■ How Russian students are educated and trained in their schools and colleges.

TECHNICAL EDUCATION IN RUSSIA

It was Emperor Peter, the Great, who started engineering education in Russia at the beginning of the 18th century. The Emperor reorganized the Russian army and was building the Russian navy, and therefore, needed men with engineering and technical skills. He wanted to prepare Russian engineers for scientific and technological undertakings, so he put up the Russian Naval Academy and the Academy of Artillery.

The development of the mineral resources of Russia also necessitated mining engineers. The School of Mines was therefore put up in 1773 under the reign of Catherine, the Great.

It was not until the 19th century, however, that considerable progress was made in engineering education system which was influenced by French ideas. At that time, French engineers were in demand and most other countries of Europe were organizing engineering schools on the basis of French ideas. In France, even at the time of the French Revolution, there was already in existence the famous Ecole Polytechnique of Paris. It was recognized then that a satisfactory engineering education at the time should include a solid preliminary traning in fundamental subjects such as mathematics, mechanics, physics, and chemistry.

Only the best engineers and scientists were engaged as professors; competitive examinations for admission were introduced; and the purpose of the school was not only for routinary teaching of various subjects but also for further development of engineering and sciences.

After the peace of Tilsit in 1807, the Russian Emperor Alexander I arranged with Napoleon to have French engineers participate in the organization of a new engineering school — the

Institute of Engineers of Ways of Communication. In this school, French ideas were introduced. French engineers, among them Lanie and Clapeyron, taught here and the French language was used in classes. These engineers did also consultation work for the Russian government in engineering projects, particularly bridge construction. Thus, the French engineers not only helped organize the Institute, but also helped in the solution of important practical problems.

Due to political reasons, however, the French engineers and professors left Russia in 1830, but at this time there were already a number of Russian engineers who were prepared to take over the teaching positions at the Institute and to tackle the engineering problems of the government. Among the outstanding young Russian engineers at this time was Ostrogradsky, a mathematician, who had a powerful influence in maintaining at a high level the teaching of mathematics at the Institute. Zhurawsky was well known for his work in the engineering sciences. His structural engineering capabilities were discovered and recognized, and he was subsequently holding positions of trust and responsibility. He was the first to develop a method of stress analysis of the members of a bridge structure under dynamic loads. He published his method in 1850 and later, he presented his work on bridges of the Howe system to the Russian Academy of Sciences and received a award for it.

The growth of engineering knowledge in Russia at that time was remarkable. Russian engineers spanned the Nova River with a metallic bridge and from the works and publications of Zhurawsky, it was concluded that instruction in strength of materials was at a high level in Russia during the middle of the 19th century, at about which time the government founded the Central Laboratory of Weights and Measures, the American counterpart of which was organized only in 1901, half a century later.

The success of the Institute led the government in the further development of engineering education in Russia. The Technological

Institute in St. Petersburg, the Technical School in Moscow which taught thermodynamics and which was one of the first schools in the world to teach aerodynamics, the Technological Institute in Kharkov and Tomsk were among the schools subsequently organized.

The prestige of a professor in the engineering schools was and still is very high in Russia. Competition for the professional chair were based not on the seniority principle but on the basis of technical publications and research papers presented. The election to a professorship was acted upon by a professors council after a rigid screening of candidates. No politics and outside pressure were used.

The engineering profession has always been regarded very highly in Russia. Most young men who desired an engineering education were admitted on a competitive basis. For instance, in the shipbuilding division of the Petersburg Polytechnical Institute, only applicants with a gold medal from high schools could be admitted. The course consisted of a broad program in mathematics. In addition to the usual two-year course in calculus, there were courses in partial differential equations, approximate methods of mathematical calculations, and an advanced course in which Lagrangian equations with applications were discussed. This was the first time in engineering education that such highly mathematical subjects were discussed. Graduates of the school were absorbed by the Russian navy.

The Russian engineering schools did not only teach the routine subjects, but also gave due emphasis on the development of the engineering sciences. Scientific papers of the various teaching staffs were published; the school's laboratories were not only used for student's experiments but were used for the solution of problems for industry and the government.

The first World War came and then the Communist revolution. The Revolution brought great changes. Principles of self-government and academic freedom which were enjoyed by the schools in the pre-revolutionary time

were abolished. Instead of having the president and deans elected by the professors' council, the administrative personnel were designated by the Government of the Soviet Union. The Administration interfered so much in the general planning of academic policy and political influences penetrated into the academic life, thus lowering the prestige of the professors.

