

National doctrine design principles in Russian engineering education within new-type industrialization: problems, objectives, challenges

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The authors analyze contemporary conditions of Russian engineering education and propose principles and strategies to improve Russian engineering education according to modern requirements.

Key words: *sengineering education, national doctrine, new-type industrialization, new education technologies.*

The state of engineering in any country is closely connected with the state of engineering education and the level of training in the field of engineering and technology. And Russia is not an exception. The survey conducted by the Association for Engineering Education of Russia (AEER) in 2011-2012 shows that engineering in Russia is in a critical condition [1, 2]. Main characteristics of this condition are quite obvious: - replacement of domestic consumer goods, facilities, technologies and equipment by imported ones, loss of competitive position in the world markets of engineering products, lack of outstanding engineering solutions within the last 20-25 years, low share of machinery, equipment and technology in the structure of Russian export (3.5%). Decrease of the training quality in the field of engineering and technology is not the only reason that led to this situation. The reasons have a systematic character and are connected with politics, economics, management and social sphere. However, one must admit that the crisis in engineering points to the crisis in the state of engineering education in the country.

Analysis of world markets of engineering products shows that Russia is irrevocably behind the world leaders in many areas of engineering and technology. Invalid attempts to catch up with or even pass them and let them ahead in competition can only lead to ruinous race for our country. In these circumstances, the most appropriate is the way of new-type industrialization, which features were outlined in Vladimir Putin's pre-election article "We need a new economy" [3].

The core idea is to find directions of industrial development (niches), where breakthrough efforts for new results and development of Russian brands are possible. In fact this will determine Russia's place in the international division of labor and can become the basis for the long term development of national doctrine of engineering education.

However, today there is no strategic program of new industrialization with structurally defined objectives and system indicators, means of achieving the objectives, organizational structure of the industrialization of the country, sources of financial, human, structural and other resources, road map and



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regional industrialization, a policy to heighten interest in industrialization of all participants. Only availability of such a document will permit to develop an effective doctrine of engineering education within new-type industrialization, providing target advanced training and massive retraining to address the new industrialization. Therefore, legislative and executive bodies of federal and regional level together with expert community should work out these documents [4], using modern methods of system and process design, project management, "foresight", etc., effective methods of expert information processing, information and telecommunication technologies.

In accordance with all stated above today it is impossible to develop efficient doctrine of engineering education within new-type industrialization. At the moment it makes sense only to discuss the principles and approaches for the development of the doctrine of engineering education within new-type industrialization. And this article is dedicated particularly to these points.

The National Doctrine of engineering education, based on the above mentioned documents should allow to formulate objectives for development and improvement of engineering education in the midterm, and to identify a list of urgent tasks to enhance engineering education in Russia.

The systemic nature of the crisis in the state of engineering and engineering requires systemic, political and economic decisions, covering preschool, general and higher professional education, changes in the statutory framework, regulating the relationship between business, scientific and academic community and governing bodies. At the same time representatives of professional (expert) community should formulate the policies pursued in these areas on the basis of a systemic approach in clear and understandable terms agreed in the related fields, providing a balance between the interests of individuals, society and the state.

Nowadays the National Doctrine of engineering education should focus on advanced training and retraining of specialists able to achieve the objectives, solve the problems of the new-type industrialization. The National Doctrine of engineering education should be approved by the Federal Law after extensive public discussion and expert consultation.

To meet the challenges of new-type industrialization the training should be focused on other areas than traditional training in engineering and technology, which are significant for the successful industrialization: production engineer, industrial engineer, service engineer, etc.

Production engineer is responsible for interaction of his unit with the heads of other departments, technologists, rate-setting engineers, engineers, mechanical engineers, etc., takes measures to improve the quality, productivity, etc. and focused on the complex process improvement of his plant efficiency.

Industrial engineer – an organizer, an ideologist of the production [5,6]. He applies modern methods of industrial engineering, interdisciplinary approach, technological forecasting, system analysis, new management tools. He studies domestic and foreign markets and is ready to complete optimization of all processes in the enterprise, to forecast market behavior and participates in their development in the interests of the company and customers.

Service engineer is responsible for installation, commissioning, adjustment setting and system testing of new equipment and technological process to ensure a given product quality, capacity and other characteristics. In addition, service engineer conducts regulated testing during the equipment and technology life cycle: primary, planned and unplanned, and also organizes innovative and inventive work aimed at improving the installed equipment and technology.

The outlined objectives of advanced training require substantial modernization of content, educational

technologies and organization of engineering education.

