An Enlightened Expert on the Movement and Globalization of Civil Engineering: Augustin Betancourt (1756–1824)

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Abstract

In this chapter, we shall examine the transnational path undertaken by the Spanish engineer Augustin Betancourt, an emblematic figure of the European Enlightenment. *Mobility, expertise* and *network* are the three keywords which sum up his great activity, which started in the Canary Isles and took him on an educational path through Europe terminating in an eminent career in the service of both the Spanish and Russian crowns, earning him the stature of a versatile expert of international renown. He played a crucial role in the construction of a new identity for the engineer based on a series of specific skills provided within a highly institutionalised framework and put at the service of public interest: he managed groups of experts, founded schools for engineers and technical corps, organised and piloted teaching and research works in various fields of engineering, initiated theoretical studies of technical phenomena (steam engines, systems of small navigation), new disciplines (foundations of thermodynamics, science on machines) and scientific schools (applied mechanics). His mobility, fruit of political conjunctures and personal circumstances which, in the last part of his life turned into exile, developed, stimulated and inspired his many interests; he spent two thirds of his life travelling. Four major capitals welcomed him at different periods of his life: Madrid, Paris, London and Saint-Petersburg. Each in its own way, gradually formed and refined his professionalism, and we will provide a detailed account of the specific impact he had on the technical culture of the engineer. Through examination of his travels, from formation to action we shall describe his wide network of multinational relationships which testify to an extensive range of different figures: engineers and inventors, mechanics and entrepreneurs, scholars and artists, diplomats and dignitaries, including ministers, heads of government and sovereigns, as we navigate with

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him through the different worlds he brought together… Moreover, his complicated relations with powerful figures allow us to measure the limitations to competency which power, politics, intrigue and expatriation were able to exert.

Keywords

Augustin Betancourt · Spain · Russia · Technological transfert · Public works · Steam engine · Circulation of knowledge · Industrial espionage · 18th and 19th centuries

1 Introduction

Augustin Betancourt (1758–1824) is an emblematic figure of the Spanish Enlightenment. He was, indeed, a versatile engineer, savant, inventor, pedagogue and science manager, who played a prominent role in the promotion of civil engineering at the European level.[1] From this point of view, this Canarian of noble lineage, trained in the best metropolitan institutions, is a paragon of a "travelling learned mediator", whose mobility, be it voluntary or forced, invariably served the cause of globalization in his professional field.

In the midst of a Europe agitated by the political and military cataclysms of the late 18th and early 19th centuries, the personal path of this man appears both typical and singular (Fig. 1). Typical because it was part of the movement in which countries in need, in particular, Spain and Russia, would send people to the various European technical centers of excellence to be trained and mobilized in line with the accelerated modernization strategies that were underway at the time. Singular because the specific circumstances of his life prompted this active and enterprising man to develop original initiatives that sometimes went well beyond his own performance and initial aims. During his peregrinations, Betancourt had an opportunity to experience activities of all kinds: he piloted groups of experts, founded engineering schools, technical corps and technical administrations, organized and headed teaching and research in various fields of engineering art, and promoted some pioneering theoretical studies of technical phenomena (the steam engine, systems of small navigation), new disciplines (foundations of thermodynamics, science on machines) and scientific schools (applied mechanics). But the same man also had an inveterate taste for invention and free enterprise, and his curiosity as a mechanic led him to go so far as to ignore prohibitions—technical and industrial espionage was one of his life-long favourite occupations.

[1]This chapter synthetizes the guidelines of the monographic study devoted to the life and work of Augustin Betancourt: (Gouzevitch I., 2018).—The general issues presented therein were the subject of preliminary analyzes in: (Gouzevitch D., Gouzevitch I., 2008-1; Gouzevitch I., 2010).

Fig. 1 Augustin Betancourt y Molina. Engraving. 1826

During his working life, Betancourt invested in many technical branches: textiles and metallurgy, mining and dye chemistry, agricultural techniques and minting, dredging of water courses and steam technologies, clock-making and measuring instruments, optical telegraphy and mechanics, hydraulics and hydrotechnics, public works and architecture, urban installations and city planning. A pioneer in many innovative fields that will be presented throughout this chapter, Betancourt was too versatile to leave a definitive mark on any one of them. He was a poor entrepreneur, because public recognition of his intellectual achievements interested him much more than the financial benefits they could provide. Ultimately, however, Betancourt succeeded in taking advantage of his accumulated experiences in the interest of others, indeed, of many others, because his disciples and followers across Europe are too numerous to count. It is enough to mention all the promotions of the *Escuela de caminos y canales* in Madrid or of the *Institute of the Engineers of the Corps of Ways of Communication* (Institut Korpusa Inzhenerov Putej Soobshchenija) in Saint-Petersburg, which still now claim this heritage … A man of the Enlightenment, Betancourt is an image of his time, but

also, synthetically, an image of the experiences that, in relation to his tastes, passions and external conjunctures, he made his own. He was a tireless traveller. His mobility enhanced his numerous interests, stimulated them, and was inspired by them: he spent two-thirds of his life on the road. However, from youth to old age, his travels changed in nature, and in this study, we will try to understand the meaning of this evolution.

Four major European capitals welcomed Betancourt at different periods of his life: Madrid, Paris, London and Saint-Petersburg. Each in its own way inspired, structured, shaped and refined his professionalism. Detailing their specific contributions to the technical culture of Betancourt will be part of our prerequisites. These contributions have different meanings depending on whether we are discussing the "Paris – London" axis, central to Betancourt's training and professional development, or the "Madrid – Saint-Petersburg" axis, essential for understanding the differentiated application of acquired experiences. The latter, in its practical applications (the promotion of training, enrollment and administration for the engineers of public works, first in Spain, and then in Russia), will be the focus of the second part of this overview.

Notably, the concept of expertise, in its polysemous complexity, played a fundamental role in Betancourt's mediation activities, even if his own line of thought took a different shape, as he used it systematically for his own work by giving priority each time to the proceedings best suited to the occasion. He acted as an expert when officially called upon by his positions, or informally when he considered it necessary, or was solicited by colleagues. He also acted as an intermediary among individuals, institutions and/or decision-making structures (academies, administrations, governments). Finally, he himself invented and promoted the expert bodies, high places of control, decisions and normalization that were given full authority. Two original instances, the Hydraulic Committee (*Gidravlicheskij komitet*) and the Commission for Projects and Budget Estimations (*Komissija proektov i smet*) in Saint-Petersburg, which crowned his work in Russia, fully embody this expert approach that issued from the synthesis of Betancourt's European experiences in the fields of engineering, art and sciences.

Efficiency in the promotion of projects, be they small or large, individual or collective, modest or ambitious, formed the basis of Betancourt's work: his action was measured by the extent of his multiple contacts within the world of European science and technology. Wherever he went and whatever he undertook, he operated as a network man who interacted intensely with those around him. Thanks to his travels, he became a mediator, activating new links while sustaining and strengthening already existing ones. If Betancourt's social skills were in line with his temperament, they were also part of the habitus of the men of science and technology of the Enlightenment, reflecting their universalist and associative culture. Betancourt, for his part, succeeded in acting with prodigious efficiency and had an eye for the future. In Russia, his European network was mobilised to set up a training system for the engineers of the future, who would be better prepared and

more efficient than the developer himself. Following Betancourt in his peregrinations, from training to great action, we will inevitably address his multinational network of relations across a wide range of expertise: engineers and inventors, mechanics and contractors, scientists and artists, diplomats and high-ranking officials, including ministers and chiefs of governments, or even sovereigns… At the same time, his personal failure to serve the Russian Crown, and previously that of Spain, testifies to the limits that power, politics, intrigue and expatriation can impose upon competence, an aspect that will be examined in the last part of this chapter.

2 The Universe of Travels: Modalities, Temporalities, Causalities

Travels to France and England took on an important, if not central, place in Betancourt's life. They represent more than thirteen years, that is, nearly a quarter of his adult life, which began with his arrival in Madrid in 1778, at the age of twenty, and ended with his death in 1824 in Saint-Petersburg, at the age of sixty-six. Compared to his Spanish period (1778–1808), this segment of his travels is even more significant, since Betancourt spent about 54% of his service time in France and England. Between 1784 and 1808, extreme dates that flank this period of intense mobility, the engineer made eight visits to these two countries, six to France and two to England.

These sojourns of various duration, from three weeks to six years, follow one another at more or less tight intervals, relatively close at the beginning and at the end of the aforementioned period, with a break of nine years, from 1798 to 1807, during which he was occupied by various works and achievements in Spain. Without marking a break in Betancourt's attitude towards these two countries and towards travel in general, this pause is indicative of the changes that were occurring in the nature of his mobility. The official missions financed by the State before 1798 gave way to an adventurous escapade of 1807–1808, which he undertook at his own risk in search for a way out.

From a biographical and circumstantial point of view, these two groups of travels are therefore considerably different, both in their material and administrative conditions, as well as in their intimate motives and final aims. The man who travelled to France and England between 1784 and 1798 was in his prime (26–40 years old), dynamic and enthusiastic, curious and ambitious, but, above all, eager to serve his country usefully and make a good career there. France and England thus served as sources of information, ideas and inspiration, springboards for social advancement, and open doors to new horizons. In contrast, the man who took refuge in France in 1807 and 1808, with a prospective trip to Russia in between, was already nearly 50 years old, and although his creativity was more vibrant than ever, his youthful dynamism had disappeared, consumed by age, trials and disillusionment. His former enthusiasm gave way to the determination of the mature

man whom political anguish, economic difficulties and professional frustration had pushed into expatriation.[2] During this second period, France served him one last time as a stopover on his way to a new destiny—Russia.

