

The Use of Organizational and Technological Innovations in the Process of Managerial and Engineering Personnel's Training

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ABSTRACT

Today in the Russian economy there is a shortage of highly skilled engineering personnel having innovative thinking, knowledge not only in the field of fundamental science, but also in the field of management and business. Given the presence in the Russian Federation of a number of highly prestigious technical universities, not all educational institutions in the country train professional staff at the required level, which determines the relevance of the study of the application of organizational and technological innovations in the process of preparing managerial and engineering personnel. In the process of studying this problem, research methods such as studying and generalizing the experience of training managerial and engineering personnel in higher education institutions, statistical methods of analysis, and the method of expert assessments were used. The study provides an assessment of the level of innovation development in the Russian Federation, highlights the most important from the point of view of innovation process competitive advantages of human capital, as the place of Russian graduates in the field of science and technology and universities in international rankings for 2015-2017. The study by the authors of the article of the best foreign and domestic practices made it possible to identify productive organizational and technological innovations in the process of preparing managerial and engineering personnel. The result of the study was the identification of the main elements of the model of the innovation-oriented process of managerial and engineering personnel's training.

Keywords: organizational and technological innovations, engineering and technical personnel, training, management personnel, education

INTRODUCTION

In the current economic climate, mobilizing new sources of growth and taking advantage of the opportunities offered by global innovation has become a priority for all stakeholders. Analysis of the experience of the newly industrialized countries shows the need to change the government's policy towards innovation. Their stimulation should become a national priority, since it is innovations that are today a key factor in improving the competitiveness of the economy and ensuring long-term growth of economic well-being [1, 2, 3]. This goal should be achieved not only through state support for individual sectors and industries, but also by creating incentives for all economic agents to innovate and enter new markets. An indisputable fact is the need to modernize the system

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of managerial and engineering personnel's training as a priority condition for the formation of Russia's innovative economy [4, 5, 6].

According to the research conducted by the Group of Companies AKIG conducted in 2016 among the graduates of Russian universities with the engineering and technical profile of training, the quantity of people working not in the specialty prevails and amounts to 34%, while those working in the specialty amounts to 27% [7]. At the same time, according to the representatives of educational institutions, almost all students of leading universities of engineering and technical profile are successfully employed by the moment of graduation. Employers "disassemble" them on the basis of practical work, practices and internships, beginning with the second-third year. Graduates of the leading Russian technical universities are in high demand not only in core industries, but also in the IT sector, investment banking, business intelligence and others. For graduates of higher educational institutions that do not occupy leading positions, the relevant industries offer a limited number of vacancies, as well as low salaries, which also forces them to seek opportunities for self-fulfillment in other spheres. That is why among the students and graduates of the engineering and technical profile the share of workers in the specialty is the lowest.

Thus, in the presence of a number of highly prestigious technical universities in the Russian Federation, far from all educational institutions in the country train professional personnel. Analysis of the situation in the field of providing high-tech industries with qualified personnel has shown that there is not a quantitative but a qualitative and structural shortage of personnel. According to the results of the survey of employers, more than half of graduates after employment are sent for professional retraining or in the system of professional development.

Therefore, the creation of first-class universities, an innovative-oriented process of managerial and engineering personnel's training and investing in research activities are extremely important factors in order to occupy a leading position in the global race for successful innovation [8].

RESEARCH METHODOLOGY

In the process of studying the problem of using organizational and technological innovations in the preparation of managerial and engineering personnel, such research methods as studying and generalizing the experience of managerial and engineering personnel's training in higher education institutions, statistical methods of analysis, and the method of expert assessments were used.

The study of problems of the use of organizational and technological innovations in the preparation of management and engineering personnel was carried out with the help of the following sources of information:

- database of the Federal Service of Statistics (Rosstat);
- database of the Federal Treasury of the Russian Federation;
- The Global Innovation Index (GII) GII is based on the methodology of the international business school INSEAD, France. The GII study has been conducted since 2007 and currently represents the most comprehensive set of indicators of innovative development in various countries of the world;
- research results of consulting firms and recruitment agencies;
- materials of scientific conferences;
- scientific publications on the problems of innovation, the use of innovations in education, etc.

