



## The Management of Advanced Training of Engineering and Technical Specialists Based on the Interaction between Universities and Business-Structures

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### ABSTRACT

The relevance and urgency of the problem under study is defined by the significance to develop a flexible management system of advanced training of future engineering and technical specialists aimed at developing human capital assets and ensuring socio-economic development in priority guidelines of scientific and technological sector of the country. The article focuses on studying the objective necessity and matter point of the advanced vocational training, its management principles and technologies through which the model of advanced vocational training of engineering and technical specialists will be realized. The article also defines the main problems which solution will contribute to achieving the goal to develop the system of advanced vocational training of engineering and technical personnel in the field of priority guidelines realization concerning scientific and technological sector. The strategic planning of the interaction between educational organizations using network-based activities and social partners as potential employers is the leading approach of this study. The article deals with the definition of systematically important components of advanced vocational training of future engineering and technical specialists. The use of these components will help establish closer interaction between vocational training and potential employers. This study reveals objective and subjective factors affecting the management efficiency of advanced vocational training of engineering and technical personnel and defines the scope of problems relevant to education community which solution will contribute to developing efficient advanced vocational training model. This model enables engineers to achieve international vocational qualification level, high level of technological open-mindedness and offers opportunities for lifelong learning and professional retraining. The materials of the article can be useful by modeling of the advanced training of engineering and technical specialists based on the interaction between universities and business structures, the development of management mechanism of vocational education and its consolidation with world education space.

**Keywords:** Management, Advanced Vocational Training, Network Forms of Interaction, Network-based Activities, Strategic Planning

**JEL Classifications:** A23, I23, I26

### 1. INTRODUCTION

The main state capital is its intellectual capacity, its personnel, science and education, thanks to which the state can be competitive in the global world. Therefore, the problem of engineering staff training and the development of vocational competence is an important part in the State program of the Russian Federation "education development" within a period of 2015-2020. Under the conditions of global world economy the research and study of

various management models of advanced training of engineering and technical personnel has become a leading direction of national science and technology complex development. The models under study are based on the interaction between educational organizations implementing network-based learning activities and social partners representing potential employers. The new form of interaction is intended to ensure the combination of student's academic learning and practical in-plant training (Duderstadt, 2008).

Russian engineering education has recently faced the range of world and domestic challenges, the most critical of them are:

- Adoption of level-degree training system for engineering and technical personnel in accordance with Bologna declaration.
- Accession to the WTO, technological advances and renewal of engineering equipment in the world market.
- Abrupt fall in prestige of engineering activity and engineering profession in Russia.
- The absence of skill standards and qualifying requirements to the specialists engaged in engineering activity that take into account the level-degree training of specialists.
- Market relations between technical universities and employers (business-structures); the inability to provide work experience internship for future engineering specialists.

The inability to respond promptly to these challenges led the engineering education to breaking point. To certain degree it resulted in the crisis in national engineering which caused non-competitiveness of engineering goods: Designs, projects, technologies, machinery, equipment, devices and their operation and maintenance.

The association of Russian engineering education founded in 1992 aimed at developing and improving engineering education carried out 13 expert workshops over a period 2012-2013 concerning the evaluation of engineering and engineering education in Russia. The scientific-academic community presented by rectors, heads of departments, vice-rectors, deans, heads of companies, engineers (400 people from 34 subjects of the Russian Federation, 63 universities and 42 industrial companies) took part in these workshops. Upon the discussions 85% of experts came to the conclusion that Russian engineering is in crisis or breaking point.

Among the major features of critical state of engineering in Russia the scientific-academic community defined the following: Low competitiveness of domestic engineering goods and products in the domestic and foreign market; low share of the import of high-tech goods and products; abrupt fall in prestige of engineering profession; aging of engineering staff; closing of plants and research-and-development institutes; deterioration of the competitiveness of strategic branches of industry.

The following features were specified as distinguishing features of crisis in engineering education: Low prestige of engineering education among school pupils and low prestige of engineering profession, weak relation between engineering education and high tech industry, aging of engineering staff workers, low motivation of young instructors, discrepancy of state educational standard and international demands (Pokholkov, 2013).

