UDC 37.013 (075.8)

Modern Models of Training a Professionally-Mobile Specialist

Tyumen State University
T.A. Fugelova

T.A. Fugelova

The main reasons hindering the establishment and development of professional mobility of a future engineer in the socio-cultural educational space of a technical HEI are: the orientation of technical universities to the previously established model of training future engineers and the underdevelopment of the content of future engineers' training. A student has to learn the logic of the development of science, learn how to get knowledge, and get engaged in real professional activities within the learning process of a university.

Key words: professional mobility, continuous education, engineering education model.

The swiftness of transitions that occur in the society "demands" specialists, who are able to analyze changes in country's socio-economic living conditions and to find untypical solutions for industrial problems, which, overall, integrates into the idea of "professional mobility".

The issue of training specialists, who are able to react to the societal changes and can forecast remote shifts in the professional activity, is highly topical for modern professional education.

In the Concept for Long-term Socio-Economic Development of the Russian Federation until 2020 a task is set to foster professional mobility relying on continuous education and professional retraining. This allows workers to increase their own competitiveness on labour market, to realize their work potential in the most dynamically developing sectors of economy [1, p. 57].

The authors agree with the point of view that engineering HEI graduates' competitiveness on labour market and their strength are being currently built upon new "untypical characteristics", rather than just upon their high level of professional training. Such characteristics include possession of extra professional qualities and skills that are not fostered within the basic study programmes, but, at the same time, that encourage amplification and deepening of future specialists' professional opportunities [2].

Besides everything mentioned above, the key trend of innovative training is training elite engineers that have the competence for broad thinking based on a system of meta-knowledge [3].

Engineers with such level of training should be masters of their profession and be familiar with other sciences. They need to have a deep understanding of information technologies and be ready to communicate and cooperate within an international group.

For any engineer it is important to be familiar with any sphere of modern culture, to have high moral standards and to be tolerant, to know well the history of his/her country and the mankind as a whole, to understand human psychology and social processes, etc.

The level of personal skills of an engineering HEI graduate, firstly, has to meet "… the requirements of specialist's adaptation to the modern-day pace of scientific and technological progress and inconstant environment of labour market, and, secondly, (should allow) him/her to harmonize own professional activity with global challenges of civilization, with the issues of preserving and sustaining adequate level of living on Earth" [4, p. 60]. The training should start at school.

In most cases modern pre-university training is focused on "cramming" enrollees on courses that are field-specific for applying to a certain university. Enrollees that choose engineering majors get enrolled based on the results of the Unified State Exams. Career guidance of high school students should develop an informed professional self-awareness and foster the emergence of motivation for studying.

Many prestige world-known educational institutions, such as Oxford, Cambridge, Harvard and other universities seek for enrollees with non-standard and flexible thinking. Enrollees send test results and short bios to the admission offices. Additionally, an interview can be held in order to evaluate the level of enrollee's fundamental knowledge, his/her reaction to unconventional questions, wittiness, personal and psychological qualities, motivation for studying. The closing arguments for the enrollment can be: grades in school diploma, third-party recommendations, extracurricular activities, hobbies and proactive attitude of enrollees [5].

And another example. Students enroll for a number of majors at Tyumen Industrial University based on the results of a creative competition for best inventions. As a rule, this competition coincides with the Day of Russian Science and is held in a form of a scientific and educational marathon. Future enrollees conduct a series of unconventional experiments in HEI's laboratories under the supervision of university teachers. For instance, they diagnose break-gear system determining the toxic level of hazardous substances emissions or design a pipeline. Based on the results of such lab works students are awarded with diplomas of "Inventor – Investigator". Authors of the most interesting ideas receive recommendations for university enrollment. However, even in such a case, the main requirements towards enrollees are still the results of Unified State Exams on physics and math.

At this, it is relevant to address the opinion of a modern philosopher, N. Krylova, who stated that "to focus the training process only on subjects and disciplines is to support Scientists, who considered physics and mathematics as "role-model sciences" and encouraged to build other sciences upon those, whereas culture inherits polysystemic ways of action [6, p. 21]. Fallacy of the Scientists' (from lat. scientia – science) concept is triggered by the fact that scientific and technological progress cannot automatically lead to dissolution of all complex problems and sharp contradictions of social life.

