Bringing it all back home:

Portuguese engineers and their travels of learning (1850-1900)

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Travels of learning are, undoubtedly, one of the most appealing features of the European intellectual tradition, dating back, at least, from the 15th century. During the Enlightenment, travelling across Europe became, we dare to say, an epistemological affair, as it meant to oppose the "enlightened space" (that is England, France, the Netherlands, the German States, Swizerland and Italy) to the obscure regions of Southern and Eastern Europe, where reason, the new sciences and the new technologies were

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slowly arriving. Those who embarked on the long journey of the *Grand Tour* aimed not only to improve their education and culture, but also to gain or reinforce their position in the community of learned men populating the Republic of Letters.[1]

During the 19th century travels of learning became more and more focused, within a framework of a growing professionalisation and specialisation of sciences and technology. The dilettante and the polymath of the 18th century gave place to the professional man; the uncompromising travel diaries and notebooks gave place to the technical and scientific report or the textbook; the concept of learning itself swift from a general approach to a well circumscribed field of expertise.[2]

It is within this context of the growing specialisation of both the travel and the travellers that the travels of Portuguese engineers during the 19th century will be examined in our paper. The tradition of going abroad to study goes back to the 18th century, mainly through the *Estrangeirados* (Europe-oriented intellectuals) who grouped together in private literary societies where 'daring' subjects were discussed, methods questioned and traditional references, analytic concepts and representations of the cognitive and physical world

[1] A. Simões, A. Carneiro, M. P. Diogo, "Introduction", in *Travels of Learning: towards a geography of science in Europe*, eds. A. Simões, A. Carneiro, M. P. Diogo (Dordrecht: Kluwer Academic Publishers, 2003), pp.1-18; J. Black, *The Grand Tour in the Eighteenth Century* (New York: St. Martins Press, n/d); B. Dolan, *Exploring European Frontiers* (London: MacMillan Press, 2000); D. Livingstone, W.Withers, *Geography and Enlightment* (Chicago:The University of Chicago Press, 1999); M. Blay, E. Nicolaidis (eds), *L'Europe des Sciences:Constitution d'un Espace Scientifique* (Paris:Seuil, 2001).

[2] Simões, Carneiro, Diogo, "Introduction".

challenged.[3] One of the finest examples is Manuel de Azevedo Fortes, a member of the "Ericeira Circle" who was appointed chief-engineer in 1719.[4] The education he received outside Portugal (in Spain and in France), his professional career which also began abroad (as professor of mathematics at the University of Sienna), the contacts he maintained with the intellectual elite of Enlightened Europe, definitively replaced the traditional view of engineering strongly associated with empiricism, by a perception of the engineer as a practical figure with his feet on the ground but whose thinking was shaped by the rigour acquired from a solid body of theoretical and scientific knowledge. This new attitude towards the role to be played by science and technology in modern societies, with which Fortes had become acquainted abroad, is amply reflected in his works, namely the well known textbook *The Portuguese Engineer*.[5]

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3 A. Carneiro, A. Simões, M. P. Diogo, "The Scientific Revolution in the Eighteenth century Portugal: The Role of the Estrangeirados (Europe-Oriented Intelectuals)", Social Studies of Science, 2000, 30:591-619; M. P. Diogo, A. Carneiro and A. Simões, "Ciência Portuguesa no Iluminismo: os estrangeirados e as comunidades científicas europeias", in Enteados de Galileu? A Semiperiferia no Sistema Mundial da Ciência, eds. J. Arriscado Nunes, M. Eduarda Gonçalves (Porto: Afrontamento, 2001), pp. 209-238.

4 The Count of Ericeira's circle was one of the havens where the new ideas found a place to take root and grow. Azevedo Fortes was one of the count's protégés, focusing on philosophy in his contributions to the series of 'Erudite Conferences' held at the count's residence. He was also the only member of the Ericeira circle who had technical knowledge and skills.