Therefore, the strategic direction of Russian engineering education was stated as follows: To create the system of advanced training of future engineering and technical specialists in the field of implementation of preferred priorities of scientific-technological development enabling international level of specialists' professional qualification, high technological open-mindedness and the ability to lifelong professional development and

retraining ensuring economic and social development of the state (Matviyenko, 2013).

## 2. METHODOLOGICAL FRAMEWORK

### 2.1. Methodological Grounds

The development and design of innovation model of advanced training of future engineering and technical specialists and its efficient management require thorough planning and prediction of possible organizational consequences of the model application. This condition can be satisfied by the use of the following methodological principles: Priority, systemacy, fundamentality, advancing, practical awareness, continuity, competitiveness and adaptivity. Key methodological principles of innovation model of advanced training of future engineering and technical specialists should be the principles of advancing and priority.

Priority principle should consider the state policy in the selection of priorities by taking specific actions concerning engineering and academic staff training in the process of the implementation of the major directions of scientific and technological development. The advancing principle supposes the development of the subject-based educational program including novel scientific and technological achievements, the establishment of scientific centers of technological university education aimed at elaborating preferred directions of scientific and technological advances, development of working specialists' vocational competence.

Comprehensive approach is required to resolve strategic problems of engineering education development. This approach involves the interpretation and consideration of historical, philosophical prerequisites and organizational and pedagogical conditions required for engineering education improving; multi-level comparative-pedagogical study of domestic and foreign experience of implementation of advanced training models of engineering and technical specialists to find out the similarities and differences in approaches.

### 2.2. Empirical Research Methods

Empirical research methods were used by data acquisition of employment of higher and secondary vocational education institution graduates in Siberian region, information accumulation and recording. These methods were also used for analyzing observed data concerning the professional intention changes of comprehensive school leavers; by information gathering, accumulation and recoding of surveys and interviews conducted among comprehensive school leavers, university graduates and employers concerning satisfaction of their vocational training quality. The analysis of the obtained results allowed to identify the following antagonisms (contradictions): The discrepancy of the educational service market to the labor market demands; youth demotivation to be engaged in working activity and get multi-level vocational education; the concern of vocational education on the enhancement of subject knowledge and passing the Centralized Testing instead of formation conscious professional career choice; the absence of relation between the teaching content and labor market demands; the lack of employers' interest in taking part in

the organization of educational process in secondary vocational educational institutions, colleges and engineering universities.

### 2.3. Literature Review

Of great importance are the works of Russian scientists devoted to studying the subject of research which present theoretical and methodological grounds of management of educational activity and modern theoretical approaches to the functioning of educational organizations (Asaul and Krishtal, 2007); the basic concepts of organization of youth pre-vocational and vocational training (Palyanov et al., 2013; Shaidullina et al, 2015a; 2015b), modern problems of the management of vocational education models in Russia and abroad (Smirnov et al., 2012), issues of strategic planning of social partnership in education system (Matviyenko, 2013), the problems of management in engineering education and strategy of national doctrine development of Russian engineering education (Pokholkov, 2013), planning and management of practice-based engineering education (Bibik and Il'yaschenko, 2014); roadmap of engineering education and science and practice management under the changing world conditions (Duderstadt, 2008).

## 3. RESULTS

### 3.1. National Doctrine in the Field of Engineering Staff Training

For some years the representatives of engineering community in Russia have carried on a dialogue with the government of necessity to develop national doctrine in the field of management of engineering staff training in the Russian Federation. The problem of organization and management of the process concerning the engineering training adaptation to the dramatically changing labor market, new technologies and global economic demands which dramatically affect the nature of engineering activity was discussed many times at Parliament hearings inviting the representatives of legislative and executive body, the representatives of regional engineering universities and secondary vocational institutions, Soviet of the Federation and the State Duma. These changes require practical knowledge enhancement, development of skills, habits and competences together with theoretical improvement.