All of these travels, however, have in common an abundance of intense and creative activities. These activities are mainly of eight types: studies (stays in scientific institutions, laboratories, workshops, educational visits, etc.); inventions (descriptions, projects, static or operational models and/or life-size objects); scientific works (academic memoirs and treatises); industrial initiatives (memoranda and proposals arguing the advantages of the introduction into Spain of various industries or, in some cases, essays of exploitation); educational initiatives and the organization of collective work (teaching projects and supervision of trainees); commissions (acquisition of equipment, teaching materials, scientific instruments, models, books); commercial mediation (for example, as a commercial agent to the clock master Abraham-Louis Breguet); and reconnaissance and espionage (collection of information on various technical inventions and industrial innovations, in the interest of States, administrations and individuals). At the same time, each instance of travel has its own characteristic, and to better understand the peculiar and summary impact of each one on Betancourt's life and work, I shall examine them one by one.

The first voyage by young Betancourt to France, from March 1784 to July 1785, was a result of his first great professional success. Three brilliant memoirs on the mercury mines of Almaden issued from his inspection of this enterprise of the Spanish Crown in 1783 established him as an expert in mining and led to the granting of a fellowship of the Secretariat de Indias[3] to study underground geometry and architecture in Paris[4] (Fig. 2). On his way to France, Betancourt, unofficially commissioned by his chief in Madrid, inspected the Aragon Channel (Canal d'Aragon),[5] a very ambitious building enterprise of the Spanish Crown, and this visit, as well as his having made his first Parisian contacts, resulted in an unexpected turn during this stay. In view of the teaching offered at the *École des Ponts et Chaussées*, directed by the famous French engineer Jean-Rodolphe

[2]In his letter of September 15, 1814, from Saint-Petersburg, Betancourt explains his motivations to his brother, José de Betancourt y Castro, in the following terms (transl. from Spanish by I.G.): «Since I observed the enmity that reigned in Spain between the Prince of Asturias (now Ferdinand VII) and Godoy, I assumed that there must have been a revolution in Spain and that in such a case it would be necessary, in order not to perish with my family, to seek asylum in a foreign kingdom […] where we could be safe, and it seemed to me that Russia must be the most suitable. I saw the storm coming and after Napoleon had requested troops from Spain and […], it seemed to me that it was already time to leave; and as at this time any individual who enjoyed some consideration was leaving the Court, I was granted permission to travel at the instant I requested it» (AHBC, 1814). Published in: (Cullen Salazar, 2008, p. 206). Betancourt fails to mention here at least two other reasons that conditioned his departure: on the one hand, the loss of his favours with Godoy (following the unsuccessful reconstruction of Soto de Roma, Godoy's domain in Andalusia) and, on the other hand, his financial setbacks due, in particular, to the failure of his business, the Ávila cotton factory. See: (Muñoz Bravo, 1987; Martín García, 1988).

[3]Governmental instance managing overseas affairs in eighteenth century Spain.

[4](Betancourt-2; Id.,2009).

[5](Sáenz Ridruejo, 1978; Rumeu de Armas, 1967; Id., 1968).

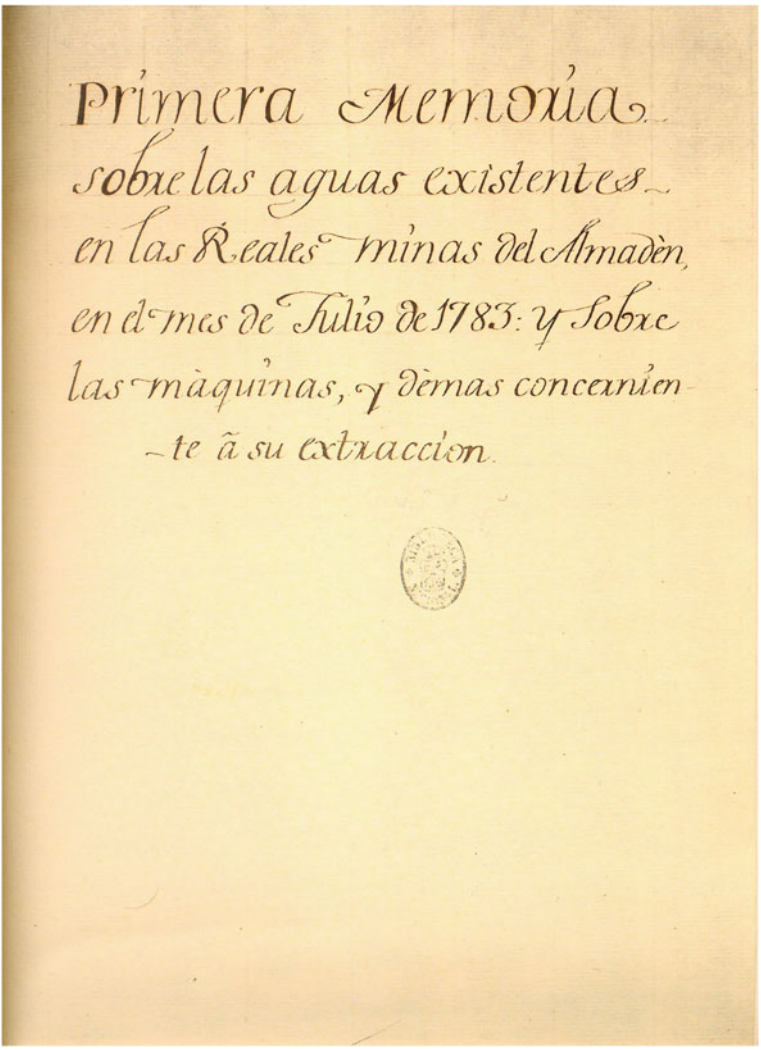

Fig. 2 Memoir of Almaden. Volume I. Cover. 1783

Perronet, the young traveller formulated a new project, more in line with his interests in mechanics and hydraulics. In the memoir submitted to the Spanish Ambassador in Paris, Aranda, Betancourt proposed organising a similar course of education in Spain aimed at promoting a new class of technical experts with specific knowledge, that of engineers-hydraulicians likely to undertake the construction of roads and canals in the kingdom. The proposal was approved by Carlos III. As a result, in September 1785, Betancourt was entrusted with a threefold aim in Paris, obliging him, firstly, to engage in, with a group of fellows of the Spanish

government under his direction, the course at the École des Ponts et Chaussées in order that they might all obtain the title of engineer-hydraulician; secondly, to acquire, at this school or another similar centre, a more thorough specialization in mechanics; and finally, to establish a collection of models of machines of general use for public works and industry, with the idea that the collection would serve as an annex to the project of the school. All these operations were supported by the Spanish Crown (Rumeu de Armas, 1980, pp. 62–65).

Betancourt's second stay in France, which this time lasted more than six years (1785–1791), was entirely dedicated to the fulfilment of this new mission. It also gave way to a new form of travel, the so-called "hydraulic team", an initiative of the Spanish government inspired and spearheaded by Betancourt in France, which, as far as we know, would seem to be without antecedent, since, unlike the classic "grand tour", the "hydraulic team" was a collective sedentary enterprise in the sense that its members had a fixed residence from which they traveled back and forth. Between 1786 and 1791, Betancourt welcomed and directed a group of his compatriots in Paris, selected according to the required skills in mathematics, technology and the construction of models: Tomàs de Verí, Juan de la Fuente, José Betancourt y Castro (brother of Augustin who joined the team spontaneously), Juan López de Peñalver, Joaquin de Abaitúa, Juan de Mata Mollero and the modeller Antonio Alvarez. Betancourt took care of everything and personally managed a daily organization of collective work, which included, besides the school courses and the manufacturing of models, a series of local trips of which he had to inform his Madrid overseers.[6]

For the spring/summer of 1788, he planned trips to Burgundy and Normandy for the fellows, to Normandy and Brittany for his brother and himself, and, finally, to England for himself alone. On the missions of the fellows, information is lacking. In Normandy and Brittany (May-April 1788), Augustin and José Betancourt visited "almost everything to be seen public as secret",[7] in particular, harbour facilities of all kinds in Brest, Lorient, Saint-Malo, and Cherbourg, to mention but a few, and focusing on the berthing and rigging systems developed later by José in Spain[8] (Fig. 3).

As for the mission to England conducted in November 1788, its consequences still arouse study and debate. During this stay, indeed, Betancourt fathomed, and later made public, the secret of the double-acting steam engine. His first trip to England was therefore largely devoted to the quest for this performant and the most efficient of James Watt's inventions. Its material conditions, as well as its character, pose a problem for historians to this day.[9] It seems that this mission received double funding, from the Spanish Crown (as part of the official mission) on the one hand and from the Périer brothers, mechanics-contractors and good acquaintances of Betancourt in Paris (in the interest of their own business) on the other. Whatever the

[6]See, for details: (Gouzevitch I., 2009; Gouzévitch I., Gouzévitch D, 2010).
[7](AHBC, 1788). Published in: (Cullen Salazar, 2008, pp.78–80).
[8][AHBC, Plano de la fábrica …]. Published in: (Cullen Salazar, 2008, p. 130); (Gouzevitch I., 2017).
[9]See, f. ex.: (Payen, 1969; Id., 1965; García-Diego y Ortiz, 1988; Rumeu de Armas, 1980).