The use of theoretical and empirical research methods, methods of economic and statistical analysis and expert assessments of employers allowed the authors of the article to assess the level of innovation development in the Russian Federation, to identify the most important competitive advantages from the point of view of the innovation process, to substantiate the list of organizational and technological innovations and to identify the main elements of the model of innovation-oriented process of preparation of administrative and engineering personnel.

RESULTS

Evaluation of the Development of Innovations in the Russian Federation

As noted above, investment in innovation is an important condition for increasing the pace of long-term economic growth. We will evaluate the current development of innovations in the Russian Federation.

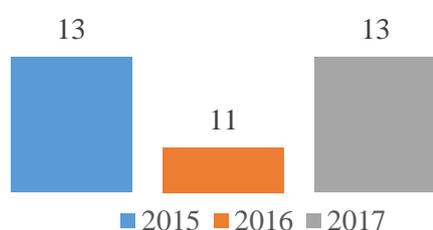
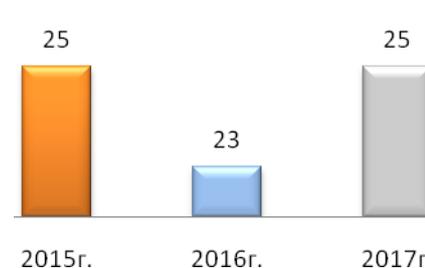
Analysis of the data presented in **Table 1**, shows that in the Russian Federation, the share of organizations implementing innovation is too small in the total volume of researches, and in 2011-2016 there are no significant changes in the values of these indicators.

Table 1. Innovative activity of organizations (specific weight of organizations that carried out technological, organizational, marketing innovations in the reporting year, in the total number of organizations surveyed), for certain types of economic activity, %

| Type of economic activity | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2016 to 2011 y. |
|---|------|------|------|------|------|------|-----------------|
| Total: | 10,4 | 10,3 | 10,1 | 9,9 | 9,3 | 8,4 | -2 |
| Including: | | | | | | | |
| mining operations | 8,4 | 8,2 | 7,6 | 7,5 | 6,9 | 7,4 | -1 |
| manufacturing industries | 13,3 | 13,4 | 13,3 | 13,6 | 13,3 | 13,3 | 0 |
| production and distribution of electricity, gas and water | 5,6 | 5,6 | 5,3 | 5,1 | 4,9 | 4,8 | -0,8 |
| communications | 13,8 | 13,3 | 14,2 | 12,2 | 13,3 | 12,2 | -1,6 |
| activities related to the use of computers and information technology | 9,2 | 9,4 | 9,6 | 8,8 | 8,0 | 6,3 | -2,9 |
| research and development | 29,8 | 30,1 | 31,0 | 33,3 | 32,2 | 30,7 | 0,9 |
| provision of other types of services | 4,9 | 4,0 | 3,5 | 3,5 | 3,1 | 3,0 | -1,9 |

The source: was compiled by the authors according to the Federal Statistics Service

http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/science_and_innovations/science/#

graduates in science and engineering**QS University rating average score top 3*****Figure 1.** Position of Russian graduates in science and engineering and universities in international rankings for 2015-2017 (Source: <https://www.globalinnovationindex.org/analysis-indicator>)

According to the results of the study “The Global Innovation Index (GII)” and the rating of the countries of the world in terms of the level of development of innovations based on the results of calculations for 2017, the Russian Federation occupies the 45th position in this rating, which is below the position in 2016 (43rd), but better than the data of 2015 (48th place). Thus, during this entire period (from 2015 to 2017), the Russian Federation was, and continues to be, in the fifth ten countries of the world rating in terms of the level of innovation development [9]. At the same time, on separate positions, in particular on indicators of the higher and secondary vocational education Russia takes better positions in this rating. This applies to the place of Russian graduates in science and engineering and Russian universities (Figure 1).

Thus, it can be concluded that Russia has preserved one of the most important, from the point of view of innovative development, competitive advantages, namely human capital.

