BRAZILIAN ENGINEERS IN THE FRENCH "GRANDES ÉCOLES" IN THE 19TH CENTURY

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1.- Introduction.

Between 1825 and 1903, almost a hundred Brazilian students passed through the French *grandes écoles* of engineering – namely, the Polytechnique, Mines and Ponts et chaussées –, and made up a significant number within the 'community' of Brazilian engineers. In this paper, I present some research results, carried out during my post-doctoral studies in 2002, under the supervision of André Grelon and Irina Gouzévitch. I attempt to map out this 'community', in time and in space, so as to contribute to the understanding of the roles played by these Brazilian engineers, and of the mark they left in the historical process.

The almost 90 engineers constituting the object of my research lived and worked in the 19th century. The results of the research allow us to determine this overall picture more precisely. Many authors, from the most diverse historiographical tendencies, recognize the 19th century as one of enthusiasm for Progress, underpinned by science and technology. From the 18th century onwards, and particularly in the 19th century, conditions emerged that gave the group of engineers its specific identity: training schemes, defined career, professional title, and social status. From the very beginning, the engineers were mainly active in the military sphere, in border demarcation, in producing maps and in the building of fortifications, as well as in scientific surveys related to Natural History, given the strategic importance of this kind of knowledge for the economic and political stability of the national States[1]. Already in the first decades of the 19th century, the participation in civil cons-

1 PATACA, Ermelinda Moutinho (2006) *Terra, água e ar nas viagens científicas portuguesas (1755-1808),* Tese de doutorado, Campinas, Universidade Estadual de Campinas.

tructions was noteworthy, and it would grow in the direction of industrial activities. This vast variety of attributions had as a common denominator the production processes of knowhow and technical devices plus the organization and control of collective work in its several stages[2]. The engineers showed themselves to be, at the same time, not just the initiators of numerous technical changes but also the organizers, and administrators of the new technical systems, guaranteeing their continuity and correct implementation[3]. There was a large degree of involvement of the engineers in general, of different nationalities, and in different parts of the world, in the such-called civilizing missions, modernization, social and urban reform projects, and doubtlessly many shared Positivist ideas – so cherished and influential on this side of the Atlantic.

The general view in the 19th century Brazil, *grosso modo*, was permeated by a strong belief in the 'improvements' that science and technical expertise, together with engineering knowledge, would bring to the country, as it is shown by Turazzi:

> *"the word 'melhoramento'* (improvement) [is] *one of the most revealing expressions of the ideological convictions that underpinned the nation-building project by the Brazilian elite in the 19th century (...). As a verbal expression of an unshakeable conviction in progress, the noun and almost all its derivative adjectives referred, directly or indirectly, to public works and to the work of engineers, architects, scientists and industrialists"* [4].

2.- Brazilian engineers in France.

The Table below, which quantifies and distributes the engineers according to their period and to their school, and the graph it generates, help us to identify three large groups of students or phases.

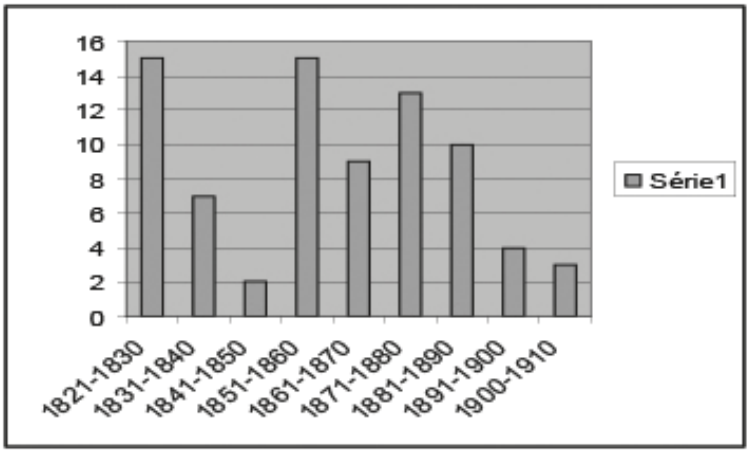
2 GRELON, André (2001) "Emergence and growth of the engineering profession in Europe in the 19th and early 20th century". In: GOUJON, Ph.; DUBREIL, B. H. (ed.) *Technology and ethics: a European quest for responsible engineering,* Leuven, Peters, 75-99.