In 1938, however, the changes introduced by the Communist regime were abolished and soon the educational system started to improve again. Teaching in the secondary schools rose to high standards and included five years of algebra and calculus, three years of geometry, one year of trignometry, and three years of physics.

After the revolution, the number of schools increased greatly: in 1958, there were 29 polytechnical institutes, 30 institutes of mechanical engineering, 27 of civil engineering, 7 institutes of aviation, 27 of mining and metallurgy, 18 of transportation, 15 of electrical engineering and communications, 13 for fish and food industry, 10 of chemical engineering, 2 for meteorology, and hydrology, and 2 for shipbuilding.

All schools of high engineering education are under the control of the Ministry of higher Education, which supervises curricula and programs. It determines the enrollment quotas and coordinates the placement of graduates.

The teaching staff of a school consists of professors, docents, and instructors, and the faculty-student ratio in a school is about 1 to 10. The professors are members of the council and each of them usually heads a definite branch of science, so their number does not depend upon the number of students. However, the numbr of docents and instructors grows in proportion to the number of students.

A doctor's degree is required of all candidates for a professor's position. The professor's monthly salary is 5,000 rubles which is 19 times larger than the salary of an unskilled laborer. His work is limited to 15 hours per week, which includes not only lecture hours but also time spent in discussions with students, preparing examinations, and other activities.

Lectures are made to groups of from 100 to 150 each. These lectures are given not only by the professor of a particular subject but also by docents who also work with small groups of 25 to 30 students. For the position of a docent, a candidate's degree is required.

There are two academic degrees in Russia: the candidate's degree, and the doctor's degree, requiring a doctor's thesis.

A docent receives a monthly salary of 3,200 rubles. Instruction in problem solution and laboratory work is usually done by instructors. The instructor's position requires a candidate's degree, but very often these positions are occupied by men who have passed the examinations for the candidate's degree but who have not completed their thesis yet.

The students do not pay tuition in Russian schools — the majority get scholarship grants of 300 rubles per month. At the Kiev Polytechnic Institute, a student can get three meals a day for 7 rubles and a place in a dormitory for a very low price, so that the 300 rubles is adequate for a modest student life. Textbooks are very cheap, and the school library usually keeps large number of copies of the required textbooks for student use.

A large number of women are also enrolled in engineering courses. Special institutions of higher education for women were organized in Petersburg and Moscow and in the other larger cities of Russia. Graduates of these schools become teachers of secondary schools. The higher engineering schools of Russia first extended admission to women students in 1907. By 1956, women constituted 1/3 of engineering students, and among engineers employed in industry, they represented 28 percent.

For higher engineering schools, the admission is limited to those who complete the secondary school or its equivalent. After the Revolution, a new type of secondary school emerged in Russia: the complete program requires 10 years of study, subdivided into 3 stages; namely, elementary grades 1 to 4, intermediate grades 5 to 7, and upper grades 8 to 10. The first stage corresponds to elementary school, the second stage corresponds

to junior high school, and the third stage corresponds to high school. The first two stages, or 7 years of study, are now compulsory in Russia. The high school is considered as preparation for schools of higher education.

All schools are controlled from Moscow. The Department of Education fixes the curriculum, the programs, and methods of teaching for the entire country. There are 33 weeks of instruction per year, 6 days work per week, and 5 or 6 hours instruction per day.

Mathematics is one of the most important subjects in high school training. A student has 5 years of algebra and geometry and 2 years of trigonometry. Altogether, every high school pupil in Russia spends about 1/3 of his school time in mathematics and science. In contrast, about 23% of public schools in America offered neither physics nor chemistry in 1954.

It is a fact, however, that because of too much systematic work to be done in the 10 years, only a small percentage of pupils are finally graduated from the 10th grade 10 years later. This percentage is much lower than in Amercian schools, but is of the same order as in Western Europe where, as in Russia, the policy of selection of the best-fitted pupils for higher education prevails. Plans are under consideration in the United States to increase secondary education to 11 years.

Those who do not progress well in high school are channeled to other directions. After the 7th grade, they enter the *Technicum* or the semi-professional schools and can be graduated in 4 years as technicians. Later, they serve as engineering aides. In Russia, it is a general policy to have in the plant and factory a ratio of two technicians to one engineer.

The engineer's profession is looked up in Russia as one of the highest and has attracted the interest of the pupils of high schools.

The latest educational reform in Russia was to send all pupils after the 8th grade to the factory, and spend 2 years there of manual labor, and then return to school to complete the last three grades. The first 8 years then will be compulsory. — *By Dr. Gregorio Y. Zarra in Science Review, August,* 1966.