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National Doctrine of Advanced Engineering Education of Russia in the Context of New Industrialization: Approaches to Development, Objectives, and Principles

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The article grounds the necessity and timeliness for the development of the engineering training national doctrine in Russia under the condition of new industrialization, considers potential structure of the national doctrine for the advanced engineering training in Russia, describes the principles of engineering education organization and the approaches to their implementation.

Key words: *doctrine, advanced engineering training, consistency, principles of engineering training management, competitiveness, educational technologies, educational programs.*

NEW INDUSTRIALIZATION

The word combination "new industrialization" was first used in the pre-election article by V.V. Putin "We need new economy" in terms of necessity to determine the place of Russia in the international system of labor differentiation. The article pointed out that in some development directions of engineering and technology Russia is falling significantly behind the developed countries, though in such directions as space research, military production, atomic industry Russia has accumulated the potential permitting it to remain competitive and occupy its places in the labor differentiation system. Development of traditional for Russia oil and gas branches of industry on the basis of national and foreign technologies allows it to keep its place among the countries defining world policy in this direction. However, in many industrial sectors it should be stated that the level of their development does not only permit to participate competitively on equal terms with advanced countries in the international market but also decreases significantly the opportunity its national production implementation into the inner market. A large number of non-domestic consumer goods embracing all engineering labour, thought and solutions are widely used throughout Russia today. Among which are computers, medical equipment, television, washing machines, refrigerators, automobiles, and motorcycles, products of added-value wood processing, other raw materials, and now airplanes of civil aviation. This list can not only be continued but also added by the list of equipment, supplying the production of capital goods – high-precision tools, molders, rolling mills, welding facilities, integrated assembly lines etc. Analyzing it, one should agree that there are only two strategic ways of industrial development in Russia:

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- development of machine, equipment, device production, other consumer's goods produced already in developed countries using foreign technologies, element base and in some cases implementing Russian ideas ("overtaking industrialization");
- development of new technologies, on this basis production of new types of machines, equipment, devices, materials giving opportunity to solve current engineering and technological problems continuously in the condition of changing world, proving formation of new Russian brands in the world market and decent place of the Russian industry in the international system of labor differentiation ("new industrialization", "advanced industrialization").

Without understanding the essence of new industrial policy of Russia one can hardly develop the national doctrine of engineering education in Russia as a basis for formation of personnel potential to realize this policy.

CHALLENGES AND ANSWERS

In recent years Russian engineering education came across the number of challenges of global and national character, among which the most urgent are:

- transition to the training in accordance with the principles of Bologna declaration;
- accession of Russia to WTO, competition in the world market of engineering labor and engineering solutions;
- sharp decrease in status of engineering labor and engineering profession;
- absence of requirements for qualification of specialists in the sphere of engineering and technology, professional standards taking into account the transition to specialists' two-level training;
- market relations with employers;
- contradiction between the former system of engineering training and new requirements to specialists on the part of employers,
- ageing material and personnel bases of universities;
- low number of enterprises provided with modern equipment, permitting for qualitative training of future engineers.

To implement appropriately and timely the above – mentioned challenges into the national education has failed, which, in its turn, has resulted in the crisis within the national engineering education itself, i.e. involving such engineering activity products as projects, technologies, installations, tools, devices, equipment, their operation and maintenance [1]. The scheme presented in Fig. 1, shows the systematic view of the problem situation in engineering and engineering education of Russia.