We will carry out a study of the dynamics of federal budget expenditures on higher and postgraduate vocational education, since this indicator is one of the key indicators of social development, as it reflects the degree of attention paid by the state and society to the education of citizens. Traditionally, the federal budget mainly finances higher education, secondary vocational, general and pre-school education is financed from regional budgets (Figure 2).

In 2016, federal budget spending on higher and postgraduate vocational education decreased by 3% compared to the previous year, and Russia still lags far behind the leading countries and even a significant number of “catching up” countries in terms of relative indicators of state funding for this sphere.

The lack of funding is significantly exacerbated by structural problems, including obsolete models of management of the educational process, lack of modern personnel in the education system, including management ones.

Today, the education system is not sufficiently focused on meeting the needs of innovative development and the economy as a whole. The assessment of the quality of education provided by Russian employers is generally low. Recent surveys conducted by recruitment agencies demonstrate a large gap between the abilities of graduates of technical universities and the expectations of employers. This means a longer learning curve for the trainee engineers expected by employers [10].

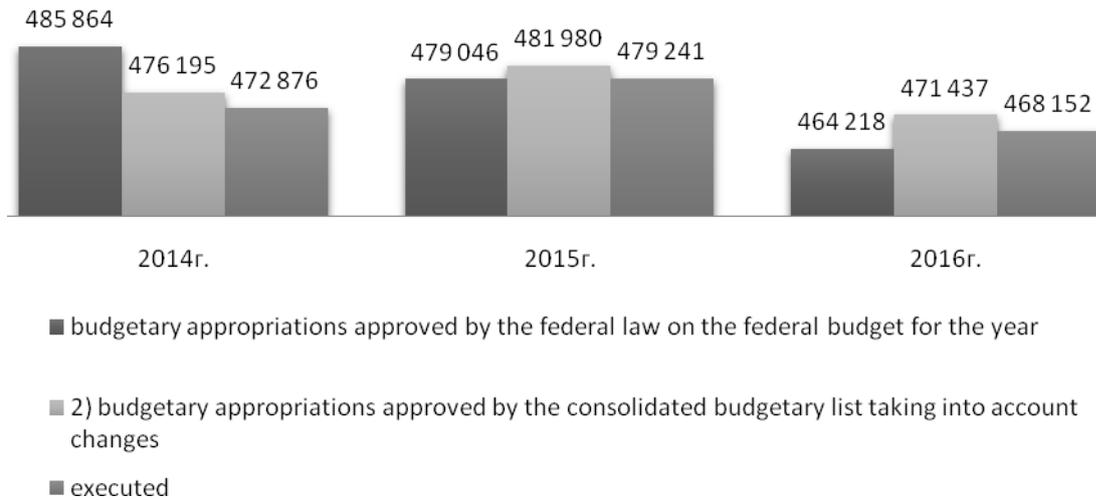


Figure 2. Distribution of budgetary allocations for "Higher and postgraduate vocational education" for 2014-2016, million rubles

Source: was compiled by the authors on the basis of data from the Federal Treasury <http://www.roskazna.ru/ispolnenie-byudzheto/federalnyj-byudzheta/>

Innovative-Oriented Process of Managerial and Engineering Personnel's Training

The remaining high level of the higher education on natural-science and technical specialties is especially important from the point of view of forming of effective innovative system.

Targeted work to develop competencies in the field of research and development, motivations for innovation in universities was launched only in recent years. According to the authors of the article, Russian higher educational institutions as a whole have not yet become a "school of innovation" for students.

According to the authors of the study, the model of the innovation-oriented process of training managerial and engineering personnel is an integral set of educational programs aimed at forming a set of competencies in the development, dissemination and implementation of technical, pedagogical and organizational innovations (Figure 3).

In the process of preparing managerial and engineering personnel, it is necessary to take into account the changing role of engineers for technological innovation and internal entrepreneurship [11]. So the German Association of Professional Engineers VDI, released a new guidance, focusing on leadership [12] as one of the expected competencies of professional engineers.