5 M. P. Diogo, A. Carneiro e A. Simões, "El Grand Tour de la Tecnología: El Estrangeirado Manuel de Azevedo Fortes", in Maquinismo Ibérico, eds. A. Lafuente, A. Cardoso Matos, T. Saraiva (Aranjuez: Doce Calles, 2007), pp. 101-121; M. P. Diogo, A. Cardoso Matos, "Being an engineer in the European Periphery: three case studies on Portuguese engineering", History of Technology, 2007, 27:125-146.

By the mid 19th century Portugal undergoes a significant change in the economical agenda, which favoured an intense growth of circulation as the core of the industrial take off. The idea of the existence of a close relationship between technological advances and progress is the main key to understand the all period following 1851 (which is called in Portuguese history Regeneração – the Regeneration Period) and the policy of its leader Fontes Pereira de Melo. Fontes was himself an engineer and firmly believed that railways played a decisive role in the development of the country's leading economic areas allowing Portugal to step in the international web of modern economic relationships.[6] In numerous public statements Fontes Pereira de Melo refers to railways as the most important feature of the new economic

[6] The acknowledgement of the role played by railways in a modern economy goes back some ten years when in 1842, Costa Cabral, then the Portuguese prime-minister, suggested building two railway lines (Lisbon-Oporto and Lisbon-Badajoz), a proposal that was denounced by his opponents as the "lunacy of a seer". Quoted in Oliveira Martins, *Portugal Contemporâneo* (1881; Lisbon: Guimarães Editores, 1979), p. 135. In 1844, Benjamim de Oliveira, a Portuguese citizen living in England, proposed to the Count of Tojal, the treasury minister, to build a railway line between Lisbon and Oporto, passing through Santarém, Leiria, Coimbra and Aveiro, an idea that was considered not have any obvious benefit. See Federico Abragão, *Caminhos de Ferro Portugueses – Esboço de uma história* (Lisbon: Companhia dos Caminhos de Ferro Portugueses, 1956), pp.120-124. Despite this lack of interest in 1844 the Companhia de Obras Públicas (Portuguese Public Works Company) was founded at the initiative of a group of Lisbon merchants. The Company's principal objective was "to undertake all the major works legally authorised for the improvement of communications in the country under the Government's supervision". The Company was founded by public deed on 19 December 1844 and its Statutes were approved by licence of 30 December 1844. In 1845 the Count of Tomar charged the Portuguese Public Works Company with building a railway along the bank of the Tagus river, linking Lisbon to the frontier with Spain. However, the project was suspended because of political instability and the company was wound up in 1848. For economic context see D.Justino, *A Formação do Espaço Económico Nacional* (Lisbon: Vega, 1988 and 1989), 2 vols.; P. Lains, Á. Ferreira da Silva eds., *História Económica de Portugal* (Lisbon: ICS, 2005), 3 vols.

and cultural framework, stating that "Above the horse driven carriage, there is the trolley, above this the locomotive and above this, progress."[7] In this context a new ministry was created in 1852 – the Ministry of Public Works, Commerce and Industry (MOPCI) – fostering the technological-driven agenda of the *Regeneração* and hence the career and work of a significant number of engineers, including Fontes Pereira de Melo himself.[8] Through the MOPCI engineers made his presence felt in the new economic atmosphere. The fact that public works, such as the railway lines, were the main hope for Portuguese modernization and that they embodied the public welfare, significantly raised the status of engineers as a professional group. On the other hand, these very same close liaisons between engineers and public works shaped the face of the technological community in Portugal.[9]

From 1850 to 1880 the Portuguese government was easily able to raise foreign funds for building national infrastructures, supported by its own credibility (Portugal was part of a selected group of countries using gold as its monetary standard) and by the interest of British capitalists in investing their money in "material structures". These foreign companies were invited to participate in the Regeneration infrastructural project by applying both their capital

7 Speech given on 18 January 1855.

8 Before this ministry was created public works were part of the Ministry of the Kingdom (Ministério do Reino). Fontes Pereira de Melo was the first to serve as minister of the Ministry of Public Works, Commerce and Industry (MOPCI). Other well-known engineers were also ministers of the MOPCI, namely João Crisóstomo de Abreu e Sousa, João de Andrade Corvo and Elvino de Brito.

