguiendo los lineamientos que el modelo pedagógico y su instructor verdadero decidieron para él (ella). Asimismo el plan instruccional considera las características personales de la

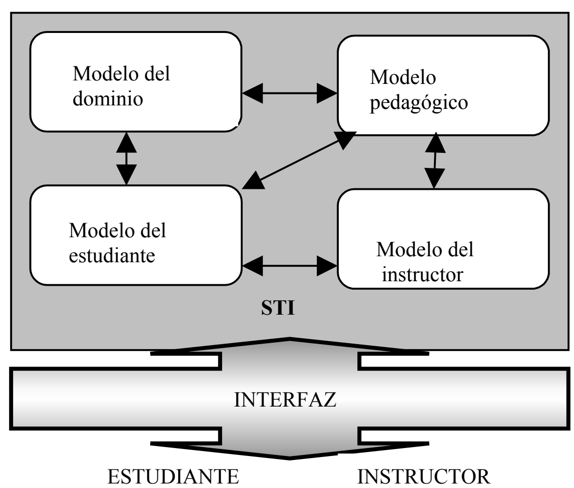

FIGURA. 1
ARQUITECTURA BASICA DE UN SISTEMA TUTORIAL INTELIGENTE.

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estudiante a fin de adaptar apropiadamente la enseñanza del tópico a su perfil.

Antes de presentar el problema que nos preocupa, i.e., el modelo del instructor, mostramos someramente los modelos del dominio y del estudiante.

MODELO DEL DOMINIO

Un sistema tutorial es creado para enseñar un tema en particular, por lo tanto debe tener suficiente conocimiento del tema y además de la forma en que se enseña. Además este conocimiento debe estar estructurado de manera tal que el sistema pueda ser flexible. Los factores que hay que tener en cuenta son: cómo organizar los ítems; cómo relacionarlos con el avance del aprendizaje del alumno; cómo relacionarlos con el material de enseñanza.

La ontología propuesta en el ámbito conceptual se divide en dos estructuras la descripción del dominio y la organización del material de enseñanza.

La metodología de representación mediante mapas conceptuales, ha sido utilizada con éxito para el diseño instruccional [5]. Como descripción del dominio los nodos representan los tópicos a enseñar y los arcos las relaciones de precedencia, inclusión o pertenencia que se desee establecer entre tópicos. Esta estructura permite al sistema seleccionar el nodo a enseñar considerando el cumplimiento de los tópicos que lo preceden y según la estrategia de enseñanza que se quiera aplicar (de lo general a lo particular o viceversa)[6]. La enseñanza de distintos tipos de contenidos requiere distintas metodologias [7] [8], el sistema necesita reconocer estas diferencias. Se han establecido tres tipos de nodos: hecho, concepto y procedimiento [9], [10], [11]. La granularidad con que se defina este mapa conceptual esta directamente relacionado con la granularidad con que el sistema enseñará.

Relacionado con cada nodo del mapa de tópicos, el material de enseñanza se clasifica por el tipo de instrucción que brinda (explicación, ejemplo, ejercicio, test, ayuda) y por características propias (importancia, dificultad, tiempo). Es presentado al estudiante considerando su perfil y actuaciones anteriores representados en el modelo del estudiante [6].

MODELO DEL ESTUDIANTE

El modelo del estudiante es una descripción declarativa de las características de las actividades de aprendizaje de los estudiantes [12]. Por ejemplo, el sistema puede usar un *modelo overlay* básico en el cual se registra el entendimiento del sistema sobre el conocimiento del estudiante en un tópico determinado. En este modelo, la respuesta del estudiante es analizada para evaluarla convenientemente.

Nuestro modelo del estudiante trata la caracterización del estudiante (datos personales y perfil del estudiante), conocimiento (almacenamiento de los temas ya conocidos, objetivos instruccionales adquiridos, equivocaciones cometidas y material didáctico usado) e historia (información de la última sesión). El modelo se ha organizado en dos módulos principales: *característica del aprendiz* y *sesión del estudiante*, el primero se refiere a las características personales y la evolución del conocimiento del estudiante a largo plazo, el segundo considera a la sesión globalmente para terminar analizando el "camino" recorrido y el nivel de rendimiento alcanzado por el alumno. Los resultados de ese análisis actualizan su perfil y su evolución personal (ver figura 2).

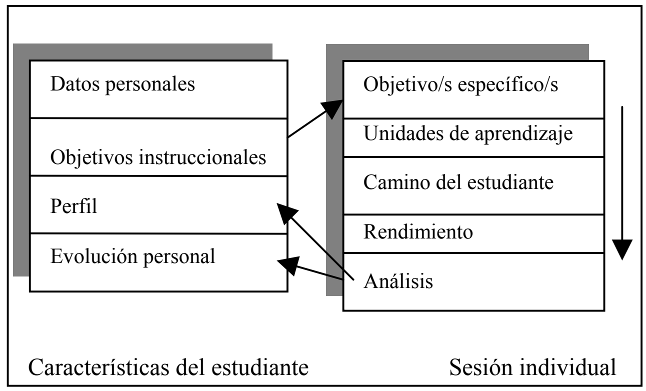

FIGURA 2
MODELO DEL ESTUDIANTE

El comportamiento del STI depende fuertemente del modelo del estudiante, sin embargo éste solo puede representar una serie de fotografías instantáneas de la actividad del alumno en determinados momentos. La consecuencia inmediata es el registro incompleto del proceso de aprendizaje individual de cada estudiante y por lo tanto solo disponer de modelos del estudiante inexactos.

EL PROBLEMA A TRATAR

La competencia en la enseñanza de un sistema tutor computacional es todavía un aspecto importante que ha tenido un desarrollo moderado. Una crítica centrada en este tema la dio Ohlsson [13] en los 80s donde pone de manifiesto el *rango limitado* y la poca *adaptabilidad* de las acciones tutoras en comparación con la riqueza de las tácticas de los maestros humanos.

La motivación de la crítica parece estar fundamentada en la pobre habilidad comunicacional de un STI. Esta es limitada, principalmente debida a los propios problemas de los sistemas computacionales. Actualmente existen pocos ejemplos de tutores computacionales que se "expresan" usando diálogos y gestos (como los usados por agentes pedagógicos animados) [14].

Asimismo, la tendencia actual sostiene que la manifestación de un sistema tutor no se debe reducir a la presentación de explicaciones o indicar cual es la respuesta correcta. Tanto el instructor como los estudiantes deberían co-construir las explicaciones y juntos seguir las mismas líneas de razonamiento. Los STIs deben ser lo suficientemente flexibles y adaptativos para manipular dificultades como *fallas* (el tutor no entiende una respuesta del estudiante, el estudiante puede responder a una pregunta de manera inesperada o la táctica tutorial no trabaja apropiadamente), *revisión de tácticas* (p.e. el comportamiento de los estudiantes indican que el tutor puede saltar pasos en la explicación) y tratar de manipular la *ambigüedad* que presentan las respuestas del estudiante en su significado.

Por otro lado, el sistema tutorial debe "interpretar" la respuesta del estudiante. Esta captación de la actividad del alumno opera con información incompleta y muy a menudo altamente incierta (inexactitud del modelo del estudiante). En consecuencia los tutores deberían poseer métodos fuertes para manipular la incertidumbre. Estos métodos, idealmente deberían ser óptimos, i.e., usando las observaciones sobre los estudiantes, los métodos tendrían que garantizar la ejecución óptima de las acciones tutoriales.

A fin de tratar, en parte, la problemática presentada, centrada en la relación comunicacional del STI con sus usuarios, se propone un modelo del instructor explícito.

MODELO DEL INSTRUCTOR

La enseñanza humano-a-humano raramente incorpora estrategias tutoriales ideales. Algunos de estos mecanismos pueden ser simulados en computadora, (como el método Socrático) mientras que otros, como aquellos donde intervienen el afecto o emoción, son muy difíciles de lograrlo considerando el actual desarrollo de la tecnología computacional.

La actividad pedagógica de un STI, hasta ahora, se ha traducido en colecciones de reglas que solo trabaja relativamente bien en la práctica. En parte, esto se debe a que no existe una enciclopedia científica donde consultar las mejores heurísticas tutoriales. En su lugar, se debe adoptar diferentes métodos de enseñanza porque diferentes estudiantes utilizan diferentes estilos de aprendizaje. La riqueza del conocimiento del instructor real se debe tomar como una de las fuentes más importantes donde extraer las líneas principales del conocimiento pedagógico de un STI.

Un autor, el creador de un STI específico en un dominio particular, suele encontrar varias dificultades cuando desarrolla un STI (por ejemplo, qué criterio usar para considerar que un tópico determinado ha sido aprendido o cuál es la granularidad apropiada de las estrategias tutoriales), en consecuencia puede dar información inconsistente a la herramienta que se traducirá en un comportamiento problemático del STI producido. En este punto se debe considerar como crucial el nivel de experticia del autor. Sin embargo, el problema principal aparece cuando un instructor debe interactuar con el STI producido por algún autor. Si el instructor real no lo acepta, no lo usará apropiadamente en una clase real. Esto nos lleva al problema de la adaptación las estrategias tutoriales incrustadas en la planificación instruccional y su asociación con las tácticas pedagógicas del instructor, i.e., como adaptar esas estrategias a los estudiantes reales.

En este punto debemos considerar *como* construir un STI. Esta tarea involucra el esfuerzo conjunto de expertos en ciencias cognitivas, tecnología instruccional y desarrollo de sistemas computacionales. Tanto el autor como el instructor (eventualmente puede ser la misma persona) generalmente no son expertos en informática. Por lo tanto es deseable disponer de sistemas computacionales que asistan amigablemente a los creadores del tutor computacional. Precisamente, las *herramientas de autoría* constituyen un tipo de sistema de adquisición de conocimiento a partir de autores/maestros/instructores/ entrenadores. A fin de asistir al autor, el sistema de autoría debería poseer conocimiento basado en diversas teorías generales, como las de diseño instruccional y psicología cognitiva.

Las herramientas de autoría actuales no son inteligentes. No poseen modelos de representación declarativa de su conocimiento sobre como construir STIs. Un ejemplo de los sistemas comerciales es Authoware v 4.0 de Macromedia. La inteligencia de las herramientas se manifiesta a través de la inspección dinámica de las descripciones declarativas de su conocimiento a fin de adaptar su comportamiento a las circunstancias bajo las cuales opera. La manipulación de ese conocimiento se hace a través de los modelos que posee el sistema.