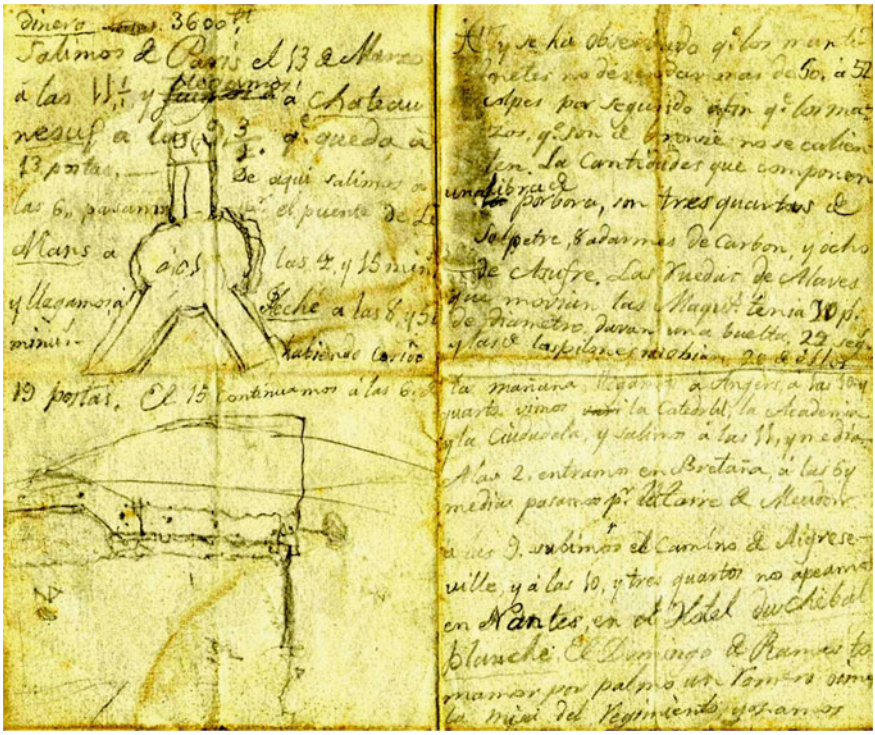

Fig. 3 Notas a lapiz de un viaje por Bretaña (Francia) realizado el 13 de marzo de 1788 escritas por José y Agustín de Betancourt y Molina, residentes en París. Fragment

source of funding, it was basically an act of espionage. The barely legal way that Betancourt accessed the secret machine (he observed it for a few minutes, from behind a wall, the day before his departure from London) leaves no doubt about it. Nevertheless, the result he obtained from this sketchy information is solely due to his talent as a mechanical engineer, coupled with the imagination of a good draughtsman well aware of geometry and his expertise in machine construction. Indeed, even his most virulent opponents admitted that Betancourt did not copy Watt's device, but rather reinvented it from the unusual outline of the cover that dissimilated the engine and from some other visible elements. He therefore created his own know-how out of his own specific skill (Fig. 4). It must also be admitted that, although Betancourt may have received commissions for the service rendered to Périer, his personal ambitions ostensibly leant towards public recognition, particularly in French academic circles, from international experts both in the world of science and in the universe of invention and industry.

As a young commissioner of the Spanish Crown hoping to make a career in his homeland, would he have been likely to seek greater gratification for this "exploit" than that granted him through Gaspard Riche de Prony's publication of

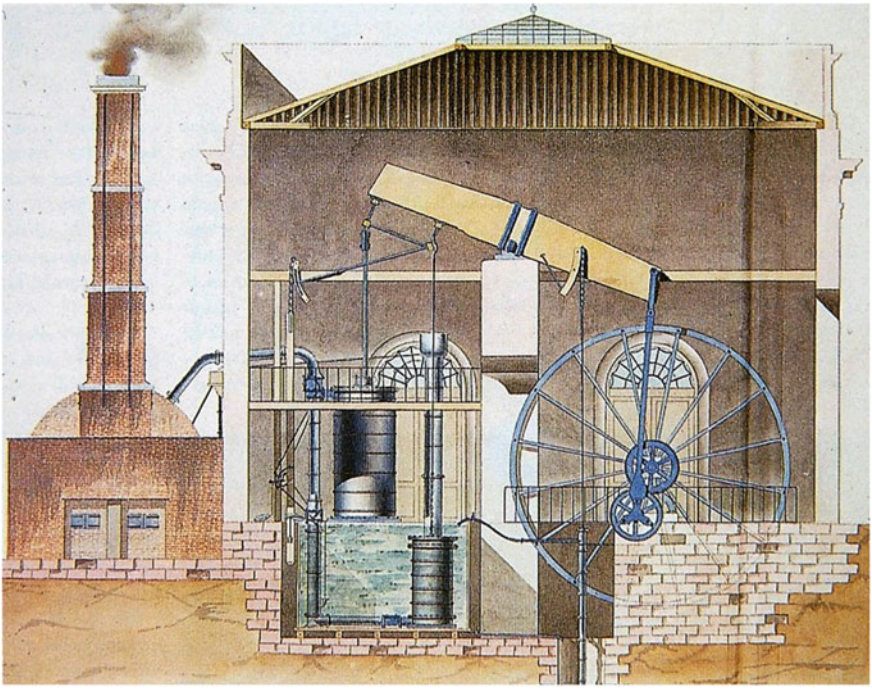

Fig. 4 A. Betancourt. Double action steam engine. 1789. Fragment

Betancourt's description of the double-acting steam engine in his *Nouvelle architecture hydraulique* (Prony, 1790–1796), regardless of Watt's feelings on the matter?[10] Meanwhile, the model of the steam engine completed the collection of machines destined for Spain, where it turned out that nobody was interested.[11] Consequently, this trip by Betancourt to England may be considered as one stage of his official French mission, both in view of its aims (seeking a specific mechanism of didactic, industrial and academic interest) and its achievements (project, model and scientific paper).[12] Taken together, these two trips allowed the engineer to carry out various activities: studies, inventions, research, industrial and educational initiatives, commissions and reconnaissance, activities that, in one form or another, he

[10]In 1807, James Watt was elected, in competition with Betancourt, foreign member of the class of mechanics at the Paris Academy of Sciences. Betancourt was elected the following year. In this way, the French academicians tried a posteriori to fend off the frustrated ambitions of the British inventor. See: (*Index biographique*..., 1979, pp. 69, 134, 504; *Procès-verbaux*..., 1913, t.1, p. 504 (séance du 2 mars 1807); Ibid., t.4, pp. 77, 78, 279, 286, 331 (séances des 13, 20.6.1808, 27.11, 5.12.1809, 12.3.1810); AAS, séances des 20.6.1808, 5.12.1809).

[11]For a revisited history of this event, see: (Gouzévitch I., Gouzévitch D., 2007; Id., 2009; Gouzévitch I., 2012).

[12](Betancourt, 1789-1). Another copy: (Betancourt, 1789-2). Réprod. in: (Payen, 1967-1; Id., 1967-2). The model is mentioned in: [Betancourt-1].

would later develop. Therein may also be found the genesis of all the main areas of Betancourt's professional interest: installations, machine-tools and processes for the textile industry,[13] devices for cleaning water streams,[14] the chemical extraction of elements,[15] and studies on the properties of steam and its applications.[16]

The next two trips followed without interruption, as, from England, where Betancourt had stayed for three years, from November 1793 to October 1796, he went directly to France, remaining there for four months, until February 1797. The factors that led him to England are threefold. On the one hand, he was driven by his curiosity as an inventor and by English excellence in the mechanical arts, which he would use both for the benefit of the Cabinet of Machines, which he directed in Madrid, and for the benefit of his own work. On the other hand, his political sympathies also played in favour of this choice; disgusted by the atrocities of the Jacobin Terror and by the danger that his friends had experienced in France (Breguet), Betancourt was seduced by British values combining individual freedoms with the stability of the social order and the rigour of political administration. The third reason was strictly personal: Betancourt looked forward to joining his family there (his wife, Anne Jourdan, and their two children), as they had settled in London after having hastily escaped revolutionary Paris.[17]

Once in England, the engineer actively set about establishing a position for himself. With his assistant, Bartolomeo Sureda, he travelled across the country, alternating visits to factories and workshops with those to public works of all kinds, carefully noting devices and innovations that could enhance the Cabinet of Machines and stimulate his own inventions. Sureda was in charge of sketching and drawing up the plans of the most interesting objects and works.[18] Thanks to his numerous contacts, Betancourt rapidly became a part of various social networks, which included, on the one hand, outstanding British scientists, engineers and entrepreneurs (such as John Sinclair, Joseph Banks and William Reynolds[19]) and,

[13]For example, the experiments on silk bleaching described in: (Proust, 1791); éd. fac-simile: [Proust].
[14]Water pump for the Channel of Aragon (1786). (Sáenz Ridruejo, 1978).
[15](Betancourt y Molina, 1785). Reprod.: (Bonet Correa, 1988; Crabiffosse Cuesta, 1996).
[16]See a detailed study: Martin Medina, Gouzévitch M., 2008-1; Id., 2008-2; Gouzévitch M., 2009).
[17](Betancourt, 1794). Fragments publ. in: (García-Diego y Ortiz, 1975, pp. 203–205); reed.: (Id., 1985, pp. 203–205).
[18]Some of Betancourt's works of this period are known through Sureda's drawings, for example, the plan of the machine for cutting grass in rivers and waterways, reproduced in: (Cullen Salazar, 2008, p. 145).
[19](Dickinson, 1921/1922). This Sketch Book belonging to W. Reynolds has 8 drawings designed by Betancourt: « Joint for cast iron plates by Mr. Betancourt. Jan., 1796»—Ink sketch, probably full size n. 10, p. 133; «Horizontal windmill [for raising water.] Chev. De Betancourt, 1784»—Copperplate engraving, elevation and plan n. 15, p. 134; A pencil note states "for the 2nd vol. of the Architecture hydraulique by Mr. Prony.» It is, however, not to be found in that work; « Istsketch of River Mill by W.[illiam] R.[eynolds]. Jan. 1796. Improved by de Betancourt»—Pencil sketch; elevation and plan; no scale n. 81, p. 135; Obviously the rough sketches for the finished drawings 99, 100, 102 and 103 below scale 1.50. « Machine for cutting weeds on rivers and canals invented by A. de Betancourt. Sept., 1796.»—Aquatint; general elevation; plan and sections.

on the other, promising young mechanics. Among the English itineraries of this period (which, apart from London and Birmingham, are not documented), one destination in particular is repeatedly mentioned, especially towards the end of his stay (1795–1796)—Coalbrookdale, a small but famous locality in Shropshire, widely known thanks to the famous Telford Ironbridge, of course, but also thanks to the density and variety of its industrial activities.[20] Many of Betancourt's works (drawings, memoirs, inventions) dated in 1796 or later seem to be inspired by his visits to this place.[21] Thus, on March 28, 1796, Betancourt signed his "Explication des principales parties du moulin pour moudre le silex", accompanied by a plan of said mill anticipated to be built on the River Severn in Coalbrookdale,[22] between the lock of the inclined plan 25 and the Iron bridge (Figs. 5 and 6).