As can be seen, from the presented model, the result of managerial and engineering personnel's training is a willingness to innovate. That is, the preparation of a competitive specialist with innovative thinking, with knowledge not only in basic science, but also in management and business.

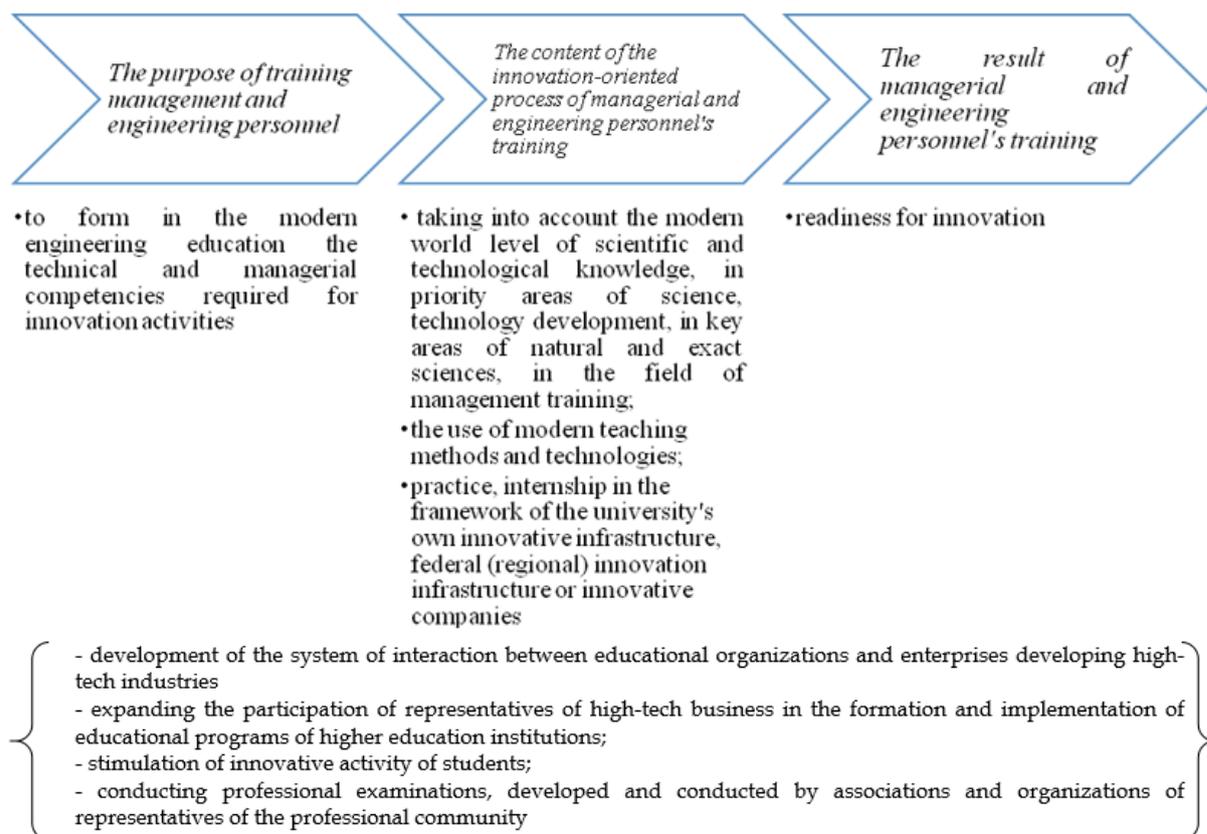


Figure 3. Model of the innovation-oriented process of managerial and engineering personnel's training

Organizational and Technological Innovations in the Process of Preparation

As noted by many researchers in the field of education, a significant role in the content of the innovation-oriented process of managerial and engineering personnel's training is given to modern methods and technologies of education [13, 14, 15, 16, 17, 18, 19, 20].

The authors' study of the best practices of solving this problem made it possible to identify productive organizational and technological innovations in the process of preparing managerial and engineering personnel.