En muchos STIs el *modelo del instructor* está implícitamente incluido y solo recientemente ha sido desarrollado explícitamente [13]. La actividad de un instructor involucra tanto conocimiento sobre el tema del dominio como sobre la pedagogía propia de esa área del conocimiento. A partir de la observación de la actividad de los instructores puede deducirse que la funcionalidad aportada por este modelo comprende los siguientes aspectos:

- Mejoramiento en la adaptación y realismo de las estrategias tutoriales.
- Provisión de ayuda inteligente individualizada para el autor/instructor.
- Refinamiento en el diseño de STIs particulares.
- Aliento a instructores novicios para que se involucren en el diseño de sistemas tutoriales
- Mejoramiento en la coordinación y cooperación entre varios instructores durante la creación del mismo STI.
- Registro de la actividad de cada instructor.

Con este modelo, los instructores de variado nivel de experiencia pueden interactuar con la herramienta de autoría a fin de diseñar e implementar sistemas tutoriales, asistido tanto por sus colegas a través del registro almacenado de su actividad como por la misma herramienta que, además puede usar teorías de diseño instruccional (como las de Gagné o Merril).

Para que el modelo alcance la funcionalidad enunciada (ver figura 3) debe capturar información sobre las preferencias del instructor en estrategias tutoriales, sus

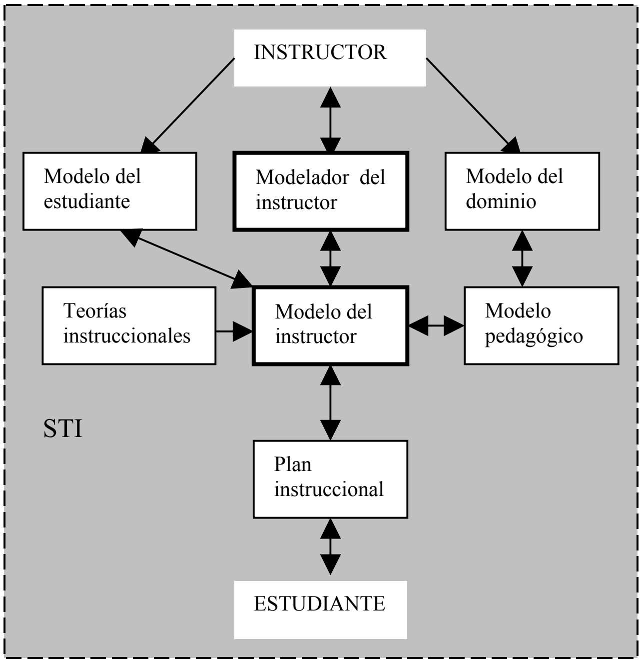

FIGURA 3
ARQUITECTURA DE STI, CON EL MODELO DEL INSTRUCTOR, CREADO POR LA HERRAMIENTA DE AUTORIA

intereses y actividades usuales con respecto a estilos de enseñanza preferidos por sus estudiantes, como su nivel de experticia ("experto", "principiante", etc.) tanto en la enseñanza en un dominio particular como en el proceso de creación de un STI.

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Durante la etapa de creación del STI, los requerimientos pedidos por el sistema al autor (concretados a través de un modelador) pueden ser hechos siguiendo dos modalidades: a través de *preguntas directas* sobre sus preferencias personales y hábitos comunes (p.e. estilo de enseñanza o periodicidad de exámenes) o a través de la *observación de la actividad del intructor* registrando los cambios sobre el perfil del instructor.

Un autor/instructor, cuyo nivel de experiencia puede ser muy variado, puede comenzar proponiendo un curso inicial, donde inicializa las estructuras básicas de los modelos del *dominio* y el material instruccional asociado, *estudiante* (grupo de estudiantes que tomarán el curso), parámetros del *plan instruccional* (pedagogía del tema del curso). El curso resultante puede ser revisado posteriormente, tanto por el mismo instructor como por otros.

Si el nuevo instructor posee un nivel superior de experticia, puede mejorar el diseño del curso. Si por el contrario, su nivel es inferior, puede aprender sobre desarrollo de cursos tutoriales inteligentes. I.e., el diseño e implementación de un STI queda sometido a un proceso de *refinamiento iterativo*, cuyo resultado será alcanzar sistemas tutoriales de mayor calidad, incentivando la cooperación de los autores.

Cuando se considera que el curso posee un nivel de refinamiento global apropiado, este es llevado a las aulas para su utilización con estudiantes reales. En este punto, el STI debe ajustarse a las condiciones reales dentro de las cuales se activará como por ejemplo, nivel de conocimiento de los alumnos, preferencias del instructor en esa aula, características del aula de computación, cantidad de estudiantes, etc. De esto modo se acrecienta el nivel de adaptabilidad de las estrategias tutoriales.

Por otro lado, la asistencia al autor/instructor atiende dos aspectos:

Diseño instruccional: el modelo debe adquirir información sobre las habilidades individuales en el desarrollo de sistemas tutoriales de cada instructor a fin de proveerlo con ayuda específica en el diseño instruccional. Un instructor principiante necesita mas ayuda que uno experimentado.

Uso del software: a fin de ampliar la cantidad de instructores que se acercan a los instructores computacionales es importante que la interfaz sea muy amigable y brinde ayuda en cada paso del desarrollo.

El modelo del instructor examina la actividad de cada instructor así como la de los estudiantes a fin de verificar la eficacia de las estrategias tutoriales del plan instruccional. El resultado de ese análisis contribuye a mejorar el conocimiento pedagógico del sistema a través del modelo propuesto.

MODELO DEL INSTRUCTOR EN CARRERAS DE INGENIERIA

La enseñanza de la Ingeniería se puede beneficiar con la inclusión de este modelo. Uno de los aspectos más importantes es la diseminación de los STIs en las aulas fundamentada en el acercamiento de estos sistemas al instructor real y no al revés. La adaptación realista al estilo de trabajo de cada instructor hace a estos sistemas más atractivos.

Hay temas que se enseñan en las carreras de Ingeniería que pueden ser controversiales en su inclusión y/o nivel de profundidad, por ejemplo, para la enseñanza de la modelización de diversos fenómenos propios del área (p.e. funcionamiento de redes eléctricas o el envío de gas natural licuado en tanques refrigerados) conviene un análisis top-down o bottom-up?. Mediante el modelo del instructor diversos profesores pueden concordar sobre el tema. A su vez, los docentes auxiliares pueden intervenir, inspeccionando la implementación del curso y aportando su punto de vista. Asimismo, la adaptación al estilo de aprendizaje de cada estudiante será mas realista porque todos los docentes del curso aportarán a la mejora de la enseñanza en forma concordante.

CONCLUSION

La inclusión del modelo del instructor mejora el comportamiento global de un sistema tutorial. Se ha enriquecido la interacción con los usuarios del sistema y las relaciones con los otros modelos del STI. La inspección de la actividad detallada del estudiante por parte de su instructor agrega realismo a la actividad tutorial computacional y da lugar a una importante retroalimentación sobre las estrategias tutoriales. Asimismo el análisis detallado del dominio por varios instructores contribuye a su mejor construcción.

Sin embargo, falta evaluar mas fehacientemente el comportamiento de STIs con la nueva arquitectura. Esto se logrará cuando gran cantidad de estos sistemas funcionen en las aulas. Falta comprobar que el comportamiento instruccional mejora fuertemente con respecto a sistemas que no contienen el modelo explícitamente, i.e., verificar si el instructor computacional ha disminuido la brecha existente con el instructor real. Las pocas experiencias en este sentido así lo señalan.

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ENSEÑANZA DE ADMINISTRACIÓN Y DESARROLLO DE PROYECTOS DE SOFTWARE BASADOS EN CMM/SEI ®, BAJO LA MODALIDAD DE TALLER.

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Abstract *— El objetivo de este trabajo es presentar la experiencia obtenida en el proceso de enseñanza – aprendizaje, de un estándar de calidad para administrar el proceso de desarrollo de software. Esta experiencia se realiza en un curso de grado, correspondiente al último año de la carrera de Licenciatura en Ciencias de la Información, de la Universidad Nacional de San Juan. Tradicionalmente la forma de impartir este tipo de curso se basa en clases teóricas expositivas. Esta forma de enseñanza dificulta el aprendizaje por parte del alumno, cuando, como en este caso, las temáticas son difíciles de asimilar sin una experiencia concreta Por lo anterior, presentamos una propuesta de un proceso de enseñanza - aprendizaje basado en la modalidad de Taller, en donde se organiza el grupo de alumnos como una empresa productora de software de nivel 2 de CMM/SEI (Capability Maturity Model/Software Engineering Institute) y se los guía en la administración y desarrollo de un proyecto de software para un cliente externo real.*

Index Terms *— Administración de Proyectos de Software, Desarrollo de Proyectos de Software, Estándar CMM, Ingeniería de Software.*

INTRODUCCIÓN

El software juega un rol cada vez más preponderante en nuestra sociedad, cada vez son más las situaciones de nuestra vida diaria en las que nos encontramos interactuando con software. El software día a día incrementa su participación en actividades cada vez más complejas e importantes de nuestra vida cotidiana. Esta rápida expansión de la industria del software se vincula con la necesidad creciente de ingenieros de software bien formados [3].

El software está creciendo fuertemente en tamaño, complejidad y dominios de aplicación, pero desafortunadamente hay problemas graves en el cumplimiento de planes de costo y tiempo, y en la calidad de desarrollo de la mayoría de los proyectos de software. La mayoría de los proyectos de software de gran envergadura nunca son terminados, y muchos de los terminados no satisfacen los requisitos del usuario y son de pobre calidad [5]. Esta situación incrementa la demanda de desarrolladores de software, no solo formados en los aspectos técnicos y científicos de la computación, sino también que tengan una preparación práctica en ingeniería de software [2]-[4].

La calidad del software depende de una adecuada oferta de profesionales actualizados y competitivos. Los desarrolladores de software han sido formados en la forma tradicional. Desafortunadamente esto no ha producido la oferta y calidad de desarrolladores necesarios para satisfacer esta creciente demanda de software [6].

Tradicionalmente, la forma de enseñar ingeniería de software está basada en clases expositivas en donde se exponen una gran cantidad de conceptos, en la mayoría de los casos en forma teórica, sin experiencias prácticas concretas. Aún en los casos en donde se realizan sesiones prácticas, estas son aplicadas a ejemplos no reales, acotados y ajustados a las necesidades del curso, es decir los llamados proyectos de software de "juguete".