The existing unsound practice of Russian university enrollment by results of the Unified State Exams puts enrollees' emphasis on entering any budget-funded major outside of their interests and desires. It turns to be a deliberate exclusion from axiological prevalue of a profession [7, p. 20].

Problems also occur on a stage of professional training at an HEI. Thus, the analysis of curricular, programmes and study books indicated that engineering training does not have succession between study courses. They barely navigate future specialists to conduct creative search, to foster reflection, readiness for innovations and changes in professional activity, etc.

The mandatory cultural components lack not only the ability to forecast and design, but also the ability to understand, interpret and integrate theoretical and practical activities, as well as to organize professional activity.

The Standard does not have any disciplines that focus on professional self-development and career planning and development.

Detachment and isolation of the knowledge acquired is particularly eminent in the process of interdisciplinary project development.

Having analyzed the activities of graduates, authors can draw a conclusion that a future engineer, who has a high grade, for instance, on "Economics" is not able

ENGINEERING EDUCATION
21'2017

to apply this knowledge in his/her professional activity. Besides, more than 70% of final-year students regularly note that professional training does not correspond to the real professional activity.

The authors attempted to find a solution of this problem by investigating expertize of foreign and domestic training of engineering workforce [8]. Thus, the theory and practice of engineering pedagogy at foreign HEIs actively relies on problem-oriented and project-based learning (C. Benjamin, E. de Graaff and others).

At the same time, problem-oriented method allows students to focus on solving a clearly defined problem situation, which motivates them to acquire knowledge needed for problem's solution and stipulates their independent "search" for knowledge from various areas with an aim of further application of it in the process of solving a particular production task.

Project-based learning, including teamwork, is a "prototype" of future engineering activity. Students get experience of comprehensive work of engineering design that intends not only allocation of work functions, but also sharing of responsibility between team members. The key part of project-based learning is the development of abilities on student's cooperation within a group.

These methods are widely introduced as innovations in the majority of foreign HEIs.

Thus, Faculty of Engineering of Leuven Catholic University (KU Leuven, Belgium) provides bachelor students with a course "Problem Solving and Engineering Design". While studying the course students get involved in real engineering practice, team work (6 to 8 students) on interdisciplinary projects, learn to solve engineering problems that require integration of knowledge on a number of disciplines. The main aim of the course is to foster technical and social competences.

In the first semester a website is created to illustrate the problems chosen by students. Within the first week students can try on different roles starting from project manager and ending with a role of a secretary or a treasurer. Teams demonstrate their work through portfolios.

During the second semester students conduct an engineering project, prepare a presentation and a report.

In the third semester students are suggested to participate in "open" projects, i.e. projects that do not have an unambiguous solution. Students propose an engineering solution, create and demonstrate a working model.

Students learn to solve typical engineering problems within this course and then they turn to the development of "open" projects.

This technology fosters the formation of professional (use of not only the fundamental knowledge, but also skills of engineering design and research) and universal competences required for project management. The emphasis is on the development of social competences rather than only technical ones.

Curtin University of Technology (Australia) executes an innovative course "Engineering Foundations: Principles and Communication" that assures fostering of students' communication competences while developing technical projects.

Project design requires students to have communication skills, because being in a role of a client intends that they propose different alternative solutions to each other. Students foster the following abilities: to analyze situations, to write a report, to prepare a project, to formulate conclusions on work results.

Grenoble Institute of Technology (Grenoble INP, France) conducts training of graduates, who are ready to do project work based on consideration and comprehensive assessment of the influence of engineering solutions on society and environment. During a semester master students participate in a project focused on responsibility in engineering decision making. Sponsor industrial companies evaluate students' work. In the framework of the project students foster competences needed for professional engineering activity with emphasis on ethics, social and environmental responsibility, as well as sustainable development.

Aalborg University (Copenhagen, Denmark) has developed an educational model that is based on solving practice-oriented tasks. Students solve proposed tasks in project groups under the supervision of a teacher – a facilitator. University has a unique environment for the development of both professional and universal competences of future engineers.

Йcole Centrale Paris (ECP, France) works on the implementation of teaching and learning methods aimed at the development of key competences that are typical for European engineers, such as leadership, efficient communication, readiness and ability to work in teams, creativity in designing modern industrial production, and social responsibility.