Present-day higher education institutions that are training specialists in engineering and technology will be able to cope with the task of preparing the required personnel if they actively join all the above mentioned processes and receive substantial support from the state and private investors to upgrade their facilities. Moreover a certain part of specialists could be trained at foreign universities.

Massive retraining and skills development could cause more urgent problem. Its solution can be found in the development of Smart education in the country using domestic and foreign educational resources.

Way to achieve the outlined goals

Achieving these goals requires restructuring of engineering education content, transition to new educational technologies and new organizational structure of the training process.

Principles of engineering education content development

Study of the requirements to engineering within new-type industrialization allows to develop principles of engineering education content [6].

The content of engineering education should include the following fractal organized totality:

- teaching, which provides mastering of the humanitarian, social and economic, mathematical and natural-scientific, general and vocational knowledge on the required level;
- education, which provides development of the methodological culture of the graduate; mastering of the methods and techniques of the cognitive and professional, communicational and axiological activities;
- ability performance, which provides a complex training of the student for professional activities and his/her professional self-actualization.

To turn a student into a professional engineer, it is important that he change the sphere of education for the sphere of activities. It is important to integrate knowledge and methods of functioning, where the key values are its system-forming factor. To increase a student's professional potential, it is important to leave the sphere of knowledge for the sphere of practical activities and problem solving.

The distinguishing feature of the system of knowledge for training engineers is the stability of natural scientific, mathematical and world outlook basis of knowledge, the broadness of the interdisciplinary system-integrated knowledge of nature, society, way of thinking, and also a high level of general professional and special professional competence, that provide functioning in the problematic situations and allow to solve the task of specialists training with greater creativity.

Not only subjects should become the basis of education, but also the ways of thinking and functioning, i.e. procedures of reflective nature. Knowledge and methods of learning and functioning should be united into organic integrity. All this poses a task of including the issues of developing methodological culture, including methods of cognitive, vocational, communicational and axiological activities into the requirements to content and level of engineering training.

The distinguishing feature of the engineering education should become a high level of methodological culture, superb creative mastering of the methods of cognition and functioning.

As experience of specialists training shows, the successful activities of the engineers are determined not only by the high level of knowledge, productive mastering of the methods of cognition and functioning, but also by the complex training for professional work. It is determined not only by the training for professional work in the conditions of the normal life and established production, but also for the tests, changes

in the ways of life, for the repeating changes of their world-outlook, ideologies and concepts. Thus, successful vocational activity suggests not only a high level of teaching and education but also spiritual, moral, social, psychological, and physical culture of any individual. The University should become not only the center for science and education but also the center for ability development of a person, his professional coming-into-being and self-actualization.

When designing the content of education and the requirements to the level of training engineers, it is important to find the place for the system of knowledge and methods, aimed at accomplishing the tasks of self-knowledge and self-actualization of an individual.

Vital role in the development of engineering education content plays its humanitarian, fundamental and professional orientation.

Valuable and semantic nature of humanitarisation of engineering education appears in providing of harmonic unity of natural and scientific and humanitarian standard of knowledge and activity, unity based on mutual understanding and dialogue.

The most crucial task of the system of engineering education in this respect is to create conditions of revival of unified natural and scientific and humanitarian standard of knowledge and activity.

Development of the engineering education content includes the following points:

- fundamental nature of scientific knowledge in engineering education and engineering activities;
- ensure the development of professional innovative thinking;
- complex training for innovative activities (ability performance).

An important role in the content of engineering training plays fundamentalization of engineering knowledge and engineering in engineering:

- development of fundamental laws of design and development of arti-

cial environment: synergy, TRIZ, CALS-technologies;

- increasing of interdisciplinary knowledge that provide innovation in problem situations;
- development of methodological culture: professional, cognitive, communicative and axiological activities;
- learning of natural science and humanities, transition on this basis to complex criteria: capacity, efficiency and quality of the designed artificial environment.

One of the important tasks of engineering training within new-type industrialization is the development of innovative thinking [7].

Innovative thinking is an integrated set of creative, strategic, systemic and transformational thinking activity based on the laws of interdisciplinary knowledge:

- creative thinking: interdisciplinary knowledge, theory of the development of engineering solutions, multicriteria formulation and solution of innovation problems, heuristics;
- strategic thinking: strategic management, synergy and the theory of self-organization;
- systemic thinking: systemic approach, system model, morphological analysis, systemic genetic analysis, systemic functional analysis;
- transformational thinking: self-management, CALS-technologies, organizational culture.