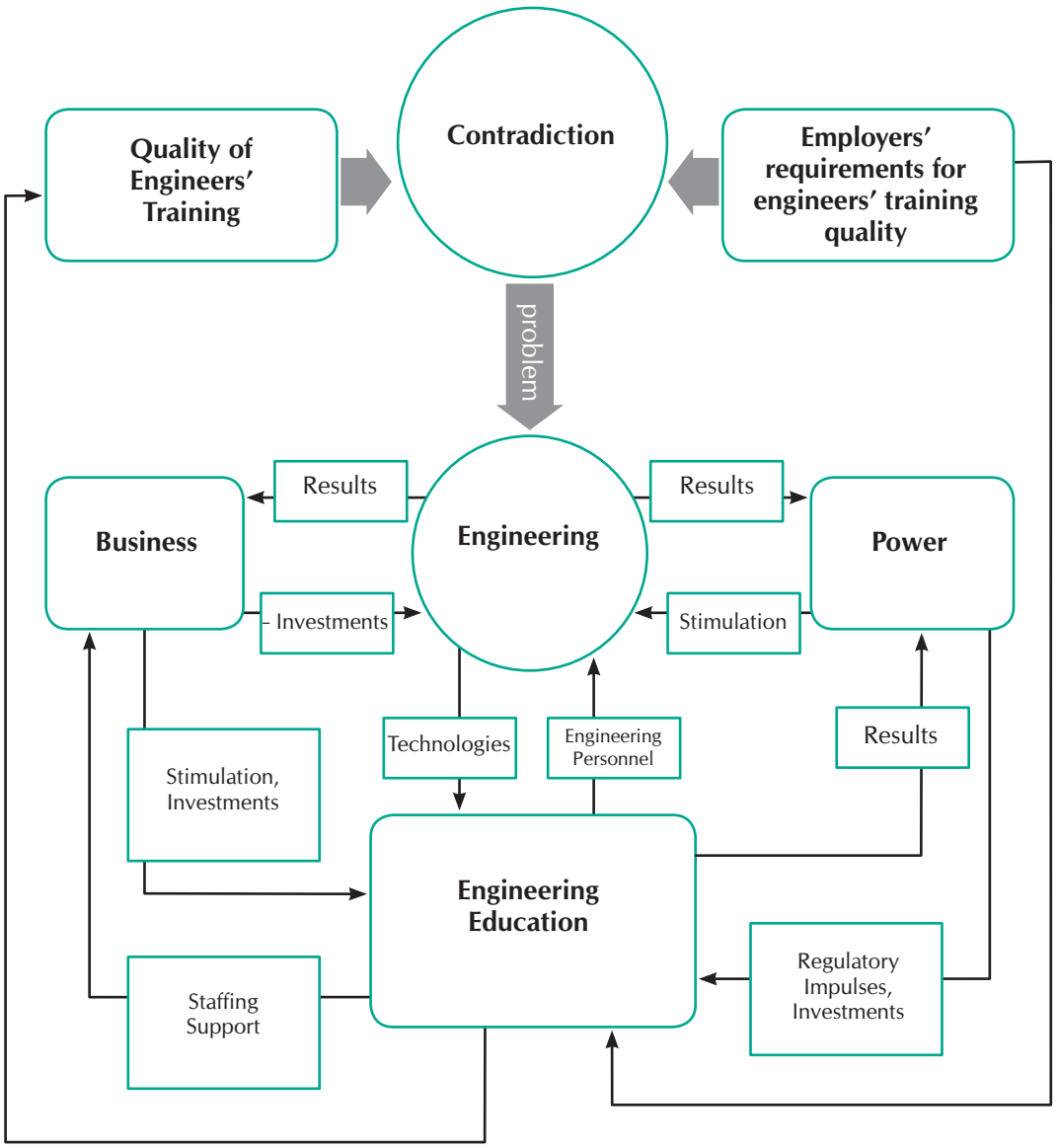
The major part is the contradiction between the quality of engineers' training and employers' requirements. Employers are interested in such specialists' characteristics as:

- ability to think systematically and autonomously and solve the production problems using the competencies developed in university;
- ability to work in a team;
- awareness in business processes and business environment in general;
- ability to generate and adopt innovative ideas;
- ability to present ideas with reasons.

As a rule, the content of engineering educational curricula and educational technologies applied today do not permit future specialists to form these qualities.

Universities arrange their work in such a way that graduates had, first of all, knowledge in subjects studied in university. Doing so, every teacher believes that the more hours he (she) has for teaching, the better he (she) would train a student. Consequently, the assessment criteria of future engineers' training in university are shifted towards the assessment of knowledge.

Figure 1. The Systematic View of the Problem Situation in Engineering and Engineering Education of Russia



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In all fairness, it has to be told that in recent years when developing curricula the so called "competence approach" including development of future specialists' necessary competencies is used. However, when the competencies are interpreted as a readiness to show ability in solving this or that production problems, but not a real ability to solve them in real production conditions, employers' expectations are not met. Besides, nowadays bureaucratization of training processes has increased sufficiently when implementing this approach; this resulted in essential increase in volume of teachers' low-efficient, "software" work.

Description of the problem situation in the sphere of engineering training in Russia would not be completed if two periods were not touched in this case – pre-university and after-university.