Among the works carried out by Betancourt during this period, we find projects for various devices such as excavators, dredges (Fig. 7) and transmissions for windmills, the machine for cutting grass in rivers and canals (for which he was awarded the prize of the Royal Society of Arts; Fig. 8)[23] or the "fire pump" composed of different cylinders intended to generate motion in the press for crushing sugar cane (Fig. 9).[24] This latest work, commissioned by two rich Cuban planters and carried out at the Darby ironworks run by Reynolds in Coalbrookdale, turned out to be quite a pioneering project for a next generation steam engine—the compound machine (Fig. 10). Its manufacturing became a prologue to a new adventure for Betancourt: his two failed trips to Cuba. The engineer was first invited to the Caribbean island in order to oversee the assembly and maintenance of the steam engine on site, at a sugar refinery in Seibabo belonging to the Earl of Mopox.[25] But ultimately, in spite of the private invitation by the local administration, the same Earl of Mopox made Betancourt part of his wider Cuban project

Apparently from a Spanish book n. 94, p. 138; Float wheel arranged to drive corn mill, by (?) A. de Betancourt [1796]—Coloured drawing; sectional elevation; scale 1.60 n. 99, p. 138; Details of roller and thrust bearing for 99.—Coloured drawing; front and side views; scale 1.30 n. 100, p. 138); Float wheel arranged to drive a corn mill, no date – Coloured drawing; two plans superimposed; scale 1.60; part of set 99, 100 and 103, n. 102, p. 139.

[20]On the history of this site, often called "the cradle of the industrial revolution", see: (Trinder, 2000; Hayman, Horton, 2003).

[21]Betancourt's particular interest in this place is related to his collaboration with W. Reynolds, then ironmaster at the Darby's metallurgical enterprises. The nature of the projects contained in Reynolds' "Sketch book" (note 20) further suggests that Betancourt's involvement in the projects of various Coalbrookdale Enterprises went well beyond ad hoc interventions; he did indeed participate in the work of redevelopment of the facilities and improvement of the working conditions. It can reasonably be assumed that, by working for Reynolds, Betancourt was also trying to improve his financial situation and that Coalbrookdale was his place of residence in England during that period.

[22]The original manuscript, consisting of an explanatory note and some drawings in black and white (general view and details), is held at the École des ponts et chaussées (Betancourt, 1796-2).

[23]See the archives of the Royal Society of Arts (ARSA, 1795–1796), reprod. in: (Betancourt, 1796-1). Between pp. 316 and 317: a folding board with 3 fig. titled: «The Machine for clearing Navigable Rivers from Weeds invented by the Chevalier de Betancourt Molina».

[24]Betancourt mentions this invention in his letter to Breguet of December 10, 1794. See: (García-Diego y Ortiz, 1985, p. 204).

[25]For a history of this important invention, see: (Gouzevitch I., 2018, pp. 212–242).

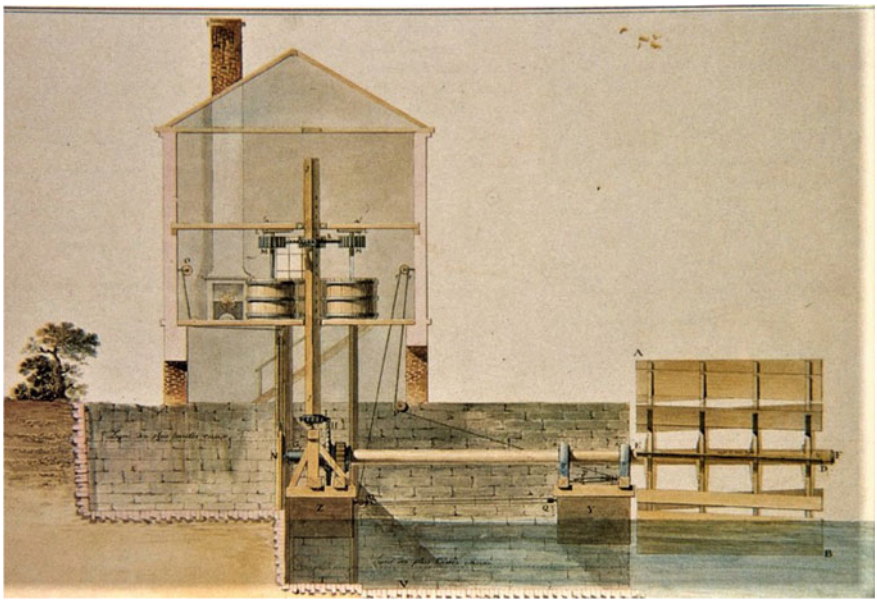

Fig. 5 A. Betancourt. Silex mill planned to be built on the River Severn in Coalbrookdale. 1796. Fragment

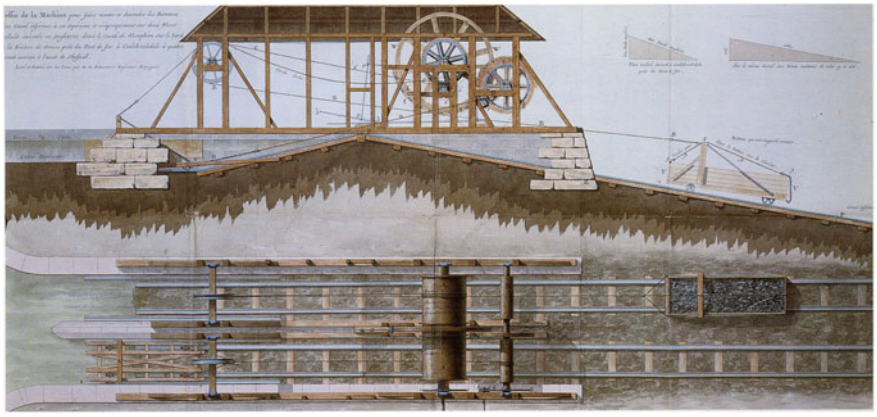

Fig. 6 A. Betancourt. Inclined Plan. 1796. Fragment

sponsored by the Spanish government, the Guantanamo expedition (1797), for which the engineer was commissioned, in addition, to purchase a large number of books and scientific instruments in London.[26] However, Betancourt missed the

[26](*Cuba ilustrada*… 1991; Tascón, 1996).

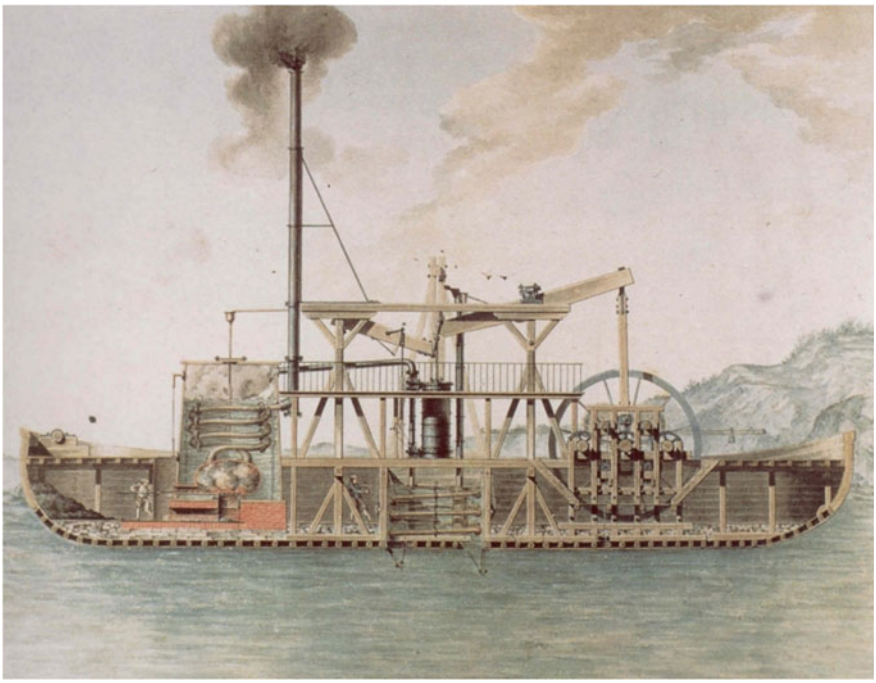

Fig. 7 A. Betancourt. Steam Dredge

departure of the expedition from La Coruña, because he was totally engrossed in another piece of work in England and France: the work, which so completely absorbed him that he would miss out on a planned trip, concerned optical telegraphy.[27]

The enormous success of optical telegraphy in England convinced Betancourt of the numerous advantages of this system and drove him to develop his own apparatus by synthesizing the advances of George Murray's English invention and the performance of Claude Chappe's system, designed in 1792 and brought to his attention by Abraham-Louis Breguet, the French inventor's co-author. Expelled from England following the break-up of diplomatic relations with Spain (Treaty of San Idelfonso, August 19, 1796), Betancourt took advantage of his passage through the French capital in November 1796 to submit to the Directoire the memoir of and plans for the optical telegraph of his own invention, in collaboration with Breguet (Betancourt, Breguet, 1797) (Fig. 11). On the benevolent agreement of the authorities, the device was tested in Meudon in the presence of Prony, who was greatly impressed with its precision, simplicity and economic assets. This initiative

[27]There is a view that Betancourt also greatly contributed to the development of the electric telegraph in Spain. However, a careful critical study of the available sources clearly showed that this is apocryphal. For analysis and argumentation, see: (Gouzevitch I., 2016–2017).