Students get involved in the development of a project "Leadership and Engineering", master a course "Challenges of the XXI Century" aimed at understanding the role of an engineer in solving problems of the XXI century, foster abilities to solve production tasks in the context of uncertainty, work on a group project that is focused on solving a particular topical engineering problem in modern spheres: energy, environment protection, modernized biotechnologies, public healthcare, information, regional development and mobility, and economics and management.

Course work starts with a three-day workshop that concerns topical problems of the XXI century. Students prepare individual reports and then participate in conducting a group project aimed at finding a solution for the identified problem. Each of the tasks is evaluated.

In cooperation with Heriot-Watt University (Great Britain), Tomsk Polytechnic University (TPU, Russia) created a Center for Training and Retraining of the Oil and Gas Specialists.

During the first year of Master programmes students study courses of the 7th (Fall) and 8th (Spring) semesters. Courses are in Russian, but an intensive course on professionally-oriented English language is executed at the same time.

Study classes are conducted in natural conditions (field practices, work at paleontological and geological museums, internships at industrial petro-physical laboratories of JSC "TomskNIPIneft"). The first year ends with a 7-week industrial internship in departments of oil and gas producing partner companies.

The second year (training is mainly in English) includes mostly theoretical courses (lectures, practices, tests, exams) and work (during spring semester) on personal projects.

An important role in training specialists is devoted to their involvement in scientific and research work. Master students get included into group projects on requests from oil and gas companies. In interdisciplinary teams students try on different functions (project developers, geologists, geophysics, extraction engineers, and, of course, practical specialists on drilling, etc.). Thus, they widen and deepen their competency. When presenting their group projects each student defends the results of his/her own part.

Students, who successfully graduate from a Master programme by defending both group and individual projects, receive degrees from two universities: TPU and Harriot-Watt University.

Introducing students to practical problem-oriented activity, as well as to individual work on solving real problems (including "open" engineering problems), facilitates acquiring the experience of fundamental knowledge practical application: conducting joint workshops together with industry representatives, developing and designing projects proposed by companies, including projects executed on premises of enterprises, inviting experts for project mentorship and assessment, allocating students' internships at industrial companies to get to know their corporate culture.

Training system developed in Tomsk Polytechnic University covers education

from high school to higher education and professional development and ensures continuous training of elite specialists.

For more than 20 years the university runs a Polytechnic Lyceum (for students of 10th and 11th grades). Training process on a number of courses in the lyceum is supported by the leading professors of TPU.

Together with mass training of students starting from 2004 TPU has been executing a system of Elite Technical Education that covers 4 stages: 1) 1st and 2nd years of bachelor programmes – stage of fundamental education; 2) 3rd and 4th years – professional training, where students learn economics and management of innovative projects, disciplines connected with entrepreneurial thinking, conduct problem-oriented projects in groups; 3) 5th and 6th years (specialist and master programmes) – special training.

Students are involved in group practice-oriented projects. Selection process for the Elite Technical Education system (ETE TPU) is based on an additional testing that determines intellectual abilities and creative potential of students.

Competitive advantages of the Elite Technical Education programme reside in the fact that integration between fundamental knowledge and professional focus is achieved within the study process.

Tomsk Polytechnic University among the first universities in Russia (from 1995) together with leading foreign universities conducts training on eight master programmes within 10 centers of excellence. These master students are notable for their innovative thinking, creativity, ability to integrate research, project, and entrepreneurial activities. They have a grip on the methodology for group design of complex systems, they are able to work in interdisciplinary teams, and they are fluent in professional English. Master students have an opportunity to receive two diplomas: a diploma of Tomsk Polytechnic University and a diploma of a partner university.

The university has a person-centered educational environment with emphasis on students' self-learning under the supervision of teachers [9].

Focusing on the principle of continuous education as on a fundamental pillar provides enhancement of the form of education acquisition. Interlinking of human forces and abilities is the topical issue for professional pedagogy. It allows focusing on *social partnership*.

Aligning interests of an HEI, employers, business leaders and science in terms of adjusting curricular, organization and contents of scientific and research training of HEI students is the leading direction for enhancement of social focus of the modern market economy.

According to "Kommersant. Dengi" journal, Bauman Moscow State Technical University (MSTU) is the leading university in the ranking of universities, whose graduates are highly demanded by the labour market.

High competitiveness, as well as high demand for Bauman students is secured by thorough fundamental training and good knowledge of real industry. The quality of education is achieved by means of integrating science, education and innovative activities, which is supported by traditions of the university, systematic joint high-end research together with enterprises, and indispensable attraction of leading specialists of industry and science for teaching.

