

Review article

UDC 656.07

doi: 10.46684/2026.2.1

EDN: TDKNOC

Engineering education in Russia: Formation, development, prospects¹

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ABSTRACT The paper analyses the history of engineering education in Russia, highlighting its most important milestones and features. The author reviews the contributions of outstanding scholars and educators to training of Russian transport engineers, identifies the challenges of the time, and outlines the prospects of engineering education in the transportation industry.

KEYWORDS: engineer; engineering education; transport

For citation: Pashkov K.A. Engineering education in Russia: Formation, development, prospects. *BRICS transport*. 2026;5(2):1. <https://doi.org/10.46684/2026.2.1>. EDN: TDKNOC.

Обзорная статья

Инженерное образование в России: становление, развитие, перспективы¹

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АННОТАЦИЯ Проанализирована история развития инженерного образования в России. Отмечены его наиболее важные вехи и черты.

Отмечен вклад в подготовку российских инженеров-транспортников выдающихся ученых и педагогов. Выявлены вызовы времени и перспективы технического образования в транспортной отрасли.

КЛЮЧЕВЫЕ СЛОВА: инженер; техническое образование; транспорт

Для цитирования: Пашков К.А. Инженерное образование в России: становление, развитие, перспективы // Транспорт БРИКС. 2026. Т. 5. Вып. 2. Ст. 1. <https://doi.org/10.46684/2026.2.1>. EDN: TDKNOC.

INTRODUCTION

The Russian school of engineering has left a profound mark on the history of human civilization. How did it develop? What has it achieved? What is it capable of today? What is still to be achieved in the near future?

“Progress is the way of human existence”. If so, an engineer is someone who drives progress. It is

an engineer who creates history, transforming the world for good. But who is an engineer? This question can be answered this way: Engineers are those who create something that never existed before.

Russia has no future without highly skilled engineers and an efficient system for training them.

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¹ Published in Russian: Pashkov K.A. Engineering education in Russia: Formation, development, prospects. *Transport in the Russian Federation. Journal of Science, Practice, Economics*. 2026;1(122):3-10. EDN: LKHDNS.

Пашков К.А. Инженерное образование в России: становление, развитие, перспективы // Транспорт РФ. 2026. № 1 (122). С. 3–10. EDN: LKHDNS.

EARLY TECHNICAL SCHOOLS IN THE RUSSIAN EMPIRE

Established by a decree of Peter I in 1701, the School of Mathematical and Navigational Sciences was the first naval educational institution in Russia. It was founded in the Sukharev Tower in Moscow and was headed by Jacob Bruce, an associate of Peter I.

The school's curriculum included arithmetic, geometry, plane and spherical trigonometry, navigation, nautical astronomy, brief geography, and optional fencing sessions. The training programme had three levels:

- Elementary level (Russian school), which provided the baseline knowledge of counting, grammar, reading, and religious education;
- Second level covering the basics of arithmetic, geometry, trigonometry, and drawing; and
- Higher level where students studied mathematical geography, astronomy, technical drawing, geodesy, navigation, and shipbuilding.
- The senior classes of the School of Mathematical and Navigational Sciences were subsequently transferred from Moscow to St. Petersburg and became the foundation of the Naval Academy (Naval Guards Academy) which was established by a decree of Peter I on October 12, 1715.

On December 15, 1752, a decree of Empress Elizabeth Petrovna closed the Moscow classes and transformed the Naval Academy into the Naval Gentry Corps, which was then renamed the Naval Cadet Corps in 1802. Some of its graduates include Admirals Nikolai Golovin and Vasily Chichagov, and land surveyors Ivan Kirilov, Mikhail Gvozdev, and Ivan Evreinov.

On January 10, 1701, in addition to the School of Mathematical and Navigational Sciences, Peter I ordered to establish a special school for artillery and engineering training under the Artillery Chancery. It was organized at the New Cannon Yard in Moscow. In fact, there were three schools: a linguistic one which taught reading and writing; the lower (arithmetic) school where students studied arithmetic (numbers); and the higher (engineering) school with courses of geometry, trigonometry, artillery, and fortifications.

The duration of studies was not fixed, but in reality it was 10 to 15 years (including practical training in the active army, at laboratories, gunpowder and cannon factories). Each student learned their subject without waiting for others. Those students who were low performing in sciences were to become carpenters, turners, tinsmiths, riflemen, sailors, soldiers, and so on. After graduation, students were not allowed to enter any service other than artillery.

In 1724, the Russian Empire got its first scientific academy, the Imperial Academy of Sciences (of St. Petersburg). Its founder Peter I wanted Russia to have a

scientific centre, similar to the one in Paris. The Academy combined the functions of managing scholarly research and education by opening a university and a gymnasium within its jurisdiction. It organized expeditions "to learn about Russia", involving the exploration of the country's natural resources across its territory, reaching as far as Kamchatka. In 1728, the annual collection of works "Commentaries of the St. Petersburg Academy of Sciences" (in Latin) began to be published. 1745 saw the creation of the first general map of the country, the Russian Atlas.