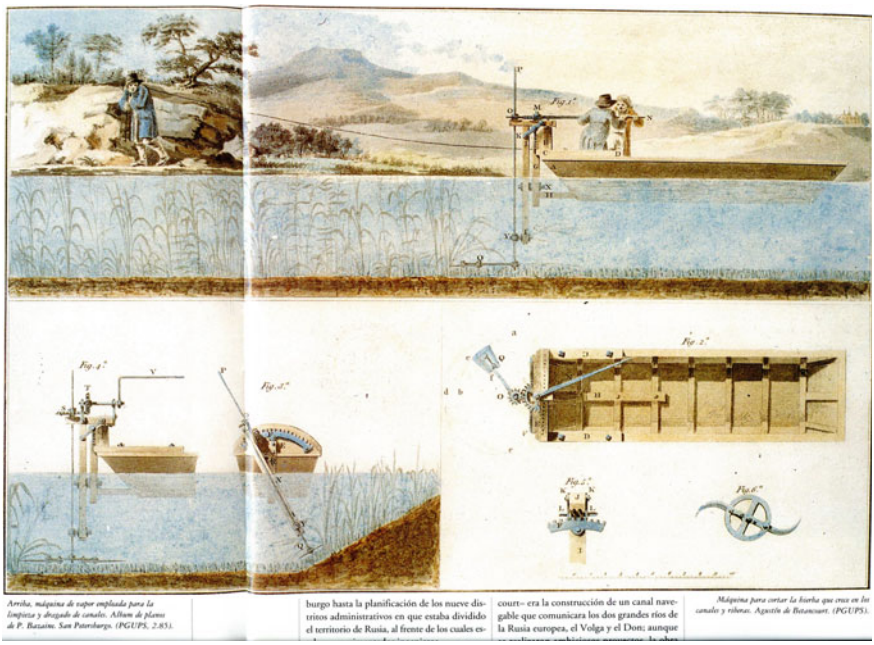

Fig. 8 A. Betancourt. Machine for cutting grass in rivers and canals

provoked the indignation of Chappe, who publically declared war on his rivals. Betancourt spent the rest of his stay in Paris fending off the attacks of the frustrated inventor. The "Réponse aux observations faites par le citoyen Chappe sur le télégraphe proposé au Directoire par les citoyens Breguet et Betancourt", dated January 7, 1797, was convincing, but the Directoire blocked the invention and archived the project. Betancourt, severely disappointed by this turn of events, finally decided to return to Madrid in order to prepare his departure for Cuba and settle his marital affairs. However, he was not the type to easily give up on what he cared about. As early as October 1797, he obtained new financing from the Spanish government to reside in France, on the pretext of acquiring a collection of mathematical instruments and books "on behalf of the king", in return for those of the Guantanamo expedition seized by the British military authorities in Portugal during the summer of 1797.[28]

Ultimately, none of these commitments prevented him, once in Paris, from devoting himself "body and soul" to perfecting the optical telegraph. This fourth visit to France, which closed the series of official trips, proved to be a longer replica

[28]Indeed, Betancourt's attempt to leave for Cuba in December 1797 quickly ended in definitive failure. The ship he had taken was attacked by a British frigate and captured. Betancourt was taken prisoner and grounded in Lisbon, but soon released. However, his luggage, including books and scientific instruments, was seized and lost.

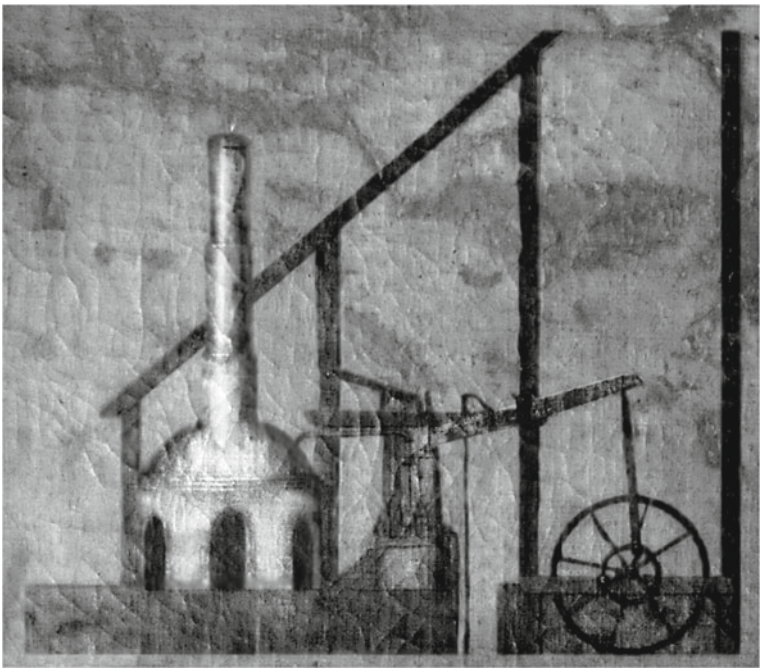

Fig. 9 Steam engine for Cuba…. Fragment. 1795

of the previous one. In fact, we find the same pervasive concern (to improve and promote his optical telegraph), the same approaches (recourse to academic expertise, experiments, public demonstrations, memoirs and academic polemics), the same setbacks (escalation of the public conflict with Chappe) (Chappe, 1797), and, finally, the same discouraging result: the definitive burial of his invention in France.[29] Since the Madrid authorities had decided to build a line of optical telegraphs in Spain (Madrid–Cadiz), Betancourt left for his motherland, and his next return to France was not until nine years later, during which time many events were to occur, not only in his life but also in the world.

The works that occupied Betancourt in Paris when he returned there in May–September 1807, and then in May–September 1808, entered a new phase during this interval. The first one concerns the diver lock—a perfectly designed hydraulic device aimed at avoiding water losses when raising and lowering ships (Fig. 12).[30] The invention itself dates from 1801, and its two models are located at the Cabinet de machines (Madrid) and the Musée de l'École des ponts et chaussées (Paris),

[29]Historians of telegraphy paid great attention to this event. See, for example: (Charbon, 1981; Id., 1988; Garcin, Narjoux, 1983). For a synthetic overview and new interpretation of this epic telegraphic story, see: (Gouzevitch I., 2020).

[30](Betancourt, 1807-1; id., 1808; Prony, 1807; Id., 1808; Id., 1809; Monge, Bossut et Prony. 1807; Id., 1808).

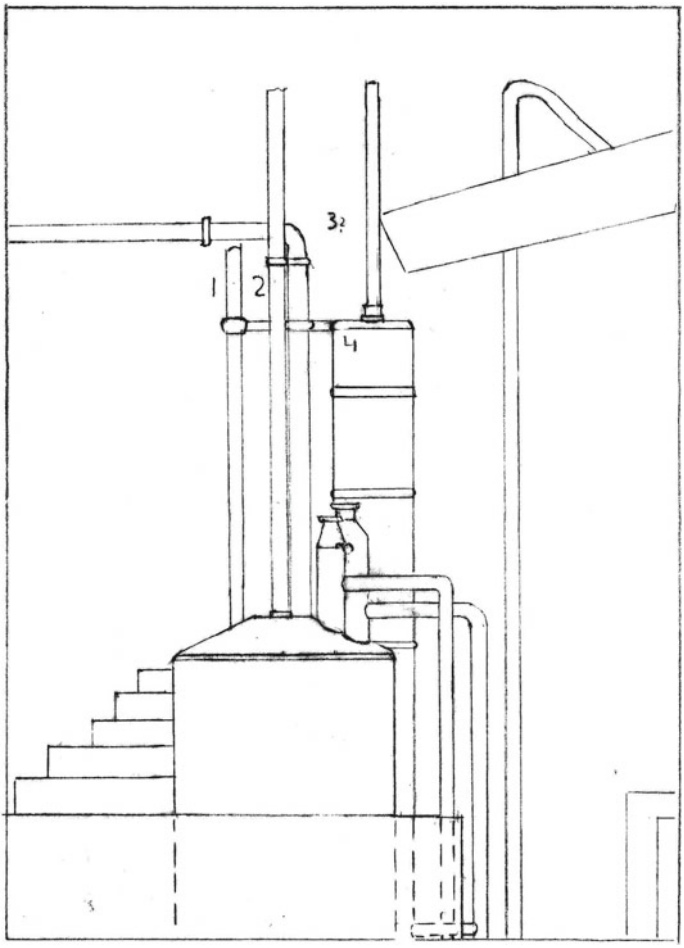

Fig. 10 Steam engine for Cuba: Dmitri Gouzevitch 's reconstruction. 2018

respectively, dated from 1802. The second of Betancourt's works of this period has an even older antecedent, insofar as the reflection on the theory of machines that he developed with José Maria de Lanz in Spain in the mid-1800s actually dates back to his first stays in France and England, and was inspired by the pioneering ideas of Gaspard Monge and Lazare Carnot on the kinematics of mechanism.[31] Finalisation of this work in the form of an academic treaty was very much a symbolic act aimed at promoting his international renown. In fact, it synthetizes Betancourt's 25 years of professional experience as an inventor, collector and classifier of machines. Both

[31](Hachette, Lanz, Betancourt, 1808; Lanz, Betancourt, 1819; Id.,, 1840; Id., 1820; Id., 1829; Fenwick, 1822). Èd. fac-simile de celle de 1808 et 1820: [Lanz, Betancourt].

