Some Problems in the Development of Engineering Ideas in Russia and Advanced Life-Long Professional Engineering Learning

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Over the last decades a new industry type - research-industrial or innovative is playing more important role in developed countries. It means that science has become an integrated part of the industry itself. The existing scientific- engineering level in Russia, which "cannot be a model for other countries "[1] has several serious problems in advancing into an innovative course of development. The major problem is lack of engineering staff with creative mentality. When considering this problem from the global viewpoint, it is necessary to take into account the national characteristics which affected the long-term development of home engineers under conditions of isolation. The result of it was Soviet engineering training system that made a Soviet engineer class. After the USSR collapse and introduction of market paradigms, this generated class and system began to fade away, but their past features, though weaker, are still dominant nowadays. However, besides the specific problems of home engineering, there are problems of the countries where knowledge-based economy is being developed. It is obvious that the development of such economy should alter its orientation as compared to the past. Innovative orientation of the new economy depends on the future young engineers-university graduates. At the same time, invariable engineering innovations can make any engineering education inadequate,no matter if it is good or bad in its content. For example, a 30-year old electronic- engineer graduate can observe the design of a chip to have changed more than 100 times, while the number of transistors in microprocessors has increased fourfold for the last 25 years. Training within the framework of one technology, an engineer-graduate can lose his\her competence when an enterprise proceeds to new up-dated technology, which, in its turn, shows the fact of necessary constant advanced training.

Implementation of innovation activities can have global troubleshooting problems in future engineering education, even if this

The article underlines the general problems of engineer training with creative mentality. Specific problems associated with the development of domestic engineering under conditions of isolation, reasons of its low creativity are described. Perspective development of engineering is mainly connected with the system of advanced life-long professional engineering learning at different enterprises, engaged in innovation activities, such as Joint Stock company (JSc) "Information Satellite Systems"

education itself is highly-qualified. Many foreign researchers state that engineering creativity is impeded by the contradiction between engineering internship at an enterprise and oriented university courses. Today's student personality is quite different from his \ her predecessor, but teacher-instructors continue to teach as they were taught years and years ago. Nowadays, as before, engineering education is basically oriented on engineering knowledge acquisition, excluding highly-qualified professional skills.

The process of engineering professionalization is impeded by the engineering science dominance to the disadvantage of other courses, which also play an important role in the future engineer's profession. Thus, such studies are considered to be only the acquisition of "discursive identity", i.e. learning those specific competencies for this or that engineering community; for example, reading and writing technical documents, applying symbolic system instrumentation for this discursive community, exhibition of typical engineering medium behavior stereotypes, etc. Although one gains all required engineering skills, there is evidently a contradiction between the university "engineering discourse" and engineering training [2].

Due to overall mathematization and computerization, a number of serious methodological difficulties have emerged within the engineering activity itself, where quantity performance aspects prevail over quality ones. The subject-matter of engineering activities is not only calculations, but also engineering design, which includes such important items as creativity and transparency and openness, i.e. all possible multiple-technical solutions for one and the same problem. However, in teaching mathematics and sciences, it is presupposed that the solution of an engineering problem has only one exact answer, as a rule,a digital one [3].

The computer has been converted from a support aid into a central terminal, where all creativity activities of an engineer are rotating, which, in its turn leads to distinctive (peculiar) one-dimensional engineering mentality. Such an engineering "one-dimensionality" usually has an inappropriate affect on complicated engineering situations. During engineering activities an intrinsic personalized project reality is formed, while the engineering process itself only executes a definite function. When desig-ning, describing and analyzing the engineering process, the character data is insufficient, because such an essential engineering activity concept as function (procedure) is not a mathematical concept.

During university training of engineer-personnel it is difficult to provide the complete set of competencies for further implementation of innovation projects. Besides definite engineering competencies (identifying, formulating and solving engineering problems; applying research approaches; designing systems, components and processes to achieve target-tasks; planning experiments; analyzing obtained data, etc), in-demand competencies involve a wider spectrum than those of engineering activity aspects. These competencies include teamwork, flexibility, responsibility, negotiating and others. However, the above-mentioned troubleshooting problems are not only methodological ones.The engineering profession itself is becoming less attractive.

