5. Strategiya innovatsionnogo razvitiya Rossiiskoi Federatsii na period do 2020 goda («Innovatsionnaya Rossiya – 2020») [Elektronnyi resurs] [Strategy of innovative development of the Russian Federation till 2020 ("Innovative Russia -2020)], utv. rasporyazheniem Pravitel'stva Ros. Federatsii ot 8 dek. 2011 g. № 2227-r. [approved by the Russian government 8.12.2011, № 2227-p.], URL: http://innovation.gov.ru/sites/default/files/documents/2014/5636/1238.pdf, (Accessed 30.03.2016). (In Russ.).
6. Proekty gubyat lozhnye idei [Elektronnyi resurs] [Projects are killed with false ideas], MIR: Molodaya innovatsionnaya Rossiya [Young innovative Russia], 2011 – 2016, URL: http://i-innomir.ru/posts/1472-chto-meshaet-realizovat-proekty, (Accessed 30.03.2016). (In Russ.).
7. Kozlov A.V. Sidorkina O.V. Pogrebnaya T.V. The level structure of creative class, Engineering education, 2015, no.18, pp. 31-36. (In Engl.).
8. Altshuler G.S. Naiti ideyu [To find an idea]. Moscow: Al'pina Biznes Buks, 2007. 400 p. (In Russ.).
9. Altshuler G.S Tvorchestvo kak tochnaya nauka [Creativity as an exact science], second ed. Petrozavodsk: Skandinaviya, 2004. 208 p.(In Russ.).
10. Mezhdunarodnaya Assotsiatsiya TRIZ (MATRIZ) [Elektronnyi resurs] [The International TRIZ Association (MATRIZ)] official site [Orem, 2010–2016],URL: http://matriz.org, (Accessed 30.03.2016).
11. Kozlov A.V. et al. Formirovanie inzhenernogo myshleniya v mirovom obrazovanii: soderzhanie i tekhnologii [Elektronnyi resurs] [Engineering thought process development in international education: content, technologies.], prezentatsiya vystupl. na Obshcheros. nauch.-prakt. konf. «Kachestvo inzhenernogo obrazovaniya» [presentation for the Russian scient-pract. Conf. "Quality of engineering education", 24–26.11.2014, Tomsk], URL: http://aeer.ru/files/Kozlov_participant.pdf, (Accessed 30.03.2016). (In Russ.).
12. Toffler A. The Third Wave, New York: Bantam Books, 1989. 537 p.
13. Usoltsev A.P., Shamalo T.N. Ponyatie innovatsionnogo myshleniya [The concept of innovative thinking], Ped. obrazovanie v Rossii [Pedagogical education in Russia], 2014, no. 1, pp. 94–98. (In Russ., abstr. In Engl.).
14. Pokholkov Yu.P. Nasha tsel' – spetsialist s innovatsionnym mirovozzreniem [Elektronnyi resurs] [Our goal is a specialist with innovative worldview], interview with Prof. Pokholkov Yu.P., recorded by Zimina T., ChemNet: Khim. naka i obrazovanie v Rossii: ofits. elektron. izd. khim. fak. MGU v Internet [Chemistry and education in Russia: official site of electronic edition of the Chemical faculty, MSU], URL: http://www.chem.msu.su/rus/innovation/welcome.html,free, (Accessed 30.03.2016). (In Russ.)
15. Podlesny S.A. Kozlov A.V. CDIO: objectives and means of achievement Engineering education, 2014, no.16, pp. 8-13. (In Engl.).
16. Kozlov A.V. et al. Izobretayushchee obrazovanie [Elektronnyi resurs] [Inventing education], Novosti VPK: sait. [News of defense industry] 2006–2016, URL: http://vpk.name/news/124611_izobretayushee_ obrazovanie.html, fee, Title from the screen (Accessed 30.03.2016). (In Rus.).
17. Development of creativity in engineering education using TRIZ [Electronic resource] / A.A. Lepeshev, S.A. Podlesnyi, T.V. Pogrebnaya, A.V. Kozlov, O.V. Sidorkina // IEDEC 2013: Proc. of the 3rd Interdisciplinary Engineering Design Education Conference, Santa Clara, CA, USA, 2013, pp. 6–9. doi: http://dx.doi.org/10.1109/IEDEC.2013.6526750.
18. Grudzinskii A.O. Proektno-orientirovannyi universitet [Project-based University], Nizhnii Novgorod: NNSU Publ., 2004. 370 p. (In Russ.).