La propia naturaleza de la ingeniería de software, en donde la capacidad de toma de decisiones en situaciones reales es una característica fundamental, hace que este enfoque tradicional pierda efectividad dejando incompleta la formación del alumno.

Para salvar estas deficiencias proponemos una metodología de enseñanza basada en la premisa que *todos los conceptos aportados en el curso se deben aplicar en un proyecto de software real*. Además, realizamos un seguimiento tanto de las opiniones de la industria como de los propios alumnos respecto del curso. Un elemento critico en el éxito de un curso de ingeniería de software es la participación de la industria y la interacción con los estudiantes para evaluar y analizar los distintos aspectos del mismo [1].

La presente propuesta ha sido probada en un curso de Administración de Proyectos de Software, utilizando CMM/SEI como modelo de proceso de software. Uno de los aspectos claves de la misma es la participación de un cliente-usuario real, el cual demanda, a los alumnos, un software basado en necesidades reales surgidas en su medio laboral o empresa. Esta participación externa trae al menos dos beneficios inmediatos:

Motivación del grupo de alumnos: el grupo de alumnos es motivado por el contacto con un medio real, en donde los requisitos, clientes, usuarios y tecnología tienen características reales y no surgidos de un ejemplo académico de libro. La adquisición de conocimiento no técnico (que excede al software) relativo al dominio de aplicación del proyecto también es de gran interés y a la vez motivador para los alumnos.

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Interacción con problemas reales: la aparición de situaciones extra-académicas, propias de la ejecución de un proyecto de software real, entrena a los alumnos en la toma de decisiones poniendo en práctica sus capacidades ingenieriles. Estas capacidades no serían posible exponerlas en proyectos académicos de "juguete".

La propuesta aquí presentada ha sido experimentada, analizada y mejorada anualmente, a partir del año 1998. Para ello se contó con la colaboración de los propios alumnos que a través de encuestas de satisfacción dieron indicios de oportunidades de mejoras del curso, que en muchos casos luego se implementaron.

PROPUESTA

Ambiente de aplicación

Se trabaja con alumnos de 5° año de la Licenciatura en Informática de la Universidad Nacional de San Juan. Esta Licenciatura es de 5 años, por lo cual se considera que los alumnos tienen una adecuada base, adquirida a lo largo de la carrera, de conocimientos en temáticas de la Ingeniería de Software como metodologías de Análisis y Diseño, Implementación y Planificación de Proyectos.

El curso se llama 'Sistemas de Información III', pertenece al Área Sistemas y es dictado en el último cuatrimestre de la carrera. El cuerpo docente contempla un profesor titular y un jefe de trabajos prácticos.

Con respecto a infraestructura, se dispone, para los alumnos, un gabinete con 12 equipos en red NT, que es el aula donde toman clases.

Objetivos del Curso

El objetivo principal del curso, es formar al alumno en los estándares internacionales de calidad de software. El alumno, que ya está capacitado a raíz de haber aprobado otros cursos del área, en metodologías de desarrollo de software, etc, necesita adquirir conocimientos de conceptos, técnicas y estrategias de calidad de software, con el fin de alcanzar una formación profesional con alta conciencia y conocimientos prácticos con respecto a la excelencia en el proceso de desarrollo de software.

Los objetivos específicos por unidad temática son:

- **Calidad**: Lograr que el alumno adquiera un conocimiento profesional del concepto de calidad, calidad del producto y calidad del proceso.
- **Administración de Requisitos**: Lograr que el alumno valore la importancia de esta etapa dentro de ciclo de desarrollo de software adquiriendo conocimientos prácticos de formalización de documentación de requisitos, a través de un estándar utilizado para tal fin.
- **CMM**: Lograr que el alumno conozca el alcance de CMM/SEI como herramienta de evaluación y auto mejora de la calidad del proceso de software. Que el alumno conozca los fundamentos y lineamientos generales de los niveles 3, 4 y 5 de CMM/SEI, y conozca en profundidad, por medio de la experiencia práctica, los objetivos y bondades del nivel 2 de madurez de CMM/SEI.
- **Administración de Riesgo**: Lograr que el alumno comprenda, identifique y gestione factores de riesgo del producto, del proyecto y del negocio, en forma práctica sobre el proyecto que comienzan a desarrollar.
- **Inspecciones de software**: Lograr que el alumno conozca los conceptos y fundamentos de inspecciones de software, cuya práctica es desarrollada durante todo el curso.
- **Testing de Software**: Lograr que el alumno adquiera conocimientos teóricos y prácticos de las distintas técnicas de testing de software aplicadas en el proceso desarrollo de software.
- **Satisfacción del cliente:** Lograr que el alumno tenga otra perspectiva de la calidad en donde el cliente-usuario del software tenga un papel protagónico.

Metodología

La primer clase expositiva del curso es introductoria sobre las temáticas abordadas por el curso, modalidad del cursado y la forma de trabajo en el taller, enseñándoles pautas de comportamiento para lograr una adecuada interacción grupal.

Luego existe una serie de clases de exposiciones teórico-prácticas sobre Calidad, analizando diferentes bibliografías, estándares de calidad, etc. Se les brinda a los alumnos un panorama sobre la filosofía conceptual del CMM/SEI, estructura y niveles, en forma general, haciendo hincapié en los fines de cada nivel, las metas de cada área y los objetivos de las prácticas claves.

Al finalizar estas exposiciones se realiza un breve relevamiento en donde cada alumno expresa sus experiencias, conocimientos y preferencias que tienen, con respecto a las etapas, metodologías, técnicas y herramientas, dentro del ciclo de desarrollo de software.

Los alumnos realizarán una presentación en detalle de cada área del nivel 2, agrupándose por afinidad entre ellos en 6 grupos en donde a cada grupo se le asigna un área clave. La presentación de cada área se realiza en clase frente a todos los compañeros. Se evalúa a los alumnos durante la presentación, por conocimiento, claridad y esfuerzo demostrado en la realización de la presentación.

En este punto del curso se toma una evaluación para controlar los conocimientos adquiridos y nivelarlos.

En base a la cantidad de alumnos y a los datos obtenidos en el relevamiento previo, se dividen a los alumnos en 1 o 2 grupos y se les asignan roles, ya sea del área de CMM/SEI nivel 2 en la que deben trabajar, como rol dentro del equipo de desarrollo de software. Cada alumno tiene responsabilidad por dos roles, en un área y en el equipo de desarrollo del software. Cada grupo se transforma en una empresa desarrolladora de software, a la que se le asigna un proyecto real y deben trabajar en pro de ello, durante los 3 meses de cursado que restan.

Durante la ejecución del proyecto, se van dando clases teórico-prácticas, de las diferentes temáticas que se van necesitando a lo largo del mismo. Se les entrega a los alumnos el Manual de Procedimientos de cada área, manual que respeta el estándar CMM/SEI y que fue generado y mejorado por los mismos alumnos en años anteriores.

La primer temática que se aborda es la Administración de Requisitos, en donde, además de prepararlos en técnicas de entrevistas, se enseña y se aplica el estándar de la ESA (Agencia Espacial Europea) para la formalización de Requisitos de Usuarios y Requisitos de Software.

A este punto, los alumnos están listos para recibir la visita del 'cliente real', todos los alumnos del grupo participan, pero son los analistas los encargados de guiar la entrevista. Esta primer visita se realiza en el aula, con el objetivo que todos los participantes del grupo se sientan involucrados en el proyecto desde los inicios y conozcan el objetivo del sistema a desarrollar, pedido por el cliente.

Las entrevistas subsiguientes que sean necesarias, ya son pactadas entre los analistas y el cliente y el lugar de reunión no necesariamente sea la facultad. Los analistas deben elaborar un completo y consistente documento de requisitos de usuario, planteando todo aquello que el cliente necesita y respetando los lineamientos del estándar de la ESA.

Paralelamente, el resto de las Areas se van involucrando en las tareas que deben realizar, estudiando el Manual de Procedimientos que se les entrega para tal fin. Las áreas comienzan a realizar las tareas asignadas. También se les da una clase teórica de Inspecciones de Software, en donde se lo instruye en la forma de realizarlas y de los beneficios consecuentes de aplicar dicha técnica a lo largo de todo el proyecto.

Se realiza inspección al documento de requisitos de usuario. Cuando este es aprobado los analistas deben generar el documento de requisitos de software, planteando todo lo que el sistema realizará, para satisfacer las necesidades enumeradas en el documento anterior y presentar la matriz de trazabilidad correspondiente. Este documento también pasa por el control de una inspección.

El área de Administración de la Configuración debe presentar su plan, generado para este proyecto y acatando lo previsto en el Manual de Procedimientos, para que todas las áreas conozcan los mecanismos con los que se deberán manejar para solicitar información o para entregar documentación para configuración.

Todas las inspecciones son registradas en actas, y estas son ingresadas al área de Administración de la Configuración, bajo el procedimiento formal consignado en el Plan de Administración de la Configuración,

El área de Planificación, ya puede ir comenzando a acordar y establecer tiempos y esfuerzos, a esta altura se les brinda clases teórico-prácticas sobre Administración de Riesgos, y sobre la técnica de Puntos de Función, con el objetivo de que puedan realizar una planificación con calendario y agenda lo más ajustadamente posible.

Las áreas de Seguimiento y Control y de Administración de la Calidad también deben presentar su respectivos planes para el proyecto y deben informar semanalmente, a todo el grupo, sobre los informes de seguimiento y actas de calidad realizados, de acuerdo a lo planificado, con el objetivo de determinar si es necesario tomar medidas correctivas.

Una vez que los documentos de requisitos de usuario y requisitos de software son formalmente aprobados, los diseñadores, que ya vienen avanzando sobre este aspecto, deben tratar de llegar a un diseño con el mayor detalle posible. Generan un documento en donde se describe como hará el sistema para obtener lo especificado en el documento de requisitos de software. Este documento no solo refleja la arquitectura del software y diccionario de datos, sino también el diseño de las interfaces, el mapa de navegación y detalle de programas particularmente complejos, este documento es una versión adaptada de los documentos de diseño del estándar de la ESA.

Una vez aprobado formalmente, el documento de diseño, con una inspección, los implementadores, que previamente se han familiarizado con el lenguaje y entorno de programación, e incluso haber realizado algún prototipo, comienzan a trabajar fuertemente en implementar todo lo indicado en el documento de diseño y se planifican las fechas de inspecciones de código.