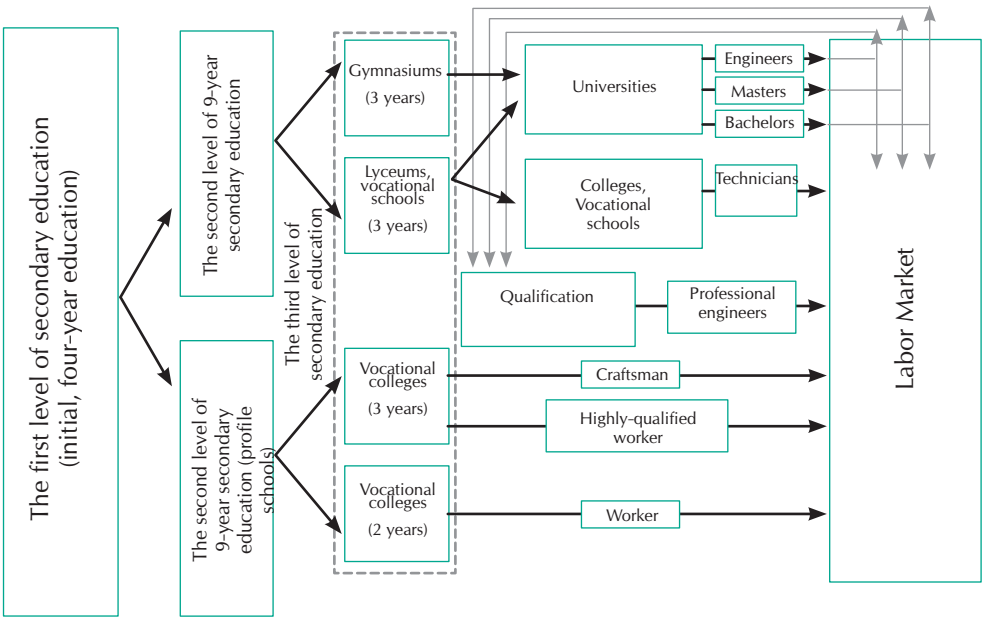
The pre-university period: today most of parents think that their children are to get higher education in engineering or non-engineering sphere. In this condition reduction of university number in the country and decrease the number of state-funded places in universities is fraught with social outbreaks, all the more so as the situation is added by the complete absence of alternatives for the children who would not enter the universities. The number and the level of technical schools (colleges) do not obviously correspond to the requirements imposed by the current society and business for specialists' training with the initial vocational and secondary vocational education. Even if it is suggested that the state and the number of such institutions can be taken as appropriate, one cannot expect that the opportunity of graduates' employment after such institutions would be high. The state of Russian economy aimed at the development of raw material industries, the level of modern Russian industrial production development does not give any promises that in the nearest future there would be arranged the necessary number of job positions for this category of applicants. One cannot forget the fact that reduction in university number will lead to reduction of teaching staff and search for the jobs for the laid off teachers and lecturers. All this will also contribute to increase in social tension of society.

One of the possible alternative ways for solution of this problem is a profound reform of school education including division of pupils' educational trajectories after the 4-th and the 9-th year of study (as in Germany), and arrangement of gymnasiums of Abitur type in Germany, A-Level in Great Britain, Baccalaureat in France. It will require creation of schools of the new type and/or reorganization of lyceum, gymnasium, vocational school, college system. Only those who have finished a gymnasium can enter a university, while graduates of all other educational institutions – only after fulfilling the requirements specified for the gymnasium graduates. Such an approach would permit for supply the labor market with qualified staff: workers, craftsmen, technicians, bachelors, masters, engineers and professional engineers (Fig. 2). Virtually, in this case the number of universities and state-funded places in them may be reduced. It is sure to be taken into account that in doing so the average level of education* and knowledge** of population in Russia would decrease.

The problem situation in the after-university period consists of the risk of disappearance of such a qualification category as "engineer". Transition of universities to bachelors' and masters' training is sure not to imply reduction in the quality of specialists' training in the sphere of technology and engineering. However, in future it will result in absence of specialists having "engineer" qualification who are the key people providing engineering progress and carriers of engineering culture in society.