3 GRELON (2001).

4 TURAZZI, Maria Inez (2001) "A exposição de obras públicas de 1875 e os 'produtos da ciência do engenheiro, do geólogo e do naturalista'". In: HEIZER, Alda; VIDEIRA, Antônio Augusto Passos (ed.) *Ciência, civilização e Império nos trópicos*, Rio de Janeiro, Access Ed., 145-172. Citation from page 148.

Decade	Polytechnique	Mines	Ponts & Chaussées	Total
1821 (1825) – 1830	7	8	??	15
1831 – 1840	6	1	??	7
1841 – 1850	1	1	11 (total for the three decades)	2
1851 – 1860	--	10	5	15
1861 – 1870	--	7	2	9
1871 – 1880	--	8	5	13
1881 – 1890	--	3	7	10
1891 – 1900	--	--	4	4
1901 – 1910 (1903)	1	1	1	3

Table 1 – Number of Brazilian students in each *grande école* and the total amount by decade. Sources: Historical Archives of the three schools.



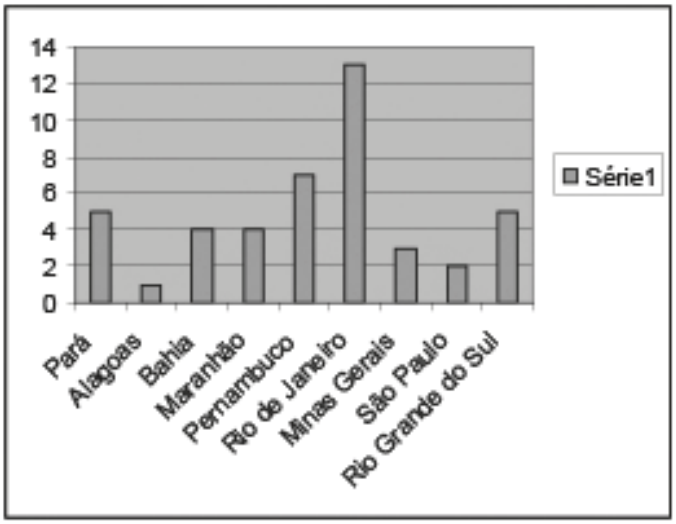
Graph 1–Temporal distribution of Brazilian students in the three *grandes écoles* by decade.

The first perceptible group (of 15 students) is concentrated immediately following the Independence of the country from Portugal in 1822 – the first enrolments date to 1825 –, followed by the turbulent decade of 1831-1840,

during which three periods of Regency followed each other in quick succession. It is well worth noting that the number of students was reduced by half, from 15 to 7. In the following decade, the flux almost comes to a standstill (only two students, in 1842 and 1843), probably reflecting the turbulence and disputes that went on after the Age of Majority (of the Emperor) were brought forward. In these three decades, we also know that besides the students mentioned by name, who frequented the École polytechnique and the École des mines, 11 more students, unidentified and not distributed with annual precision, frequented the École des ponts et chaussées. We leave them out of the specific count by decade, in view of the inaccurate data.

The second largest group appears from 1853 onwards, when an upturn in student numbers is clear: once again, 15 students followed their courses in Paris. However, in contrast to the previous period, until the end of the century the enrolments were distributed between the École des mines and the École des ponts et chaussées, with a notable predominance of the former until 1880 – only then will there be an inversion, with predominant enrolments in the École des ponts et chaussées. In this inversion, we may identify our third group, or wave, which will decline in the following two decades (1891–1900 and 1901-1910), to the point of almost disappearing from the records.

As for the geographical origin of these Brazilian students, the following graph shows their distribution by province in the case of the École des ponts et chaussées, for which the data is available:



Besides Rio de Janeiro (Province and Court, because the data does not allow us to separate them specifically), understandably prominent for its pivotal political and economic role, our attention is drawn to the concentration of students from the old North region (provinces of Pará, Alagoas, Bahia, Maranhão and Pernambuco), which amounted to 22 students, more than double those from the South-Southeast region (São Paulo, Minas Gerais and Rio Grande do Sul provinces). On the one hand, this could be due to the economic and political power of the North/Northeast. On the other, perhaps the greater proximity to the Court may have led young people from São Paulo and Minas Gerais to the pre-existing engineering schools there.