9 Maria Paula Diogo, "In search of a professional identity – The Associação dos Engenheiros Civis Portuguezes", *ICON*, 1996, 2:123-137.

and technical expertise. As these companies used their own technological know-how, management models, and engineers, Portuguese engineers were only used to suggest minor changes and to approve the plans which were presented to the Ministry of Public Works, Trade and Industry[10].

In 1853, when Fontes Pereira de Melo signed a contract with the Companhia Central e Peninsular dos Caminhos de Ferro Portugueses (Central and Peninsular Railway Company), its leader, Hardy Hislop, chose an English engineer, Thomas Rumball, to design the first railway line (Lisbon-Carregado).[11] Although in this initial phase the work of Portuguese engineers was not very visible some adjustments to the initial plans were made by João Crisóstomo de Abreu e Sousa and Joaquim Tomás Lobo d'Ávila. The next stage in the building of the railway network proved to be an excellent opportunity for Portuguese civil engineers to show their proficiency. The Northern and Eastern lines were already planned and directed by the most important Portuguese engineers of that period.[12]

The relationship between Portuguese and European engineers was, hence, always double folded: on one hand, European engineering was accepted as the main reference concerning know-how and expertise; on the other hand, being praised by European fellow engineers meant to be

[10] Magda Pinheiro "Os engenheiros portugueses e a construção ferroviária no século XIX", Unpublished paper presented at the *XX Encontro da APHES*, 2000.

[11] Thomas Rumball (1824-1902) was a railway engineer who worked in England, Portugal, Spain and Argentina. He was a member of the Institution of Civil Engineers.

[12] João Evangelista de Abreu, Pedro Inácio Lopes, Manuel Espregueira.

recognized as members of a wider community. Therefore Portuguese engineers envisaged international contacts as a powerful tool for both promoting technical exchange within the European space and building a professional identity back home. These contacts were made mainly through: (i) academic training of Portuguese engineers at foreign schools; (ii) "travels of learning", including going to world exhibitions and international meetings and visiting railway facilities and factories; (iii) institutional contacts with European and American professional associations of engineers.

Studying Abroad

In Portugal, academic training engineers remained, until quite late, within the borders of military training. It was commonly accepted that engineers should be able to perform both military and civil engineering tasks; their academic training aimed, therefore, to develop military expertises, which were complemented by a set of subjects related to civil engineering. This kind of "hybrid" training is the core of the Civil Engineering Course taught at the Army School: as usual, students had a previous scientific training at the Polytechnic School of Lisbon or at Academia Polytechnic Academy of Oporto, where they learned mathematics, physics, chemistry, natural history, geology and astronomy; they then pursued their studies at the Army School, with a two years

degree on civil engineering, based on an extended version of one of the subjects taught at the military course.[13]

The idea of having specific schools or courses in order to train civil engineers was not a peaceful matter in Portuguese political circles. Already in the beginning of the 19th century, when the Polytechnic School was founded, the question of technical education was only the forefront of a deeper debate between different strategies for national modernisation. In 1854 Júlio Máximo de Oliveira Pimentel, a well known chemist and teacher at the Polytechnic School as well as a member of the Parliament, submitted a project that aimed at converting part of the military training institutions into Scientific and Technical Professional Schools: the Army School (for cavalry and artillery officers and military engineers) and the Navy School (for navy officers and shipbuilders) would be kept as part of the military training, but a Public Works School (for civil engineers, builders, architects, geographical and hydraulics engineers and mining engineers) and an Industrial School (for mechanical, chemical and metallurgy engineers and foremen) were created. This highly controversial project, especially regarding the poor role played by polytechnic schools, generated a strong opposition, in particular from the teaching staff of the

[13] M. P. Diogo, A. Cardoso Matos, "Aprender a ser ingeniero. La enseñanza de la ingeniería en el Portugal de los siglos XVIII y XIX" in Maquinismo Ibérico, eds. A. Lafuente, A. Cardoso Matos, T. Saraiva (Aranjuez: Doce Calles, 2007), pp. 123-145.