The comprehensive management strategy concerning the vocational engineering education, however, has not been developed yet. Unless the taking measures the absence of comprehensive strategy caused the deficiency of engineering workers both in quality and quantity and this deficiency will increase (Bibik and Ilyaschenko, 2014).

### 3.2. The Causes of Engineering Staff Deficiency

Scientists and researchers are aware of the causes of engineering staff deficiency. Despite the fact that about 200000 graduates with engineering diploma graduate from Russian universities, more than 50% of them get a job not connected with their major. Being the most time-consuming and labor-intensive education, it, however, does not guarantee material success and decent person's self-realization. There are some unsolved problems and tasks inside the system of engineering training. Over the last years powerful federal universities are founded in different Russian

regions on the basis of scientific and educational centers which successfully participate in the integration of science, education and real manufacture. The training quality of engineering specialists in some universities, however, does not satisfy the current requirements due to poor material logistics, the lack of modern equipment, and crisis of academic staff training and the absence of national doctrine and management strategy of engineering education (Smirnov et al., 2012).

### 3.3. Integration of Engineering Education and Business

The most important and relevant direction in improving training quality of engineering specialists should be the integration of engineering education and business. The federal law passed in 2007 intended to ensure the employers' participation in the development and realization of the state policy in the field of vocational education management does not work efficiently.

The current existing system of engineering staff training is not adapted to changing demands of the real sector of economy. There is no forecasting system which analysis the demand in engineers specialized in different skills profiles. There is no monitoring of situation which analysis the demand in specialists in the major industrial branches and social sphere. The employer-sponsored education and target training are also weakly developed.

Law being in force since 2009 allows universities to found small innovation enterprises. The results of the constant monitoring showed the lack of the desired effect.

The objective of the system of the advanced engineering education is to train well-educated youth segment able to information perception, engineering solutions and new innovation ideas generation.

The specified model contributes to efficient management of the advanced training through engaging students in scientific and innovation activity which leads to improving vocational training of engineering and technical specialists capable of working in industry on the state-of-the-art equipment controlled by computers.

The implementation of management model of advanced engineering training allows preparing engineers possessing professional competences which satisfy innovation industrial demands, developing new techniques and methods, establishing educational-sectoral clusters. The model implementation enables target intensive training of engineering staff which in turns will result in quality improvement of vocational and technological engineering education under the conditions of constant interaction between engineering universities and business structures.

### 3.4. The Role of Educational-sectoral Clusters in the Solution of Strategic Problems Concerning the Planning of Engineering Activity Planning and Advanced Training of Engineering and Technical Specialists

Educational-sectoral clusters are considered by many researchers of engineering education as a tool of social and economic

development and competitiveness of the country. Companies, organizations, higher educational institutions united in clusters can increase national and regional competitiveness in the international market, since these clusters can have a positive impact on productivity of firms, companies and branches and ensure the increase of possibilities for innovative advanced development which in turns stimulates the foundation of new business (Asaul and Krishtal, 2007).

The tendency of interaction strengthening between engineering universities and business structures can be explained by the losing the leading role of the state as a holder of national intellectual and industrial potential. This change has created a tendency of making order on certain engineering specialties and scientific research. To realize the potential of the interaction between engineering universities and business structures is possible only by strengthening and improving research and practice activity aimed at the industrial needs, which corresponds with the logic of "technological era." Science develops under new conditions due to the dynamic economic, scientific and legal changes and serves interests of industry becoming "practically-oriented."

Under the conditions of rapid technological expansion, business development, the change of employment structure and qualifying requirements (skill standards) to engineering staff and the loss of support of engineering universities by leading production enterprises, the perspective of strategic interaction planning between engineering universities and enterprises and companies of all forms of ownership is of great importance. This partnership creates educational-sectoral cluster working as a group of cooperating organization including educational institutions, complementing each other by mutual interaction in solving the problem of advanced training of engineering specialists who possess professional competences meeting the requirements of innovation high-tech industry.