The Academy had three "classes": the class of mathematical sciences where scholars studied mathematics, astronomy, navigation, and mechanics; the class of natural sciences, where they studied physics, anatomy, botany, and chemistry; and the class of "humanities, history, and law", where academicians conducted research in rhetoric, classical and modern history, natural and public law, politics, and ethics. In total, the Academy of Sciences had a staff of 11 academicians: four in each of the first and second classes, and three in the third one.

In the early days of the Academy of Sciences, academicians were solely invited from abroad. Among those foreigners were the French astronomer and cartographer Joseph-Nicolas Delisle, the Swiss physicist, mathematician and specialist in mechanics Daniel Bernoulli, the German historian and philologist Gottlieb Siegfried Bayer, and others.

Let us highlight some engineering projects related to the activities of the Academy of Sciences in the 18th century:

The design of the world's first screw-cutting lathe with a carriage, developed by the Russian scientist and specialist in mechanics Andrei Nartov in 1729;

In 1741, he also built a rapid-fire battery of 44 mortars;

In 1763, the heating engineer Ivan Polzunov assembled a steam engine;

Ivan Kulibin designed and made a model of a 298-metre-long single-arch bridge across the Neva River and a "mirror lantern", the predecessor of a searchlight;

Kulibin also invented a water-powered boat (vodokhod) and a self-propelled carriage, and designed an elevator for the Empress's palace.

In 1724, St. Petersburg University was founded alongside the Academy of Sciences. Although this scientific and educational cluster, as it would have been called in the modern language, was founded by Peter I who was thirsty for knowledge and discoveries, no engineers were trained on the banks of the Neva at the time, and they were invited from Europe.

In 1755, Moscow State University was opened. Nowadays, it rightfully bears the name of Mikhail Lomonosov, a great scientist, encyclopaedist, and naturalist known as a "born genius from Arkhangelsk". But this revered university did not train engineers either.

On October 21 (November 1), 1773, Empress Catherine II founded the Mining School in St. Petersburg (known as the Mining Cadet Corps from 1804; the Institute of the Corps of Mining Engineers from 1834; the Mining Institute from 1866; the Empress Catherine II Mining Institute from 1896). Scholars of the Mining University have thousands of patents, hundreds of medals from the most prestigious international exhibitions, and dozens of government awards and prizes.

Some of the University's graduates include Alexander German, Ivan Gubkin, Ivan Efremov, Alexander Karpinsky, and others. Its graduates have made many discoveries and inventions in the study of the earth's interior and extraction of mineral resources.

To summarize, what can be said about the early engineering schools in Russia in the 18th century – maritime, technical, and mining? They taught some basic skills in engineering, borrowing ideas and achievements from Western countries. Russia was largely in the wake of the foreign engineering thought, using the fruit of the European school of engineering.

AUGUSTIN DE BETANCOURT AND THE INSTITUTE OF THE CORPS OF TRANSPORT ENGINEERS

In the 18th century, Russia was technically backward and was just trying to catch up with Europe. It was then that an outstanding Spanish – and later Russian – engineer, specialist in mechanics, architect, and manager, came. His life and achievements helped build a bridge between European science and Russian progress. Without exaggeration, he is one of the major technological reformers of the Russian Empire.

216 years ago, the Institute of the Corps of Transport Engineers (presently Emperor Alexander I St. Petersburg State Transport University) was opened in St. Petersburg. Its first rector was Augustin de Betancourt, an iconic personality in the history of Russian transport (*Fig. 1*). It was his institute that gave the Russian Empire its first engineers. It was after the opening of this educational institution that the very term “engineer” appeared in Russia.

Betancourt saw his main goal as follows: “Provide Russia with engineers who would be capable of being assigned to any job in the Empire immediately after their graduation.” Note, “any job”! This means it was not just about transport, but also what we call today “industrial and civil engineering”.

Augustin de Betancourt² was born on February 1, 1758 in Puerto de la Cruz on the island of Tenerife, Spain, to the royal engineer Angel Betancourt and a noblewoman from the Molina family. From an early age, Augustin showed interest in mechanics and science. His father taught him the basics of engineering, and in 1778,

he entered the Royal School of Arts in Madrid, where he studied mathematics, physics, and drawing. Then he studied in Paris, where he mastered hydraulics, bridge construction, and mechanical engineering.