Oporto Polytechnic, which addressed a petition to the Members of Parliament. The proposal was never approved.[14]

In 1859, the Parliament resumed the debate on the training of Portuguese engineers. The obvious lack of schools was, once again, the keystone of the discussion. However the solution which was considered the most suitable was not to create new schools in Portugal but to send abroad the best students. The Ministry of Public Works, Commerce and Industry was bound to send at least three students per year to study abroad. The *École des Ponts et Chaussées*[15], the *École des Mines* and the engineering schools at Gand, Freiberg and Liège were considered the top schools at the time, and thus the ideal scientific and pedagogical milieu to complete their engineering training. After this period abroad students were expected to return to the motherland "with the training required to fulfil the noble functions of an engineer and through useful work payback Portugal what the country had invested."[16]

The idea of sending students abroad to study instead of investing in a national plan of high education was part of a long tradition. In fact, Portugal always preferred to "buy" knowledge, science and technology in the European marketplace and not to create its own centres for developing

[14] This petition was later published as, "Breve Memória sobre a Instrucção Publica Superior no Porto e nas Provincias do Norte, offerecida aos Senhores Deputados da Nação Portugueza pelos Lentes da Academia Polytechnica", *Jornal da Associação Industrial Portuense,* 1854, 19:296-304; 20:312-320; 21: 330-336.

[15] On the *École des Ponts et Chaussées* see A. Picon, *L'invention de l'ingénieur moderne. L'École des Ponts et Chaussées, 1747-1851* (Paris: Presses de l'école nationale des ponts et chaussées, 1992).

[16] *Diário do Governo*, 1859, 251:1361.

expertise and skills. The notion of "payback" allowed, on the other hand, to emphasize the obligation of using what was learnt abroad at home, by dedicating themselves to public works, that is to say, to the modernization of Portugal, thus "paying" back the government investment. Students attending foreign schools should have a high performance in order to be able later, as engineers, to allow Portugal to free itself from foreign dependence.[17]

Based on data from the Portuguese Association of Civil Engineers, the academic training profile of Portuguese civil engineers showed, on one hand a clear hybrid pattern (military and civil training at the same time) and on the other hand a steady interest in studying abroad.[18]

For those who went abroad, France was the favourite choice, reaching almost 70% of the preferences of the students[19]. Most of the future civil engineers applied to the Éco-

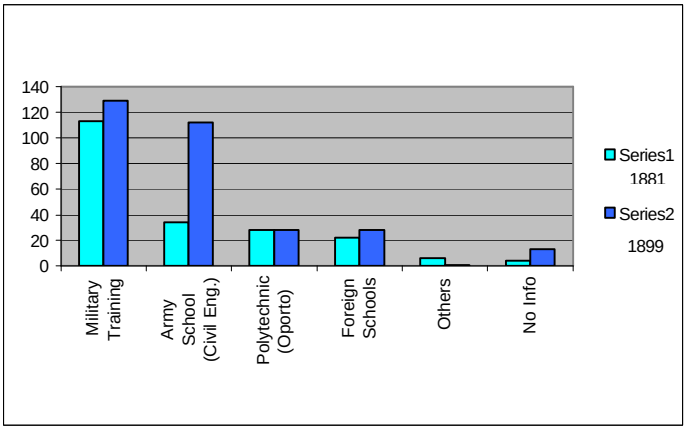
[17] In a petition presented to the government – Representação dirigida aos Senhores Deputados da Nação Portugueza pelos Engenheiros e Conductores do Extincto Corpo d´Engenharia Civil e seus Auxiliares (Petition Addressed to the Members of the Portuguese Parliament by the Engineers of the late Corps of Civil Engineers and Assistant Engineers) – Portuguese engineers argue that "Part of our students should be sent abroad to study both theoretical and practical subjects. By attaining the highest standards of engineering training, these new engineers will be able to free our country from foreign dependence as far as public works are concerned."