The employer is a consumer of scientific and technological advances who realizes his potential in educational institution by entrant selection, the influence on educational program content for engineering staff training and retraining and takes part in assessment of quality of training quality within the bounds of Federal State Education Standards being member of the State Attestation Commission. Education as worthwhile common good is carried for the sake of people, family and state, meeting society needs through satisfying the industry and business interests and maintaining high standards of living and competitiveness of our country in the world market.

### **3.5. Professional Orientation (Occupational Guidance) and Formation of Senior Pupils and Students' Self-determination as a Factor to Increase Motivational Attractiveness of Engineering Education**

One of the integral features and components of the advanced engineering training model is the management of pedagogical processes of professional orientation (occupational guidance) and senior pupils and students' self-determination through their part-time employment in engineering field, including open access of young people to information concerning professional career, the

improvement of professional skills, mobility and competitiveness in the labor market. The specified directions contribute to the solution of the problem relating to increasing motivational attractiveness of engineering education, priority sectors of economy and the prestige of specialties in the technological and innovative activity.

The study of the process of senior pupils and students' professional self-determination formation conducted by scientists from Yurga Institute of Technology, Tomsk Polytechnic University, Novosibirsk State University and Hong Kong Institute of International Education and Lifelong Learning in four regions of Siberian Federal District within a period 2008-2014 showed that the career choice is mainly made randomly and is not related to learners' occupational (vocational) fitness. As a result about 15-20% of students drop out or are expelled from universities after the first year, about 8-12%, leave universities after the second year and more than 40-50% of graduates cannot find a job in accordance with their specialty.

The results of the conducted research showed that only 7-9%, school leavers entering secondary vocational education institutions (about 10-15%) drop out after the first year c, and more than 50% of college graduates find a job in accordance with their specialty.

The conducted study allowed to make a conclusion that only 4-9% of senior pupils take part in activities and clubs (special modeling, design clubs, hobby groups and etc.) organized by secondary vocational e education institutions. After leaving secondary comprehensive school only 8-15 % of pupils choose engineering universities for their further education. This fact evidences the necessity to develop the system of lifelong engineering education (Palyanov et al., 2013).

The orientation of vocational training on innovation technologies in engineering, technological, economic and social spheres allows to obtain international certification of educational engineering programs, syllabus and educational institutions and ensures the international level of young specialists' vocational skills which will contribute to sustainable increase of youth employment and their ambition of getting a career promotion under the conditions of the realization of priority directions of scientific and technological development.

### **3.6. Main Objectives on the Development of Management System for Advanced Training of Engineering Staff in the Field of Realization of Priority Directions of Scientific and Technological Development**

The final part of this article suggests the range of main objectives which solution will contribute to achieving the goal to develop the management system of advanced training in the field of realization of priority directions of scientific and technological development. The developed system will ensure international level of specialists' professional qualification, their high technological open-mindedness, their ability to lifelong development of their vocational competences, thus, ensuring economic, technological and engineering security of the state. These objectives are as follows:

- To provide system analysis of the engineering situation and engineering activity with the participation of engineering experts, experts representing business, authorities from different fields of activity, the aim of this analysis is to establish the objective cause of engineering staff training problems.
- To develop and adopt the national doctrine of engineering education as the leading national doctrine of advanced training of engineering staff.
- To broaden and increase the participation of legislative and executive authority, universities, colleges and business structures in the solution of the research problems on the basis of introduction and realization of target intensive vocational and technological engineering training.
- To pass the law concerning engineering profession and certification of engineering qualification.
- To develop the system of professional standards, to specify the conditions of mutual influence (interference), to show the possibility and necessity to use professional standards to make modifications of federal educational standards.
- To develop and realize the system of measures indented to increase the prestige of engineering profession in society.
- To take systemic measures for improving technological open-mindedness and decreasing the innovation resistance in society (Kust, 2014).
- To continue with work to introduce supplementary (further) vocational education and to establish basic educational departments at plants. These measures are aimed to reducing the interaction (interrelation) between training and practical activity.
- To organize territorial interaction network among comprehensive schools, colleges and technical universities.
- To develop private-state partnership and other modern network instruments of cooperation, including the participation of the Russian Union of Industrialists and Entrepreneurs.
- To ensure the leavers of profession-oriented school the entry to colleges and universities providing education on preferred directions of scientific and technological development.
- To provide students with certain amount of practical periods conducted at customer's plant as a form of internship and practically-oriented theses research.
- To make alternations to syllabus, certain discipline programs, the content of laboratory and practical works, the themes of term papers (projects). They should be focused on industry and manufacture and the customer should make an order on specialists.
- To develop the coordinated with the regional administration roadmap of educational-sectoral clusters on preferred directions of applied science development in accordance with certain regional needs.
- To train students at a certain plant which realizes the preferred directions of scientific and technological development or educational-sectoral clusters.

