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The Engineering Schools: Restoration the best Russian Traditions of Technical Education

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So what is the Russian engineering school? Why exactly is it necessary to restore it? Among the many publications on the founding of 30 engineering schools in Russia, there is almost no explanation of this phenomenon [1]. Perhaps this is due to the fact that historians of science know more about the "Russian engineering school". Experts in the history of science and Higher Education in Russia are in solidarity in their main assessments and conclusions [2]. According to their opinion, from the birth of engineering education in Russia under Peter the Great and up to the present day, the engineering school has been preparing true engineering élite, who were capable of resolving the most challenging issues of ensuring security and technological development of the country. Since the end of the 19th century it has achieved such a level that it has always been a role model for others to follow. For a better understanding of the Russian engineering education, it is necessary to look at the main periods of its formation and development [3].

The beginning of engineering education in Russia was launched on January 27, 1701. According to Peter the Great's decree on the establishment of the School of Mathematical and Navigational Sciences in Moscow, "this school is essential not only for the unified navigation and engineering, but also for artillery and citizens' benefit" [3, 4]. However, it was under Peter the Great that Theophanes Prokopovich introduced into Russian the word engineer, which goes back to the Latin ingenium - "witty invention". However, Russian engineering education itself is directly linked to the establishment of the Imperial Moscow Technical School (nowadays - Bauman Moscow State Technical University) [6, 7].

According to experts, there are two specific reasons why the Russian engineering school was established in its most advanced form at the Moscow Technical School.

1. First, the most technical universities of the Russian Empire were established immediately as higher educational institutions. It was a natural tendency to develop, first of all, the theoretical disciplines, which distinguished higher educational institutions from secondary ones. Meanwhile, the college had a long evolutionary path, commencing with classes in handicrafts. Precisely the system of applied learning became its distinguishing feature. During those years, the systematic approach to training was formulated: "Know to manufacture what you have engineered, and learn from it!" [8].
2. Second, no foreign professors were invited to the college, but it initially maintained the closest ties with Moscow University. The professors invited by the university were incorporated into the already established system of training, enriching it.

The Soviet Union inherited a well-balanced system of engineering education from the Russian Empire. Having gone through a series of inevitable revolutionary transformations, the traditional system of education was restored. Real achievements of the Soviet regime in the field of the education were not associated with the revolutionary experiments, but with the restoration of the old educational traditions, first and foremost, in the area of natural-science and engineering education. The majority of the institutes have returned to programs similar to those of the pre-revolutionary period. The Higher Technical Institutes are separated from the universities and have a 5 or 5.5-year program in each specialty.

Especially visible was the progress of Soviet (Russian) engineering education after the successful implementation of the space program in the USSR. The high effectiveness of the Soviet system of education in engineering training was noted by many American experts, who studied it in details after the first artificial Earth satellite launch. Educational issues are crucial to the evolution of any society. A well-known fact is that after Yuri Gagarin's flight into space, American President John F. Kennedy highlighted that the Space Race was victorious because a Soviet teacher had won it. The Soviet education system long served as a role model for the whole world. Indeed, even today it is known that British high schools teach the sciences and engineering based on the translated Soviet textbooks [9].

So what was this 19th century famous and constantly proudly mentioned nowadays Russian methodology of engineers' training, called the "Russian engineering school"? According to experts, there are three main components:

1. Dedicated study of all theoretical subjects at the same level as they are taught at classical universities.
2. Profound practical work based on the real experience of students in conditions as close as possible to those with which they will have to deal afterwards in factories and plants.
3. Continuous reciprocal cooperation of the Higher Technical School with the industry.
4. One more critical factor in the effectiveness of the Russian engineering school. That is the level and high quality of secondary general education training.

Acknowledgement formulated in the resolution of the Central Committee of the All-Union Communist Party (of Bolsheviks) of August 25, 1931, that "the fundamental drawback of the secondary school at the moment consists in the fact that school education does not give the sufficient amount of general educational knowledge and does not adequately solve the problem of preparing fully literate people for vocational schools and universities with a profound knowledge of the basic sciences (physics, chemistry, mathematics, native language, geography, etc.)" is very relevant today [9].

Following this decree, the teaching in secondary schools began to improve rapidly, especially in science and mathematics. Without this factor, improving the standard and the quality of the engineering education would have been simply impossible. Evidently, by the end of the 1930s the requirements in mathematics in secondary schools had already approached the pre-revolutionary standard. Following many changes during the revolutionary years, a new type of secondary school emerged in Russia in the mid-1930s, whose full program required 10 years of education and was divided into three stages: elementary school (1st through 4th grade), junior high school (5th to 7th grade), middle school (8th-10th grades). The upper grades, from 8th to 10th, are regarded as preparatory for the higher school. The general organization of schools and teaching methods are very similar to those of the pre-revolutionary years. Examinations were restored and class restrictions on admission to institutions of high education were abolished. One must admit that the real achievements of the Soviet power in the field of education were connected not with revolutionary experiments, but with the restoration of old educational traditions (first of all - in the field of natural-science and engineering education) while expanding the " social base" of education [7].

