

Agustin Betancourt and his contribution to higher engineering education in Russia

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Abstract - This paper describes the foundation of Russia's higher engineering education and the contribution from Agustin Betancourt, the founder of the first high engineering school in Russia. The results in this paper explain Russia's engineering education in the early stage.

Key words: Agustin Betancourt, Higher engineering education, St-Petersburg University of Transport

I. Brief Biography

Agustin Jose Pedro del Carmen Domingo de Candelaria de Betancourt y Molina (figure 1) was born on February 1, 1758 in Puerto de la Cruz, a town on the Island of Tenerife (Canary Islands, Spain), in an aristocratic family (figure 2) [1], [7], [9].

From 1778 to 1784 he studied in Madrid in the "Reales Estudios de San Isidro" and in the "Real Academia de Bellas Artes de San Fernando". In March 1784 as a capable



Fig. 1. Agustin Betancourt
(1758-1824)

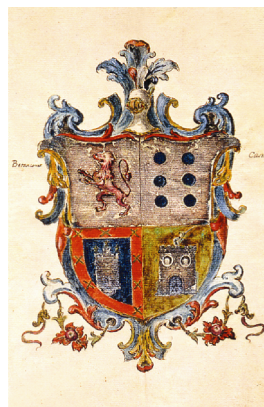


Fig. 2. The patrimonial arms of
Betancourt's family

student he was sent to Paris where he participated at the activity in the "Ecole des Ponts et Chaussees" [7]. But very soon he went back to Madrid and after an interview with the Secretary of State D. Jose Monino, Conde de Floridablanca, he was asked for the establishment in Spain of a new school, namely, the "Escuela de Caminos y Canales" (School of Roads and Channels). The agreements included to select students for the "Ecole des Ponts et Chaussees" in Paris in order to obtain the degree of Hydraulic Engineers; to form experts in mechanical (industrial) engineering; and to collect models of machines of general utility in public works and industry. On September 10, 1785, Betancourt went again to Paris, where he was well accepted from the Director of the School Jean Rodolph Perrone (Rodolphe Perronet) (1708-1794) and Professor Gaspard Francois de Prony (1755-1839).

In 1788 the Spanish ambassador, Conde Fernan Nunez, by chance visited the home-workshop of Betancourt was very impressed of the many scale models he collected and in his letter to the Secretary of State, dated 23 April, 1788, he proposed the creation of a Cabinet of Machines in Madrid [9], [10].

In 1791 since the situation in France, the king Carlos IV decided that Betancourt should return to Spain, and he would have brought with him the collection of drawings and scale models. The whole collection (including 42 drawings) was received in Spain between July and September. In April 1792 the Cabinet, located in the king house "Palacio del Buen Retiro", was opened to the public. The 14th October Betancourt was officially appointed Director of the Cabinet. The whole collection was composed of 271 models, 359 drawings and 99 memories, library of rare books and manuscripts. (Betancourt 1789; Betancourt 1792). Thus, the first-ever museum on Science and Technics History was established. Towards the close of 1790s Betancourt was thought to be the best and the greatest engineer of Spain.

In 1802 Betancourt got the position of Chief Inspector, and he established the School of Roads, Channels and Bridges in Madrid, that was located at the Royal Cabinet of Machines. From 1802 to 1807, he worked at the School, at the Cabinet and as a Chief Inspector of Engineers of Roads Corps.

In October 1808 because of the unstable political situation in Spain and for family reasons, Betancourt went to Russia to work under the auspices of the Russian Czar Alexander I.

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In Russia he spent great efforts to develop successfully an engineering framework through several activities in designing, teaching and organizing in many fields of engineering until his death in 1824 in Saint Petersburg. This activity was fully recognized to Betancourt and still today there is great memory of him in Russian history of Mechanical Engineering.

II. Arrival to Russia

The beginning of Betancourt's activity in Russia has coincided with his 50th anniversary. In November 1808 he was appointed in Russian Military service with the rank of General-Major [12]. He came to Russia with all his family: wife Anna, three daughters and son - Carolina, Adeline, Matilda, and Alfonso.