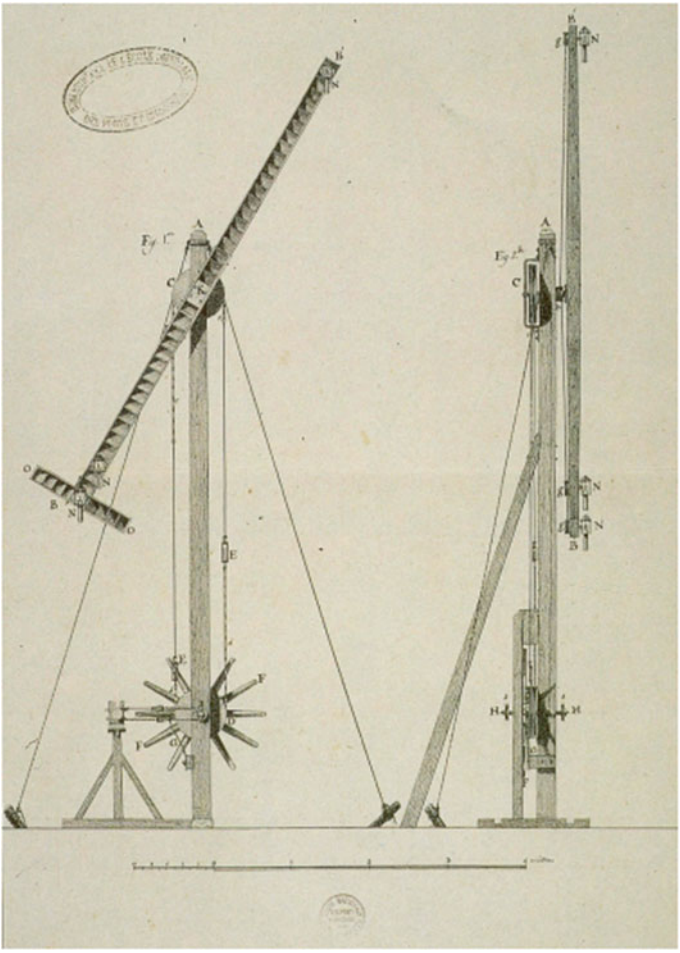

Fig. 11 A.L. Breguet et A. Betancourt. Project of optical telegraph. 1797

of these works were rewarded. The *Mémoire sur un nouveau système de navigation intérieure* submitted to the Institut National in 1807 and published soon afterwards earned Betancourt a corresponding membership in the mechanical section of the first class of this company (Betancourt, 1807-2). As for the *Essai sur la composition des machines*, submitted in 1808 for consideration by the Conseil de l'École Polytechnique and published at the expense of this institution during the same year, it was the founding work of a new science that placed its authors, Lanz and Betancourt, among the leading figures in European engineering (Fig. 13).[32]

[32]For the most complete analysis, see: (Gouzévitch D.,Gouzévitch I., 2015).

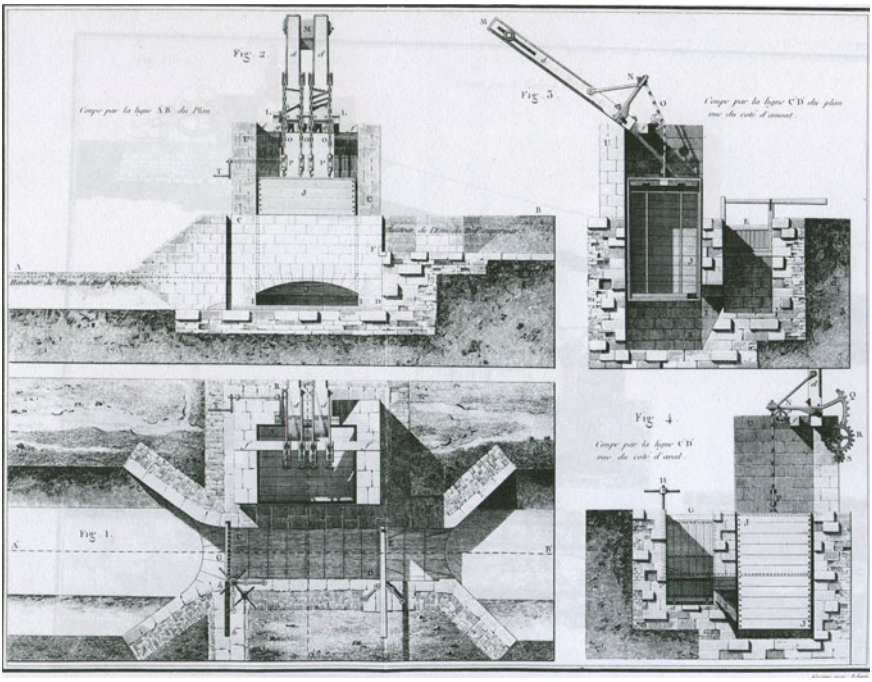

Fig. 12 A. Betancourt. Diver lock. 1807

3 The Expert at Work, or the Rise of Technical Expertise in Russia

When the *Essay* was published in Paris, Betancourt was already in Saint-Petersburg and, during his lifetime, he would never again return to France or England.[33] The extent of his responsibilities in Russia was to put an end to the escapades, and thus the flow of inventions diminished. Even if he did not completely abandon this activity, it was reduced to some interesting but narrowly fixed innovations (the steam dredge, the arches of the Kamennoostrovskij bridge or the covers of the Moscow Manege; Figs. 14 and 15). Nothing comparable to the *Essay* would be produced.

[33]Given Betancourt's status in Russia, as well as the importance and variety of his initiatives as administrator, project manager and organizer of research, citing the mass of Russian-language documents and works concerning him could clutter this overview. Having spent more than twenty years exploring this subject, I have accumulated a rich bibliography that systematically appears in my various publications in French and English. The reference to these publications in this "Russian part" of the chapter is therefore essentially intended to assist those who would like to gain a deeper insight into the subject.


Inv. 590
Q

ECOLE IMPÉRIALE POLYTECHNIQUE.

PROGRAMME
DU
COURS ÉLÉMENTAIRE DES MACHINES,
POUR L'AN 1808,
Par M. HACHETTE.

ESSAI
SUR
LA COMPOSITION DES MACHINES,
Par MM. LANZ et BÉTANCOURT.

À Mr. Bossut
De la part du Conseil
d'Instruction de
l'Ecole Polyque

A PARIS,
DE L'IMPRIMERIE IMPÉRIALE.
1808.

Fig. 13 Essai sur la composition des machines. Cover. 1808

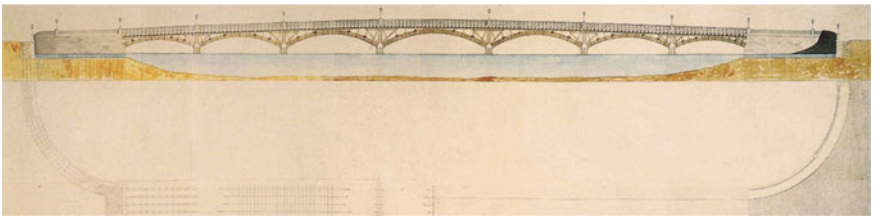

Fig. 14 A. Betancourt. *Kamennoostrovskij Bridge. 1811. Fragment*

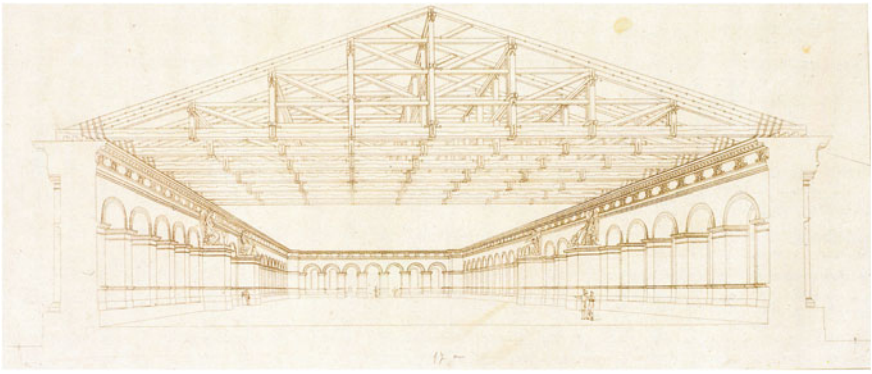

Fig. 15 A. Betancourt. Manege de Moscou. 1817. Fragment

These two passions, invention and systematization, which, until then, had filled and punctuated his existence, gave way to quite different occupations—ones that were pedagogical, administrative and organizational. His experience in the organization and management of the *Cuerpo* and the *Escuela de caminos y canales* in Spain certainly weighed in favour of his invitation to the service of the Russian Crown at a time when the Russian government was launching a reorganization of its administration of public works.[34] In a way, he worked within the scope of his

[34]Originally, the idea of entering Russian service was hinted to Betancourt by Ivan Murav'ev-Apostol, Russia's envoy in Madrid in 1801. The friendly contacts with the Apostol family were renewed as soon as Betancourt settled in Russia. Two sons of the former diplomat, Matvej and Sergej Murav'ev-Apostol, were admitted to the Institute of the Corps of Engineers of Communication at its opening (1810). However, the poor academic performance by Matvej and the ensuing dispute between his aristocratic father and the Spanish engineer on this occasion caused the breakdown of relations. Instead of encouraging his son to make his greatest effort, the dignitary supress went after the mathematics, requiring that Betancourt simplify the teaching curriculum. Betancourt ignored this claim, and Matvej had to leave the institution. One perceives the kind of difficulties that Betancourt had to face in setting up an extremely advanced system of technical education. In contrast, Sergej was a brilliant student, one of the best in his class. However, neither of the two brothers went on to embrace an engineering career. Their names are

charges in Spain, but on a much larger scale, since, there, he was involved in the organization of a big technical corps, that of the Engineers of Ways of Communication (public works), and became a promoter of an engineering school specialized in public works, the Institute of the Engineers of Ways of Communication. Moreover, he did all that was within his power to sustain the institution during its difficult period of growth.[35]

However, it was in the specific context of Russia that, thanks to his previous engineering practice, Betancourt perceived the importance there and elsewhere of the pioneering initiatives he was led to promote. These initiatives involved the creation of national structures for technical expertise that were supposed to control all construction activities in the Empire, which had increased considerably thanks to the building boom that Russia experienced in the mid-1810s.

