

# THE PRINCIPLES OF DOCTRINE FORMATION OF ENGINEERING EDUCATION IN RUSSIA

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**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 <sup>1</sup>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 economies 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 strategic 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 following 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 extramural 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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