En este punto se da una clase de Testing de Software y técnicas de testing. Los encargados de realizar el testing ya pueden comenzar a planificar el testing del software, tomando como base los documentos anteriores aprobados. Este plan de testing debe ser presentado en clase.

Una vez que el sistema es terminado y se realiza la presentación formal, los encargados de testing deben comenzar a testear el software y presentar un informe de resultados de testing.

A esta altura, nos encontramos al final del período de cursado de la materia, se les enseña otra forma de medir calidad, como es la medición de la satisfacción de los usuarios del software.

Se hace un cierre de la materia con una clase en donde los exponen su experiencia, sus sugerencias, su grado de satisfacción y proponen 'mejoras' que se podrían realizar a los Manuales de Procedimientos, de acuerdo a la experiencia obtenida por su uso.

Consideraciones generales

No está de más aclarar que todas las clases teóricas y teórico-prácticas y exposiciones se realizan para todos los alumnos, no solos los involucrados en las temáticas. Las inspecciones también son practicas obligatorias para todos los alumnos del curso.

Algunas veces se puede plantear que en lugar de realizar presentaciones de los planes de las áreas, pueden realizarse Inspecciones a los planes. Esto lo hemos realizado, sobre todo, con el Plan de Planificación del Proyecto.

Los alumnos deben satisfacer un mínimo de 75% de asistencia a clases y exposiciones tórico-prácticas, como así también a las presentaciones de planes, inspecciones, sistema, etc. El resto del tiempo asignado a la materia se destina para que los alumnos trabajen en las tareas que les han sido encomendadas, en aula o en el lugar que ellos dispongan. Estos días no se computan en la asistencia.

CONCLUSIONES

El resultado de aplicar la modalidad de taller para este tipo de currícula, es realmente satisfactorio. Los resultados obtenidos son de muy buen nivel académico y de desarrollo. Los alumnos mismos ven superadas sus expectativas.

No es una tarea fácil, requiere de un dedicado seguimiento al trabajo de los alumnos, muchas veces exigir y tratar de hacer respetar la planificación original, para que vaya de acuerdo a la restricción temporal del cursado.

Las encuestas que miden el nivel de satisfacción reflejan un grado de satisfacción que va del bueno al elevado.

La participación de un cliente externo al ámbito académico es un factor importante de motivación para los alumnos, imponiéndoles restricciones reales en donde las capacidades ingenieriles de los alumnos se pueden llevar a la práctica.

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EVALUACIÓN DE ASIGNATURAS DE TIPO TECNOLÓGICO

Marc Barracó-Serra[1] , Mª àngels adrià-Casas[2], Ricard Torres-Cámara[3],Pere Surià-Lladó[4]

Abstract — *The technical syllabus of technological matters modifies their contents and their methodologies, introducing new tematic subjects or suppressing others.*
The justification of such changes must be centered in approaches of educational effectiveness and adjustments to the industrial world reality in each moment.
The way to proceed, according with this exposed sense, is making particular and general evaluations of the matters, in the aspects of motivations, objectives, methodologies, resources, etc.
It is necessary to keep in mind that the succession of changes is done with very big speed, because their foundations are based in the development of the new information and communication technologies. For this reason a value systematic analysis is proposed.
The creation of an "educational protoplasm" that contact universitary Departments, educational Institutions, scientist and industrial world professionals., favors the discussion of the question and facilitates the taking of decisions in the sense of profiling a curricular reality more adapted to the moment.
A specific mention about the creation of an "educational proptoplasmatical structure" in the "Departament de Mecànica de Fluids" of the "ETSEIB-UPC", as well as the perspectives of its operativity, is treated.

Index Terms — subject evaluation, educational protoplasm, technical curriculum, University-Industry.

INTRODUCCIÓN

Los Planes de Estudios varían sus contenidos periódicamente introduciendo o modificando asignaturas. Quiere esto decir que se está asistiendo a la implantación de asignaturas total o parcialmente nuevas respecto a los contenidos curriculares anteriores.
Las razones que provocan estas modificaciones han de ser justificadas desde un punto de vista de mejora de la eficacia docente. Se han de esgrimir, por tanto, argumentos de peso para producir estos cambios.
La única manera objetiva de proceder es mediante una evaluación de toda la asignatura, desde las motivaciones iniciales hasta los objetivos, metodologías, soportes utilizados en su desarrollo, criterios de evaluación , etc.
El contenido de lo que se apunta es de tipo general, pero es obvio que en materias tecnológicas las velocidades de cambio son tan altas que se puede asegurar que las actuaciones en los Planes de Estudio han de ser continuadas.

Establecimiento, modificación o supresión de una asignatura

La razón que inicialmente se puede dar para la aparición o modificación o desaparición de una materia, es la voluntad de la Administración que, asesorada convenientemente, publica en sus medios de comunicación los nuevos contenidos, indicando ligeramente la metodología de enseñanza (tiempo, prácticas,...). Esta realidad, a pesar de ser la que ha prevalecido tradicionalmente, es la menos importante desde el punto de vista docente, siendo de tipo oficialista y tendiendo a obtener criterios para poder facultar para el ejercicio profesional a quienes han seguido las enseñanzas que se hayan derivado.
La motivación real, de la cual la Administración ha de ser transmisora, ha de ser el estado actual del mundo industrial y su estado previsible en el futuro.
La sociedad demanda técnicos formados para hacer frente a los problemas que la industria presenta y que ha de resolver de manera correcta y de la forma más rápida posible para no interrumpir el proceso productivo y optimizarlo de manera continuada.
Los recursos empleados han de ser utilizados de manera adecuada para garantizar la consecución de los objetivos fijados en su grado máximo.

Objetivos generales

De forma ambiciosa, que es como se han de enfocar las actuaciones, se ha de procurar que se adquiera un nivel de aprendizaje por parte del estudiante suficientemente importante para potenciar sus competencias y habilidades así como un buen bagaje de conocimientos para adquirir el criterio suficiente para dictaminar sobre las situaciones técnicas que se planteen.
Estos objetivos generales hacen énfasis en las actividades de aprendizaje, superando la clásica transmisión de conocimientos del profesor al estudiante y abogando por un aprendizaje mutuo acentuando el matiz formador de la enseñanza.

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Es preciso considerar que la asignatura en cuestión no se ha de analizar en forma aislada, lo que supondría una concepción micro, sino que se ha de integrar en un sistema de conocimientos diversos y complementarios, lo que supone un análisis global macro del plan de estudios.
Llegados a este punto se ha de ser consciente del volumen de trabajo que supone el cumplimiento de un mínimo de objetivos (adquirir una base sólida y la posibilidad de una cierta especialización). Se hace necesario el establecimiento de unos criterios de priorización de objetivos. Estas opciones propiciadas por el Centro docente son asumidas por el estudiante.
En cursos numerosos la atención del estudiante en el asesoramiento sobre las opciones a elegir es dificultosa, pero se han de implementar sistemas de comunicación para que el Plan de Estudios se realice de manera personalizada y tutelada.

Objetivos específicos

Al ser de características particulares para cada temática se ha optado por enunciar algunos puntos que son aplicables a más de una materia pero más concretos que los mencionados hasta ahora:

- Enseñanzas teóricas. A pesar que el título no es el más adecuado, hace referencia a la exposición del cuerpo doctrinal de la materia. Es preciso indicar que éste contenido es concreto y tomará como base inicial lo que el estudiante sabe de los conocimientos básicos ya cursados.
  Es claro que se trata de entender el núcleo del tema presentado par iniciar de esta manera una fase de discusión, de diversidad de pareceres, de distintas opiniones y de elaboración de bases de actuación.
  El planteamiento de situaciones no analizadas y que se pueden producir en ocasión de la explicación, daran validez universal a la exposición.
  La introducción de nuevos parámetros y el hecho de contemplar problemáticas contrarias a las formuladas completarán el aprendizaje.
- Enseñanzas práticas. Conllevan el contacto con la realidad experimental. El desarrollo teórico de la manipulación a realizar, la manipulación propiamente dicha (con el conocimiento de la instrumentación y las técnicas de medida), el análisis de los resultados obtenidos (con los errores introducidos y la no conservación de las hipótesis iniciales) y las conclusiones finales, constituyen la totalidad de la actividad que se completa con la exposición del conjunto del trabajo con la discusión subsiguiente.
  Las enseñanzas prácticas han de aportar como valor principal el hecho de colocar en su lugar correspondiente la vertiente de aplicación, adquiriendo rigurosidad en las operaciones, espíritu crítico en trabajo realizado y todas las facetas de iniciativa y creatividad necesarias para resolver aspectos conflictivos del problema estudiado.
- Enseñanzas diversas. Bajo este título se engloban un conjunto de actividades que complementan de manera trascendente los conceptos teóricos y experimentales. Se trata de contemplar las visitas técnicas, las conferencias especializadas, debates sobre un tema determinado, trabajos dirigidos de una parte o la totalidad del temario del programa, etc.
  A pesar que han sido consideradas como enseñanzas de segundo orden, cada vez es más intensa la opinión de su eficacia. Factores como el trabajo en equipo, la faceta de discusión de aspectos tecnico-económicos con vistas a realización industrial, así como el contacto y el cambio de opiniones con los responsables científicos y tecnológicos han de representar el bagaje formativo más relevante.

Evaluación de la asignatura

Se ha de entender que efectuar una evaluación de una asignatura, es hacerlo desde todos y cada uno de los condicionantes que han procurado su incorporación al curriculum.
La primera cuestión que se prevee es la manera de realizar la evaluación. En efecto,
¿Quién ha de hacer la evaluación?
¿Cómo se ha de realizar la evaluación?
¿Cuándo se ha de hacer la evaluación?
¿Qué consecuencias se derivaran de la evaluación?
Evidentemente no existe una respuesta precisa para todas estas preguntas, pero es muy claro que han de hacer la evaluación los responsables de la docencia (profesores, estudiantes, centros docentes, entorno industrial,...)
Paralelamente a la información extraida se han de analizar y valorar los resultados docentes (éxito o fracaso en el aprovechamiento, validez o inutilidad de la materia propuesta,...).
La frecuencia de evaluación ha de ser la máxima posible, conservando su significación y la posibilidad de actuación, sea para la introducción de una modificación o para aconsejar su anulación.

