

Modern Engineering Education as a Key Element of Russian Technological Modernization in the Context of Digital Economy

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Abstract— The article deals with the problem of modernization of modern engineering educational system in Russia with regards to the transition to digital economy. Nowadays science and innovative technology play a principal role in the social and economic development of the society. The article explains new requirements to the education of future highly qualified engineers in compliance with the requirements of the civil society and the needs of national economy. The transition to digital economy implies a completely new way for economic growth, a transition to a new techno-economic paradigm, aimed at the modernization and diversification of the economy with further development of processing and high-tech industries. Given circumstances require the institutions to introduce new methodological approaches and innovations which would reflect the modern pillars behind the creation of knowledge-intensive educational programmes for engineering. One of the key focus points is the variability of modern education that allows for its adaptation to completely new circumstances – namely, changed academic and economic autonomy of regional educational institutions. The article considers the question of providing highly qualified specialists in the sphere of knowledge-intensive tech and industry from Kurgan State University (KSU), which has been preparing specialists for the social and economic complex of the region for years. As part of the implementation of “Digital economy in Russia programme”, the article overlooks priority development trajectories in KSU for the coming years in the sphere of automatization of technological processes and industries, as well as the development of IT that shall foster growth in number of available communication mechanisms for educational institutions, businesses and local government. Developing higher education cannot be imagined without joint

scientifically oriented clusters with participation of regional business that shall stimulate R&D and, consequently, foment the formation of professional competences of future graduates.

Keywords— *engineering education, digital economy, modernization, professional training, educational programme, professional standard*

I. INTRODUCTION

Higher education is one of the most effective levers of technological, economic and social progress, as well as one of the key enablers of national policy and the creation of democratic society. Comprehensive state support and stimulation of various educational strategies on creation of innovative programmes and knowledge-intensive industries are main strategic tasks stipulated in the concept of long-term social and economic development of the Russian Federation. Government Decree #295 of April 15, «On confirming the state program of the Russian Federation “Development of education” for 2013-2020”) » defines the priorities of national policy in educational sphere that reflect the changes in the needs of Russian economy as well as necessity to form single renewed educational system. [1]. The roadmap for «The creation of National system of competences and qualifications» aimed at the overall improvement of investment environment in Russia, issued by the agency of strategic initiatives, outlines the concept framework for long-term social and economic development until 2020. According to it, the goal is to ensure the transition of Russian economy in

the innovative, knowledge-based way of development. [2]. In the context of given strategic tasks, the most important directions of technological modernization in Russia are the improvement of the educational system and the creation of circumstances for the education of future engineers.

II. PROBLEMS OF ENGINEERING EDUCATION DEVELOPMENT IN THE CONTEXT OF THE TRANSITION TO DIGITAL ECONOMY

Preparing professionals for high-tech enterprises requires an utmost high level of engineering education quality. This is a strategic task of national importance, which shall influence the competitive positioning and the safety of the state [3, 4]. Russian and regional economy lacks highly qualified engineers, especially given the process of transition to digital economy – which, in turn, demands innovation and considerable investment in high tech and knowledge-intensive enterprises. Special attention to engineering education reflects its exceptional importance in terms of the advent of digital economy and the overall modernization of existing technological paradigm in Russia. [5].

The development of innovation economy, national technological base and knowledge-intensive industries requires advanced personnel. In certain works [6, 7] special attention is paid to the understanding of integration and interconnectedness of education and the development of digital economy. It is demonstrated that the introduction of completely new corporate strategies considerably influences global educational environment, which is why it is worth focusing more on talent development, education, informational infrastructure and safety. Changes in the economy that are currently taking place result in changing tasks and qualitative criteria for the assessment of engineering education – with regard to developing creativity and generating new ideas in various spheres of activity [8-12]. The article [13] provides detailed analysis of a complex of skills and competences required for a future professional. Implementation field for these ideas is all about using infinite possibilities made open due to the advent of digital [14].