Starting from 3rd and 4th years students take part in scientific research of Bauman MSTU. Expectedly, MSTU participates in a state project – "Skolkovo Valley", similar to the American Silicon Valley. Skolkovo is to become the biggest "shooting ground" for new economic policy in Russia. Specific conditions for research and development, including the development of energy and energy-efficient technologies, nuclear, cosmic, biomedical and computer technologies, are introduced on a specially allotted territory.

The idea of Skolkovo creation served as a basis for the development of Futurussia community – an international community of talented scientists, engineers, innovators, who are interested in the process of economic and cultural development in Russia.

Membership in the Community gives "an opportunity to communicate with like-minded people - with those, who have already become professionals in their field. And this is important for personal development" (N. Denisov-Vinskiy – PhD student of Power Engineering Faculty, employee of the Center for Innovation Infrastructure and Youth Entrepreneurship of Bauman MSTU), "a wide ground for self-realization, for acquiring new knowledge" (Yu. Chekhov), "an opportunity to create a "City of the Future", that is firstly built for those, who are involved in innovative activities" (N. Denisov-Vinskiy).

The key idea that Futurussia members face today is to simulate a building Skolkovo city and to live in it. There are several areas of work here. Each member chooses an areas that is close to him, for instance, business, education, e-administration and information environment, programmes for marketing and sociologic research and Skolkovo products promotion on specific markets, etc.

In order to create modern power machines it is essential to receive a thorough fundamental field-specific training both in the specific field and in the areas of economics, psychology and management. For this very reason, students of the Faculty study management, marketing, consulting, along with learning fundamental disciplines. Students can get diplomas of Bachelor, Specialist and Master levels at the Faculty, as well as continue their education at PhD level. "I like the creative style. Bauman School is not only the knowledge; it is a wonderful and very useful school of life" (Aleksandra Saydikova, graduate of Power Engineering Faculty).

The Faculty of Engineering Business and Management operates successfully at Bauman MSTU. The specific nature of the Faculty resides in the integration of engineering and humanitarian training in the field of economics and management. Trained managers and engineers-managers are able to solve problems of production management and organizational management of companies with different forms of incorporation.

When graduating the university young specialists face a choice: to work as an employee, to engage in creative work, including research activity, or to become an entrepreneur. It is not a mere coincidence that the Faculty has a Department of Entrepreneurship and International Activity. Bauman graduates know that success in the modern society can be assured if engineering skills are supplemented with knowledge on economics and basics of entrepreneurship. Many students acquire second higher education degree at the Department of Entrepreneurship and International Activity in parallel with their first degree.

Objectives related to understanding the need for creation and development of professional mobility of a future engineer can be achieved only by perceiving a student as a subject of educational process.

It is essential to note that education, being a subject's function, is proportioned to his individual life course and experience, to specifics of coping with critical moments of professional development, and is determined by the socio-cultural experience and historical past of the professional community that he belongs to.

Hence, future engineers should be involved in the activities on designing forms, methods and contents of education that correspond not only to the actual culture, but also to the opening horizons for future creativity and professional development.