Fig. 1. Platon Tyurin. Portrait of Augustin de Betancourt. 1859. Oil and canvas, 70×60 cm. The Central Museum of Railway Transport of the Russian Federation

Back in Spain, Betancourt became famous as an inventor. He created an optical telegraph for long-distance communication, designed steam engines for pumping water from mines, and built canals and dams. In 1798, Betancourt became chief of the Corps of Transport Engineers of Spain, but had to leave his home country, fearing persecution amidst the political turmoil – the Napoleonic occupation in 1807. In 1808, at the invitation of the Russian ambassador Ivan Muravyov-Apostol and on the personal orders by Alexander I, Betancourt arrived in St. Petersburg.

Impressed by his reputation, the emperor accepted the engineer into service with the rank of major general. This was a turning point: Betancourt saw Russia as a huge field for ambitious reforms, where his experience could transform the backward infrastructure with its segmental roads, rivers without canals, and lack of engineering manpower, into a modern system. He quickly adapted, learned the Russian language, and started the reforms that would tie his life with the Russian Empire for 16 years, making him a key figure in the fields of transport and education.

² Full name: Agustín José Pedro del Carmen Domingo de Candelaria de Betancourt y Molina.

By the early 19th century, Russia had a strong need for highly skilled engineers. The Napoleonic Wars and reforms by Alexander I required the development of infrastructure: roads, canals, bridges, and ports, but there was a catastrophic shortage of personnel. Engineers were rare, often foreigners without formal education, and projects dragged on due to the lack of specialists capable of designing structures and managing work.

Dependence on imported talent hampered the country's sovereignty and progress.

On November 20, 1809, Alexander I signed a manifesto establishing by a single act three interrelated institutions: the Corps of Transport Engineers for practical work and coordination of projects, the Institute of the Corps for higher education of engineering officers (Fig. 2), and the School of Conductors for training junior specialists – technicians and foremen.



Fig. 2. Emperor Alexander I Institute of Transport Engineers at 9 Zabalkansky prospect (currently Moskovsky Avenue) in St. Petersburg. Photograph of the late 19th century. Science and Technology Library of Emperor Alexander I St. Petersburg State Transport University

The single manifesto established a system where the Institute trained theoretical experts and leaders for the Corps; the school trained operators for field work; and the Corps coordinated everything, distributing the personnel among infrastructure projects. This minimized bureaucracy, accelerated the launch of reforms, and integrated education with government needs, avoiding fragmentation. Betancourt, who drafted the manifesto together with his colleagues, convinced the emperor that a unified approach would be effective. Separate institutions could have been competing for resources, but the integrated system made it possible to quickly enrol one hundred students and launch projects. The manifesto reflected the pressures of the time: wars required mobility, while reforms required specialists. This laid the foundation for the Ministry of Railways which was established in 1865, demonstrating how strategic planning could transform a country.

The Corps of Transport Engineers was a paramilitary organization. Engineers were assigned military ranks, swore an oath to serve the country, and worked on real projects, focusing on practical skills, such as hydraulics, mechanics, geodesy, and construction. The

Corps brought together the existing specialists and began training new ones, providing the empire with manpower. Betancourt adapted the Spanish model to the Russian realities, introducing a strict selection process, field training, and state funding.

Without the Corps of Transport Engineers, the development of transport would have come to a standstill. Russia would have continued to be dependent on foreign experts, and industrialization would have lagged years behind. Betancourt saw his brainchild as a foundation for modernization, having built a system where engineers became an elite who served progress. This not only solved the shortage of personnel, but also laid the basis for national education in engineering: graduates built railways, bridges, and canals, and even contributed to the construction of the building of the Admiralty in St. Petersburg.

Betancourt had colossal ambition, aspiring to make Russia a leading technical power on the continent by using his experience as an inventor and manager for integrating science and practice. He dreamed of a comprehensive network of canals and roads to connect the Baltic Sea with the Black Sea and the Urals with the

central regions of the country, as well as to introduce steam engines everywhere, from factories through mines to transport and construction. His vision extended beyond infrastructure. Betancourt wanted to build a system of education where young people would learn frontier science knowledge, like it was in his Cabinet of Machines in Madrid – a collection of models for demonstrating the principles of mechanics.

In Russia, he taught hydraulics and mechanics, developed programmes, and amassed a library of thousands of volumes. He worked to integrate the industries of transportation and industry, as it was done in his design for the Nizhny Novgorod Fair which featured steam-powered mechanisms for loading and hydraulic systems for canals. He planned ambitious projects, such as the Volga–Don canal, improvement of river navigation, construction of bridges using new approaches to strength design.

What makes the Corps of Transport Engineers remarkable is that it was the first specialized engineering institution in Russia, combining military-type discipline with education and practical applications. The Corps of Transport Engineers was not a desk-based agency, but rather a field-based one, with a particular focus on innovation, such as steam engines and precise analysis, making it a model for other industries.