The Russian engineering school from the beginning of the 19th century was strategically based on the triad "education - science – industry" with the leading role of its industrial component. The Russian engineering school and the system of engineering education in Russia made it possible to create the railway industry in the 40-80s of the 19th century and the atomic and rocket-space industries in the 40s-80s of the 20th century. These two technological breakthroughs ensured Russia's long-term presence among the leading industrial countries and contributed greatly to the technological environment in which mankind lives today.

Proficiency in solving complex scientific and technical problems on the basis of fundamental knowledge opened the way to state and social recognition, material well-being. For the acquisition of these skills and knowledge through many years of hard work at the school and university level was aimed at the natural science component of the educational system of the USSR. School and university stages were inextricably linked. First and foremost, the problems of fundamental study of natural science subjects by schoolchildren, and of natural science disciplines by students were solved. In the undergraduate technical universities, the fundamental basics in

higher mathematics and general physics were studied, on which the basic and advanced engineering disciplines were based. Due to this fact, engineering universities, regardless of their major, actually trained specialists of a broad professional profile, able to adapt quickly to work in any technical field [9].

Unprecedented amounts of anti-Russian sanctions and the demonstrative withdrawal of hundreds of foreign companies from the Russian Market have clearly demonstrated dependence on modern foreign technologies. As President Vladimir Putin noted in one of his speeches back in 2016, we need our own advanced R&D and scientific solutions to achieve a new level of economic development and President Vladimir Putin added - the countries that will be able to generate such solutions will have a long-term competitive edge, an opportunity to obtain a huge technological benefit. And those who do not, will find themselves in a dependent and vulnerable situation [11, 16, 19].

The necessity to substitute the shortage of many imported commodities and hardware the task was set for promoting import substitution. Unfortunately, it became clear that it was insufficient to reach a new technological level through the mere production of missing imported analogues. One disputes that to overcome the sanctions pressure it is necessary to expand the spectrum of accessory production, especially in the high-tech sector. The core issue today is the new national industrialization based on digital technology.

The harsh 1990s did irreparable damage to the Russian economy. As a result, today Russia, according to some estimates [15], produces about 5% to 10% of the Soviet level of machine tools and 3% of tractors. Current levels of Russian aircraft production are well known: today there is virtually no Russian fleet of airliners. Such situations are characteristic of the automotive industry, shipbuilding and a number of other important modern industrial sectors. Also critical is the dependence of the Russian Federation on imported goods in the information sphere. It is reasonable to recall the fact that in the 1990s at least 250-300 thousand highly educated Russians were employed in foreign universities, research and academic companies.

Such personnel losses are those that need to be compensated today. President Vladimir Putin pointed out the relevance of this problem back in 2014, emphasizing that the quality of engineering personnel becomes one of the core factors of the state's competitiveness and the backbone for its technological and economic independence. Undeniably, a certain number of personnel problems have been solved. This is confirmed by the development and creation of the cutting-edge technologies, for example, in the field of hypersonics. Nevertheless, further development of the engineering training system demands the reform of the currently existing system of higher education. The majority of experts agree on the expediency of reviving the best Russian traditions of engineering training. Their revival has already taken the ground-breaking step in education.

Prime Minister Mikhail Mishustin, speaking at Innoprom in Yekaterinburg on July 4, said that engineering schools will be launched in Russia to train highly qualified personnel [14]. According to Prime Minister Mikhail Mishustin, engineering schools will specialize in different industries - from heavy engineering and aviation technology to artificial intelligence and nuclear energy. Moreover, it is planned to create the school in partnership with national enterprises. Today these are the companies that face staff shortages: Yandex, Rosatom, Rostec, Russian Railways, KamAZ and others [14].

Simultaneously, specialists from these enterprises will be encouraged to teach in secondary schools and conduct internships for students. Partially the training will take place at the industrial premises of the regional enterprises. It is encouraging to note that in Nizhny Novgorod region such schools will appear on the basis of Lobachevsky University (NNSU) and Alekseev Technical University (NSTU). It is known that the NNSU engineering school will work in the direction of "Aviation and Rocket and Space Engineering", and the NSTU - "Nuclear Engineering".

The engineering schools will be founded in Russia to train highly qualified personnel. Currently, a list of universities, on the basis of which they will function, has been published. The Coordinating Council for Grants to Support State Support to Establish and Develop Advanced Engineering Schools selected 30 higher education institutions in 15 regions of Russia [11, 15, 14]. During this year, the grant support of the universities-winners provided by the state will constitute 2.5 billion rubles. Another 4 billion rubles will be sent to the technological partners [11].

Most universities are represented by the Volga (nine universities), Central (eight universities) and Northwestern Federal Districts (five universities). The fourth place is taken by the Siberian Federal District (four universities), the fifth by the Southern Federal District (two universities). One institute each has been selected in the Far Eastern and Urals Federal Okrugs.