** The level of education in society can be estimated as the number of years spent for education of one man beginning from seven-year age in average.*
*** The level of knowledge in society (conventionally) can be estimated as a part of population with higher education.*

Fig. 2. The Scheme of Labor Market Supply with Specialists of Engineering Qualifications



Most of those working in engineering universities are quite aware of convention in conferring engineer qualification to university graduates without neither experience nor results of engineering activity by the time of receiving engineer's diploma. It is also well understood by the production workers meeting diplomaed graduates with the following words: "Forget everything that you were taught in the university, we will start to teach you here".

"Engineer" or "professional engineer" qualification, as in most countries in the world, can be conferred to the people with higher engineering education in the sphere of technology and engineering (bachelor, master) as a result of certifying their engineering qualification by professional community. It is provided by engineering certification system in those countries. For examples, in Japan a certificate of professional engineer is given to a specialist graduated from university in Master or Bachelor curricula accredited by public professional organization, having worked in specialty not less than 7 years. He has also to present the documents proving the presence of performed autonomously and implemented engineering solutions, pass two exams on such subjects as "Engineering ethics" and "Ecology" (in the sphere of his engineering activity). A certified specialist is included in the national register of professional engineers [2, 3]. The number of specialists certified as professional engineers to the general number of specialists who wish to get such certificates is not more than 15 per cent. The major part of university graduates trained for technology and engineering sphere work in this sphere in accordance with their qualification (bachelors, masters, specialists) and the basis for engineering corps.

The alternative way of the higher engineering education system development in this condition is not a reduction in university number and state-funded places in them, but organization of large-scale training of specialists for technology and engineering sphere (mostly bachelors) and engineering activity (mostly masters) (Fig. 3). In this case it does not matter whether the general secondary education system will be reformed or it will remain the same. In the

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former case the functions of highly-qualified workers, craftsmen, and technicians will be performed by bachelors prepared for the work in the sphere of technology and engineering.

It is just "training specialists for technology and engineering sphere" is to become the main task for engineering education system of our country.

The group of Masters trained for engineering activity will become a basis for formation of engineering corps, but Bachelor's group trained for technological sphere – the basis for engineering and technological activity for the society.

Bachelor graduates (Bachelors in the sphere of technology and engineering) in addition to professional competencies provided by Bachelor's curriculum are to have skill category in not less than one blue-color job and business competencies. It would allow them to hold the positions of highly-qualified workers, technicians, craftsmen and organize the production in the system of small business. Besides, bachelors may claim for "engineer" or "professional engineer" qualifications under the condition of performing the requirements specified for these qualifications.

Master graduates (masters in the sphere of technology and engineering) in addition to Bachelor's competencies are to have competencies (professional and personal) allowing for successful engineering activity, independent solution of engineering problems, organization of production in the small and medium businesses. This group of master graduates trained for engineering activity and working in chosen profession successfully are the main candidates for award of internationally recognized "professional engineer" qualification. They will form the basis for engineering corps of the country.

MODEL OF ENGINEERING EDUCATION DOCTRINE

Search for the answers for the mentioned questions requires reasonable approach to both situation assessment and choice of development strategy for national engineering education. One of the key tools for this is development of fundamental document presenting "The national doctrine of engineering education in Russia".

Generally speaking the Doctrine presents "A set of officially accepted view points of a definite problem and the means of its solution" [4]. For example, Foreign Affaire Doctrine, Legal Doctrine, Military Doctrine which, by the way, can be "Defense" or "Attack", Educational Doctrine etc.

In any case, a doctrine is an important strategic document having a definite philosophy, on the basis of which the goal is formulated and the ways of its achievements are described in a definite sphere of activity for a long period of time. In modern terms it is possible to be referred to as "a road map".

"National doctrine of engineering education in Russia" is a document where the strategic goal of the native engineering education is set, its role in the economic development of Russia is determined, tools and means of its improvements, methods and main principles of realization are defined on the basis of adequate evaluation of the situation in the sphere of engineering education in Russia and the world.

The importance of the Doctrine development at the given stage of economic development of the country is obvious.

Undoubtedly, the goals of national engineering education development, its role in the economic development of Russia, methods of its improving, tools and means could be different. Their choice and principles of implementation is a subject of thorough analysis and public discussion among the specialists and the society.

The given article presents a definite approach to the organization of engineering education in Russia at the contemporary stage of economic development and has its purpose to conduct "reconnaissance" and, as the saying goes, "draw the fire upon oneself". The argumentative criticism of the statement suggested here for formation of national

Doctrine of engineering education in Russia, new additional suggestions and concepts would permit for finding the optimal ways for efficient development of national engineering education system.