Initially, the Institute of the Corps of Transport Engineers was an open higher educational institution with a four-year curriculum. In December 1823, it was transformed into a closed institution, modelled after the military cadet corps, and had an eight-year curriculum.

The Institute was established as a centre of reforms in St. Petersburg. But during the Patriotic War of 1812, because of the risk that the Russian capital could be captured by Napoleon, the educational part of the institution was evacuated to Tver Province. The new site allowed for enhancing focus on practice by means of field training, such as hydraulic experiments, construction of highways, and geodetic surveying. Besides, Betancourt chose Tver for strategic reasons: it was close both to Moscow and St. Petersburg and was located on the Volga River, which was convenient for testing canals. Thus, the evacuation did not interrupt education, but enriched it with real-world environment, promoting the development of the region. During the Patriotic War, graduates from the Institute showed their worth in building bridges, crossings and roads, and this was recognized by a special order of Field Marshal Michael Andreas Barclay de Tolly.

The activities of the Institute of the Corps of Transport Engineers not only addressed the critical shortage of personnel, but also inspired the creation of similar institutions, for example, the Mining Corps, having laid the foundation of the Russian engineering tradition.

In 1837, the Institute launched the Railways course, and just two years later, 35 graduates became Russia's first railway engineers.

Betancourt created the scientific foundation for education of transport engineers on the basis of a curriculum that combined general scientific, general engineering, and specialized training in a single higher education institution. Specialists who took part in the construction of the Nikolayevskaya Railway between St. Petersburg and Moscow, which was opened in 1851, had been trained by the Institute.

In 1854, the Institute opened the world's first specialized educational and research laboratory for studying strength and deformation of materials and elements of engineering structures. In 1864, the Institute was declared a first-grade civil higher education institution with a five-year curriculum and became known as the Institute of Transport Engineers.

Meanwhile, Russia implemented a number of projects personally designed by Betancourt. For instance, 1813 saw the construction of the first permanent bridge across the Malaya Nevka River in St. Petersburg. The machines, structures, and all the equipment for the construction of a wooden arched bridge were created under the guidance of Betancourt. In 1816–1818, he designed steam engines for the papermaking and printing departments of the factory known as the Expedition for Preparation of State Papers. It was the first time steam engines were used in the paper industry.

In 1816, Auguste de Montferrand from France became a draftsman for the Committee for Structures and Hydraulic Works headed by Betancourt. Montferrand used the Institute's library to study works that were useful for his work on St. Isaac's Cathedral. In 1822, Betancourt developed scaffolding and mechanisms for lifting and installing the columns of the cathedral. Later, Montferrand used a design proposed by Betancourt to create a device for lifting the Alexander Column on the Palace Square in St. Petersburg.

Besides, Betancourt invested much effort in the improvement of the transport management system in Russia. In 1819, he led a large-scale reform of the transport system as an inspector of the Committee of Ministers. Betancourt compared transport with the circulatory system of a country, where smooth operation promotes economic growth, trade, and military mobility. Before his arrival, management was fragmented: the department of waterways and the department of overland routes worked separately, without coordinating their efforts, which led to delays in projects and dependence on foreign professionals.

Betancourt led the creation of the Main Directorate of Transport that brought waterways, overland, and engineering projects into a single system. He reorganized the departments and introduced centralized planning. In 1820, he founded the Commission for Projects and Cost Estimates, which was the first nationwide Russian design organization for standardization of roads, bridges, and canals.

The following key projects were implemented under his leadership:

- Building the Obvodny Canal in St. Petersburg for improved navigation;
- The Nizhny Novgorod Fair;
- The Moscow Manege with a unique design of the wooden roof without internal supports;
- Reinforcement of the Taigan Pass in Crimea;
- Building bridges across the Neva River;
- Introduction of steam engines for river dredging.

Betancourt's reforms connected remote regions. In particular, navigation on the Volga and Neva Rivers was improved, and the first highway connecting St. Petersburg and Moscow was built. This contributed to economic growth: exports increased and the industry picked up momentum.

Betancourt developed the principles of a scientific approach to infrastructure, which remain valid to this date. His engineering thought had a radical impact on the development of transport in Russia, laying the foundation for the scientific and technical revolution in the industry and accelerating the transition from backwardness to modernization. Betancourt introduced a scientific approach featuring the precise design concept and new steam technology, thus promoting the development of science and technology. Without his ideas, Russia would have lagged behind in rail and waterway transport for decades. His influence is prominent in the transition from horse-drawn trams to steam and then electric railways, which made transport the engine of progress.

To complete the story about Betancourt, it should be noted that in Russia, the 20th of November is the Transport Worker's Day. Nowadays, the country has about five million transport workers. And the fact that we have our own professional holiday is also largely owed to Betancourt.