It is known also, that a year before, in November 1807 under the recommendation of Russian well-known diplomat I.Mouraviev-Apostle who was the Secret Adviser of Foreign Affairs Colleague and the Envoy of Russia in Madrid (1802-1805), Betancourt visited Russia for the first time in order to get acquainted with a new to him country and to discuss an opportunity to join the Russian Military service. In the Archive of Spain there is a report dated December 8, 1807, from Count Noronya, the Proxy Minister of Spain in Russia (1799-1807), in which he informs the Prime Minister Pedro Sevallios on that fact. Agustin Betancourt was received by Count Roomyntcev (Minister of Commerce, from 1808 - Minister for Foreign Affairs) with great courtesy and presented him to Emperor for private audience [1], [11]. It is obvious, that for Betancourt, nobleman, the attitude to him on the part of high-ranking officials and the Russian Czar Alexander I in particular played an important role, and it is possible, this fact has underlain his choice to come to Russia.



Fig. 3. A model of a steam-driven dredger (St-Petersburg University of Transport)

It is not easy to estimate the heritage which is left by Betancourt on his new Motherland, Russia. Even an enumeration of the towns: Tsars Selo, St-Petersburg, Tula, Kazan, Warsaw, Tver, Moscow, Nizhniy Novgorod where Betancourt's projects have been built, can give a limited figure of it. For incomplete 16 years he carried out a lot of engineering projects, invented a steam-driven dredger, a forerunner of the present excavator, for cleansing the water area of the Kronstadt port (figure 3), improved the army industry [4], designed and built bridges using a new system of arches.

In 1817 Betancourt presented to Alexander I, the Russian Emperor, a project of a roofed-in riding horse school (manege) in Moscow with the sizes inside walls 166,1 ÷ 44,7 meters [12]. He offered an original decision on an overlapping construction made from wooden rafters. The arena should not have any inner support, and the rafters 44,86 meters long should block all the space. The then such engineering decision was unique [2]. On November 30, the same year the Manege was opened for public and social celebrations. Its area made about 7,5 thousand square meters and contained more than 2 thousand people. Betancourt's contemporaries wrote that the Manege (figure 4) «had no peer elsewhere in Europe in sheer bulk, architecture and design of the roof». The singular combination of wood and metal, which lent a touch of aerial to the solid structure, was particular striking [6].

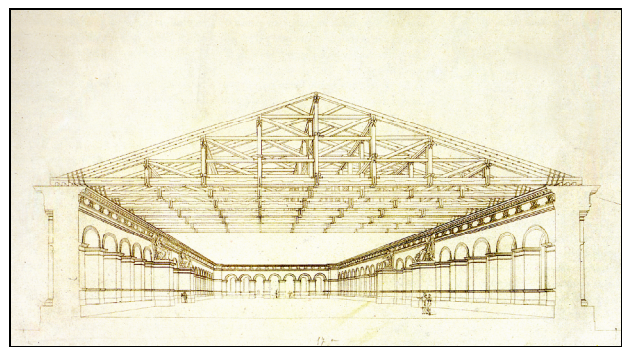


Fig. 4. Moscow Manege

Betancourt-engineer invented original fixing elements to hold and keep apart the metal and wood elements [2]. The innovation consists that on the end of every rafter had been used a tip from the bleached iron that interfered direct friction of wood in other parts of a supporting arch. Betancourt had taken the advantage of his own experience of building a bridge across the Malaya Nevka River to Kamenny Ostrov (island) in St-Petersburg where he used a similar technique and connected seven large wooden arches.

In his Manege project Betancourt tried to exclude all possible risks which could arise in future, for instance, the threat of flooding from Moskva River quite nearby, and a River that burst its banks now and then: so, he had the foundation laid 4 meters deeper and the walls wider at the base. It is also important that the roof was designed for asymmetric, unequal loads of snow in wintertime on the sunny and shady sides [6].

III. Saint Petersburg State University of Transport

Among Betancourt's main achievements can be considered the establishment of the first-ever in Russia Higher Engineering School, which was named as the Institute of Corps of Engineers of Routes of Communication (nowadays Saint Petersburg University of Transport).

The Institute was established on November 20, 1809, according to a document signed by Alexander I, the Emperor of Russia. In it there is a paragraph about the organization of Corps and Institute of Corps of Engineers of Routes of Communication. It is important to point that since the very beginning Betancourt participated in the commission for developing this document project. For his excellent work in this commission he was promoted to the rank of General-Lieutenant and on August, 30, 1809 was appointed as the Institute Inspector and Advisor [12]. Later in 1816 he was appointed as the President of the Committee for Constructions and Hydraulic Works and in the same year he organized an important exhibition in Nizhniy Novgorod. In 1818 he was nominated Chief of Department of Routes of Communication (Transport).