- Evaluación del programa.
  Se han de analizar entre otros factores:
  - El equilibrio del tipo de enseñanza (teoría, práctica, trabajos dirigidos,...)
  - La adecuación de la asignatura a la idiosincrasia del Centro
  - La adecuación del programa a las necesidades del entorno industrial
  - La facilidad en el establecimiento de comunicación entre los diferentes grupos integrantes de la enseñanza

- La evolución que se produce entre las sucesivas evaluaciones.
- La eficacia en la utilización de recursos docentes.
- La adaptación a los contenidos del Plan de Estudios.

- Evaluación de los objetivos.

Los puntos más importantes incorporados son:

- La adecuación al Plan de Estudios.
- La consecución de los niveles de formación fundamentales y amplios (visión general y definición del perfil del estudiante analizado colectivamente).
- La concordancia entre la consecución de resultados y los medios empleados en ello.
- La claridad en que han sido planteados los objetivos desde el punto de vista formal.

- Evaluación del contenido

Extraida de la experiencia adquirida en la industria y la aportación de la Universidad, se ha de considerar:

- La correcta situación de las enseñanzas en el total del Plan de Estudios. En el caso presente se trata de garantizar la consecución de los conocimientos básicos necesarios para poder intensificar la característica tecnológica de la asignatura. Con todo, se ha de procurar que el contenido no sea puramente informativo.
  La concreción de lo que se ha expresado indica la necesidad del carácter de aprendizaje de la enseñanza (en materias tecnológicas resulta más problemático).
- La buena organización. Comporta un orden correcto de actividades de dificultad creciente. La incorporación de los trabajos prácticos en el momento idóneo y la realización de trabajos dirigidos (proyectos, estudios,...) de forma eficaz (es corriente el parecer según el cual estas actividades es conveniente programarlas de manera continuada a lo largo de todo el curso -y de toda la carrera- incorporando en cada estadio los conocimientos adquiridos recientemente).

- Evaluación de la metodología

Es el aspecto que puede validar o anular una nueva implantación. En este sentido es preciso:

- Constatar que la forma de impartir la asignatura asegure un verdadero aprendizaje. Es conveniente comprobar cuales son los sistemas que se pueden emplear para este objetivo. Las técnicas de aprendizaje cooperativo y, en general, toda manifestación de participación activa del estudiante ha de ayudar a logro de este propósito
- Insistir en el uso de los recursos más elaborados, sean materiales o estratégicos, para la participación mayoritaria.

- Evaluación del sistema de evaluación

Hace referencia a la calificación que se ha de asignar al Estudiante como medida del aprovechamiento adquirido al haber cursado la asignatura propuesta. Es imperativo que:

- Se adopte un sistema de evaluación que ponga de manifiesto el progreso en la incentivación de conocimientos, habilidades y competencias, antes mencionadas, en el proceso global del aprendizaje
  Resulta claro que este sistema ha de ser continuo con posibilidades de recuperación individual y colectiva en caso de retraso en el aprendizaje.
  La valoración de cada una de las actividades realizadas, con el análisis de los éxitos y las dificultades, facilita la labor evaluadora (incluso la de tipo sancionador)

Evaluación general de la asignatura

Planteada la asignatura y desarrollada (en el periodo de tiempo conveniente para la extracción de conclusiones) se llega a la valoración de los criterios que han motivado su introducción en el Plan de Estudios y/o su posible eliminación del mismo.
Todos y cada uno de los aspectos que conforman el desarrollo han de ser objeto de evaluación. Siendo así cabe sintetizar:

- ¿Se ha desarrollado el programa como estaba previsto?
  Es preciso que ofrezcan su opinión justificada, estudiantes, profesores, responsables de las instituciones académicas y representantes del entorno industrial. La valoración ha de abarcar:
  - la utilidad (aplicabilidad)
  - la coherencia institucional y social
  - La utilización razonable de recursos
  - La adecuación al Plan de Estudis vigente
  - La mejora sucesiva de las evaluaciones efectuadas anteriormente
  - El sistema de incentivación dado a profesores y estudiantes

- ¿Se han obtenido los objetivos previstos?
  Los mismos colectivos protagonistas han de cuestionarse sobre:
  - La adecuación al Plan de estudios
  - El grado de adquisición de los criterios de formación-aprendizaje
  - La caracterización personalizada de cada estudiante
  - La claridad y precisión empleada para que los objetivos sean comprendidos

- ¿Han sido adecuados los contenidos?
  Son la concretización del programa. Se ha de valorar:
  - Su correcta organización.
  - Su concordancia con el Plan de Estudios

- Su buena contribución a la formación-aprendizaje

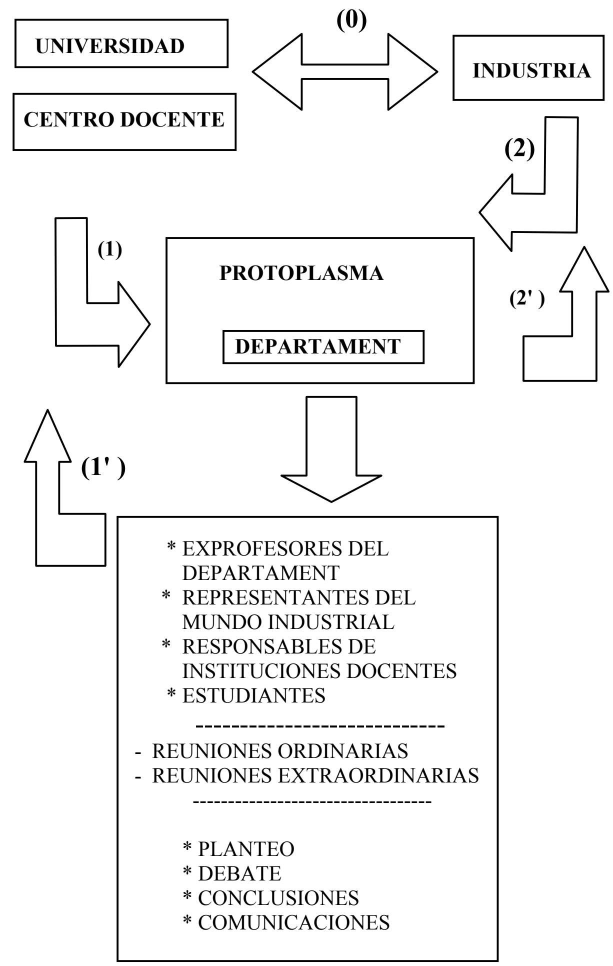
- ¿Se han empleado metodologías docentes eficaces? Representa una buena parte del éxito de la asignatura. Contempla:
  - La consecución del binomio enseñanza-aprendizaje
  - La consecución por parte del estudiantado de los objetivos propuestos

- ¿Han sido idoneos los recursos utilizados? Es, seguramente, el elemento decisorio del éxito (enseñanza-aprendizaje correcto) de la implantación. Es preceptivo analizar:
  - La utilización de recursos materiales idóneos
  - La introducción de estrategias adecuadas.

REFLEXIONES FINALES

En el esquema adjunto se indica la cristalización del contenido expresado realizada en el "Departament de Mecànica de Fluids" de la "ETSEIB-UPC" en sus actuaciones en diferentes etapas de actuación.
El objetivo primordial ha sido el establecimiento de los contactos necesarios: Universidad-Industria (0), a través del "Departament" para incidir en la evaluación de las asignaturas de su área temática (Mecánica de Fluidos y Máquinas hidráulicas fundamentalmente) y decidir las modificaciones que se consideren pertinentes.
La creación de la estructura de "protoplasma docente" se ha realizado con el concurso de ex-profesores del Departamento, representantes del mundo industrial y científico, responsables de las Instituciones docentes, estudiantes, y cualquier persona o estamento con voz propia en la temática en cuestión.
El sistema de funcionamiento es de tipo comisión con reuniones periódicas ordinarias, de control e información y reuniones extraordinarias con motivo de temas puntuales trascendentes.
Los planteos, debates y conclusiones, desprovistos de los aditamentos formales innecesarios conllevan a la elaboración de comunicaciones que redundaran en la solicitud al centro docente -en primera instancia- de ciertas medidas a incorporar en el Plan de Estudios (1').
La respuesta del Centro e Instituciones (1), indicará la conveniencia o no de la incorporación de las medidas propuestas y, en su caso, la provisión de recursos suficientes para ello.
La manifestación de las opiniones del mundo industrial y la respuesta que, despues del proceso, ofrecerá el "Departament" se señalan mediante (2) y (2').
Los resultados obtenidos, a lo largo de los años, por la actuación del protoplasma docente en forma directa o como consecuencia se centran en:

- Remodelación de las prácticas de laboratorio de Mecánica de Fluidos según criterios de mayor contenido experimental.
- Visión de la asignatura de "Centrales hidroeléctricas" desde el aspecto de maquinaria hidraúlica, reduciendo el contenido eléctrico y económico (los Departamentos correspondientes ya lo incorporan en sus programas)



- Planteamiento de introducción de una asignatura de mantenimiento de máquinas hidráulicas (en el futuro se ha presentado como una asignatura reglada)
- Establecimiento de criterios de uniformización de definiciones, clasificaciones, nomenclatura y simbología de los elementos de todas las asignaturas impartidas por el "Departament"
- Participación del sector industrial en las tareas docentes (conferencias, seminarios,...etc). De especial interés en las asignaturas de "Centrales hidroeléctricas" y "Ventiladores industriales y compresores"
- Planteamiento de creación de criterios concurrentes en la formulación de las ecuaciones fundamentales (acción conjunta con los Departamentos que imparten Elasticidad y Transmisión de calor y que

ha concluido en la introducción en el Plan de estudios de la asignatura "Mecánica de medios continuos")

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CONEXIÓN NORMALIZADA DEL EQUIPAMIENTO EN LOS LABORATORIOS DE ENSEÑANZA DE CONTROL

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Abstract *— En este trabajo se describe una forma de interconexión normalizada de diferentes procesos y plantas de laboratorios para la enseñanza de control automático. El sistema de adquisición y control es común para todos los prototipos y se implementa con una PC estándar provista con software para control en tiempo real. La conexión de las diferentes plantas con las PC's, usadas como controladores, se realiza mediante una red CAN (Controller Area Network), y de esta forma se logra hacer intercambiables a las diferentes plantas existentes mediante una conexión normalizada. Además se garantiza que las futuras plantas incorporadas al laboratorio podrán ser controladas con cualquiera de las PC's que posean la interfaz CAN. Para el diseño de los algoritmos de control se utiliza los paquetes Simulink, Real Time Workshop y Real Time Windows Target de MATLAB. El manejo del protocolo CAN, se realiza mediante una S-Function de Simulink la cual es transparente para el diseño del algoritmo de control. En base a los resultados satisfactorios obtenidos se propone una normalización para interconexión de procesos y plantas de laboratorio basada en la red CAN.*

Index Terms — CAN networks, control education, equipment interconnection, MATLAB, real-time control, Simulink.