It is worth separately pointing out currently the most relevant problems with regard to professional training and using qualified human resources for so-called “smart cities”, which are increasingly becoming an inseparable part of digital economy itself [15]. It is usually for such cities to utilize IT tools and innovative technology. That is why developing professional competences of future experts and developing polytechnic and computer literacy become crucial in modern society [16-18]. Practical realization of this concept implies the used of artificial intelligence, information and communication technology and social and economic potential, which, combined, shall shape the image of “smart cities” of the future and define the trajectory for overall economic development of the region.

III. INFORMATIZATION AS A BASIS FOR THE MODERNIZATION PROCESS IN ENGINEERING EDUCATION

Modernization theory is one of modern doctrines intended for leading the country to new historical milestones, for the transition from industrial society to that based on information,

where knowledge management technologies are nothing short of a key component of production processes. Informatization is one of basic elements of modernization process of education in Russia, aimed at improving its quality and satisfying current and future needs of a person, a society and the state. Systemic thinking, ecological, legal and informational culture are becoming key factors in the formation of personalities – of both future specialists and citizens in the world ruled by digital economy [19]. This multicomponent system implements a complex multilevel process which leads to profound changes in education and overall improvement of professional competences, by providing the necessary environment for high-quality education that would comply with the requirements of innovative economic development and respond to societal needs.

Educational projects, implementation of innovative technology and supplying required human resources has allowed to partially eliminate existing disproportions in skill and competence formation required for innovative activity. With dynamic development of the Russian economy, increasing complexity of the infrastructure the current trend indicates the increase in industrial knowledge-intensity, fomented by a rapid growth of IT development and the formation of a new market niche for intellectual products and services. All that highlights the importance of information management (IM), which not only executes the conservative function of supplying production process or developing new products, but is also engaged in the development and exploitation of corresponding communication structure for the rational use of that knowledge. At the current stage, IT acts as a systemically important element of social infrastructure, being a key factor of acceleration of innovation process and modernization of Russian economy. That is why the development and implementation of IT is one of top priority tasks of educational policy in Russia.

IV. REGIONAL ASPECTS OF ENGINEERING MODERNIZATION EDUCATION IN THE CASE OF KURGAN OBLAST

Transition of the economy to the new socially oriented model requires a set of actions that should be aimed at the realization of long-term goals of national socio-economic development with regard to regional contribution. The 2020 strategy reflects the importance of innovations for Kurgan oblast as a main resource of enhancing its socioeconomic potential. [20]. Given existing regional specifics, it includes main suggestions on how to further improve the structure of socioeconomic development of the region. It is highlighted that the potential of the region in terms of science and education shall form a basis for the innovative component of technological renovation of all industries.

Main problems in educational sphere include several aspects worth mentioning: the lack of effective stimulation mechanisms for efficient teaching and management activity; insufficient material and human resources supply; lagging behind in terms of content and technology of educational process; remaining inconsistency between the level of qualification and the requirements of modern labour market.

Regional educational policy has a set of priorities that includes the creation of educational environment which would ensure the availability of high-quality education; improvement of education technology and approaches; enhancement of quality assessment systems; development of a regional system for continuous learning; improvement of economic mechanisms and human resource policy in educational sphere; increase in management efficiency; establishment of favourable economic, legal, informational, cultural, educational and ideological environment with regard to innovation; development of partnerships and collaboration with industrial and public institutions; development of systematic nature for engineering education.

Analysis of existing problems in engineering education has revealed several important points. Among them a sharp decrease of the prestige of engineering as a profession, levels of technical and technological culture of the population, limited capabilities of regional universities to attract material and human resources, small number of enterprises equipped with modern technology that could support high-quality practical experience for both students and more experienced colleagues. It is worth separate mentioning that the labour market has a supply / demand problem caused by certain controversy between educational system and new requirements to future engineers on the part of employers. Nonetheless, given the fact that regional universities do have comparatively high potential, one of key tasks is to coordinate the dialogue between public authorities, educational institutions and business structures of the region to foster creation proper conditions for the education of future engineers.