[18] In 1864, the government had created the Corpo de Engenharia Civil e Auxiliar (Civil and Auxiliary Engineering Corps), thus indicating the importance, both in number and in work, of Portuguese civil engineers. When in 1869 the Civil and Auxiliary Engineering Corps was and surprisingly abolished, civil engineers were already powerful enough to build their own professional association – the Associação dos Engenheiros Civis Portuguezes (A.E.C.P.) (Portuguese Association of Civil Engineers). Diogo, "In search of a Professional Identity", cit. n.9.

[19] On models concerning the training of engineers see Irina Gouzévitch, André Grelon, Anousheh Karvar eds., *La formation des ingénieurs en perspective. Modèles de références et réseaux de médiation, XVIIIe-XXe siècles*, (Rennes, Presses universitaires de Rennes, 2004).

le des Ponts et Chaussées (in 1881, 41% of Portuguese engineers with a degree from a foreign school came from the École des Ponts et Chaussées; in 1899, 30% came from the same school); the Parisian École des Mines, was the first choice for mining engineers.

Graphic 1: Comparative data on the academic training of the members of the Portuguese Association of Civil Engineers, 1881 and1899



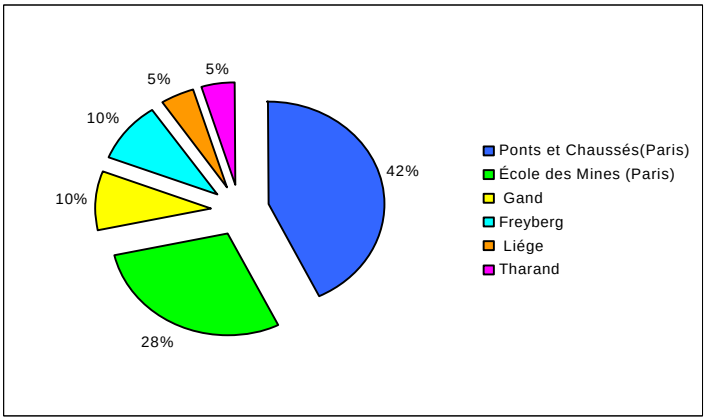
Source: "Relação dos Sócios em 2 de Abril de 1881", Revista de Obras Públicas e Minas, 1881, XII(135/136):46-58; "Sócios efectivos e aggregados em 30 de Abril de 1899", Revista de Obras Públicas e Minas, 1899, XXX(351/352): 167-201.

Up to 1851 we identified seven Portuguese engineers who attended the École de Ponts et Chaussées, all of them future leading actors of the Regeneration agenda.[20]

[20] Following Picon, *L'invention* (cit. n. 15), pp. 405-406, until 1851 19 Portuguese engineers attended postgraduate courses at the École de Ponts et Chaussées. However until now we have only been able to

From 1852 onwards the Ministry of Public Works, Commerce and Industry financially supported engineers who went to study abroad, in order to provide them with the theoretical and practical know-how necessary for the public works that were being undertaken all over the country.

Graphic 2: Foreign Schools attended by the members of the Portuguese Association of Civil Engineers, 1881 and1899



Source: "Relação dos Sócios em 2 de Abril de 1881", Revista de Obras Públicas e Minas, 1881, XII:46-58; "Sócios efectivos e aggregados em 30 de Abril de 1899", Revista de Obras Públicas e Minas, 1899, XXX(351/352): 167-201.