The first of these structures, created in 1816 under Betancourt's direction, was called the Committee for Hydraulic Construction and Works at Saint-Petersburg and in the surrounding areas (the Hydraulic Committee = Gidravlicheskij komitet). Conceived with the ambition of "promoting construction in the capital", it offered an original synthesis of engineering and art thanks to the specific and complementary skills put at the service of collective expertise. One can find, among its first members, some renowned architects, such as Karl Rossi, Vassilij Stassov, Andrej Mikhaïlov II, and Antoine-François Mauduit, and three engineers, Guillaume Traitteur, Aleksandr Gotman and Pierre-Dominique Bazaine (Fig. 16). The latter, a Polytechnician and French engineer of public works (ingénieur des ponts et chaussées), invited to the service of the Crown in 1809 by Betancourt, took charge of the Committee after Betancourt's death in 1824 and assumed it for ten years, until 1834. The projects of all of the works, both those in progress and those to be undertaken in the capital, had been previously examined within this regulatory framework, which required a complementary commitment of expertise concerning all the projects involving urban planning, including dredging canals, installing rainwater sewers, paving streets, establishing anti-fire measures, and so on. Matters of embellishment and urban planning that fell within this framework were still being carried out well into the middle of the 20th century. It can be said without exaggeration that the classical aspect of Saint-Petersburg as it was formed during the 1810s–1830s is widely dependent on the continuous effort of the Hydraulic Committee, which brought together, directed and piloted the work of thousands of architects and engineers.

All urban planning at the time was part of the architect's functions. However, the development of the city in the 1820s posed problems the solution of which required specific knowledge in engineering, mathematics, hydraulics, physics and chemistry. This task exceeded the competence of architects, while the service of urban

celebrated in the history of Russia for a completely different reason: as active members of the famous Decembrist revolt (December 14, 1825), they suffered a tragic fate: Sergej was executed along with four other leaders of the movement, while Matvej spent about thirty years in exile. Correspondence of the Murav'ev-Apostol family: (GARF, f.1002, op.1, d.2-4).

[35]For the early history of the Corps of the Engineers of Ways of Communication and of its Institute, see the bibliography in: (Gouzévitch D., Gouzévitch I., 2000; Gouzévitch D., 2009).

Fig. 16 Pierre-Dominique Bazaine. Portrait. Acquarelle. 19th century

engineers had not yet been created. In the meantime, this function fell to the engineers of the Hydraulic Committee. Having received high-level architectural training, they proved themselves capable of approaching such problems in a complex way that combined the vision of an engineer with that of an urban planner and architect.

Thus, through the creation of the Hydraulic Committee, Betancourt managed to address the difficulties of architecture and urban planning in the capital for a quarter of a century to come. The second expert body he created in 1820, the Commission for Projects and Budget Estimations (Komissija proektov i smet), had, as its main

task, the solution of another very important set of problems dealing with the solidity and reliability of constructions, as well as their cost. The variety of areas and the range of problems faced by the Commission strikes the imagination: bridges, wharves, locks, canals, landing sites, harbours, houses and industrial buildings, mills, churches, roads, belltowers, boats, steam engines, dredges, machine tools, pumps, artillery guns, cartographic structures, steam ships, locomobiles, snow-ploughs, railways, and so on. Documents concerning the listed fields can be grouped into three categories: projects and specifications of constructions to be carried out, in progress or already executed; inventions and discoveries of individuals, from the universal motor to the quadrature of the circle; and information sent from abroad, collected by diplomatic channels and all kinds of specialized missions, as well as articles and reports by foreign correspondents of the Department of Ways of Communication and proposals from foreign engineers and architects. Further important activities of the Commission were to standardize, normalize and unify construction works; to develop rational methods for realizing projects; and to produce normal records, guides concerning construction and maintenance standards and rules, and all kinds of manuals and normal drawings.

On the one hand, the Commission sorted out projects by eliminating all of those that looked unreal or of poor quality and highlighted errors by pushing to correct or redo the projects and budget estimations until they reached the required level. On the other hand, the Commission itself, using its enormous amount of experience, prepared and enforced the standards and rules for effecting these projects and estimations. It also insisted on the mathematization of the art of engaging in projects, and perfected the methods for the proofing of constructions, their elements and building materials. The main result of its activity was a significantly reduced number of disasters in construction due to errors by the engineers. Indeed, Russia has experienced very few such disasters. And so many lives have been saved!

These two examples are emblematic of the particular spirit that animated their founder, a spirit that combines the rationalism of the Enlightenment based on unity of the sciences with the romantic belief in the omnipotence of the individual armed with knowledge.[36] That individual's lucidity, however, goes beyond their own ambitions, because the objective is not within the reach of a single person, whatever their personal competence, but of a group of experts with diversified and complementary skills.

4 Social Network and the Construction of an Expert Authority

Betancourt's Spanish-Russian comparative experience prompts us to reflect on another phenomenon closely linked with his mobility: the creation of an international sociability network. Wherever he went, Betancourt made contacts and

[36]For the early history of these organizations, see: (Gouzévitch D., Gouzévitch I., 2005-3).

brought in his wake a multitude of people who supported him, worked alongside him and then took over. This lifelong network included, above all, technical experts (engineers, inventors, mechanics, entrepreneurs and tradespeople), but also scientists and artists, writers and art lovers, diplomats and senior officials, and, finally, sovereigns and their ministers. This network was multinational and integrated the representatives of France and Britain, Spain and Russia, Switzerland and Germany. As for the criteria for their selection to be associated with one task or another, Betancourt formulated it as follows: "I had on principle to always address the best artists…" (Betancourt, 1799). Notably, the word "artist" must be understood here in its broadest meaning, which is equivalent to "the expert", that is, one "versed in the knowledge of something by practice", and consequently "capable of judging something, a connoisseur" (*Grand Larousse…*, 1961). In short, a specialist with specific and appropriate knowledge and know-how in a given field, who has authority in their milieu. Comparing Betancourt's activities in France, England, Spain and Russia, this approach was highly selective and differentiated according to whether it involved cooperation in a project of invention and its public recognition or in the creation of an educational institution, professional administration or instance of technical expertise with respect to national interests. The list of Betancourt's contacts in France and England reflects the variety of approaches that he himself used to apply in his personal work as an engineer, inventor and entrepreneur and in his activities as a public, state servant in Spain and Russia. He logically adapted the profile of his collaborators both to the needs of concrete projects and to the conditions of a given country.

In this context, France and England serve as reference models, each of which has its own specific features. Thus, Betancourt's sociability network in England mainly included individual contacts with some outstanding mechanicians, engineers and entrepreneurs, such as James Watt, Matthieu Boulton, William Reynolds, and John Rennie. There was only one institution, the Society for the Encouragement of Arts, Manufacturing & Commerce, and, again, it was a free association of experts and patrons (which, in 1796, awarded him a prize for the device for cutting grass on the edges of canals). France, in contrast, provided two quasi-parity lists, one of individual contacts and one of institutional contacts. The first, in addition to mechanics and entrepreneurs (Jacques-Constantin Périer, Étienne Calla, Abraham-Louis Breguet, Jean-Pierre Droz, Sébastien Erard), also comprised many eminent state engineers (Jean-Rodolphe Perronet, Gaspard Riche de Prony, Jacques-Elie Lamblardie, Gaspard Monge), savants (Barthélémy Faujas de Saint-Fond, Joseph-Louis Proust, Jean-Nicolas-Pierre Hachette), including many academicians (Jean-Charles de Borda, Mathurin-Jacques Brisson, Charles-Augustin Coulomb, Jean-Baptiste-Joseph Delambre, Pierre-Simon Laplace, Joseph-Louis Lagrange), and politicians (Jean-Paul Marat, Ange-Marie d'Eymar). As for the institutions, they were all the bodies of authority—intellectual and/or political—in the world of science and technology, in France and beyond its borders, such as the Jardin des Plantes, the École des Ponts et Chaussées, the Académie des Sciences and the École Polytechnique.

In Betancourt's life as an engineer and inventor, these two experiences (French and British) followed parallel paths for a long time. In the practice of actions in which he engaged successively in Spain and Russia—and which concerned, above all, the management of major public works and the creation of institutions and administrations—they eventually intersected and merged. The comparative study of these activities suggests that this synthesis took its completed form in Russia, even if the French influence prevailed first.