It is possible to associate these groups within the known overall framework. The first institutions of military education in the Portuguese colonies date back to the end of the 17th century, resulting from the context of the Portuguese Restoration and from disputes with Spain. During the reign of D. João V, the Conselho Ultramarino (Overseas Council) was involved in the teaching initiatives in the Academia de Fortificação in Rio de Janeiro, with a view to providing the necessary elements for the defence of the coast, given the growing tension between Portugal and Spain. The Ordem Régia of August 19th, 1738 made military education obligatory and no officer could promote without having spent five years in the Aula Militar (Military Class). At this time, the Aula do Regimento de Artilharia (the Artillery Regiment Class) was established in Rio de Janeiro under the directorship of the well-known José Fernandes Pinto Alpoim[5].

Independent Brazil followed the movement of intensifying the use of technics and the demand for engineering. Since the transfer of the Court (from Portugal, in 1808), training institutions for engineering professionals emerged as a result of the perception of how the Portuguese empire was greatly out of phase with the Industrial Revolution in progress. First, the Academia Real Militar (Royal Military Academy) was founded in 1810. It was later (1839) transformed into the Escola Militar (Military School), which gave birth, in 1855, to the Escola Central (Central School) –heir to the civil branch of engineering, thus separating definitively from military engineering. The Escola Central was transformed into the Escola Politécnica (Polytechnic School of Rio de Janeiro) in 1874. In 1875, the Escola de Minas de Ouro Preto (Mining

5 TELLES, Pedro Carlos da Silva (1984) *História da engenharia no Brasil*, Rio de Janeiro, Livros Técnicos e Científicos Ed.

School of Ouro Preto) was also created, in order to foster the education of professionals for mining activities[6], besides other engineering schools that followed. The main activities of engineers in Brazil during the last quarter of the 19th century were basically concentrated on buildings, ports, and railways.

It seems clear that sending the first group to France was connected to the training of staff for the new independent State, while the second wave coincides with the period when Brazil had already concluded the phase of political consolidation, thus being able to dedicate itself to investments and to improving infra-structure[7], which includes staff training. On the political, material, and social level, the task in hand was the effective construction of the Empire: its consolidation at different levels. On the representational level, the challenge was to conquer space for the young nation within the world community –that is, the *civilized world* to which Brazil aspired to belong, with its ideals of progress and of order which became points of reference. Thus, France continued to be a relevant option, but it was no longer the École polytechnique that stood out, but the École des ponts et chaussées.

Let us also keep in mind that the definitive split between the civil and military branches and the diversification of engineering courses took place in Brazil in the 1870s, with the founding of the Escola Politécnica do Rio de Janeiro in 1874 (which had a course of mining engineering) and the Escola de Minas de Ouro Preto, in 1876. Therefore, the inversion in the flux to France between 1881 and 1890 seems plausible. This phase coincides with the end of the Empire and the much-vaunted surge in modernization. In 19th century Brazil, especially in the second half, there was an awareness that these changes were in progress in the West and pressing for access to modernity. As Pesavento pointed out, the Brazilian intellectual elites understood technical-scientific progress not just as "something they had heard of" but rather as an objective that the country "should pursue so as to attain the status of modern"[8].

The modernizing projects that circulated during this transition, totally or

6 CARVALHO, José Murilo de (1978) *A escola de minas de Ouro Preto: o peso da glória,* São Paulo, Ed. Nacional; Rio de Janeiro, FINEP; FIGUEIRÔA, Silvia Fernanda de Mendonça (1996) "Engineering schools as institutional *loci* for geological sciences in Brazil during 19th century", *Antilia*, vol.1, num.1, January, 12 pages. (http://bddoc.csic.es:8080/detalles.html;jsessionid=097B0230B4F60D7FF73E5DC8BE45D425?id=276685&bd=HISTORI&tabla=docu).