All over the world, assorted procedures are being used in improving the university education training quality and increasing student motivation in future engineering professions. These procedures are aimed to show students what the teaching content and its significance are; to learn how theory in solving practical problems is applied; and what role engineering has achieved in post-industrial society, etc. Students are involved in different activities- science days, excursions to advanced regional enterprises. Engineer-instructors of such enterprises tutor university classes, etc. Nevertheless, this progress is invisible, and it becomes evident that no university education in training engineers for future innovation activities could substitute "on-site" training. The more predominate the industrial knowledgeable component is, the more important life-long professional engineering learning becomes.

Above-mentioned problems of engineering training in future innovation activities could be interrelated with the existing problems in home engineering institutes, including not only global problems, but also specific ones. Only through a detailed historical examination of both the formation of home engineering training system and characteristic features of the engineering development as a product and medium of engineering itself could these mentioned problems be comprehended.

Although the pre-revolutionary engineering developed apart from the European civilization, namely, the European approaches were used in the solution of most engineering problems. The most significant figures of Russian engineering were creative and apt to implement complex innovation projects, for example, two worldwide famous inventors-Zworykin, inventor of the television and one of the founders of helicopter engineering - Sikorski. Highly- developed Russian engineering level was ensured through the pedagogic-organizing framework in the existence of several elite technical (engineering) education institutions, while the pedagogic- ideological framework in the nature conformity principle [4].

After 1917 the government followed not so much the nature conformity principle rather than the revolutionary practicability principle, where priority was to the working-peasant class. This resulted in two facts - the first one was that many creative first-rate engineers, including the so-called "generators of engineering ideas", who determined the development target in many engineering spheres during decades, for example, Zworykin and Sikorski, were forced to work and implement their ideas beyond the USSR. The second fact is that under such new conditions the engineering science could not develop normally and engineering European-type schools could not be established to involve all the prominent engineers.

The Soviet engineering developed otherwise, i.e. centralized, mass and systematically as in a totalitarian country. To solve the problem of increasing the small engineering sections, an effective system of mass engineering training was constructed which exists in the same form even now. This system excluded the basic disadvantages of the tzarist engineering system, i.e. much prominence was given to practical skills of future engineers. Thereof, according to some quantity parameters, this engineering system surpassed the engineering training systems of more advanced countries.

As a result, the newly-based engineering class emerging in the 30's, developed further, in the 50's of the last century, into a class that was characteristic of the technologically-developed countries of that time. At this time, the category "Soviet engineer" was revealed, a particular class which functioned only by instructions. "Instructive" engineering orientation totally corresponded to the principal development trends of the Soviet society and was to some extent progressive for this survival development stage. At the same time, it subsequently disguised potential negative consequences, for example, initiative judgment, restraining engineering ideas, copy-development of Western engineering, etc.

The corresponding organizational legalization of this elite class developed simultaneously as "a conductor" of innovation. The major organizational legalization included the collaboration of numerous Research Institutes, engineering-design offices, other secret closed cities (MBX) - organizations working in military defence, as well as, the so-called notorious "shady businesses", where, to the mid-50's of the 20th century, convicted scientists and engineers worked. Subservient engineering labor could not exist within a bourgeois society itself, but even if the Soviet organizations were structurally similar to those of bourgeois ones, their content was quite different, which, in its turn, hindered the development of engineering.

Their engineering profession was extremely ideologized which was the result of not only Party and government decrees and resolutions, but also the illusion of most employees that an intellectual engineer could be any capable person. This illusion (even existing up to now), arising from visible successes during mass engineering training, inspired the Soviet engineers that they could solve any problem, even the most complex ones. Many of these engineers did not even realize that all their engineering activities were controlled and issued from different authorities. Under such conditions the organization of normal engineering schools was impossible, and those that were established or existed as relicts were quickly degrading.