Currently, more than 40 industrial partners participate in the project, specializing in information technology, finance, mining, heavy metallurgy, mechanical engineering, and agriculture. Engineering schools will cut the path from theoretical knowledge to practical experience for young specialists. The project has aroused great interest among both universities and high-tech companies throughout Russia. The industrial partners of the universities include KAMAZ, Roscosmos, Almaz-Antey, Sibur, Gazprom Neft, Tatneft, Norilsk Telecom, the United Engine Corporation, the Electro-Technical Equipment Plant, the Integrated Instrument Manufacturing Corporation, and others.

The Federal Project "Advanced Engineering Schools" included 25 universities under the jurisdiction of the Ministry of Education and Science, the Ministry of Health (3), the Ministry of Agriculture (1), and the Ministry of Digital Development, Communications and Mass Media (1). The Federal Project "Advanced Engineering Schools" was developed on the basis of one of 42 strategic initiatives approved by the Chairman of the Government Mikhail Mishustin and became a part of the state program "Scientific and Technological Development of the Russian Federation". The project is aimed at training qualified engineering staff for high-tech industries.

The universities - finalists in the selected federal project "Advanced Engineering Schools" and the fields of their expertise [16]:

- Ural Federal University named after the first President of Russia B.N.Yeltsin (expertise "Artificial Intelligence and Digital Technologies", "Advanced Manufacturing Technologies");
- D. Mendeleev University of Chemical Technology (expertise "Chemical engineering and technology");
- The Yaroslav-the-Wise Novgorod State University (expertise "Artificial Intelligence and Digital Technology");
- The Moscow Institute of Physics and Technology (National Research University) (expertise "Artificial Intelligence and Digital Technology");
- Tomsk State University of Control Systems and Radioelectronics (expertise "Electronics, Radio Engineering and Communication Systems");
- Moscow Aviation Institute (expertise "Aviation and rocket-space engineering", "Engine building");
- Innopolis University (expertise "Software Engineering");
- South Federal University (expertise "Artificial Intelligence and Digital Technology");
- Nizhny Novgorod State Technical University named after R.E. Alekseev. (expertise "Nuclear Engineering");
- Pskov State University (expertise "Heavy Engineering");
- National Research Tomsk State University (expertise "Food Industry", "Artificial Intelligence and Digital Technologies");
- Novosibirsk National Research State University (expertise "Aviation and rocket and Space Technology", "Artificial Intelligence and Digital Technology");
- St. Petersburg State Maritime Technical University (expertise "Artificial Intelligence and Digital Technology");
- Perm National Research Polytechnic University (expertise "Engine Engineering", "Artificial Intelligence and Digital Technologies");
- Ufa State Aviation Technical University (expertise "Engine Engineering");
- Far Eastern Federal University (expertise "Biotechnology");
- N.I. Lobachevsky National Research University of Nizhny Novgorod (expertise "Biotechnology", "Aviation and rocket-space engineering");
- Bauman Moscow State Technical University (expertise "Aviation and rocket-space engineering");
- Voronezh State Agrarian University named after Emperor Peter the Great (expertise "Biotechnology in Agriculture");
- Kazan (Volga Region) Federal University (expertise "Mechanical Engineering");
- Don State Technical University (expertise "Agricultural Engineering");

- Peter the Great St. Petersburg Polytechnic University (expertise "Artificial Intelligence and Digital Technologies", "Advanced Manufacturing Technologies");
- National Research Technological University "MISIS" (expertise "Artificial Intelligence and Digital Technologies");
- I.M. Sechenov First Moscow State Medical University of the Ministry of Health of the Russian Federation (expertise "Medical Instrumentation');
- National Research University ITMO (expertise "Biotechnology");
- N.I. Pirogov Russian National Research Medical University (expertise "Medical instrumentation");
- Kazan National Research Technological University (expertise "Chemical Engineering");
- Samara National Research University named after Academician S.P. Korolev (expertise "Aviation and rocket-space engineering");
- Samara State Medical University (expertise "Medical Instrument Engineering").

On September 21, 2022, Vladimir Putin held a meeting with the heads of engineering schools and representatives of regional authorities, where issues of implementation of the federal project "Advanced Engineering Schools" were discussed. As well as the stated programs for the development of universities, which passed the competitive selection in June of this year. Participants noted the priority areas of research and development, which today are of strategic importance to ensure the technological sovereignty of the country, and described how they are overcoming the challenges of the new times [16].

"It was important to combine intellectual capabilities, i.e. those achievements that had been made before in practical terms: theory, applied science, the needs of our flagship companies, their financial capabilities and, most importantly, the final product market. That was the idea of creating such engineering schools in order to achieve the success the country needs," said Vladimir Putin [11, 16].

Also the President has emphasized that now the attention of universities should be focused not only on creating new products and technologies, but also on the development of existing national developments. The President added that it is necessary to improve their quality and create conditions for mass production [11, 16].

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