7 CARVALHO (1978).

8 PESAVENTO, Sandra Jatahy (1997) *Exposições Universais: espetáculos da modernidade no século XIX*, São Paulo, Hucitec, 62-63.

partially implanted, required engineers with very diverse training, whether it be for sanitation works, urban reorganization, building of new cities, for interventions in the natural environment, such as combatting droughts, road building, surveys of natural resources (see the Geographical and Geological Commissions of São Paulo and of Minas Gerais, or the Brazilian Geological and Mineralogical Service), among others. Engineers, together with doctors, incarnated the role of 'missionaries of progress', as denominated so appropriately by Kropf[9].

3.- Students abroad: why?

I believe that it is possible to discriminate this general framework and the phases even better. Focusing on the first wave of students, it is important to bear in mind two points, following in the footsteps of Karvar[10], which are essential when considering the Brazilian case. In the 19th century the concept of "Polytechnique" was understood as synonym of a training school for technical staff at the service of the State, with a view to the unification, and defence of the territory, its spatial organization, and the exploitation of its natural resources. What is more, at the beginning of the 19th century,

> *"France, with its corps of professionals working for the State and its complex system of training civil and military engineers, offered the best example of the technocratic model of recruitment of specialized civil servants based on scientific and technical merit. The civil and military profile of the Polytechnic engineer, as a remarkably successful example of integrating science in the command structures of the State, was highly valued outside France"* [11].

In the case of foreigners who at least partially completed their training in these institutions, Karvar shows that "the foreign students did not make

9 KROPF, Simone Petraglia (1996) "Sonho da razão, alegoria da ordem: o discurso dos engenheiros sobre a cidade do Rio de Janeiro no final do século XIX". In: HERSCHMANN, Micael; KROPF, Simone Petraglia; NUNES Clarice (ed.) *Missionários do progresso: médicos, engenheiros e educadores no Rio de Janeiro: 1870-1937*, Rio de Janeiro, Diadorim, 69-154.

10 KARVAR, Anousheh (1997) *La formation des* élites *scientifiques et techniques étrangères à l'École polytechnique française aux 19e et 20e siècles*, Thèse de doctorat, Paris, Université Paris VII - Denis Diderot.

11 KARVAR (1997), 14.

up a significant population in proportion to the total number of students. However, great variations are observed in the flux of these students" [12]. Besides this, the statistical analysis carried out by this author identified the arrival of groups of students, in given periods, coming from the same country or, conversely, the constant presence of students from the same country, when looking at the long term. Karvar also verified that in two centuries of its existence (1794–1985), the École polytechnique attracted approximately 1.000 foreign auditors and students who studied there, either partially or fully –despite the actual scientific decline of the school during the second half of the 19th century.

From 1816 onwards, a government order banned the category of external students and auditors, with the exception of "foreigners admitted to please the government of their countries"[13]. Among these may be found the first Brazilians, as well as Mexicans, Russians, Polishes, Romanians, and Egyptians, whose countries were all undergoing great political and social upheaval at this time. According to the author, this could explain the need to educate their elite elsewhere, as well as the collaboration of the French government. Between 1816 and 1830, Brazil occupied second place together with Russia, with both countries having sent seven students each. For the following period (1831-1851), again there were seven Brazilians in absolute numbers, but in relative terms this corresponded to the eighth position.

The motive for the exception –"to please the government of their countries"– is a subject for thought and discussion. The exception extended to recently-independent Brazil would strengthen France's interests in this region of the world, already convulsed with independence movements, and a potential market for the most diverse products (including culture). However, I would like to add some points coming from the political science to incorporate these fluxes of students into a framework that extrapolates, and completes, what has been discussed by the history of science and technology in Brazil. Oliveira[14] analysed the coronation ceremonies of D. João VI, D. Pedro I, and D. Pedro II, as well as contemporary texts, so as to understand the politics of each period. This author shows that the ceremonial of D. Pedro I was marked

12 KARVAR (1997), 14.

13 KARVAR (1997), 36.

14 OLIVEIRA, Eduardo Romero de (2003) *Salus Populi – As transformações da política (Brasil, 1818-1841)*, Tese de doutorado, São Paulo, Universidade de São Paulo.

by swearing obedience to the laws and defence of the Empire. Defence and the relevance of the military in this context are, in my opinion, a significant fact in understanding the first wave of students, some already graduated from the Academia Real Militar, and who went to France to refine their skills.