Thus, after 1917 the development of engineering slackened, even though the governmental ideology ensured the fact that "generators" of engineering ideas could be cultivated in the same way as of those ordinary engineers working under instructions. However, up to the USSR collapse, this problem was not as acute as it is nowadays. First of all, not all "idea generators" and simply creative engineers could emigrate or not and continued to work more or else effectively up

ENGINEERING
EDUCATION
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to a certain moment. Secondly, there were even some intellectual ("thinking") individuals in such a totalitarian country. Thirdly, the state itself focused on mass labor in some particular spheres, and this was a quantity index, but not a quality-skill index.

Gradually, in the Soviet and post-Soviet period "an idea deficiency" emerged into the research and engineering spheres and growing troubleshooting problems became obvious in creating and providing one's own foundation for intellectual innovation projects and ideas. Thus, the solution to this main problem-engineering creativity- was to import the research and engineering ideas, engineering solutions and technology from highly technical-developed countries. During many decades, this invisible, all-embracing phenomenon, i.e. importing foreign scientific-engineering intellectual products and being approved by the authorities, extended throughout the USSR and had a negative effect on the development of home engineering and science.

Importing ideas, techniques and technology from highly technical-developed countries, adapting them into closed organizations, implementing them as material projects within the USSR itself, and only then, nationally submitting these as Soviet achievements in science and engineering included a whole range of negative consequences. These consequences were the following: the foremost one being the mythologizing of the Great Soviet Science which is even extendible nowadays. This fact resulted in the decrease of engineering creativity, degradation of scientific and engineering mentality, irreversible formation of "instructive" engineering orientation, decline of prestige engineer profession, etc. Another significant consequence is the despairing deceleration of domestic engineering and technology in comparison to global level, increasing year to year.

According to above-mentioned factors, one should have a rather critical viewpoint on those technical and engineering innovations which were the implementation of Soviet engineering ideas in closed research institutes and engineering-design offices. As a rule, these achievements were not the results of the intellectual property of Soviet engineers, but only the up-dating of secret materials from highly-technical developed countries. Such a system was typical of the cold war, which included powerful and efficiently-developed technology espionage. This system involved leading USSR scientists and CEO of closed organizations as the promoter, while the executives were employees of relevant Soviet intelligence service.

These materials through external channels included different items- not only information and abstract ideas to be implemented as "hardware", but also ready-made products which were dissembled and assembled on the basis of domestic components. Such an "innovation activity" showed a rather high development level of Soviet engineering in comparison to the global one. Otherwise, it would have been impossible to design the analogs of foreign technology –a phenomenon which can even be observed today in practically all home industrial spheres. At the same time, that system being involved in such an innovation – type would be nonplussed.

Actually, importing ideas, techniques and technology can lead to certain consequences which are interrelated to the increasing contradictions between the domestic and global engineering development level. Due to two global revolutions - scientific-technological revolution (beginning in the mid- 50's of the previous century) and technological revolution (occurring nowadays) there was a backward development of domestic technology and engineering in comparison to the global development level. Thus, the above-mentioned development procedure has become non-effective. In other words, under today's modern conditions all necessary material - from information to products- can be legally purchased to implement any innovative projects.

Although the situation has changed drastically, there are some significant circumstances preventing the implementation of this or that innovation. The raw material source orientation has been increasing in home economy, while engineering cooperation with other developed countries has tailed away. The integration between science and production, without which innovation activities are impossible, has changed on the contrary [5].The collaboration with other research establishments abroad was suspended, home scientific centers were practically destroyed, while existing ones could not function even when all provided material for innovation was reliable and on-time. As a result, even defensive products (equipment and enginery) which were of great significance in all times, are now uncompetitive. "...Even those few cases when defense technology was sold abroad, confirm the fact that this defense potential hasn't been completely destroyed or diffused...." [1].