Problems of engineering education are of complex nature. Currently there is no single concept of the development of Russian engineering education. Educational programmes and applied technology should achieve required quality standards. Moreover, a set of special measures must be adopted to form a database of scientific products and intellectual property, creating attractive environment for graduates. [21-23]. Ontological engineering paradigm is all about integrating students' knowledge into a single knowledge system which should form the base for improving the quality of engineering education in the context of digital economy.

V. KSU: STATUS QUO AND DEVELOPMENT PROSPECTS OF REGIONAL SYSTEM OF ENGINEERING EDUCATION

Kurgan State University (KSU) is one of the leading universities in Trans-Ural region that have been educating future professionals for social and economic complex of the region for years. Its scientific, innovative and educational potential allows the university to be actively engaged in the economic development of Kurgan Oblast. KSU offers 107 educational programmes in natural science, technical, economic and liberal science.

For high-quality education that would satisfy industrial requirements, there have been created basic knowledge-intensive departments at the university, where experts from the industry also participate in the education process and the development of educational programmes and materials.

Engagement of external experts allows using applied technology in practice, demonstrating similarities with relevant industrial processes and multiple solutions existing in the market. All those factors combined foster students' motivation, overall educational process effectiveness and, consequently, the increase in the extent of integration to which industrial entities are engaged in the formation of their potential employees. In the near future KSU plans to develop and present a roadmap of a set of action aimed at the transformation of the university and the achievement of target indicator values with regard to educational, scientific and innovative results [24].

With the aim of achieving more active collaboration with leading industrial entities, in 2015 the Board of Trustees was established in KSU, among whose members are university representatives, public figures and community leaders as well as top managers of large regional enterprises. One of its key functions is to coordinate joint efforts aimed at preparing human resources for regional economy and attracting additional resources – which is to foster the region's competitiveness.

Among the problems solved at the university with regard to preparing employees for high tech knowledge-intensive industries several important aspects should be highlighted. In 2013-2015 KSU has successfully implemented a project "Engineers of Trans-Ural region" aimed at innovative development of programmes for transport industrial entities of the region. Educational programmes in engineering sphere has been renewed in close collaboration with large employers of Kurgan Oblast, taking into consideration the requirements of labour market. The project resulted in considerable modernization of the material base. Another example with mutually beneficial collaboration with KSU is targeted student training within the context of the project "Human resources for Defense industry".

Since 2014 Kurgan State University (KSU), together with secondary vocational schools, has been implementing an educational project within "New technologies of valve industry" cluster, aimed at providing the entities of the cluster with highly qualified professionals [25]. Since 2015 the cluster has been engaged in the preparation of specialists in the field of equipment automatization for oil and gas industry. as a master's degree programme «Computer engineering and automatization in valve industry», majoring in «Mechanical engineering». To provide practical opportunities of future specialists in the sphere of producing import substitution pipeline valve for nuclear and oil and gas industries a set of professional competences required for a qualified post-graduate has been carefully developed and approved.

In the context of existing problems of engineering education with regard to digital economy we should emphasize that KSU – is the only university in the region that is engaged in preparation of engineers of most demanded spheres of industry: «Automatization of technological and industrial processes», «Management of technical systems», «Information security of automated systems», «Applied computer science», «Software engineering», to name a few. The quality of education aimed at future specialists for highly

productive workplaces is ensured by modern and flexible implementation of innovations and new education technology into the educational process.

The university's plans for the near future include the continuing optimization and restructuring – in particular, with regard to the creation of educational engineering cluster (a center for IT innovations), which would unite several departments of KSU's Technological faculty, namely those educating future specialists in the sphere of high tech and knowledge intensive industries. We assume that this center will be integrated in the general development programme of the university and its activities will be aligned with the development strategy of the region. Besides, new innovative infrastructure shall foster the development of high tech entrepreneurship and, consequently, the commercialization of results of intellectual activity of scientists and university professors. Direct engagement of the experts from engineering educational cluster and industrial enterprises of the region will allow to more efficiently form the professional trajectory of human resources development in the context defined as "Education – science – technology – business".