At the end of the 90's "The National Doctrine of engineering education in Russia" was developed and approved by the Government Resolution of the RF №751 of 14.10.2000 [5]. It is a fundamental state document stating the priority (place) of education in the governmental policy, strategy and main directions of its development. Therefore, its principles, structure, and content can serve as a basis for "The National Doctrine of engineering education in Russia" in spite of non-performance of some points.

Approaches to formation of "The National Doctrine of engineering education in Russia" are to take into account global and domestic challenges, trends and tasks of new industrialization, problem situations, their system, possibility of transformation in methods and tools applied for the goal achievement at changing the external conditions. That is the system of engineering education developed in accordance with the Doctrine is to be adaptive.

When defining the long-range goals and tasks of engineering education development in Russia it is reasonable to perform expert evaluation of the required level of the engineering education in the society providing the minimal level of its "innovative resistance" and maximal level of "technologic sensibility".

In the condition of market economy, education and intelligence are the main asset guaranteeing the victory in competition on the world markets as, on the one hand, they allow for production and putting the competitive goods of intellectual labor on the markets, on the other hand, accenting and using efficiently the best current international results of intellectual activity and science-absorbing industry. Defining education as "a public goods" or as "a market goods" is of particular significance in this condition. The principles of education system organization and quality of both every citizen's life and entire society will rely on which of these definitions will be given a preference. At development of the National Doctrine of engineering education and goal setting definite suppositions and hypothesis are to be formulated taking into account of which the models of engineering education structure in our country can be constructed. The most obvious of them are:

1. the world development is based on competition;

2. in struggle (competition) of two cultures and civilizations the culture and civilization of lower level dies or falls in stagnation;

3. the culture and civilization level of society (nation, country, people) is defined by the level of its education;

4. education in society depends to a great extent on the education level of society in general and that of every person, in particular;

5. the level of knowledge and education in society, especially in the sphere of technology and engineering, defines the level of its general and engineering culture, "technologic sensibility", " innovative resistance" and, hence, defines the vector of society development, forms the potential necessary for victory in competition in the world market;

6. a large part of educated population in society is a basis (source) for formation of cultural, scientific, and engineering elite, the activity results of which would permit for breakthroughs in the mentioned spheres and guarantee of victory in competition on the world markets in case of proving appropriate working and living conditions;

7. society with higher level of knowledge and education is considered to be less conflictive, characterized by higher level of general, economic, social, spiritual, engineering, ecological and physical culture, provides decent conditions for life and development of every person.

Acceptance of the mentioned suppositions and hypotheses permits for suggestion of a consistent model of National Doctrine of advanced engineering

education in Russia. Realization of such Doctrine model is sure to allow for competitiveness of the Russian engineering developments, goods, and services in the world markets and basis for guarantee of cultural, economic, engineering (hence, military) safety of our country.

The strategic goal in development of engineering education in Russia declared in the National Doctrine of advanced engineering education can be formulated in the following way:

"To design the adaptive system of specialists' advanced training with higher education in the sphere of technology and engineering in Russia, providing the world level in a personal professional qualification, high level of technological sensitivity of society guaranteeing economic, technical, engineering safety of the state".

The organization model of the advanced engineering education in Russia consists of two parts.

The first part of the model that can be conventionally called "Formation of technically educated nation" suggests the organization of the first cycle (Bachelor) of higher education in the sphere of technology and engineering at the expense of state budget. In this case education is rather "a public benefit", but not "a market goods". Implementation of this part of the Doctrine will provide for the high rate of technological society's sensitivity, decrease in the level of its innovation resistance and creation of the basis for the advanced development.

The task of the first part of engineering education organization model in Russia is training of wide population strata in competent and efficient use of ever-changing (complicated) engineering devices, information technologies, software etc. in life and work. The result of this stage implementation in the Engineering Education National Doctrine (increase in technological sensitivity and decrease in innovative resistance) makes possible to hope for acceleration of technical and engineering re-equipment and progress in industry, social sphere and everyday life.