At first these engineers were freely appointed by the Minister, but after 1855 a competitive examination establi-

identify Joaquim Simões Margiochi, Joaquim Nunes de Aguiar, Francisco Maria de Sousa Brandão, Joaquim Tomás Lobo d'Ávila, José Anselmo Gromicho Couceiro, Joaquim Júlio Pereira de Carvalho and Jaime Larcher. See A. Cardoso de Matos, "Asserting the Portuguese civil engineering identity: the role played by the École des Ponts et Chaussées", in A. Grelon, M.P. Diogo, A. Cardoso de Matos I. Gouzevitch eds., *Jogos de Identidade: os Engenheiros, a Formação e a Acção* (Lisbon:Colibri, forthcoming).

shed new criteria for the selection.[21] Nevertheless some Portuguese students and engineers went abroad at their own expenses. During the second half of the 19th century, twenty-seven Portuguese engineers enrolled at the École des Ponts et Chaussées. To guarantee a sustainable policy a group of students was sent to Paris every three years, which meant that new trainees were only sent when the previous group of students had finished their degrees. Up to 1866 sixteen Portuguese students attended the École des Ponts et Chaussée; between 1866 and 1878 there are no registers of Portuguese students; and after 1878 the number of those attending the École each year is uneven.[22]

For Portuguese future engineers going abroad to improve their academic training and expertises was, thus, a popular choice during the second half of the 19th century. A considerable number of future and senior engineers with a Portuguese degree applied for grants to study in European Engineering schools, both at undergraduate and postgraduate levels. Some of the most influential Portuguese engineers of the second half of the 19th century complemented their academic training by attending courses at the most prestigious European engineering schools.

[21] Article 30, Law of 17 July 1855.
[22] Matos, "Asserting the Portuguese Civil Engineer Identity".

Travels of learning

Going abroad to "study" foreign railway systems (tracks, trains, organization and the people needed to operate it), harbours or factories became more and more common among Portuguese engineers. A considerable number of these travels of learning were made at the expenses of the Portuguese government and aimed at improving specific expertise concerning mostly public works. Between 1845 and 1897, we have already clearly identified 20 travels most of them from 1850 to 1880. The main destinations were France, Belgium, the Netherlands and, in a second row, Spain.

Once again we find influential Portuguese engineers committed to these technical pilgrimages which allowed them to acquire a significant amount of technical expertise that proved to be crucial to the new technocratic agenda.

In 1845, José Vitorino Damásio, known among his colleagues has the "pope of Portuguese engineering", was invited to work with the Portuguese Public Works Company[23], which commissioned him to supervise the construction of the Alto da Bandeira to Carvalhos road in Vila Nova de Gaia. Because of his mastery of road building technology and his knowledge of the road building techniques used in other countries (such as Polonceau's rolling method) he was asked by the Company to make a research visit to France and Belgium. The purpose of the visit was to study leading Industrial plants on the spot and to determine which machinery and industrial processes would be best suited to the Arsenal

[23] See n. 6.

de Obras Públicas (Public Works Depot) that the company planned to set up in Portugal. Another aim was to choose foreign plants where Portuguese craftsmen who were to work on the company's projects could be sent as trainees. However, the closure of the company meant that these goals would not be achieved.

Damásio, gifted with an immense scientific curiosity and a desire to keep up-to-date with technological developments, used his visit to Paris to take a course at the École des Ponts et Chaussées in locomotive engines and, uniting theory with practice, also studied the building of these engines at the Resrones & Cail plant.

Although he was not able to give them any practical application at the Portuguese Public Works Company, the skills he acquired on his visits as well as the studies and research he carried out at this time were fundamental in his decision to set up the Bolhão factory, an industrial venture launched in 1847[24]. The plant, where he was responsible for technical management, introduced a new chemical process for 'manufacturing malleable iron, or making pig iron objects malleable by means of a new chemical process'. This enabled the production of new iron products, including small pieces of ironware for domestic use, many of them enamelled. The growth of the plant also led to the production of machinery, including the first dredger to be built in

[24] In partnership with Joaquim Ribeiro de Faria Guimarães and Joaquim António da Silva Guimarães.