The feeling is that Betancourt carried France in his baggage, in his head, in his heart, and that, without being able to return there, he took it to Russia and put it to work for all of his enterprises. French remained his language of communication in Russia. Even his entrance into the Russian service directly depended on his French experience, since, having preferred Betancourt to a renowned competitor, the Bavarian engineer Karl Friedrich Wiebeking, who offered his services to the emperor in Erfurt, Alexander I actually confirmed the choice he had made in expressing his preference for the French educational system embodied, in his eyes, by Betancourt (Gouzévitch D., 1994). And this is all the more true if one believes that the Escuela de caminos y canales was designed on the example of the Ecole des Ponts et Chaussée during its early period under Perronet. However, in Russia, Betancourt took his keen knowledge of France much further. Although it is generally known that the Institute of Engineers of Ways of Communication had fully benefited from his Parisian contacts, it is also evident that the Russian institution did not simply reproduce its Spanish counterpart, but was rather inspired by a later reference bringing together, "under one and the same roof", the École Polytechnique and the École des Ponts et Chaussées as an "application school".[37] Another fundamental difference from his Spanish experience is that Betancourt invited, as professors for his Russian institution, a group of French polytechnicians, and not his former Spanish students and colleagues who had followed him to Russia (brothers Joachim and Michael Espejo, Rafael Bauza, Agustín Monteverde, and Joachim Viado). As for his British colleagues, they first appeared only in his entrepreneurial transactions. Thus, a certain Ingram Binns took over from Betancourt in the management of the cotton factory of Àvila in Spain (the factory itself having been founded by another Englishman, Thomas Milne) (Martín García, 1988). The Brits that Betancourt knew in Russia were all entrepreneurs, manufacturers or managers of various industrial enterprises. Neither in Spain nor in Russia did Betancourt associate any of them with the teaching of future state engineers in the schools he had founded.

The picture looks quite different when we consider another major aspect of Betancourt's activity in Russia—the organization of scientific research in engineering. The multinational group of engineers and mechanics who were part of his entourage in Russia formed the origin of fundamental research in the fields of construction, transport and steam technologies.[38] The fact that Betancourt included

[37]Pour une analyse comparée: (Gouzévitch I., 2004; Id., 2000).
[38](Gouzévitch D., Gouzévitch I., 1997; Id., 2001; Id., 2003-1; Id., 2003-2; Id., 2005-2; Id., 2006-1; Id., 2008-2; Gouzévitch D., 2008; Gouzévitch I., 2008).

the famous British mechanic and contractor Charles Baird in these projects, a man who took an active part in the experiments carried out by French and Russian engineers by offering them the technical power of his mechanical works in Saint-Petersburg, illustrates a synthetic approach forged at the crossroads of his two European experiences. This synthetic spirit, based on two pillars—French theory and British empiricism—is the essence of the scientific school of Russian engineering that was then set up in the country.[39] The same approach is typical of the expert organizations mentioned above. Because, even if the British (Charles Baird, Matthew Clark, Alexander Wilson, and Adam Armstrong) were not officially members of either the Hydraulic Committee or the Commission for Projects and Budget Estimations, they intervened in most discussions concerning the major works and technical initiatives to be undertaken in the Empire.

In a more global way, the activity of Betancourt in Russia marks the advent of the modern engineer in that country. As for Betancourt himself, during the latter part of his career, he took on the role of international mediator, integrating Russia into the European professional social network. Thanks to his colleagues and students, he thus ensured his own return to Europe.

5 Some Concluding Remarks

Thinking back on this overview analysing the role of travel, or, more broadly, of either desired or forced migration, in the construction of the identity of an expert, I will conclude along two different lines.

Firstly, I will re-affirm their essential role in the life of Augustin Betancourt, man and scientist. It can be said without exaggeration that each of these stays, and even more so the sum experience, punctuating his career, from youth to old age, and accompanying his professional development, contributed to perfecting his education, refining his professionalism, forging his character and building his personality. In short, they helped him to accomplish his vocation. Their pivotal and transversal role is clear from the major initiatives he was able to deploy in Spain and Russia, as promoter of the modern educational and administrative structures for the engineers of public works inspired by the French model. Travel therefore contributed to making Betancourt an important player in technical progress in each of these countries. It also helped him to go beyond national frontiers and to become a European-sized mediator, called to weave the links of sustainable communication among individuals, institutions and States.

On a personal level, the impact of his travels in France and England seems more complex. Betancourt developed intimate and emotional ties with both countries. Moreover, he succeeded in drawing from these two experiences the best that each could offer him: their institutions, their libraries, their collections and workshops, their companies and scientific organizations, their knowledge and know-how, their

[39](Gouzévitch D., Gouzévitch I., 2006-2; Id., 2005-1).

technical and scientific achievements, and, finally, their sociability. In short, something that would today be called "a nutritive environment" conducive to creation. Merged and assimilated, Betancourt's French and English experiences contributed to refining and disciplining this original talent, to make it bloom at the crossroads of two technical cultures, which were then referential in regards to the whole of Europe. This dual culture made him a learned expert of rather special stature who served the cause of modernization by combining the charges of a civil servant with the verve of the vocation of an inventor, but who, ultimately, sacrificed material benefits (industrial applications) in favour of intellectual recognition and public notoriety. In most cases, indeed, he finalised his work in the form of academic memoirs and, through them, sought the attention of men of science. As for applications, he mostly abandoned them to his colleagues and friends with greater business skills.

The growth of these activities contributed, over time, to transforming the nature of Betancourt's travels. If his first trips outside of Spain were classic official missions aimed at gathering information on European technical advances, entirely in line with the modernization policy of Spain since the mid-18th century, the later ones are more reminiscent of escapes that the engineer strove to disguise as commissioned charges. Even if he performed these duties honestly, he did not hesitate at the same time to undertake his own works, since he was not eager to go back to Spain.

Betancourt's recurrent returns to France and England, in favour of which he did not hesitate to abandon his high functions in Spain, as well as other advantageous proposals (Cuba), suggest that these stays, over time, provided him with a sense of autonomy, as necessary to him as the air he breathed, that he was guided by the unfulfilled desire to act, love and work in his own way. This brings me to my other conclusion, which concerns the complex motivations that conditioned Betancourt's travels.

Indeed, on closer inspection, there is not a single reason for these incessant comings and goings. The freedom to devote himself to his inventions, the pleasure of communicating with like-minded colleagues, the intellectual context conducive to creation represented only one facet of this epic, while the other was personal and social. His wife and family undoubtedly played a major role in his choice in favour of mobility and final definitive expatriation. By joining in union with a foreigner, under conditions that were not particularly "Catholic", he committed a grave social imprudence that never ceased to weigh heavily on his existence.[40] The evolution of his political opinions and social relations in Spain and France is another problem that needs to be mentioned. A liberal monarchist in his youth and with convictions that strayed far from the great problems of politics, Betancourt was so immersed in his own affairs that he hardly noticed the beginnings of the French revolution in

[40]Indeed, Betancourt married Anne Jourdan twice in the same year, 1797, first by a civil marriage in France, then by a religious marriage in Spain. However, their common life dates back to the early 1790s, because, at the time of their two marriages, they were already the parents of two children. See: (Breguet, 1983).

1789. At least, there is no trace of it in his abundant correspondence. However, the terror, which came close to striking his family and close friends in France, completely distracted him from any spirit of revolt and social contestation.

Forced to evolve in a world where the king was the law, Betancourt felt seduced by British liberalism. As a civil servant, he was entirely dependent on power, and this created great tension in his existence, torn between two extremes: the naive vanity of benefiting from sovereign favours and having state responsibilities on the one hand and the creative freedom that incessantly pushed him away from them on the other. After fleeing repeatedly from Spain, an action that inevitably led to his resigned return to the bercail, he thought he could overcome this split in Russia, having trusted in the Emperor's protection. Yet by doing so, he became caught in his own trap. For the king's servant was never safe from arbitrariness. And, like many other creative actors, Betancourt suffered its devastating effects.

This leads me, finally, to ask the fundamental question that links this man's mobility with his role as a learned technical expert and social professional mediator: what was so exceptional about his career? The study shows that, at every stage of his existence, Betancourt strove to grasp the important techno-scientific problems of the day and to propose daring solutions. Their local implementation sometimes came up against one or another of the following typical problems: lack of skills, infrastructure and materials; poor management amid political confusion; inertia of the milieu; or insufficient technical culture due to the lack of required training. Betancourt, on the other hand, was too self-confident to dwell on such trivialities. His curiosity encouraged him to constantly push back the cognitive boundaries and not mind if certain projects momentarily failed. He was confident in his art and in the omnipotence of science… Thus, his pragmatism involved a lot of idealistic and speculative dreaming, but, overall, it was perceptive, for most of his innovative ideas stood the test of time and eventually revealed their usefulness and relevance.

The originality of his approach was therefore due to the very personal, interactive and intimate relationship he had with the world of technology. This relationship, both intuitive and reasoned, was nourished by a love of art, a respect for science and a deep conviction that techniques and engineering have their own intelligence. Seen from this perspective, his life and work appear as a sustained effort to give this particular brand of intelligence a sense of nobility, visibility and fully recognised socio-professional respectability.

If one must designate his professionalism in terms of vocation, it was based on three pillars: expertise, network and mobility. This particular combination of operational modes was proper for Betancourt. Thanks to individuals like him, the Europe of engineers became a connected space. For all of these reasons, I can affirm that Betancourt, as a learned travelling mediator, owing not only to the scope of his work and the diversity of his talents, but also to his complex personality and path, unquestionably remains one of the emblematic characters of this generation of the Enlightenment, which gave origin to modern engineering in the sense that we understand it today.

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