Nowadays, additional education, being an inevitable part of continuous education, is expected to efficiently react and adapt to new requirements dictated by regional economy, as well as growing social requirements and demands to professional qualification and retraining. In 2017 in KSU was launched an online project named «Success trajectory for a professional of XXI century». Its main objective is to further improve the systems of professional and additional education in spheres of development and exploitation of hardware and software supplies of automated systems and ensuring their information security via the application of modern educational online technology.

Project objectives:

- creation of an innovative system of multi-level education with the use of online IT technologies with regard to programming, information security, robo technology and automatization for school students, undergraduates, industrial experts and everyone else who would want to enhance their professional skills and knowledge;
- assistance in the programmes for specialist retraining in accordance with the state programme «Digital economy of the Russian Federation», approved by the government decree as of 28.07.2017 No. 1632-r);

The project is intended for the formation of aligned continuity on secondary school and university levels of student education, compliant with existing requirements and relevant tendencies. It includes formal school subject as well as specialist classes with the use of online resources; introducing different professional spheres attributed to digital economy; preparation of professional teacher and professors. Application of online educational services should allow to considerably enlarge the number of potential students to be engaged. Project realization shall foster further development of the innovative model of the system of continuous education in IT – from school classes up to university graduation – hence securing the prestige of engineering education, providing

professional orientation for school students and helping them to better understand the professions that are in demand in the context of digital economy. Using the experience of applying online education in other spheres will allow to expand the range of educational programmes with the use of distance learning opportunities.

VI. CONCLUSION

In the coming years, Russian education system is facing a set of challenging tasks regarding the creation and implementation of requirements to basis competences of digital economy for each particular education level. What is more, it will need to ensure their consecutiveness (with regard to competence model); reorientation of the whole education system towards adaptation of Russian citizens to digital economy and preparation of highly qualified experts. Other important aspects include the creation of schools for Master and PhD students based in leading universities and scientific entities for each direction of end-to-end technology in cooperation with competence centers; development of supplying mechanisms for the system of specialist preparation of highest qualification which would be able to conduct research in that sphere of technology on world-class level.

With regard to the implementation of the programme "Digital economy in the Russian Federation" Kurgan State University has defined a set of prioritized development trajectories, some of which are already being actively explored:

- An online information portal has already been created – based on which the university has placed "The atlas of professions" in IT and information security; a system of recommendation for professional orientation is currently being developed.
- Realization of advanced training programme, vocational rehabilitation and retraining, continuous professional development of teaching personnel, ensuring their readiness to implement modern education models with regard to the needs of digital economy; first runs of pilot projects on improving «digital literacy» of older generation with engagement of students' initiatives.
- Creation of a complex system for support and guidance of highly-motivated and talented students based on their competence profile and personal development trajectories – with regard to adaption to digital economy environment.
- Involvement of industrial IT experts in the education process, development of education programmes in the sphere of digital economy that would consider studying both national and foreign research and development.

Working in abovementioned directions should allow to expand the horizons for successful search of potential opportunities of engaging efficient cooperation mechanisms of all parties concerned (incl. educational establishments, business structures and the government of Kurgan Oblast), interested in further development of the system of higher engineering education in the region and preparation of

qualified human resources for highly technological economy. Organization of scientifically integrated education clusters and structures with the obligatory participation of the university and regional industrial enterprises should allow to use modern technological and scientific bases to realize research and development work, to arrange internships for students and, generally, foster the creation of high-quality specialist preparation – of the experts that would be highly demanded in the modern market of science-based technology. It will contribute to the formation of the whole new environment for engineering education based on the synergies between education, science and industry – as well as realization of preparation model for educating future specialists based on the principles of continuous and forward-looking education at the core of which lies competence approach.

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