Engineering education in the system of modern innovation

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Abstract. The paper discusses and reviews key issues of engineering education development as one of the most important component of modern innovative activity in the Russian Federation. The discussion is based on the example of modern educational technologies used in the Institute of Engineering at Kazan Federal University.

As the military tensions continue to grow across the globe and the competition escalates in the global high-tech market, it is very important for our country to ensure the reproduction of intellectual personnel trained not only for highly specialized activities, but also to perform in the field of innovations, which implies creativity and ability to find extraordinary solutions. We cannot afford to lag behind in the development of basic and key technologies providing innovative breakthroughs in the current environment [1-3].

Analysis of social features of engineering activity at the turn of the 20th and 21st centuries reveals the following major trends in this area have emerged over the last 15–20 years [3]:

1. The steady growth in the significance of innovations in the economy, which contributes to the rapid development of technologies and increase their scientific content.
2. The role of small and medium-sized innovative companies in a modern high-tech economy is gradually increasing.
3. The breakdown of centuries-old patterns, when each subsequent generation generally became more educated than the previous one. There has been a reverse trend, and the education system itself has begun to degrade everywhere (a trend that is characteristic not only of our country but noted in many economically developed countries of the world).

The above trends form a number of requirements to the engineering education, which can be regarded as the challenges of modern time to the traditional educational system [1, 3]:

1. The requirements to the basic education of engineers, the quality of their intellectual, volitional and organizational skills become dramatically tougher.
2. The extended responsibility of a modern engineer, who is increasingly being considered all in one as a scientist, specialist, technical expert, and often the leader of small and large groups of projects. All this places high demands on the integrity, versatility and breadth of training an engineer.
3. Training of engineers at the university, at enterprises of various sizes – from small-size companies to major corporations, implemented in the forms of additional education acquires a holistic personal character.

All of the above brings us to the conclusion that the classical concept of engineering education is becoming actual again, but with a pronounced individualization [5-8].

The Institute of Engineering of the Kazan (Volga Region) Federal University introduces the concept of training of engineers qualified for innovation activities. At the same time, innovations are regarded as an aggregate process that combines several stages:

1. Studying the fundamentals of engineering.
2. Forming insights into the nature of scientific work, targeted search and the development of technical ideas.
3. Learning the basis of development of applied technologies and bringing them to industrial use.
4. Studying the methods of work management and control of small groups of diverse professionals.
5. Legal backing of the new product and its commercialization.

The Institute of Engineering introduces a two-level system for training specialists in undergraduate and graduate programs, which differ in the depth and breadth of coverage of the treated stages [11,12].

The undergraduate program is focused on the training of a specialist who is good at background and applied knowledge, as well as the principles of economic management [4].

The graduate program is focused on the development of outside-the-box thinking skills, the formation of a scientific view of the process, and the training of a specialist for the role of performer and leader of small innovative groups [9,10].

Building an innovative infrastructure in the educational institution is an extremely difficult mission and requires in-depth analysis of the scientific and engineering capabilities. For this purpose, the Institute of Engineering has launched a system of R&D laboratories (R&DLab), among them:

- R&DLab for Bioengineering and Life Safety;
- R&DLab for Prototyping (additive process);
- R&DLab for Production and Processing of Construction Materials;
- R&DLab for Plastic Production Process;
- R&DLab Precision Technologies Center;
- R&DLab for Engineering and Management Systems Research

The Institute of Engineering also has a Comprehensive Training Center for Energy Efficiency, which focuses on the development of energy-saving technologies, the study of the scientific background of energy conservation, the development of applied aspects of alternative energy and the advancement of dedicated supplementary education [13-15]. As part of the supplementary education, students have the opportunity to learn the components of robot-operated and fully automated productions, including control systems and setting up of Siemens Sinumerik 840 D sl.

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