The first building of the Institute (figure 5) was chosen by Betancourt because it was surrounded by a wonderful park with a lake where all the students could have a rest during the breaks and it had also a lot of large and light rooms for lessons.



Fig. 5. Photo of the first building of the Institute

To develop a new educational system Betancourt made use of his own experience of the establishment of the School of Roads, Channels and Bridges in Madrid. Basing also on achievements of his French teachers: Gaspar Monge (1746-1818), the founder of Polytechnic School, and Jean Rodolf Perrone (1708-1794), the founder of School of Bridges and Roads, he did not simply repeat the western style of teaching in Russia, but he made a significant improvement as specifically adapted to Russia environment in such a way that it was a new type of the higher technical education which still, two centuries later, keeps its significant value [4]. In 2004 St-Petersburg University of Transport celebrated 195 years from its foundation.

By the beginning of 19th century in France there was already a numerous staff of engineers, and therefore Betancourt could invite qualified experts for teaching special disciplines in the Institute of Engineers of Transport in Russia. The first 20 years the teaching in the Institute was carried out in French and this permitted students to study the latest proceedings on engineering inventions from original documents and at early publications. The program and curricula were defined by Betancourt with providing simultaneously scientific, engineering and practical training that was an innovation for Russia and, as a whole, advanced at that time. Theoretical teaching to students was combined with their practices in laboratories and workshops, even outside Institute, by including intensive work on design and drawing. All that gave a profound base for good professional young specialists.

The approach of the new program was verified by time, and became a sample for other higher technical schools along the 19th century. Russia was in great demand of the new generation of professionals and the Institute gave a lot of young people capable to design a wide spectrum of engineering projects. Major principles of the new educational system were:

- 1) Serious general-theoretical education of students with a strong basis in mathematical disciplines;
- 2) Universal approach to engineering activity on the basis of wide culture, providing a creative orientation of graduates;
- 3) Development of practical skills of students for working with mechanisms and machines;
- 4) Practical training under the real conditions.

The main aim of education program as Betancourt liked to repeat was «to supply Russia with engineers who after the graduation from the Institute could immediately be effective in the industry». He wished the students of Institute «should be familiar with the basis of science and its practical application to engineering» [5]. The Institute of Corps of Engineers of Transport really became “that trunk” of higher

technical school of Russia from which all the numerous branches were formed.

From the very beginning Betancourt started to organize a library and rooms for practical studies in the Institute. For that purpose the first books, various tools and scale models under his order had been purchased in Paris and in 1810 delivered to Saint Petersburg. Nowadays in the Institute's library you could find a lot of rare and interesting books, including the works of Betancourt [2], [3].

With a view of continuity the best graduates were appointed in the Institute and later they became well-known professors. For example, one of the most talented graduates of 1813 year was A.D.Gotman (1790-1865) (figure 6) who later became the Rector of Institute (1836-1843) [8].

Betancourt, as the first Rector of the Institute (figure 7), paid the very special attention to manuals. From 1816 the Institute began to lithograph and to issue professors training courses and lectures. In «Voenii journal» (Military magazine) from 1811 it was marked, that «higher mathematics and mechanics in Russia is taught only in the only one Higher School - the Institute of Corps of Engineers of Transport where well-known General Betancourt has introduced it recently».



Fig. 6. Andrew Gotman - Rector of St-Petersburg University of Transport (1836 - 1843)



Fig. 7. Agustin Betancourt - the first Rector of St-Petersburg University of Transport (1809-1823)

Among special disciplines for the high level of engineering teaching the «Course de construction» was developed by M.S.Volkov. The new course included methods of designing and construction of all transport overland and hydraulic engineering systems and it included as important sections: building materials, building mechanisms, manufacture of civil construction, highways, bridges, hydraulic engineering.

The second significant course was in Applied Mechanics. In 1821 it was allocated as an independent subject from «Theoretical mechanics». This course provided knowledge in steam machines, building and road mechanisms and all other mechanical devices and machines that are connected to construction and operation of transport constructions and water supply.

In 1823 «Note about appendix of the beginnings of mechanics to calculation of action of some of machines, the most common» by professor D.S.Chizhov was published as the first textbook on Applied Mechanics in Russia.