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Project of Innovative Engineering Education

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The paper provides the analysis of engineering education and proves the necessity to develop an innovative engineering education programme. Basic principles of the innovative education programme as well as qualifications of engineering Bachelor degree programmes are suggested. Education modules of the suggested programme are described.

Key words: innovative education programme, fundamentality, automated systems, mechanics.

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Reform of higher education system is continuing, although reversal of the education itself is absent. The development trends of engineering education remain the same, and, in most cases, the existing transfer from 5-year to 4-year education system reveals the fact that the professional content of most education programmemes remain practically unchanged. To implement the principle of continuing education, to integrate and apply the diversity of education programmemes, and to enhance further qualification of engineer-graduates (receiving a Master degree), a new schematic model of developing innovative education programmes has been proposed comparable to the existing programmes. An overview and brief justification including the basic principles of such programmes are being discussed further.

The market expectations of the engineering workforce within Russia revealed the fact that Russia is lagging behind the leading countries within engineering and technology domain [1]. One can observe such a factor as noncompetitive low-quality and expensive product output governed by low efficiency and weak performance (production rate). In Russia today the existing labor market requires no highly-qualified graduates due to the orientation towards resource economy. At the present moment there is a market flooding of low-demand specialists, including engineers. One of the major drawbacks of this situation is the unbalance between higher engineering education content and modern society economic development goals.

The economic development of any country is directly interlinked with the technological infrastructure and automation of present-day production, application and implementation of innovative and energy-efficient technology At this stage the development trend of global economics is determined by advancing high-quality production, promoting knowledge-intensive industry, updating materials, technology and techniques, and developing conceptually new industry sectors.

The infrastructure of any production involving technology and sophisticated techniques is impossible without qualified engineering and technical HR (human resources). The utmost task of professional education is the personnel training, oriented on the needs and demands of developing production and society. The technological modernization of economy and industry is marked by the demand for new generation engineers. Today's knowledge-intensive production requires such specialists that could develop and implement conceptually new engineering and technological approaches based on the

integration of different science domains; could perform research, development, design, and engineering tasks and provide the functioning of complicated engineering systems. Consequently, the integration of innovation approaches into the education system is essential in training specialists for high-tech and knowledge-intensive industries.

All in all, the target-oriented requirements involve improving the professional engineering training system itself. At the present moment this system is based on the principle of continuous professional education. However, this system itself is being improved due to the uprising of different education system levels. One major integration stage of a sophisticated system could be considered the development and design of an engineering education and training system within the framework of technical universities under the guiding, counseling and mentoring of well-educated and highly-qualified personnel.

So, what should this innovative engineering education system be? First and foremost, it should be as dynamic as science and technology in its development; it should enhance innovative transformations within engineering and technology domains; it should provide flexible and mobile education programmes relevant to the employment market requirements; it should ensure equal opportunities of receiving qualified higher education for all social groups through flexible educational paths and alternative paths within the framework of different education system levels.