INTRODUCCIÓN

En los últimos años se encuentra una tendencia generalizada a incorporar más trabajo experimental en la formación en control automático. Tradicionalmente esta formación se centraba en cursos con fuerte contenido teórico, pero cada vez más se reconoce la importancia de enfrentar problemas de la práctica profesional en el marco de los estudios de ingeniería. En este sentido, se citan frecuentemente las conclusiones del Workshop de la National Science Foundation y la Control Systems Society de la IEEE (NSF/CSS) con nuevas directivas para la educación en control automático, que impulsan a modificar los actuales métodos de enseñanza [1]. Un primer acercamiento a los problemas de la práctica se consigue con el uso de herramientas de simulación. En este sentido se han desarrollado varios "Laboratorios Virtuales" aprovechando las posibilidades y recurso de Internet [2],[3].

En cambio, no hubo un desarrollo similar en lo relativo a experimentos reales. Y son las aplicaciones y el control en tiempo real los ingredientes esenciales en el aprendizaje de la ingeniería en automatización. Creemos que un factor limitante en el desarrollo de experiencias en este campo se debe a que cada aplicación implica, además del experimento en sí, un trabajo considerable de interfaces, conexionado y software dedicado. Además, estas tareas requieren frecuentemente, del aporte de especialistas de diferente orientación. Por ello entendemos que disponer de una interfaz normalizada, común a las distintas experiencias de un laboratorio, permitirá desentenderse de los aspectos laterales, para concentrarse en el experimento de interés.

Por otra parte, la internacionalización de la educación universitaria se expande día a día, tanto en las carreras de grado como en las de postgrado. La necesidad de compatibilizar las herramientas usadas en las distintas disciplinas es un punto importante para facilitar la integración de los estudiantes. La estandarización de los métodos de trabajo e interconexión en el terreno experimental facilitará la posibilidad de cooperar y compartir experiencias entre instituciones tanto nacional como internacionalmente.

En este marco la idea propuesta en este trabajo es la estandarización, a nivel educativo, de sistemas de control en tiempo real y aplicaciones experimentales. La utilización del software MATLAB/SIMULINK juntamente con el paquete para control en tiempo real RTW ya está siendo utilizada como un estándar por varias instituciones [4]. Este paquete permite generar algoritmos, juntamente con su código para la ejecución en tiempo real, en forma gráfica. De esta forma se logra que los estudiantes y profesores se pueden concentrar en el diseño del sistema de control, su implementación y evaluación sin necesidad de entrar en la tediosa tarea de programación con lenguajes de bajo nivel e interfaces a hardware [5].

LA RED CAN

La red CAN (Controller Area Network) es una red de comunicación serie que fue originalmente diseñada para su utilización en la industria automotriz, aunque actualmente, también se ha hecho una red popular en la industria de la automatización y otros campos. La red CAN se utiliza principalmente en sistemas embebidos y ofrece una excelente solución para manejar la comunicación entre múltiples microprocesadores. Es una red de dos hilos, half duplex (un sentido a la vez) apropiada para aplicaciones de

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alta velocidad utilizando mensajes cortos. El protocolo CAN utiliza identificadores de mensajes (ID) que pueden ser asignados en diferentes categorías de información de control [6]. Estos ID son a su vez indicadores de la prioridad de cada mensaje. En caso de disputa de la red, los mensajes de menor ID prevalecen respecto a los mensajes de mayor ID. Estos hace que la red CAN sea adecuada para su utilización en control en tiempo real. La velocidad de comunicación puede llegar hasta 1 Mbits/seg en distancias de aproximadamente 40 metros. El protocolo es ampliamente utilizado en aplicaciones sobre vehículos aunque su uso se está ampliando rápidamente a aplicaciones de todo tipo debido a su bajo costo. Los puntos a destacar de las redes CAN son los siguientes:

- Capacidad de control en tiempo real, gracias a la posibilidad de asignar prioridades a sus mensajes y a la no destrucción de mensajes en el caso de una disputa del bus.
- Capacidad de comunicación multi-maestro. Cualquier nodo puede iniciar una comunicación en forma independiente en cualquier momento.
- Bajo costo de implementación debido a la disponibilidad en una gran cantidad de microcontroladores de diferentes fabricantes como Intel, Motorola, Philips, Dallas, etc.
- Posee diferentes mecanismos de detección de errores que la hace muy robusta e ideal para trabajar en ambientes ruidosos.
- Es fácil de configurar y modificar.

Estos son los puntos que se tomaron en cuenta a la hora de elegir una red para interconectar los procesos de laboratorio con las PC's. Las beneficios de inerconectar plantas y PCs con las red CAN en los laboratorios son enormes. Entre los puntos que podemos resaltar de estos beneficios son:

- Un protocolo de comunicación estándar simplifica y reduce los costos al conectar diferentes plantas y subsistemas de varios vendedores en una red común.
- El algoritmo de control es realizado por la CPU o DSP en la PC dejando tareas como adquisición, protección, y generación de señales al nodo. De esta manera, la CPU o DSP encargado del algoritmo de control tiene más tiempo para tareas específicas de control.
- La red CAN, multiplexa todos los mensajes mediante un cable de sólo 2 conductores, esto elimina la tediosa tarea del conexionado punto a punto de todas las señales entre la PC y la planta, ahorrando tiempo, dinero y facilitando las tareas a la hora de la interconexión.

HARDWARE

Existen varias maneras de implementar el hardware necesario, con capacidad de comunicación CAN. Si se consulta la documentación on-line de Mathwork se pueden encontrar soluciones para varios sistemas embebidos

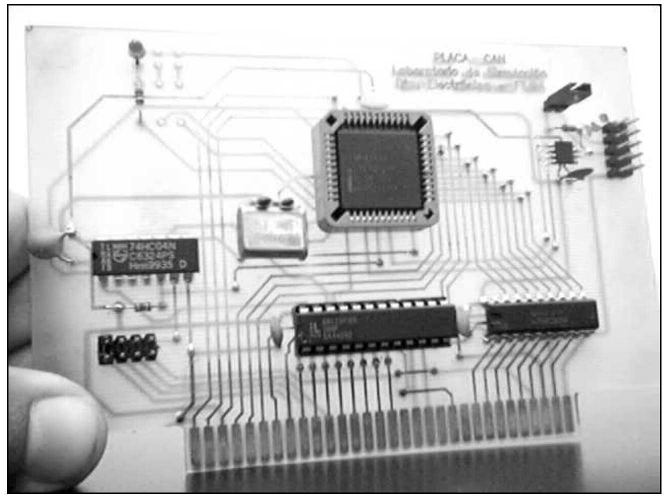

FIGURA. 1
PLACA DE RED CAN PARA PC

posibles. En nuestro caso la comunicación CAN con las PC's se logra mediante una placa ISA en un slot de la PC (Figura 1). Esta placa contiene un controlador CAN AN82527 de Intel, el cual maneja completamente todos los detalles del protocolo CAN. Para la capa física de la red se utilizó un integrado UC5350 que cumple el estándar ISO11898 y maneja velocidades de hasta 1 Mbits/segundo.

Las estaciones remotas (nodos) fueron realizados con el mismo controlador CAN AN82527. Además los nodos poseen un microcontrolador MC68HC11 que se encarga de las tareas específicas de adquisición como conversiones A/D, D/A, generación de PWM (Modulación de Ancho de Pulso), sistemas de protección de la planta y supervisión de bajo nivel. El microcontrolador se comunica con el controlador CAN para su configuración, recepción y transmisión de mensajes. Cada nodo además maneja la capa física de la comunicación con el estándar ISO11898.

SOFTWARE

Todo el software de simulación utilizado pertenece al entorno MATLAB, herramienta de uso generalizado en los cursos y proyectos de control. Se describen a continuación dos componentes importantes de MATLAB [7] utilizados para la simulación y control en tiempo real de los sistemas y el hardware que se empleó para el control de los ejemplos.

Simulink

En términos generales, Simulink es un paquete de software que permite modelar, simular, y analizar sistemas dinámicos. Soporta sistemas lineales como no lineales, modelos en tiempo continuo, discretos e híbridos. Para diseñar los modelos, Simulink provee una interfaz gráfica (GUI) que permite construir los modelos como diagramas de bloques, de la forma habitual en que se plantea el diseño de sistemas en el ámbito del control automático. Simulink incluye un conjunto de bloques de librería. Algunos de estos bloques están incluidos en el paquete principal, otros son "toolbox"

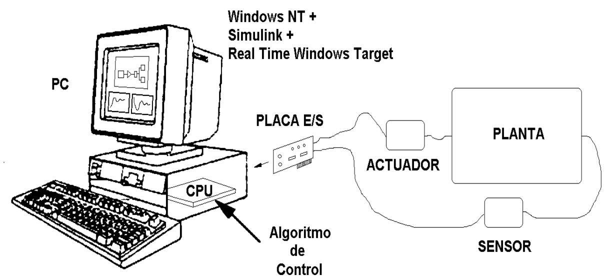

FIGURA. 2
CONTROL EN TIEMPO REAL CON EL REAL TIME WINDOWS TARGET.

específicos de determinados temas, que enriquecen la capacidad de Simulink [8]. Un vez definido un modelo, se puede simular eligiendo diferentes métodos de integración y observar los resultados de la simulación mediante bloques especiales, que muestran las variables del modelo en función del tiempo, de igual forma que un osciloscopio.

RTW

El RTW (Real Time Workshop) genera código "C" directamente del modelo realizado en Simulink. También puede generar en forma automática programas que pueden ser ejecutados en plataformas de tiempo real sin la necesidad de que estén instalados el MATLAB o el Simulink. Esto permite la ejecución de modelos continuos, discretos e híbridos en una variedad de computadoras, e interactuar con el hardware para la adquisición y generación de señales. De esta forma, se pueden construir fácilmente, no sólo controladores, sino también se pueden simular plantas que están operando en tiempo real, de modo que las señales de entrada y salida de dicha simulación, son una aproximación de las señales de la planta real.