As a whole from 1816 to 1828 several courses were published or lithographed. Many of them were in French: «Lecons de mecanique applique» by B.Clapeyron, «Traite des proprietes projectives des figures» by J.V.Poncelet, «Traite elementaire de calcul integral» by Pierre Bazaine avec Gabriel Lamé, «Integral calculus Initial base» and «Differential calculus Initial base» by P.Bazaine, «Base of Mechanics» by Morice Destreme, «La Geometrie Descriptive» by Charles Potier (figure 8), translated into Russian by J.A.Sevastjanov. There were also some courses in Russian: «Spatial Geometry» by A.I.Majorov (figure 9), «Initial bases of analytical geometry» by J.A.Sevastjanov and etc.

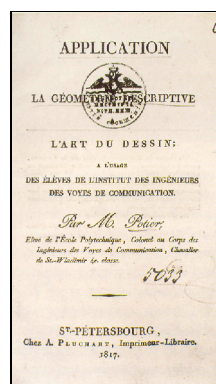


Fig. 8. Charles Potier «La Geometrie Descriptive»

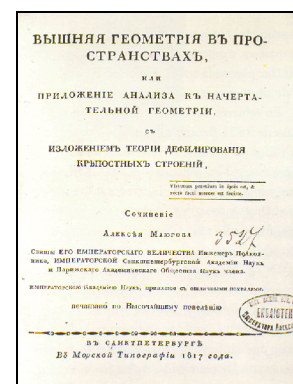


Fig. 9. A.I.Majorov «Spatial Geometry»

Betancourt managed to organize a Museum of models in the Institute by using his own previous experience at the Cabinet of Machines in Madrid. In 1813 the first arrived exhibits were shown in the «Special hall». The Museum consisted of six cabinets: modeling and mechanical, building - working tools, samples of building materials, physical, geodetic, mineralogical. In those cabinets practical lessons were carried out. The collection of the Museum was continuously enriched with scale models, drawings concerning with construction of bridges, channels and buildings. The collection helped to study more deeply

disciplines, to use knowledge in practice. Students were used to make scale models and mechanisms in workshops of Institute (figure 10), thus, in Museum there were 14 models on the Descriptive Geometry, some models and mechanisms made by Betancourt himself or under his supervision.



Fig. 10. Model of mechanism (St-Petersburg University of Transport)

Betancourt's basic efforts have been directed on education of qualified Russian engineers with European level. He became the founder of professional traditions which even nowadays provide the country with qualitative employees in mechanical engineering, construction of bridges, roads, and buildings.

Betancourt's contribution to establishment of the Russian higher engineering education is really great. Those young scientists from graduates of the Institute established a Russian scientific language since then by translating into Russian terminology and have adapting to Russian culture the system of training engineering.

The Institute of Corps of Engineers of Routs of Communication (Transport) became a cradle of Descriptive Geometry in Russia. The theory of this science was not only developed but many new applied disciplines appeared on its basis. Monge's dream: «young experts have to apply Descriptive Geometry in many areas and use it for machine construction and then a human being taking a power of nature will use only a power of his brains» came true.

With the advent of railways Russia immediately has joined the European process of railway construction because it had super professional engineers and they all were Betancourt's students - graduates from the Institute. They were able to solve any kind of problem: technical, cultural, social and national. And, certainly, in front of them they always had Betancourt to follow.

Students of Betancourt's Institute got the higher technical and engineering education first-ever in Russia. Intellectual scope of the theorist, experience in Engineering and brilliant teaching talents helped Betancourt to establish

a new educational system with huge potential opportunities. He displayed great acumen in marrying theory and practice. It is remarkable, but Russian engineers of last two centuries are well known for their competence and imagination.

In his activity Betancourt followed principles of well-known Roman architect and engineer Vitruvius: durability, common weal, beauty. Thus those few kept Betancourt's designs are not only engineering constructions, but also masterpieces of art. Primitive service to momentary benefit was alien to him. He used to say: «In technical equipment it is not enough to get the desirable result, it is necessary to use the most simple, the strongest designs and the most suitable to the workers skills».

St-Petersburg University of Transport, founded by Betancourt, became one of the leading Russian scientific educational centers, for the higher engineering education in Russia.

In 2003 a new planet in the minor planets register of Solar System, No. 11446, was named after Betancourt under the request of scientific community of St-Petersburg: a worthy tribute to the Great Spanish-born engineer and scientist who devoted his talents to Russia, who founded this country's first higher engineering Institute and became the first Rector of Saint Petersburg University of Transport.

IV. Conclusions

Agustin Betancourt is presented as outstanding engineer who became the founder of the first-ever higher engineering Institute in Russia and who has contributed considerably to the development of higher technical and engineering education in Russia.

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