To design the innovative engineering education system, one should consider the fact that the technological modernization of the economic processes involves the acceleration of new engineering knowledge, i.e. progressively fundamental theory is being applied in practical purposes and further transformed into engineering principles. The present-day engineer should have fundamental understanding of nature of things and core phenomena, on the one hand, and possess a vivid imaginative mind in solving difficult technical and engineering production problems, on the other hand. It should be noted that only a well-educated person could be socially protected in the expanding information world. It is a person that is capable of changing his/her profile and always being involved in life-long learning. During a lifetime a person could change his/her sphere of professional activities. In the post-industrial society information, knowledge, research and development have become the basic production resources. It is the results of fundamental research that ensure high production development, prospect of new engineering sectors, as well as so-called "industry saturation", which, in itself involves instrumentation, research, monitoring, modernization and automation. Under these circumstances it becomes evident that the transfer from functional to fundamental learning is vital and could be based on both learning and practical acquisition of the basic development principles of natural, technological, and social systems [2, 3]. The emerging engineer status in this developing society should optimally meet the requirements of the new social-structure: good fundamental training base, being the major distinctive characteristic feature of university education would ensure the graduate's success not only in the professional but also in the social sphere, promoting his/her welfare due to possible professional activity orientation.

The first higher education level (Bachelor) should involve the function of developing the future specialist unique potential to select his/her profile from the far-reaching range of professional specializations. Accordingly, the Bachelor graduate (in engineering and technology) is eligible to take a Master degree programme in any university. In this case basic engineering discipline invariance is required. Growing extent of information, updated IT occurrence, access to knowledge database, electronic manuals, journals and guidelines, and possible e-learning necessitate modification of not only the education content but also learning technology itself.

Based on the above-mentioned aspects the major developing innovative education system principles are the following:

1. continuity;
2. multiple-level system;
3. fundamentality;
4. proactive training;
5. flexibility and diversity;
6. development of economically in-demand engineering education profiles.

Based on the described analysis it is possible to specify and distinguish the dominating functioning engineering education system concept which includes a diversity of education programmes. The proposed innovative education programme would be one of the most important components in this system, focusing on improving the engineering training quality.

The economic analysis of developed countries revealed the fact that there are all possible alternatives in future automated and robot-based engineering-production process development growth. In the environment of the North more or less competitive productions could exist only by using limited manpower energy-efficient technology and backyard production. Many branches of production are mechanized, however, their productivity is rather low since they are not modernized to the existing local climatic conditions. For example, in the construction and mining sectors mechanization is popular, but only involving transportation, drilling, and other similar processes. Predominately, technologically continuous linked systems are not so widely used in production. These technological system are not automated and each is managed separately. There are no robot-based systems. To implement sophisticated industrial (technological) processes, new generation trained engineers are necessary, i.e. specialists in design & development and automated system production & operations. Training such specialists is a multi-stage process which requires an advanced fundamental base to assimilate knowledge-based technology.

Thus, designing innovative education programmes is closely connected with the future-oriented development of advanced economic areas, such as automated and/or limited manpower productions which involve a wide application spectrum of mechanized, automated, robot-based production systems emerging as a module of different mechanisms. The most appropriate education programme (curriculum) within the framework of the Bachelor level is "Applied Mechanics" as it fully accommodates to the above-mentioned principles. The programme project was designed within the context of education modernization principles involving the transfer from functional learning to universal fundamental training. The new project model based on the "Applied Mechanics" programme includes disciplines in mechanics relevant to machinery design. However, it is elaborated, specifically pertaining to fundamentalization of professionally-oriented disciplines. The basic disciplines in the curriculum include basic engineering disciplines in mechanics, which involve an intensive education programme. A student could obtain basic knowledge in mechanics, kinematics, dynamics, interaction of different linking mechanisms and preliminary skills in computation and modeling. The major objective is training students for further Master degree programmes in Russian and foreign universities. In view of this fact the core (professional) module in the education programme also includes basic engineering disciplines. This approach ensures basic fundamental education, which, in its turn, offers an opportunity to continue one's professional learning in different in-demand engineering profiles. Within the framework of such a programme the students also learn the essentials of

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IT, principles of automation, including computer programmeming skills – this is the third discipline module. Another important aspect of this programme is developing competencies, i.e. in-depth understanding of technical knowledge, domestic and/or foreign experience pertinent to the engineering discipline through courseware, science literature and journals. To accomplish this, integrated methodology and English language learning are included – fourth education module. **Integrated methodology includes three English learning levels- basic (1-2 courses), university component (3 course) and teaching engineering disciplines in English (3-4 courses).** After completing the Bachelor degree programme students would have the opportunity to continue their education in Master degree engineering programmes in any university abroad.