The Augustin de Betancourt Medal was established thirty years ago as a symbol of the lasting legacy of the Russian Spanish, the founder of the Russian engineering school of thought. The award is given to employees of higher education institutions, research organisations, and foreign experts for their contribution to the development of engineering, new technologies, and implementation of infrastructure projects.

LEADING HIGHER EDUCATION INSTITUTIONS IN THE 19TH CENTURY: TECHNOLOGIES AND DEVELOPMENT OF TRANSPORT

In the 19th century, an entire network of leading higher education institutions in the fields of engineering, technology, and transportation was established in Russia. It reflected, in one way or another, the processes of industrial development and infrastructure growth that were rapidly gaining momentum in the country.

The Institute of Transport Engineers remained central among them. An important place was taken by the Mining Institute, with its curricula placing an emphasis, among other things, on extraction and transportation of raw materials, as well as on integration of knowledge in the fields of geology and engineering (Fig. 3).



Fig. 3. Building of the Mining Institute. St. Petersburg Postcard of the late 19th century.

In 1876, the Higher Marine Engineering School for Shipbuilding and Marine Transport (currently Makarov University) opened in St. Petersburg. In the late 19th century, in 1896, the Imperial Moscow Engineering School of the Railway Department opened (Fig. 4). By 1913, it evolved into a large higher edu-

cation institution with training programmes in railway construction and operation. The Ministry of Transport coordinated the activities of educational institutions for transport to ensure that uniform standards are followed and training is connected with practice.



Fig. 4. The building of the Imperial Moscow Engineering School of the Railway Department. Moscow. Photograph of the late 19th century. Museum of Russian Transport University.

In the hinterlands, polytechnic institutes were opened. For example, the Tomsk Technological Institute (1900) focused on training manpower for

the implementation of infrastructure projects, in particular, in Siberia, including the Trans-Siberian Railway (Fig. 5).



Fig. 5. Building of the Tomsk Technological Institute. Photograph of the early 20th century. Tomsk. Museum of the Tomsk Polytechnic University

By the turn of the 19th and 20th centuries, the country had about ten higher educational institutions with technical faculties and departments training thousands of students to become builders of roads, bridges, and ports.

Among the main personalities in engineering education in the 19th century were successors of Augustin

de Betancourt: Pierre Bazaine (Fig. 6), who continued to develop the Institute's training programmes in the period between 1824 and 1834, bringing their content closer to Russian realities; Charles Potier, Director of the Institute from 1834 to 1836, who developed courses in hydraulics, railways, and construction; and Andrei

Gotman, Director from 1836 to 1843, who introduced courses in transportation technologies and adapted them to the needs of Russia (Fig. 7). These heads of

the Institute ensured that it continued to grow and the quality of training was in line with the challenges of the time.



Fig. 6. E.V. Andreyev. Portrait of Pierre Bazaine. 1995. Museum of Emperor Alexander I St. Petersburg State Transport University

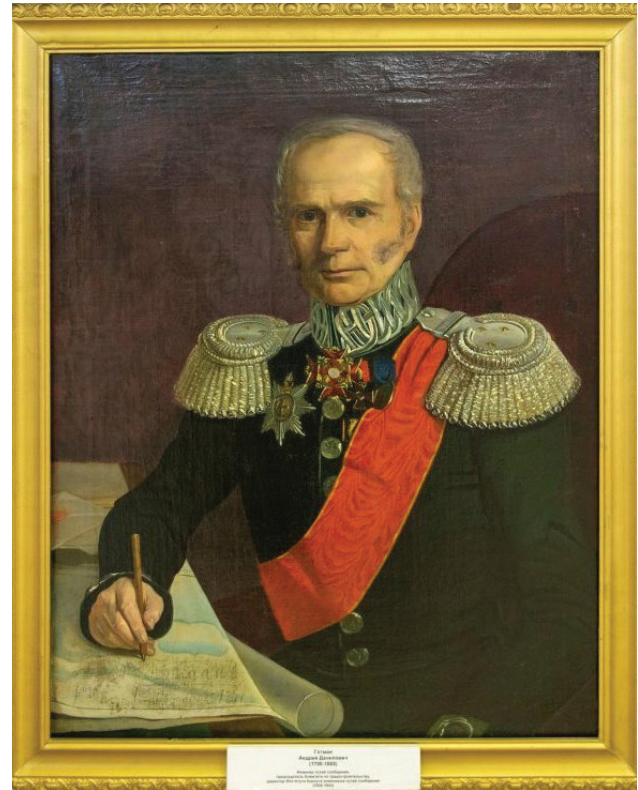


Fig. 7. Portrait of Andrei Gorman. Unknown artist. *Transport in the Russian Federation. Journal of Science, Practice, Economics*. 2026;1(122):8

Some of the prominent faculty members include:

- Semyon Guriev, academician and professor of mathematics, who enriched the structure of engineering education with mathematical courses;
- Vasily Viskonatov, academician and professor of mathematics, who helped integrate mathematical knowledge in engineering education;
- Mikhail Ostrogradsky, professor of higher mathematics, who contributed to the Institute's scientific potential by offering advanced mathematical methods;
- Viktor Bunyakovsky, professor of higher mathematics, who developed the theoretical base for engineering professions;
- Adolph Kupffer, professor of physics, who integrated physical knowledge into programmes in transport technology;
- Hermann Hess, professor of chemistry, who enriched the Institute's scientific potential with chemical research;
- Alexander Voskresensky, professor of chemistry, who contributed to the development of chemistry courses for engineers;
- Dmitri Mendeleev, chemist and natural scientist, whose work enriched the Institute's scientific

potential influencing the contents of education as a whole (Fig. 8).

Worth a special note among graduates of the Institute are the bridge builder Stanislaw Kierbedz and the structures specialist Nikolai Belelyubsky who made a significant contribution to the creation of a unique Russian school of thought in engineering. They called for training specialists capable of working in diverse environments, from capital cities to remote regions, and actively advocated for overcoming the technological backwardness of Russia.

In the 1830s, with the development of manufacturing and the advent of railways, specialized faculties in waterways and railways began to be established. The duration of studies was reduced to four years, and hands-on disciplines were enhanced.

By the 1870s, recognizing the importance of technical education, the Ministry of Finance began to establish polytechnic institutes for training professionals in metallurgy, mechanical engineering, and transport, where students studied not only relevant processes and technologies but also organizational and economic aspects of projects implemented in various sectors of the national economy. The reforms by Minister of Finance Ivan Vyshnegradsky in the

1880s strengthened the connection between vocational schools and higher education institutions, making education more coherent.

By the end of the 19th century, the number of technical educational institutions increased, and their curricula brought a focus on steam engines, electrification, and modern materials, thus reflecting the industrial upsurge of the 1890s. Students were actively involved in real projects, such as the construction of the Trans-Siberian Railway, integrating knowledge of management and logistics.

In 1833, Pavel Melnikov (subsequently the first Minister of Transport of Russia), a graduate from the Institute of Transport, began to teach applied mechanics at his alma mater. In 1835, he published a fundamental work on railways, which had a direct impact on training programmes (Fig. 9).

Although the system of education was still not free from elitism (foreign schools continued to have influence in a number of branches of knowledge, and many sectors of the economy were dependent on imported technologies), the number of domestically trained professionals steadily increased throughout the second half of the 19th century and the early 20th century.

However, it was in the 20th century that the system of transport and engineering education underwent radical reforms.

TRANSPORT EDUCATION IN THE 20TH CENTURY

After the 1917 Revolution, transport and engineering education in Russia changed dramatically, becoming widespread and focused on Soviet industrialization. In 1918–1920, decrees on the democratization of education established workers' faculties (rabfaks), giving an opportunity to study to workers and peasants, and not only privileged social categories as it was the case before.

By the 1930s, higher educational institutions became narrowly specialized, enhancing the training of manpower for the implementation of Soviet five-year plans, and introducing courses in electrification, aircraft engineering, and military technologies. The number of educational institutions grew, integrating science and practice for the recovery of the economy after the era of wars and revolutions. Despite the emigration of a number of professionals, new authorities were able to provide training of manpower, engaging the masses of workers in education. Education in general and in engineering in particular became a state priority, with an emphasis on developing hands-on skills in graduates to make them able to uplift sectors of the national economy, regions, and major industrial centres of the country.

A significant role among higher education institutions in the field of transport was played by Moscow