#### 4. DISCUSSION

Over the past decade there have been many publications devoted to the problems of technical and engineering education under the conditions of global economy and the constantly changing labor market. The overwhelming majority of investigations deal with

the management and administration of technical and engineering universities under new economic conditions, discuss the organization of instructional work and the revision of instructional content. There are far fewer publications devoted to the problems of technical (engineering) education quality, forms, teaching techniques and aids. There is almost complete lack of theoretical studies concerned with the management of advanced vocational and technological education of secondary school pupils, college and technical university students. The majority of investigations on the problems of career education, adaptation to new labor conditions under the conditions of sustainable development of social and economic internalization, technical education globalization and integration have weak methodological grounds and lack of experimental verification and empirical support of obtained results, which make these studies not completely reliable.

The management models of advanced and continuous (lifelong) training of engineering specialists is relevant and urgent problem for scientists engaged in the field of comparative pedagogics. With the advance of information technologies there is a considerable increase in access to research materials conducting in different countries, making the results of these studies available to wide scientific community through electronic journals, web-sites and other tools (Bray et al., 2014).

Among these investigations are the studies of foreign scientists where they offer some approaches, forms and management techniques based on knowledge and competences intended to modernize the engineering education enabling engineers respond to modern global challenges in economic and social fields:

Educating the engineering of 2020: Adapting engineering education to the new century (Committee on the Engineer of 2020, Phase II, Committee on Engineering Education, National Academy of Engineering, 2005).

Innovate America. The National Innovation Initiative Summit and Report. Thriving in a World of Challenge and Change (Council on Competitiveness, 2005).

Educating tomorrow's engineers: The impact of Government reforms on 14–19 education (House of Commons Science and Technology Committee/Seventh Report of Session 2012-13).

Review of vocational education - The Wolf Report, Department for Education, [www.education.gov.uk](http://www.education.gov.uk), 2 July (Department for Education, 2013).

Profound interest and attention to the issue concerning the modernization of engineering and technical education and search of relevant effective management models aimed at engineering specialists' training will certainly lead to the changes in this field of education in the coming decades.

#### 5. CONCLUSION

The development of the advanced system of vocational training of engineering specialists based on strategic planning of the

interaction between educational organizations and business structures contributes to the emergence of flexible system aimed at lifelong learning and development of human potential able to cope with the problems. The advanced training allows to increase the number of engineering institution graduates who will be able to find a job on their specialty (major) within one year time after completion of education. The efficient management of advanced training allows to cover a large segment of the population through supplementary vocational education and advanced training courses. The practical results of this work will result in meeting the demands in high-qualified specialists required by Russian economy, especially in the field of state-of-the-art technology. The employers will get specialists with modern competences, positive attitude to work and practical experience.

The participation of employers in education institution management will contribute to the increase of education space openness, strengthening of the interaction between universities, vocational institutions and real sector of economic activity, coordination of education program content.

The materials of this study can be useful for specialists and heads of education institutions, production-and-training centers, by the definition of forms and methods of interaction as well as by the selection and structuring of learning material and content through training based on cooperation between business and education.

Upon the obtained results a range of scientific problems and directions can be highlighted which call for further investigation: The extension and thorough research of some theses specified in the article related to creating system of advanced training; the development of the mechanisms of advanced vocational training management based on the interaction between universities and business structures and its consolidation in the world educational space.

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