It is supposed that in the course of this stage a man is free in choice of his (her) activity sphere and level of occupied position. The government should not expect from a university graduate (bachelor) to be hired for a job in specialty and for positions corresponding the level of received education, as it does not expect it from the school, college or lyceum leavers. A university graduate has right to choose any suitable for him sphere of activity and may apply, for example, for a position not related to qualification or a worker after university graduation. In this case intelligent potential of the position will be sufficiently higher. A person with higher engineering education is, as a rule, better prepared for application of technical and engineering innovations in the work place of any level that would serve as a guarantee in enhancement and technological development of industry.

People having higher engineering education of even the first level are more prepared for adoption to changing life conditions in comparison with people having initial vocational, secondary or secondary engineering education. They are able not only to find a job, create working places for others, but also, which is more significant in the condition of new industrialization, develop actively small and medium business occupying those niches where victory is more possible in competition of the world market.

The basic conditions for formation of the cohort receiving higher engineering education at this stage must be wishes and abilities of every person. It means that everyone who wishes to get higher engineering education declares his (her) wish applying the necessary documents for the chosen university, but everyone who is enrolled in university in terms of the entrance test is, as a rule, able to receive this education.

It should be repeated that at this stage education is free for everybody, but the expenses are covered by governmental funding of universities compared to university funding in the developed countries.

As a result of implementing the first part of Engineering Education Doctrine, a wide stratum of technically educated population will be formed in Russia; it will present "fertile ground" for growing native scientific and engineering elite and provide favorable conditions for generation and adoption of new engineering solutions and technologies. At the same time, in the course of this stratum formation in the society, the level of engineering culture will be increasing in the society, which is a basis for qualitative project, production, and operation of engineering devices and their safe operation that, in its turn, decrease in anthropogenic and technogenic catastrophes.

From the standpoint of high level of society's engineering sensitivity, the community of people with higher engineering education of the first level (cycle) is to be not less than 40 per cent on average out of the number of people with higher education (Fig. 3). This stratum of population will virtually become the staff ground for new industrialization of the country.

The second part of the advanced engineering education model organization*** that is to be reflected in the National Engineering Education Doctrine in Russia can be referred to as "Formation of research-engineering elite".

In this case engineering education is more likely to be "market goods" the value of which is compensated by the customers the role of which may be performed by government, business enterprise, students themselves, together or individually.

Realization of the second part of the model will make possible to form elite personnel potential for new industrialization of the country, increase the competitiveness of Russian engineering solutions in the world markets sufficiently, provide new Russian brands in the sphere of technology and engineering, and create more favorable conditions for development of the breakthrough technologies.

The goal of the second model part is organization of advanced training (individual or in team) of specialists with higher engineering education (masters, engineers) possessing exclusive professional competencies, capable of generating engineering ideas, take engineering decisions, provide development, production, operation and maintenance of competitive engineering products.

In fact, customers will pay for just specialists' exclusive competencies whose activity results are to provide quick and efficient pay-back of customers' expenses.

Theoretical grounds and practical implementation of the advanced training of elite specialists and professional teams of the world level in the promising trends of technology and engineering were successfully performed in Tomsk Polytechnic University in 2001-2008 that supports the opportunity to organize engineering education in Russia using this scenario [6,7].

The part of people with higher engineering education of the second level (cycle) is to be not less than 5 per cent on average out of the number of people with higher education or 10 per cent out of the number of people with higher engineering education (Fig. 3).

Achievement of the formulated goal for development of engineering education in Russia under the condition of new industrialization will provide putting Russian engineering and technological brands in the world markets and permit Russia to occupy a decent place in the international system of labor differentiation.

PRINCIPLES OF ENGINEERING EDUCATION ORGANIZATION IN RUSSIA

An important element of the Advanced Engineering Education National Doctrine in Russia is principles of engineering education organization the use

*** *By Advanced engineering education is meant higher professional one in the sphere of technology and engineering organized on the basis of progressive research, scientific, research-engineering developments and educational methods allowing for training of highly qualified specialists and teams of professionals possessing exclusive competencies and skills in their application in practical engineering activity efficiently.*

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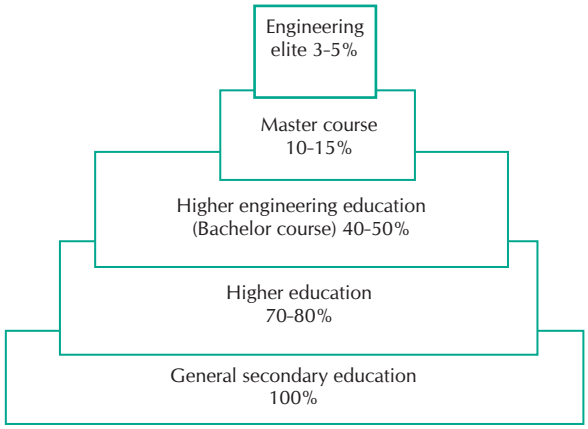
Fig. 3 Specialists' Training for the Sphere of Technology and Engineering



of which would allow for realization of the Doctrine to the fullest extent.