REFERENCES

1. Ob utverzhdenii Kontseptsii dolgosrochnogo sotsialno-economicheskogo razvitiya Rossiyskoy Federatsii na period do 2020 goda (On Approval of the Concept for Long-Term Socio-Economic Development of the Russian Federation until 2020) [Electronic resource]: Russian Federation Government Decree of 17 November 2008 No. 1662-p. – URL: http://www.ifap.ru/ofdocs/rus/rus006.pdf, free. – Tit. from the screen (usage date: 04.09.2016).
2. Naumkin N.I. Metodicheskaya sistema formirovaniya u studentov tekhnicheskikh vuzov sposobnostey k innovatsionnoy inzhenernoy deyatelnosti (Methodological System for Preparation of the Students of Technical Universities for the Innovative Engineering Activities) / N.I. Naumkin. – Saransk: Mordovian State University, 2008. – 172 p.
3. Varnavskikh E.A. Tvorcheskaya inzhenernaya aktivnost spetsialista i realizatsiya metodik ee formirovaniya u studenta v tekhnicheskom vuze (Creative Engineering Activity of a Specialist and Realization of the Methods for Its Formation for Students of Technical HEIs) [Electronic resource] // Pedagog. – 1999. Iss. 7. – URL: http://www.altspu.ru/Journal/pedagog/pedagog_7/a07.html, free. – Tit. from the screen (usage date: 15.09.2016).
4. Lozovskiy V.N. Fundamentalizatsiya vysshego tekhnicheskogo obrazovaniya: tseli, idei, praktika (Fundamentalization of Higher Technical Education. Goals. Ideas. Practice) / V.N. Lozovskiy, S.V. Lozovskiy, V.E. Shukshunov. – SPb: Lan, 2006. – 128 p.
5. Naumkin N.I. Osobennosti podgotovki studentov natsionalnykh issledovatelskikh universitetov k innovatsionnoy inzhenernoy deyatelnosti (Special Aspects of Training the Students of National Research Universities for Innovative Engineering Activities) / N.I. Naumkin [et.al] // Integratsiya obrazovaniya (Integration of Education). – 2013. – Iss. 4. – pp. 4-13.
6. Krylova N.B. Kulturologiya obrazovaniya (Culturology of Education) / N.B. Krylova. – Moscow: Vysshaya Shkola, 2000. – 184 p.
7. Karmin A.S. Kulturologiya (Culturology) / A.S. Karmin. – SPb: Lan, 2003. – 928 p.
8. Chuchalin A.I. Kachestvo ingenernogo obrazovaniya (Quality of Engineering Education) / A.I. Chuchalin. – Tomsk: Tomsk Polytechnic University Publishing House, 2011. – 124 p.
9. National Research Tomsk Polytechnic University [Electronic resource] : [official website]. – Tomsk, 2002-2017. – URL: https://tpu.ru, free. – Tit. from the screen (usage date: 10.10.2013).
10. Moscow State Technical University [Electronic resource]: [official website]. – Moscow, 1997-2016. – URL: http://www.bmstu.ru, free. – Tit. from the screen (usage date: 12.12.2016).

UDC 338.4:378

Generation of Macroregional Network Innovation- and Educational Cluster in the North Caucasian Federal District

Dagestan State University of National Economy
M.Kh. Abidov, S.E. Savzikhanova, L.A. Borisova

This article validates the generation practicality of the network innovation- and educational cluster, which would combine leading universities of the macroregion, research- and infrastructure entities and the business community. The main difference between the proposed model of the cluster generation and the existing ones is that originally the initiative of cluster establishment comes from entrepreneurs, who are interested in investments in the development of innovation- and educational activity of the macro-region, and the North Caucasian Federal District (NCD) in particular. This article also proposes patterns of networking cooperation of the cluster participants, in order to optimize expenses in the course of cluster creation and operation.

Key words: innovation- and educational cluster, synergy effect, network cluster, cluster policy, networking cooperation, infrastructure of innovation activity.

Currently, the creation of integrated interactive network educational space is one of the major tasks of education system modernization. This can be implemented if comprehensive information- and communication system with broad and in some degree unique functional capabilities is in place. New technologies create the potential for sustainable development of cluster formations in the research- and educational system of higher education. This process generates missing links of the market infrastructure, including distributed virtual research- and educational structures.

At present, numerous policy papers indicate the importance of development of territorial clusters in various forms.

Catering to the needs of the post-industrial paradigm of global development, economic systems change. The cluster policy of leading economically developed countries also changes. It is reflected in the transformation of approaches to the cluster concept. Interactive cooperation forms of innovation parties, network cooperation forms of cluster participants begin to play a more significant role. This helps to overcome territorial and country restraints, and achieve a higher synergy effect in cluster cooperation.

Approaches to the definition of clusters have significantly altered. While in the XX-th century territorial vicinity of its participants, which defined the essence of the cluster, played an important role, in the present interpretation common ideas, goals and their joint achievement with the application of resource-, informational- and financial potential of cluster participants is the key element of the cluster cooperation. In this regard, the authors define the network cluster as a group of independent commercial and (or) non-commercial entities, which are united at the resource level in the technological network to implement a common idea. This technological network provides for the achievement of synergy effect sufficient to produce competitive products or services in the course of innovation-oriented activity as part of the integrated space [1].

From this definition one can see that cluster participants preserve their independence and combine resources as part

M.Kh. Abidov

S.E. Savzihanova

L.A. Borisova