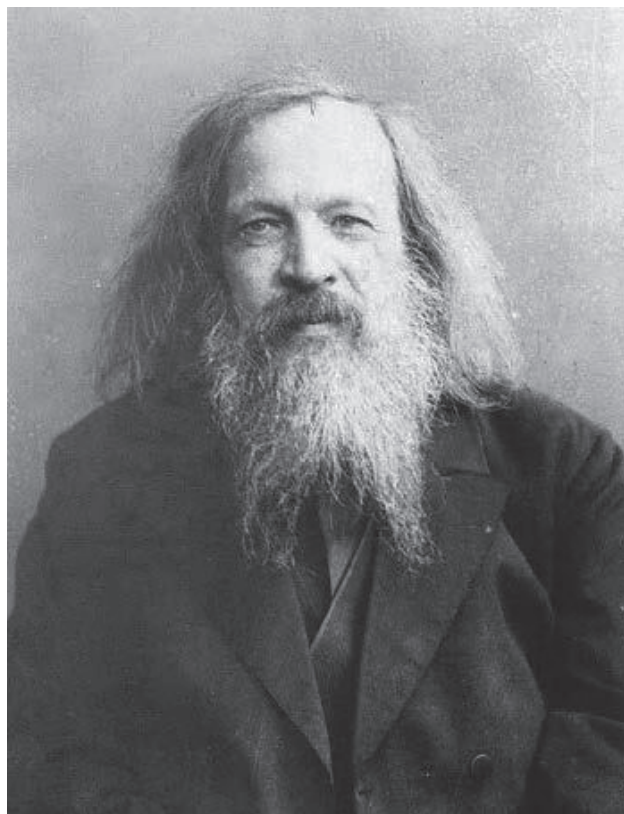


Fig. 8. Photo portrait of Dmitri Mendeleev. Early 20th century. *Transport in the Russian Federation. Journal of Science, Practice, Economics.* 2026;1(122):8



Fig. 9. Portrait of Pavel Melnikov. Unknown artist. *Transport in the Russian Federation. Journal of Science, Practice, Economics.* 2026;1(122):8

Automobile and Road State Technical University founded in 1930. It became a centre for training specialists in road transportation and road construction: engineers designed roads and bridges, and developed standards for the automotive industry. Curricula included mechanics, design, and economics of transport, as well as hands-on training at production facilities for highway construction and fleet modernization. Engineers who graduated from the Institute during the first five-year periods made an important contribution to the industrialization of the country.

Founded in 1932, Novosibirsk State Transport University trained personnel for Siberia and Far East, including the development of the Trans-Siberian Railway and construction of transport facilities and engineering structures of various purposes.

An important role in training of manpower for railway transport in the corresponding regions of the country in the period before the World War II was played by Rostov State Transport University opened in 1929 and Far East State Transport University founded in Khabarovsk in 1937.

During the Great Patriotic war, transport education was totally focused on meeting military needs and restoring districts liberated from the German occupation. Many higher educational institutions in the European part of Russia (LIIZhT, MIIT, etc.) found themselves in evacuation, but continued their research and educational activities. Branches of higher education institutions in the field of transport were created in regions of Russia.

The post-war years were the beginning of a period of intensive development of industry-specific transport education. In 1954, the Makarov Leningrad Higher Maritime Engineering School was established as a result of the integration of a number of educational institutions. Today, Makarov State University of Maritime and Inland Shipping works to develop the main areas of professional training, such as navigation and shipbuilding. The university's strong point is training professionals for nuclear fleet.

Established in Sverdlovsk (currently Yekaterinburg) in 1956, Ural State Transport University has been training manpower to ensure the maintenance of transport links in a vast region and the sustainable operation of infrastructure facilities. Privolzhye State Transport University (founded in 1973 in Kuibyshev, currently known as Samara) is currently actively engaged in the integration of rail and river transport. Irkutsk State Transport University (founded in 1975; born by the BAM Railway) currently works to develop geoinformatics and environmental monitoring. Moscow State Technical University of Civil Aviation, tracing its history back to 1971, trains, among others, professionals in aviation safety and air traffic control.

CHALLENGES OF THE TIME; TRANSPORT EDUCATION AND SCIENCE TODAY

Russian engineers have always met challenges of the time with honour, whether it was the construction of the country's first Tsarskoye Selo Railway or the creation of the high-speed rail line between Moscow and St. Petersburg. And nowadays, in the era of unprecedented global competition and explosive geopolitics, much, if not everything, depends on engineers.

In the 21st century, we can observe a natural growth of demand for engineering manpower. The reason is obvious: the import substitution and technological sovereignty programmes are being implemented in critical sectors of the economy. At the government level, the development of engineering education is recognized as a top priority. In the next five years, Russia will need at least 1.5 million qualified engineers.

Digitalization has become a megatrend in modern engineering. CAD systems, 3D modelling, and big data are becoming part of the basic requirements. The IT sector and high-tech start-ups are actively attracting engineers from conventional industries by offering higher remuneration and flexible conditions of work. Demand creates lucrative supply. The labour market develops a demand for certain professionals. For example, in automotive engineering, it is no longer sufficient to have a design engineer in the previous format. It requires professionals in design and construction of electric cars.

In 2015, Russia launched the Engineering Classes, a project allowing students to immerse themselves in a technology environment and choose their future profession while still in school. The engineering classes are equipped with digital laboratories, surveying instruments and nanotechnology systems, as well as equipment for 3D modelling and studying the structure of materials.

In 2025, Russia's advanced engineering schools launched 89 new curricula. There are currently 445 training areas for higher education students across the country. By order of the President of Russia Vladimir Putin, by 2030, the number of advanced engineering schools should be increased to reach one hundred. Since 2022, the government has allocated almost RUB 34 billion for their operation.