As it is well known, the reign of D. Pedro II was characterized by science, but Oliveira shows how much this aspect, far from being an idiosyncrasy, was part of the prevailing conception of politics and good governance. Sending these students to the two schools that trained professionals of 'application' (infra-structure and exploitation of resources) thus acquires a significance of State politics –which is confirmed by the decrease, and end of the flux immediately following the Republic. Hence, the presence of Brazilian students in the French *grandes écoles* integrated and addressed a more encompassing political project of the imperial governments. Moreover, its temporal coincidence almost exactly with the 1st and 2nd Reigns was not a mere coincidence, in my opinion.

Several of these students had outstanding careers, and held high positions, be it in government or in the profession strictly speaking. Candido Maria de Azevedo Coutinho, Luis Bellegarde, Cândido Batista de Oliveira, José de Figueiredo Rocha, Giácomo Raja Gabaglia, Honório Bicalho, Aarão Reis, to quote just a few, are all examples of this. Of course, there are many about whom we have no data, possibly due to lack of research or because they were not remarkable. Among those of the first students who stood out was Paulo Barboza, major-domo in the imperial house, who might have been the key-player in working out and putting into action this policy of technical training in France. There were others, such as Cândido Batista de Oliveira, who became minister, ambassador, and higher education teacher, among many other functions.

4.- Bringing all back home.

This significant number of Brazilian students at the French schools of engineering was the solid and constant bridge across which the famous "band of new ideas", immortalized in the expression of Silvio Romero, penetrated Brazil, especially but not exclusively Positivism. However, not like a band that invades suddenly. Rather it was through a long process that lasted decades. In my research, I also came across with the important role played

by Saint-Simonism alongside French engineers, be it at the École polytechnique, at the École des mines, and even at the École des ponts et chaussées. This understanding is largely due to the works of Antoine Picon, and André Thépot. I believe that the influence of Saint-Simonism on at least a part of the Brazilian students in the French *grandes écoles* paved the way for the intense penetration of Positivism in Brazil. Indeed, the questions of modernity and of progress, much beloved by a large share of the Brazilian elite, were interwoven in the ideas of the Saint-Simonians. The members of Saint-Simonist group saw themselves as apostles of progress: progress that strictly associated social reorganization with scientific and technical innovation and definitely did not constitute a marginal phenomenon[15]. With regards the links between Saint-Simonism and Positivism – beyond the fact that Auguste Comte was himself Saint-Simon's secretary–, it is necessary to remember from the start

> "*that Saint-Simon and his disciples dedicated numerous reflections to Science and to the disciplines such as astronomy, mechanics, physics or physiology*"[16].

In sum, there are some points of the Saint-Simonian doctrine which could have attracted the interest of members of the Brazilian elite who went to study in France from the first half of the 19th century onwards, above all if we consider that the first students arrived in 1825, in the early days of the construction of an independent Brazil: science and technology in the service of modernization, be it material or social; a hierarchy of knowledge and of men, the role of the educated and scientific elite in leading society; the authoritarian conception of knowledge. According to Thépot[17], in his admirable and encompassing study of engineers in France, the École des mines de Paris comprised a veritable nursery of Saint-Simonians. It is worthwhile mentioning that, as we saw, the first wave of Brazilians sent to Paris coincides with the flourishing of Saint-Simonism.

Positivism started to be disseminated in Brazil around 1840, but it was from 1870 onwards that its influence was most notable[18]. Comte's first texts

15 PICON, Antoine (2002) *Les saint-simoniens: raison, imaginaire et utopie*, Paris, Belin, 17-19.

16 PICON (2002), 177.

17 THÉPOT, André (1991) *Les ingénieurs du corps des Mines au XIX*e *siècle: Recherches sur la naissance et le dévéloppement d'une technocratie industrielle*: Thèse de doctorat, Nanterre, Université de Paris X– Nanterre.