The most important of them are the following:

1. Priority
2. Consistency
3. Fundamental character
4. Advancing principle
5. Practice-focus
6. Continuity
7. Competitiveness
8. Adaptability

The essence of these principles consists in short in the following:

1. Priority principle

Realization of priority principle suggests the governmental policy of priority in taking concrete measures related to engineering education in the country.

In particular, they are:

- development and adoption of the Federal law "On engineering activity in the RF" regulating the requirements for engineering qualification, an engineer's rights and responsibilities, procedure of engineering qualification certification taking into account the best world experience, formation and introduction of internationally recognized national register of professional engineers in the RF;
- inclusion of physics exam in the list of compulsory Unified State Examinations or reorganization of school education including arrangement of gymnasiums finishing of which gives a right to enter a university (like Abitur in Germany, A-Level in Great Britain, or Baccalaureat in France);
- raise in teachers' and lecturers' salary involved in teaching engineering subjects and exact sciences;
- priority in funding the development of engineering university material base, advance training of teaching staff;
- stimulating involvement of experienced native and foreign experts and teachers in the process of specialists' training in the sphere of technology and engineering (including design of educational programs);
- stimulating participation of employers in specialists' training in the sphere of technology and engineering (development of professional standards, curricula, providing equipment, places of students' and teachers' internship, investment in the development of engineering education etc.).

2. Consistency principle

This principle is realized using the system approach in planning measures taken for development and improvement

of the advanced engineering education in Russia.

In particular, one should take into account that:

- engineering education is a part (subsystem) of the education system in the country including initial, secondary, vocational secondary, higher professional, extra-qualification for higher education, professional upgrade courses. Any changes in all spheres of public and state activity, changes in peoples' priorities are reflected in the system of higher engineering education;
- engineering education presents itself a system, where quality of engineering training is defined by not only academic, research, innovation activity connected with each other but also depends on a lot of other factors. Such, for example, as a university material base, presence and level of its international cooperation, quality of classrooms, infrastructure, academic buildings ... lavatories;
- when planning higher engineering system and engineering university development, application of consistency principles suggests using management-by-objective method. Implementation of this method is most efficient in case of Development Complex Program development and performance (system, university);
- engineering education programs are to include courses of system techniques and applied system analysis.

3. Fundamental character principle

Application of this principle implies that the basis of future engineers' training consists of fundamental natural science knowledge in accordance with the best traditions of the Russian education that provide:

- high level of future specialists' training in the sphere of fundamental sciences (physics, mathematics, chemistry etc.);
- possibility to use fundamental, basic knowledge for solution of problems in the process of future engineering activity;
- development of mental abilities, system, abstract and analogue thinking;
- development of analytic and synthetic abilities, abilities of attention focusing and mental potential in solution of theoretical and applied problems in different spheres of technology and engineering and taking adequate action in different conditions (for example, in exam session, non-standard and extreme situations).

The necessary conditions for this principle realization are:

- high level of research performed at profiled departments;
- active participation of academic science representatives in training process;
- students' active participation in scientific research.

4. Advancing principle

The given principle suggests:

- inclusion of courses, the content of which represents the latest achievements in the given sphere of technology and engineering, in the curriculum that would provide advanced knowledge;
- design of curricula (content + educational methods) performance of which would permit future specialists to form not only standard but also exclusive competencies providing high level of being in demand in the professional sphere and successful career;
- arrangement of elite engineering education in universities that allows for selection and training of most gifted, talented and motivated students in the advanced curricula for the further engineering and research activity;
- organization of university "centers of excellence" focused on the performance of perspective researches,

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students' elite training and workers' upgrade courses.