Another necessary element should be a complex training for innovative activities:

- development of scientific principles and methods of innovation, technology transfer;
- mastery of knowledge and the development of marketing and modern management methods, business ethics and laws;
- studying of foreign languages at the level providing professional

work in a foreign language environment.

Transition to new educational technologies in the engineering education

The essential point in engineers' training is to use active and productive methods of global information resources for learning, methods of forming cognitive and professional activity, development of personal qualities:

- benchmarking, case studies, personal & professional development training, business training;
- organizational and business activity-games;
- problem-and project-based learning;
- creative workshops;
- design sessions;
- interdisciplinary projects;
- projects on the real customers' needs.

The major direction of engineering education development in this respect is the special organization of student's work throughout the period of study at university in complex multidisciplinary practice-biased teams, students' involvement into a creative activity, maintenance of their mass participation in research, creation of purpose-biased education.

All these should create favorable preconditions of evolutionary transition in the engineering education from the educational ("the school of memory") to the research and educational processes.

Nowadays, the educational process can be presented as the system of workshops led by creative, skilled and prominent researchers and leading engineers. The updated community of students, competitors for bachelor's and master's degree and engineering status, post-graduate students and people working for a doctoral degree form creative teams, a kind of scientific school capable of maintaining the continuity of cognitive activity, awareness of the world and the individual's place in it, ideals, values and objectives of the scientific and engineering work.

Modern education technologies in the system of engineering education embrace widespread academic mobility.

Today all-sufficiency of the university in any country, which is aimed at professional training of engineers competitive on the world market of intellectual labor, has been exposed to fair criticism. The need for academic mobility, training at some Russian and foreign universities and active involvement of industry representatives in the training process is considered crucial for changing the qualitative status of specialist's training.

Keeping the quality of engineering education at the level demanded by the society

The doctrine shall include an integral system aimed at keeping the quality of engineering education at the socially adequate level. The following system components should be included:

- the new generation of national educational standards and individual universities' standards set on the basis of the former;
- system of public and state attestation of engineering educational institutions;
- system and technology of accreditation of vocational educational programs in different academic fields performed by both domestic and foreign public vocational associations along with national specialized agencies;
- system of engineering specialists certification and awarding of engineering certificates of all the levels (e.g. European instructor, engineer);
- system of social and economic stimuli aimed at professional promotion and elevation of the public status of an engineer;
- system of continuous advanced training and postgraduate engineering education.

Conclusion

To conclude, it is crucial once again to emphasize the importance and necessity of the national engineering education doctrine as it is the document, which accurately reflects the views of the scientific community, society, individual and state on the future of the Russian engineering education.

The National Doctrine of the engineering education should serve as a basis for Federal Program for Vocational Education Development while legislative acts and government decrees should correspond to its provisions. It should provide sources for professional engineering ethics development and for all the decisions taken by public associations and other organizations.

The National Doctrine of the engineering education can only become efficient if all the necessary mechanisms are established and its continuous application, actualization and enhancement in response to the changing conditions, factors, and new engineering requirements are provided.

REFERENCES (ALL TITLES IN RUSSIAN)

1. Yu. P. Pokholkov Sad but true. The thesis about Russian education being the best in the world sounds unconvincingly today // Poisk - 2011.- .№ 10-11.-p.13
2. Materials of expert seminars and trainings on expert evaluation of the state of Engineering Education and Engineering in Russia [Electronic resource] – <http://aeer.ru/events/ru/trainings.htm>
3. V.V. Putin We need a new economy [Electronic resource] // Business daily Vedomosti URL: http://www.vedomosti.ru/politics/news/1488145/o_nashih_ekonomicheskikh_zadachah (usage date: 02.07.12)
4. New industrialization of Kazakhstan must meet the current mode of the world economy [Electronic resource] // Ministry of economic development and trade of Kazakhstan - official website <http://www.minplan.kz/pressservice/77/24022/> (usage date: 06.07.12)
5. Yu. P. Pokholkov, B.L. Agranovich On the development of the national doctrine of engineering education// Innovations in the higher technical school of Russia (State and problems of modernization of engineering education). M: MADI, 2002. p.62-79.
6. Yu. P. Pokholkov, B.L. Agranovich The National Doctrine of engineering education.
7. Basic principles [Electronic resource] // official website of the Association for Engineering Education of Russia http://aeer.cctpu.edu.ru/winn/doctrine/doctrine_1.phtml
8. B.L. Agranovich Challenges and Solutions: Master's Student Training for Post-Industrial Economy // Engineering Education Инженерное образование – 2011. - № 8. - p. 62-67.