18 DANTES, Maria Amélia Mascarenhas (1996) "Os positivistas brasileiros e as ciências no final

to arrive in Brazil were those in which he discusses his scientific and epistemological concepts, especially the volumes of *Cours de philosophie positive* and the *Discours sur l'esprit positif*. For some Brazilians, they signified a first access to sciences[19]. This author also showed the strong presence of positivist orientations at the heart of the professional schools of medicine and of engineering, above all in the theses defended by students who obtained their diplomas, ever since the first one, in 1844, in the Faculdade de Medicina da Bahia. In the three schools of engineering that followed each other throughout the century – Escola Militar, Escola Central and Escola Politécnica –, one third of the theses defended were manifestly positivist, besides the presence of clearly positivist professors, such as Álvaro de Oliveira, Licínio Cardoso, Benjamin Constant or Marshal Trompowsky. Thus, Positivism, for a series of reasons, found fertile ground in Brazil.

Nevertheless, a more detailed analysis of ideas of two of the last students of the period researched here –namely, the brothers Luiz and Alberto Betim Paes Leme– unearthed unexpected data *vis-à-vis* the almost absolute supremacy of Positivism[20]. In his works, Luiz Betim used several times the term 'miracle', referred to in a religious sense and connected to the notion of Divine Providence and of Catholicism. The apex of his efforts was an attempt to (re)approximate modern physics and metaphysics, in such a way as to conceive the 'miracle' as a perfectly plausible manifestation, and to conciliate science and faith, demolishing

"*the insurmountable wall the one-eyed stonemasons of the Positivist philosophy had erected between physics and metaphysics*".

In turn, Alberto Betim proved to be a follower of the renowned Catholic scientist, Albert de Lapparent, an alumnus of the École des mines[21]. The

do século XIX". In: HAMBURGUER, Amélia Império; DANTES, Maria Amélia Mascarenhas; PATY, Michel; PETITJEAN, Patrick (ed.) *A ciência nas relações Brasil-França (1850-1950)*, São Paulo, Edusp and Fapesp, 49-62. Citation from page 51.

19 DANTES (1996), 52.

20 FIGUEIRÔA, Silvia Fernanda de Mendonça (2010) "Os irmãos [Paes] Leme: Luiz (1881-1943) e Alberto (1883-1938) Betim Paes Leme, engenheiros nas primeiras décadas do século XX". In: HEIZER, Alda; VIDEIRA, Antonio Augusto Passos (ed.) *Ciência, Civilização e República nos Trópicos*, Rio de Janeiro, Mauad X and FAPERJ, 357-373.

21 FIGUEIRÔA, Silvia Fernanda de Mendonça (2012) "A sample of geological textbooks: the book História Física da Terra (1943) by Alberto Betim Paes Leme", *Almagest*, vol. 3, num. 1, January, 106-121.

'miracles' of Luiz Betim and the philosophical speculations of Alberto Betim in his geological studies may represent more than an interesting historical curiosity. I tender the hypothesis that both were (informally) part of, or were at least influenced by, the movements of Catholic scientists, engineers and entrepreneurs who flourished in France, in Belgium and in other European countries from the end of the 19th century until more recent periods in the 20th century. Grelon and Subileau[22] closely analysed the Mouvement des cadres chrétiens (MCC) and the Vie Nouvelle (VN). The MCC is a branch of the Union sociale d'ingénieurs catholiques (USIC), founded in 1905, which in turn arose from catholic associations of engineers, founded from 1892 onwards, with a strong influence in the engineering schools such as the École centrale or the *grandes écoles*[23], where Luiz and Alberto studied at this time. It is curious to note that the motto of the USIC is identical to the one on the Brazilian flag, created by the Brazilian Republican government: "Ordre et progrès", order and progress, notwithstanding, of a quite different nature than that conceived by the Positivists. Hence, the country's commitment to progress might not, exclusively, stem from Positivism in its diverse aspects, albeit its prominence is unquestionable. It seems necessary to investigate in other directions to continue to compose the overall picture of science and technology in Brazil. Catholicism/Christianity and other interpretations of what would be "Order and Progress" may arise, more forcefully than we suspect at present. But it is without doubt that the Brazilian engineering students in France played a crucial role in this whole process.

Acknowledgements

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22 GRELON, André; SUBILEAU, Françoise (1989) «Le Mouvement des cadres chrétiens et La Vie nouvelle: des cadres catholiques militants», *Révue des Sciences Sociales*, vol.39, num.3, June, 314-340.

23 GRELON; SUBILEAU (1989), 317.