5. Practice-focus principle

Performance of the principle suggests:

- application of practice-focused educational methods based on techniques of problem-oriented and project training as well as block-modular structure of a curriculum;
- using method of team training;
- sufficient increase in share of students' self-study in the common volume of curriculum including performance of real tasks and projects in the chosen sphere of technology and engineering forming skills of detecting problems and finding ways of their solutions;
- obligatory inclusion of courses or parts of courses providing formation of future specialists' skills to solve non-standard engineering problems (for example, TIPS etc.) and public defense of engineering solutions;
- employers' participation in training that can be expressed in both invitation of experts in training process (discussions of problem situations) and arrangement of practice for the future specialists in the advanced native and foreign plants;
- changes in training process design including teaching load distribution in departments and formation of staff timetable not in terms of academic hours but the number of students;
- training process arrangement (especially in masters' and engineers' training) in terms of block-modular curricula giving possibility to reduce the period of a graduate's adaptation for production conditions.

6. Continuity principle

Performance of the continuity principle suggests:

- formation of future specialists' demand for consistent, systematic upgrading of the competencies developed in the training process;
- development of continuous system of re-training and upgrading in all profiles of specialists' training in the sphere of technology and engineering;
- development of network of problem analysis centers in the sphere of technology and engineering to form and operate (upgrade) the database of engineering problems;
- arrangement of engineering business center network (business activity in engineering), providing formation of conditions for development of people's business and creative initiative, working in different spheres of technology and engineering;
- formation of conditions (stimulation) for wide publicity of engineering activity results and development of engineering skills in children and adults in mass media.

7. Competitiveness principle

Development of competitiveness for native engineering education, increase in the share of Russia in the world education market is one of the key tasks, decision of which is be foreseen in the National Doctrine of the Advanced Engineering Education in Russia.

Performance of competitiveness principle suggests:

- development and design of engineering educational programs on the basis of best experience in design and performance of similar educational programs of leading and well-known universities in Russia and world (presumably, with participation of leading foreign experts) and the best traditions of the Russian education;
- formation and advertising of the best traditions of Russian education in the international mass media;
- formation of conditions (stimulation) for active participation of Russian universities in the international exhibitions, fairs and other events;

- internationalization of higher engineering education, development of academic mobility;
- formation of conditions necessary for foreign students' training in the universities training specialists for engineering activity (language environment, teaching staff, research conditions, quality of classrooms, domestic conditions...);
- arrangement of qualitative specialists' training university centers.

8. Adaptability principle

As it was mentioned above, engineering education is a subsystem of the world and Russian educational system, in particular, the systems of social, cultural, economic sphere in general. Hence, all changes in these systems and spheres result in new challenges in the system of engineering education. Appropriate and timely replies to these challenges would provide the efficient functioning of higher engineering education system, its international competitiveness. In other words, engineering education system is the ability to adapt to the changing conditions of the environment. This criterion is the continuous demand of the specialists with Russian higher engineering education in the domestic and world spheres of engineering activity.

Performance of adaptability principle suggests:

- arrangement of special analytical centers (of the federal, regional, and university levels) for continuous analysis of environment challenges to the system of engineering specialists' training and development of recommendations for the higher engineering education system adaptation to the changing conditions;
- development and efficient operation of international and native system of professional certification in engineering educational program;
- using the results of certification for educational program improvement and their adoption to the new requirements;
- arrangement of university feedback with the graduates to manage the quality of specialists' training with minimal delay period.

CONCLUSION

Development of the National Doctrine of Engineering Education in Russia is a complex and time-consuming process. In formation of this important document a number of factors and conditions are to be taken into consideration, a plenty of activity spheres are to be involved (schools, colleges, vocational schools, Russian Academy of Education, Russian Academy of Science, business, mass media, educational technologies, education content, university teaching staff formation, students' stimulation etc.).

The central figures in this process are to be Russian experts and professionals in the sphere of organization and performance of higher engineering education. Selection of these experts is also rather a hard business. The practice of tendering process is not appropriate in this case. The Doctrine is a state document and its executive is to become a state institution responsible before the President and Government. In the given case it is the Ministry of Education and Science of the Russian Federation. The scenarios of such process organization can be different from performance of this job by experienced and highly qualified workers of Ministry to arrangement of some independent expert teams by the Ministry working simultaneously at the project of this document. Then the suggest versions of the Doctrine are to be discussed by public and professionals and undergone an independent examination under Ministry guidance. A more appropriate variant of the Doctrine as advised by the RF Ministry of Education and Science is approved by the RF Government and becomes a document defining the future of engineering education in Russia over a long period.

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