Una opción del RTW es el Real Time Windows Target [9]. Este paquete permite utilizar una PC con sistema operativo Windows 95/98/NT como plataforma para las simulaciones en tiempo real (Figura 2). Una serie de bloques de librería para placas de adquisición son incluidas en el mismo. Si se tiene alguna de estas placas, la interfaz al hardware es directa. En caso contrario, se puede escribir en código "C" la interfaz específica para la placa hardware por medio de una S-Function [10]. Las S-Functions son bloques dinámicos del Simulink, que cumplen distintas funciones en una simulación. Entre ellas, tareas de entrada y salida, si se las programa en lenguaje "C".

DRIVER DE LA PLACA CAN

Para permitir la interfaz entre el algoritmo realizado en Simulink y la placa CAN se utilizó una S-Function. Esta función realiza la configuración del CI AN82527 así como la configuración de los ID de mensajes, su recepción y transmisión. Los detalles de la configuración y manejo de mensajes son transparentes para el usuario, el cual sólo utiliza un bloque S-Function configurado como entrada o salida de la planta. Desde Simulink, los detalles de la configuración y manejo de mensajes es transparente para el usuario, el cual sólo utiliza el bloque S-Function como entradas o salidas de las señales de la planta.

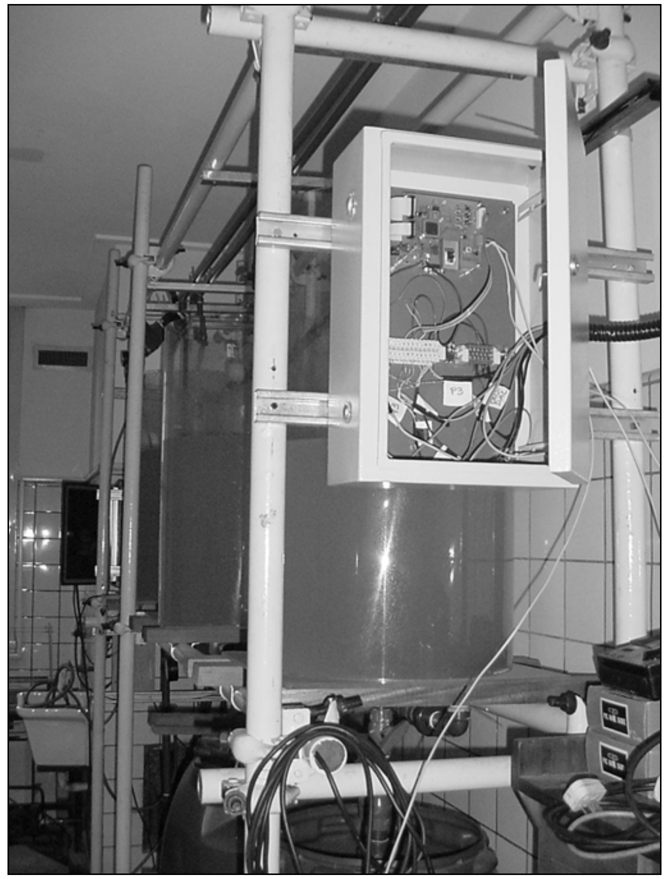

FIGURA. 3
PLANTA PARA CONTROL DE NIVEL DE LÍQUIDOS Y NODO CAN

LAS APLICACIONES EXPERIMENTALES

Hasta el momento se han integrado dos aplicaciones con la red CAN. Una primera aplicación es una planta experimental para control de nivel de líquidos (Figura 3). Consiste en tres tanques que descargan su contenido (agua) a un depósito. Los tanques están interconectados y provisto de válvulas manuales para regular su descarga o intercambio de líquido entre ellos. Cada tanque posee un transmisor de nivel de líquido realizado con un sensor de presión diferencial. Una bomba centrífuga aspira el agua del depósito y la envía a uno de los tanques a través de una válvula neumática. El experimento consiste en controlar el nivel de líquido del primer, segundo o tercer tanque mediante el control de la válvula neumática. El nodo CAN, se encarga de adquirir las señales de los sensores de nivel y generar la señal para la

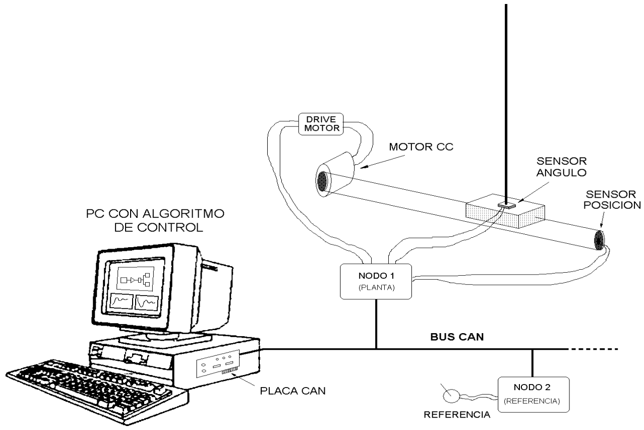

FIGURA. 4
CONTROL DE UN PÉNDULO INVERTIDO A TRAVÉS DE LA RED CAN.

válvula neumática. Por otro lado, el nodo se encarga de comunicar estas señales con la PC a través de la red CAN.

La segunda planta es un péndulo invertido el cual debe ser mantenido en posición vertical mediante un adecuado algoritmo de control (Figura 4). El nodo se encarga de adquirir la señales del ángulo del péndulo y la posición del carro así como la generación de la señal de modulación de ancho de pulso (PWM) utilizada para controlar el motor que mueve el carro. Este nodo envía y recibe estas señales a la PC a través de la red CAN.

Las dos plantas del laboratorio están conectadas a dos PC mediante una red CAN común a ambas. Cada PC puede controlar indistintamente a cualquier planta. Otra configuración posible es que una de las PC controle una planta y la otra PC utilizarla como monitor del proceso y adquisición de datos o como ajuste de los parámetros del algoritmo de control.

CONCLUSIONES

Los trabajos realizados demuestran la conveniencia de disponer de una interfaz normalizada para vincular desarrollos experimentales.

En el caso presentado, un proceso de laboratorio para control de nivel de líquidos y un sistema mecánico para estabilizar un péndulo invertido, fueron controlados usando la interfaz CAN propuesta.

Los resultados demuestran que la red se comporta en forma apropiada para el control de ambos experimentos.

En el caso de la operación de ambas plantas en forma simultánea el tráfico en la red resultó transparente para el control de las mismas. La facilidad a la hora de la conexión de la PC's con los experimentos justifica ampliamente el uso de la red. La posibilidad de que en un futuro todas las plantas del laboratorio de control, así como de otros laboratorios, pueden ser conectadas bajo el mismo protocolo común CAN nos alienta a seguir profundizando aún más en el tema.

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INTRODUCTION OF MICROCONTROLLERS OF INTEL MCS-96 FAMILY IN EDUCATIONAL PROCESS

Nataly Yu.Ershova[1]

Abstract — Embedded microcontrollers are used in various apparatus, measuring devices and other machinery. Students of physical-technical department study the architecture of Intel MCS-96 family microcontrollers at lectures and practical classes. During tuition students become familiar with ASM-96 assembler language and acquire knowledge in programming of built-in microcontroller devices such as timers, analog-digital converters, pulse width modulator, high speed input output devices, peripheral transactions server and programmable interrupt controller. Microcontrollers are widely used in implementation of student's research and degree works. Students design microprocessor systems and automatic experimental equipment connected to computer. Some results were reported in students conferences. Electronic textbook on modern microcontrollers and instruction for laboratory classes on microcontrollers theme were created.

Index Terms — *built-in devices, embedded microcontrollers, microprocessor systems.*

The versatility and low cost led to fast development and distribution of one-crystalline microcontrollers (MCU). Modern MCU have all resources for solving tasks of control. Microcontrollers are made in such a variety, that they can satisfy any requirements. For example, the development of the new Texas Instruments firm microcontroller takes from 8 to 12 weeks.

Special attention is presently given to the introduction of microcontrollers providing the solution of automation control tasks regarding mechanisms, devices and equipment. The adaptation of microcontrollers to specific features of a particular task is carried out by creating the necessary software and hardware.

At Petrozavodsk State University, physical-technical faculty students carry out practical work within the course "Microprocessor devices", using the microcontroller 8XC196KC/KD of the Intel MCS-96 family. These microcontrollers are designed to be used in control systems as built-in microprocessor devices.

Laboratory models and an integrated environment for programming of the controllers were developed on the basis of MCU 8XC196KC/KD at the "Microprocessor Technology" (St.Petersburg).

The integrated environment includes the following modules: the built - in window text editor, debugger, means for compilation of the programs and creation of executive files, and also an information subsystem (Help). All these allow to organize interactive loading of program code in the microcontroller. The program code may be executed continuously or with stop point and in a step-to-step manner. The microcontroller, block of external memory consisting of microcircuits ROM and RAM, driver of the serial channel RS-232, block of light and sound indication, sockets of expansion are located on the laboratory model. Therefore, this laboratory model may be used as an embedded device.

An electronic textbook and the instruction for practical work on microcontrollers were written. The structure and general characteristics of Intel MCS-96 family, memory addressing mode and command system are considered there. Structure and technical parameters of MCU 8XC196KC/KD are described in more detail. The schemes of the built - in peripheral devices and the algorithms of their functioning and programming are also considered in the textbook.

During tuition students become familiar with ASM-96 assembler language and acquire knowledge in programming of built-in microcontroller devices such as, 16-bit timers, analog-digital converters, pulse width modulator, high speed input/output devices, peripheral transactions server and programmable interrupt controller.

For example, students realize a stopwatch on the basis of the 16-bit counter Timer1. The number of seconds is displayed in a binary-coded decimal code on the block of light indication. This block is integrated with the 8-bit first parallel input/output port. In another work, the first counter Timer1 sets the time of luminescence of the microcontroller light matrix. The second counter Timer2 sets the delay of light matrix switching. Thus, brightness of the light matrix luminescence may be slowly changed.

The 8XC196KC/KD have three Pulse Width Modulator (PWM) modules. These outputs may be filtered to produce a smooth analog signal. Students receive a sine wave signal, while programming duration

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of pulses. The shape of the signal is observed on the oscilloscope.