From 2026 onwards, it is planned to make physics a mandatory subject for admission to engineering programmes. This is included in the action plan for the improvement of the quality of education in mathematics and natural sciences until 2030 (approved by the Government of Russia in November 2024).

Today, transport education in Russia is at the peak of modernization, with a focus on advanced technologies and sustainability. This is true renaissance. One in six students in Russia is trained in transport-related specialties. The industry has 19 higher education institutions with 86 branches across the country. In total, more than 500 thousand people are receiving higher, secondary, and additional education (Fig. 10).

TRANSPORT EDUCATION AND SCIENCE TODAY

TODAY



PLANS TO BE ACHIEVED BY 2030:

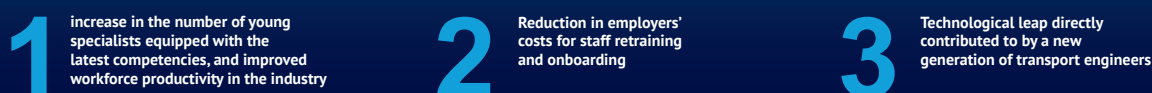


Fig. 10. Transport education and science today. *Transport in the Russian Federation. Journal of Science, Practice, Economics.* 2026;1(122):8

For the first time in history, the federal project “Development of Human Resources in the Transportation Industry” was launched (as part of the national project “Efficient Transportation System”). This is a new, large-scale initiative of the Ministry of Transport of Russia, aimed to systemically update and enhance the research, educational, and human resources of the transportation industry.

By 2030, several effects are expected:

- An increase in the number of young specialists equipped with the latest competencies, and improved workforce productivity in the industry;
- Reduction in employers' costs for staff retraining and onboarding;
- Most importantly, a technological leap directly contributed to by a new generation of transport engineers.

Leading transport universities of the country train personnel at an accelerated pace in specialties of the future, such as operation of unmanned aerial systems and autonomous navigation.

Russian University of Transport (RUT (MIIT)) is currently the backbone higher educational institution, leading the way in training engineers and other currently sought-for professionals for high-speed railways, logistics, and intelligent transport systems. Not only conventional subjects, such as construction and operation, but also new disciplines, such as unmanned transport and artificial intelligence for traffic control, are taught in RUT (MIIT). Students gain hands-on experience by working on real-life projects. For example, students of the Advanced Engineering School at RUT take part in the creation of the high-speed rail line between Moscow and St. Petersburg.

- The Ministry of Transport and Ministry of Education have outlined large-scale changes in the

system of training for the transportation industry. In 2026, it is planned to implement a pilot project for training transport professionals for the key technology leadership areas.

- Industry-specific higher educational institutions expand their participation in the Priority-2030 and the Advanced Engineering Schools initiatives. It is planned to develop new educational standards in transport.
- The Ministry of Transport prepared, and the Committee for Science and Technology Development approved, the Concept of Scientific and Technological Development of the Transportation Industry of Russia until 2035. It is not just another policy document. We would like to define – clearly and concisely, in the spirit of Betancourt – the main areas of fundamental research in transport and methods for achieving the goals set.
- Science is key to our strategy in transportation. We will create and launch nine research centres in the main areas of development of the transportation industry:
- High-speed rail traffic; transport safety; autonomous and unmanned transport systems; digitalization and intelligent transportation systems; creation of the Trans-Arctic transport corridor; rapidly erected, efficient, cost-effective, and durable transport infrastructure; new vehicles and systems; new logistics and international transport corridors; a single science and technology space for transport.
- These are our technological keys to the future. In some areas, work has already been launched, and we see real, practical effects.

CONCLUSION

The history of engineering and transport education in Russia is a vivid example of consistent service to interests of the country and the public good. From the first schools and academies in the 18th century to modern higher educational institutions, the system has always demonstrated the ability to adapt to challenges of the time, keeping faith with professional traditions, duty, and the Fatherland.

Today, the powerful corps of engineers in Russia is one of the best in the world. It plays the key role in achieving strategic goals, such as economic growth, import substitution, technological sovereignty, enhancement of the defensive potential and national security.

Russian Prime Minister Mikhail Mishustin has repeatedly underlined: “Russia needs transport engineers”. It is only the comprehensive development of transport education on the basis of government support, relying on Russia’s science and embracing the principles of interdisciplinary approach that will ensure that professionals trained are able to efficiently solve large-scale problems facing the country. This is to be completed in the historically shortest time spans.

Taking the lead rather than lagging behind and catching up – this is the only way for Russia to retain the leadership in key sectors of the world economy and confidently respond to technological challenges of the future.

Bionotes

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The author declares no conflicts of interests.

Автор заявляет об отсутствии конфликта интересов.

The article was submitted 04.05.2026; accepted for publication 30.05.2026.

Статья поступила в редакцию 04.05.2026; принята к публикации 30.05.2026.