Thus, innovative engineering education programme includes four professional-oriented modules: **mechanics, fundamental-profes-sional, modeling and programmeming, and communicative.**

The implementation of the proposed innovative programme enables a student to enter any engineering Master degree programme after completing the Bachelor degree programme. The basic innovative education programme provides universal, diverse, fundamental and basic engineering education in effective modeling of different linking system mechanisms. This advanced education major would boost the development of innovative engineering education within North Eastern Federal University in Yakutsk.

REFERENCES

1. Pokholkov Y.P. and Agranovich B.L. National doctrine design principles in Russian engineering education within new-type industrialization: problems, objectives, challenges. Engineering Education, 2012, no. 9, pp.5–11.
2. Prokhorov V.A. Nekotorye voprosy modernizacii inzhenernogo obrazovanija (Issues in modernization of engineering education) 2013, no. 10, pp. 13–19.
3. Bagdasaryan N.G. Dihtomija «fundamental'noe» i «uzkoprofessional'noe» v vysshem tehnicheskom obrazovanii: versija FGOS (Dichotomy of "fundamental" and "professional" in higher technical education: FSES version) Vysshee obrazovanie v Rossii (Higher Education in Russia), 2012, no. 5, pp.21–28.

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Humanities and Social Technologies to Develop Engineer's Personal Potential in Self-Developing University Environment

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Techno-humanitarian balance conditions the prospects of human survival as well as competitiveness of Russian industry on the global market. This balance depends strongly on such engineers' qualities as way of thinking, ethical priorities and reflexive positioning. The paper describes a practice-oriented approach to study personal potential of modern engineers, development of their personal qualities by means of socio-humanitarian technologies and reflexive approach used in educational process.

Key words: socio-humanitarian technologies, engineer's personal potential, reflexive management, self-developing environment of higher education institution.

The engineer of the 21st century is a key figure in social and economic space of modern Russia headed for technical and technological breakthrough in science and industry, import substitution, upgrade of engineering education. The vector of thinking, ethical priorities, reflexive position of a future engineer influence today the choice of techno and humanitarian balance both as a condition of survival and prospects of mankind, and as a solution of the local problem of competitiveness of the Russian industry in the world market. The dialogue of natural-science, technical and technological, and humanitarian thinking, logic of interrelation of professional and socio-humanistic knowledge and experience, personal potential of the engineer, their implementation in engineering practice is set by the order and nature of the acquired knowledge to meet challenges of fast transformation in social and technological practices and actual trends of an engineering profession; they serve as prerequisites of the solution of this fundamental problem. Today highly specialized training of the engineer with a dominant of engineering intelligence under «laboratory conditions» of acquiring knowledge and experience becomes insufficient for adaptability to new types of knowledge, change of the purposes and means, ethical priorities, activities in professional practice.

Professionalizing and personal qualities of a modern specialist in general depend on methodology and effective technologies of his education and transfer of professional knowledge in engineering practice. The relevance of research in personal potential formation modality of the engineer of the 21st century and opportunities of its reflexive provision in modern Russian higher education is caused by a block of theoretical and practical factors. The first one is the essence of reasons, certificates of theoretical knowledge as a development of socio-humanistic technology in the self-developing environment of higher education institution, formation of personal potential of the engineer, relevant to modern social and economic requirements with a high level of creative engineering thinking, presenting professional socialization, a set of professional abilities, personal resources, values. The second block considers a problem of transfer, implantation of educational experience of the 21st century

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