Students learn how to program the analog-to-digital (A/D) converter and to read the conversion results. The A/D converter module converts an analog input into an 8- or 10-bit digital representation. Students restore an entrance analog signal (amplitude and frequency) using results of ADC during the work.

Some programs are devoted to the organization of service of interruptions from internal peripheral devices. Programmable interrupt controller is used for service of interruptions and peripheral transaction server is used for service of interruptions without interrupting the basic program. Enclosed interruptions are served in the programs, too.

The most advanced students develop methodical instructions to some new interesting work independently. For example, a student offered the work " The reactor chamber temperature control". In the given work the microcontroller should trace the temperature of an object and on the basis of the data received from ADC to carry out the following actions:

- At an increase of temperature, to increase the voltage applied to the digital-analog converter (DAC);
- At an increase of temperature above critical, to disconnect the object by a 6-second pulse;
- At a reduction of temperature, to reduce the voltage on DAC.

Microcontrollers are widely used by students in their research and degree work. Students design microprocessor systems and automatic experimental equipment connected to computer.

The first applications of the microcontroller were connected with control of step motors. Then, more interesting projects appeared, such as an independent device for temperature and light exposure measurement indoors, "intellectual" monochromator and colorimeter, system for spectral investigations.

Some developments were used for industrial orders. The control system of the electric drive of knife shaft of the machine tool cross was produced for a company.

The laboratory model of the device was created in one of the diploma works. This device controls the electrical power of burning of headlights of the automobile depending on the time of the day (i.e. brightness) and the level of accumulator charge (Figure 1). The user himself can set the current values of the brightness and charge level of accumulators with the help of variable resistors. The values of voltage are converted with ADC. Then there are transferred to the control program in MCU.

The program calculates the number of steps of the step motor. Then this number is given out through the high speed input/output device to the step motor controller. The step motor can move the variable resistor, which changes resistance in the circuit. Electrical current and power in the circuit change also.

The software of this system realizes fuzzy control algorithm. Fuzzy logic facilitates design of system that mimics human reasoning. A fuzzy system accepts data input from sensors, and then makes decisions based on that input. These decisions are the basis for a control system. The package FuzzyTECH was used for control program.

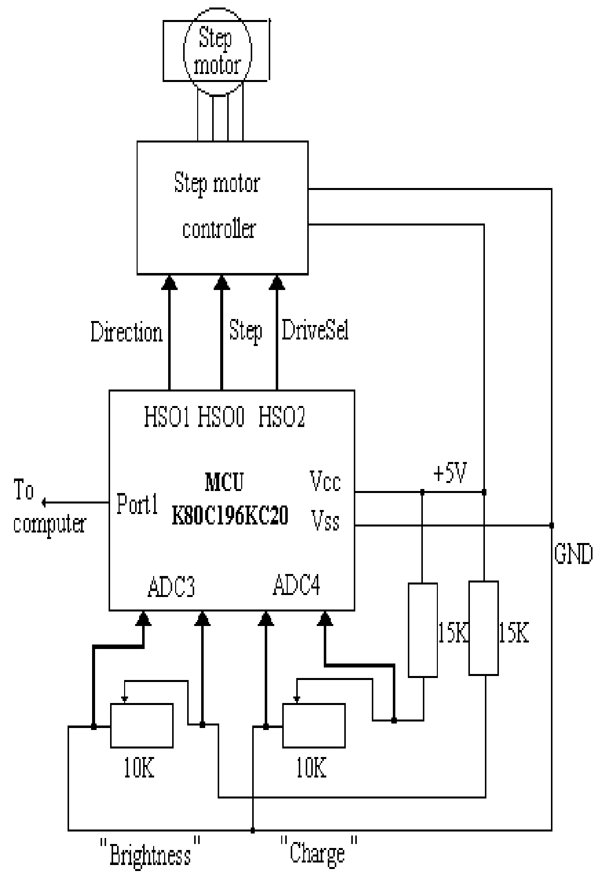

FIGURE 1
A LABORATORY MODEL OF THE DEVICE TO CONTROL THE CAPACITY OF AUTOMOBILE HEADLIGHTS BURNING, DEPENDING ON THE TIME OF THE DAY AND THE CHARGE LEVEL OF ACCUMULATORS.

The three elements required to realize a fuzzy system are fuzzyfication, rule application and defuzzification. Fuzzification is the scaling of input data to the universe of discourse (the range of possible values assigned of fuzzy sets). Rule application is the evaluation of fuzzyfied input data against the fuzzy rules written specifically for the system. Defuzzification is the generation of a specific output value based on the rule strengths that emerge from the rule application. The values of the voltage from variable resistors are converted into the fuzzy format. So, the current values of brightness, level charge of accumulators and values of electrical power are defuzzyficated (Figures 2, 3, 4).

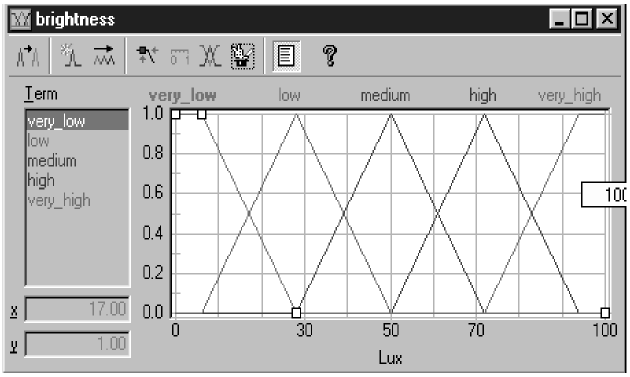

FIGURE 2
CURRENT VALUES OF BRIGHTNESS.

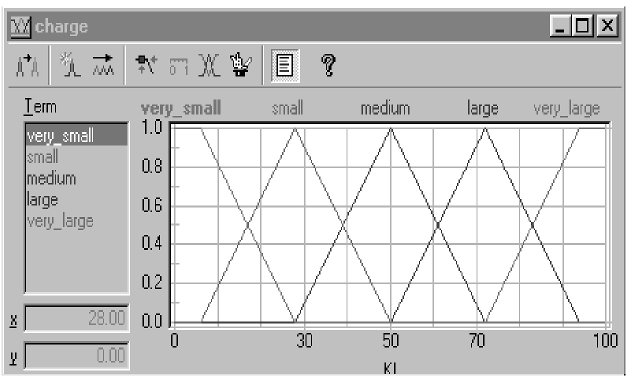

FIGURE 3
THE CHARGE LEVEL OF BATTERIES.

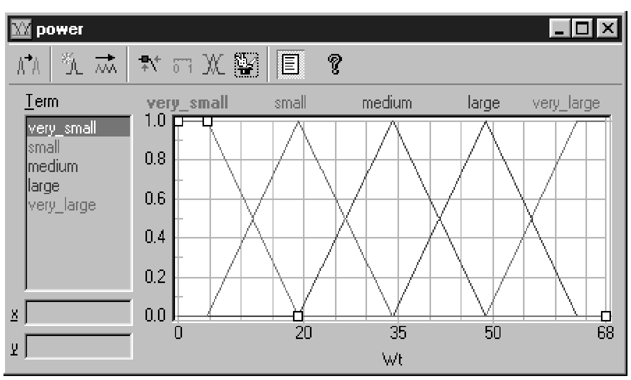

FIGURE 4
THE VALUE OF POWER.

X-axis values on figures 2 –4 have not been obtained as a result of a measurement. They have been choosen arbituarily.

Then, the table of rules for the fuzzy value of electrical power is calculated. Figure 5 shows the relationship between fuzzy input values and fuzzy output value.

Spreadsheet Rule Editor - RB1

#	IF brightness	charge	THEN DoS	power
1	very_low	very_small	1.00	medium
2	very_low	small	1.00	large
3	very_low	medium	1.00	large
4	very_low	large	1.00	very_large
5	very_low	very_large	1.00	very_large
6	low	very_small	1.00	medium
7	low	small	1.00	medium
8	low	medium	1.00	large
9	low	large	1.00	large
10	low	very_large	1.00	very_large
11	medium	very_small	1.00	small
12	medium	small	1.00	medium
13	medium	medium	1.00	medium
14	medium	large	1.00	medium
15	medium	very_large	1.00	large
16	high	very_small	1.00	very_small
17	high	small	1.00	small
18	high	medium	1.00	small
19	high	large	1.00	medium
20	high	very_large	1.00	medium
21	very_high	very_small	1.00	very_small
22	very_high	small	1.00	very_small
23	very_high	medium	1.00	small
24	very_high	large	1.00	small
25	very_high	very_large	1.00	medium

FIGURE 5
THE TABLE OF RULES FOR FUZZY VALUES OF ELECTRICAL POWER.

For example, if the value of brightness is very low (i.e. very dark) and the charge level of batteries is very large (accumulators are completely charged), then the value of electrical power should be very large.

This fuzzy value of electrical power is already understandable to the user, but not to the executive device. Therefore, it is defuzzyficated (i.e. it is converted into digital form) and it is transferred to the step motor controller.

The students created electronic textbook on modern microcontrollers and an instruction for laboratory classes on microcontrollers are created.

New microcontrollers constantly appear on the world market of microprocessor, however, it is possible to claim with confidence, that the skills received in programming MCU of Intel MCS-96 family today will help to master programming other one-crystalline microcontrollers tomorrow. The skill to design and to create microprocessor systems will allow our graduates to shows themselves as competent specialists in their future profession.

ENGINEERING EDUCATION AND THE ROAD TOWARD PROFESSIONAL REGISTRATION

Yolanda Guran-Postlethwaite, Oregon Institute of Technology

The technological advances permeating our life in the 21st century made the engineering profession extremely competitive. Engineers and technologists must be more specialized and skilled technically. In addition to this they have to compete in a global market and interact with a new society. For many engineering disciplines, the seal of approval is the professional licensing granted by different states. Engineering students should be encouraged to consider the path of obtaining professional engineering registration. To be a Professional Engineer is an honor and a warranty of professional competency and high ethical standards, recognized all over the world.

The first step in becoming licensed as a Professional Engineer in United States is the Fundamental of Engineering (FE) examination. Many universities started to use this examination as an assessment tool for engineering programs.

The paper will describe the process of obtaining professional registration in the United States. It will also discuss how colleges and universities could encourage and prepare students for become licensed. It will also show the value of professional registration for transfer of engineering knowledge and ethical standards around the world.