"The outdated system of engineer training exists" so far and "had been only convenient under conditions of Soviet economy planning and operated excellently in totalitarian regimes" [1]; but this could not promote the further generation of an innovative -oriented individual and the development of creative mentality. If a Soviet engineer, being trained in such a system, could possibly become an innovator with a store of all necessary external - obtained materials, then, today, the same engineer with the same store of materials, including schemes, diagrams, etc. could hardly implement all this into home production. There are several reasons: (1) the gap between the actual level of global scientific-engineering achievements and its individual limited possibilities in the perception and assimilation of these achievements themselves; (2) the realization of engineering ideas within the Russian reality which is rather complicated as a result of the destruction of high-technological sectors and practically no material basis to develop a sophisticated electronic network within any technology.

The community of young engineer-specialists is declining from year to year- not only the number of graduates working in different enterprises, i.e. "engineers show minimal dependence between obtained and factual specialty (35.9%)" [1], but also the decrease of engineering quality. The quality of engineering education is a rather painful topic. However, many admit the fact of its total decrease, especially during the last few decades, including not only the relative global level of quality, but also according to certain absolute parameters. Even though the fact that "the new generation is much more well-informed and adapted to solving contemporary problems" [1], the issue is mainly not only their education, but also their training which is more or else crucial. Nevertheless, it is said that the quality of engineering education and the necessity of definite changes are vital.An example of this fact is that on the basis of a problem research in life-long professional engineering learning, SEFI Committee (European Society for Engineering Education) declared that in the near future American educators would have to implement new models for life-long professional engineering learning adopted from other countries (Alborg Conference) [6].

Based on above-mentioned facts it would be difficult to presuppose the forthcoming large number of engineers apt to innovative activity through the existing engineering education system [7]. To change this system "a new training personnel system could be considered, where there are cardinal changes in the engineering education system itself" [1]. At the same time, there could be the development of engineering ideas within the framework of existing life-long professional engineering learning system, which can be found in different enterprises engaged in innovative activities. An example of such a high-tech enterprise in space could be Joint Stock Company "Information Satellite Systems"(JSC ISS) [8].

Therefore, the problem of life-long professional engineering learning system development with all its vital characteristics for generating innovation activities cannot be solved within only one separate enterprise. Only the establishment and development of knowledge-based economy could make it possible to properly interpret and exactly solve this problem [9]. Not only different forms of skills (even from abroad) are applied, but also such skills as production of advanced technology products, highly-qualified services and experimental products and education are developed within the economy where life-long innovations and professional engineering education system are interrelated.

Countries, where professional engineering activities are legally regulated, promote the development of life-long professional engineering learning to develop knowledge-based economy. European Federation of National Engineering Associations publishes a guideline describing all professional requirements, excluding specific criteria. And the engineer selects the level of professional development which is characteristic of the country where he is living. For example, in Great Britain where life-long learning is supervised by different industrial sectors, the development-progress of an engineer is not specified, but it is implied throughout his career. In Japan the engineers annually spent 50 hours devoted to professional training which doesn't include any specific requirements to the content and type of studies. In Canada there are more restricted requirements; however National Organization of "Canadian Engineers" doesn't specify the obligatory requirements in the professional engineering development.

In Russia there is no common government approach to life-long professional engineering education, but such a development could exist within the corporative system, for example, Joint Stock Company "Information Satellite Systems" (JSC ISS). Much attention is paid to the development of life-long learning within the enterprise itself to provide on-site engineering personnel, who are capable of working under conditions of consistent innovation development [10]. Life-long education system including a prevailing pre-university, target university and engineer training interrelationship develops as an essential component in the personnel policy of this enterprise. Within the framework of this new personnel policy, an integrated education space concept was designed, where life-long professional engineering learning of the enterprise personnel is confirmed to be the innovation basis of the development of this enterprise itself [11].

This concept is that the innovative approach in economic growth is based on life-long professional engineering learning of the personnel which, in its turn, is established on the advanced integration of all education stages within the enterprise and includes a concentric organization content principle of the professional requirements in the differential personnel training and developing approach. This concept can be implemented within one functional personnel management center and aimed at the development of an innovative- oriented creative individual for the aerospace industry [1, 2].

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