In a study conducted by M. Malik et al. [21] it is shown that in the era of rapid transfer of knowledge and information for organizations, today it is very important to adopt new technologies and find new ways of doing work to maintain or enhance their competitive positions in the industry, the effectiveness of such a training tool as a webinar in the training of engineers.

According to J. C. Santamarta et al. [22] the use of new technologies in Spanish universities goes along the path of growth, and in many cases technological devices replace other materials that have been used so far, such as books, notebooks and so on. The authors note that this innovation is gradually entering the learning process at the university. Tablet PCs make learning more dynamic and accessible to students through the use of modern digital materials, which is the basis for engineers' training.

Numerous positive examples demonstrate that learning using modeling is a good strategy for promoting student performance and working groups [23]. Training effectiveness, from the point of view of transfer, using simulations, for pilots (flight simulators) and surgeons (virtual reality systems) was proved [24].

Despite a wide range of modern computer tools that allow modeling of various production processes, laboratory and practical training of engineers should be based on real equipment. In the research of S. Lavrinenko et al [25] it was proved that the introduction of the laboratory complex, which is a real model of the power plant, in the educational process led to the improvement of academic achievements in the main theme of the field. This equipment allowed students to acquire practical skills for performing various types of work with equipment, and also increased the interest of students in conducting laboratory and practical work.

As noted above, the readiness for the innovative activity of the graduate of higher engineering education assumes the formation of competences for managing the engineering project, teamwork and leadership, which implies active participation of the student in the learning process, the use of the project approach in training.

As an example, we give some of the best practices of using the project approach in the process of training of engineering personnel [26]. Innovative training technologies developed at the Siberian State Aerospace University in cooperation with the strategic partners JSC "Information Satellite Systems named after Academician MF Reshetnev" (JSC "ISS") and the Krasnoyarsk Scientific Center of the Siberian Branch of the Russian Academy of Sciences (KSC SB RAS) suggest participation in the project at the same time students of 3rd, 4th and 5th year. When moving to the next year of study, the student becomes a tutor for the younger student of the same direction, shares his experience with him. The final result of student scientific works with a subsequent diploma project in its direction is the development and production of a real device or element that will be used by enterprises [27].

This example illustrates the practical development of the system of interaction between educational organizations and enterprises developing high-tech industries, increasing the participation of high-tech business representatives in the formation and implementation of educational programs of higher education institutions.

T. B. Heinis, I. Goller, M. Meboldt [28] described in their study a "design education model, consisting of two linked courses that allow students to learn key engineering and social competencies by experiencing real situations. During the course "Innovation Project" (IP), for example, freshman solves a development task in a team (creating mechatronic system). The course "Leading Engineering Projects and Coaching Design Teams" educates IP student coaches in team dynamics and how to coach an innovation team".

Thus, the achievement of the set result of an innovative-oriented process of managerial and engineering personnel's training is a willingness of a specialist to innovate, possibly using organizational and technological innovations, problem-oriented training.

DISCUSSIONS

The authors of the article wrote earlier that the managerial and engineering personnel's training requires substantial modernization [29,30]. It is necessary to use organizational and technological innovations more actively, to apply the project approach, which is in many respects similar to the position [31, 32, 33]

At the same time, developing the ideas of S. Peillon, K. Medini, N. Dubruc [34], the main characteristics of the program in engineering education are multidisciplinary, in the blending conditions of engineering and management approaches, and "mixing theory, case studies and the use of simulation, based on several educational tools", we note that the preparation of a competitive specialist combines in modern engineering education, along with technical managerial competencies related skills of production management, marketing, logistics, engineering, system design.

CONCLUSION

In conclusion of this study, authors note that the use of organizational and technological innovations in the process of managerial and engineering personnel's training is aimed at the continuous development and further improvement of creative thinking, skills and motivation, identifying and posing problems, creating new knowledge aimed at their solution, search and processing of information, independent and team work and other competences of innovation activities.

The conducted research has shown that effective use of organizational and technological innovations in the process of preparation of managerial and engineering personnel is achieved by meeting the actual requirements of the external environment, the flexibility and innovative orientation of the scientific and educational system, the integration of scientific, educational and innovation activities.

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