Portugal and the first mechanised rope-making plant to be set up in Oporto.[25]

In 1846, João Crisóstomo de Abreu e Sousa, the future President of the Portuguese Association of Civil Engineers[26] and a firm supporter of the Regeneration project, traveled at the expenses of the Portuguese government to England, France and Belgium to get acquainted with the construction of roads, canals and railways. Ten years later he would return to these countries and traveled also to the Netherlands to study the progress being made in the operation and management of railways and other transportation systems.

In 1844, Manuel Afonso Espregueira, another future leading figure in the modernizing agenda of the Regeneration, also visited France, Belgium and the Netherlands to collect information about their railway systems. In 1865 Bento Fortunato Almeida d'Eça, travelled during ten months across France, Italy, Belgium and Spain in order to study management and law issues applied to irrigation systems; in 1878 he returned to Belgium to study the prison facilities at Louvain. In 1868 Joaquim Nunes de Aguiar, chief engineer at the Companhia das Águas de Lisboa (Lisbon Water Company) went to Paris to study issues concerning water supply and mostly to buy pumping machines to raise the water for supplying the eastern part of Lisbon[27]. In 1887, Frederico Ressano Garcia, an engineer who shaped the face of Lis-

[25] Diogo and Matos,"Being an engineer" (cit. n. 5).

[26] See n. 16.

[27] T. Saraiva, *Ciencia Y Ciudad: Madrid y Lisboa, 1851-1900* (Madrid: Ayuntamiento de Madrid, 2005), p. 128.

bon[28], travelled to Italy, Spain, France and Belgium, to study the construction and maintenance of sea harbours.[29]

Although the majority of these travels had as main target different issues related to public works, urban infrastructures included, we have some examples concerning the industrial *milieu*. The weakness of the Portuguese Industrial structure, unable to break with old technological routines, didn't promote travels sponsored by private firms. However it is possible to find a few exceptional cases in which technology transfer through travels does occur: in 1873, the Companhia de Torres Vedras, a textile factory, asked the engineer Jaime Larcher to study the most updated features of mecha-

[28] Ressano Garcia assumiu o cargo de engenheiro da Câmara Municipal de Lisboa em 1874 e a ele se ficaram a dever algumas das mais importantes obras de melhoramento da cidade de Lisboa como foi o caso da abertura da Av 24 de Julho. Raquel Henriques da Silva dir., *Lisboa de Frederico Ressano Garcia, 1874-1909* (Lisbon: Câmara Municipal de Lisboa / Fundação Calouste Gulbenkian, 1989).

[29] We used mainly the database built during the research project *Portuguese engineering and engineers – 18th to 20th centuries* (FCT/PRAXIS XXI,1999-2001). This database only covers information about engineers who were members of the Portuguese Association of Civil Engineers. We collected other information from other sources but further research may bring new data, namely concerning private travels. In addition to the engineers mentioned in the text we have the following information on other engineers who travelled abroad: Afonso Soares (1875, six monthes, to study European harbours, mostly concerning machines and management); Alfredo Freire de Andrade (travelled to South Africa to study mining technics); Carlos Ribeiro (1858, France, Spain, Italy and Austria) and later Nery Delgado (1878, Spain) both well know geologists, travelles abroad to study different geological surveys and to establish a network of scientific relationships; Carlos du Bocage who went to Belgium, France and Spain (1878 and 1879) to study military issues; João Schiappa de Azevedo stayed in Spain during nine months studying mining technics; João Maria Magalhães after graduating at Nancy travelled across the Alps to Germany to study irrigation and forestry; João Castanheirinho went to Antwerp to study the local harbour in order to apply some og the Belgium solutions to the harbour in Lisbon; Joaquim Sousa Gomes, after graduating at the École des Ponts et Chaussées travelled across Russia, Italy, Germany, France and Spain in order to broaden his training.

nical of looms in Northern Europe. When returning to Portugal, Jaime Larcher presented a set of plans for a new factory and renewed the existent machinery. In 1894, when the firm António Moreira Rato & Filhos decided to build a factory for producing Portland cement, it also sent an engineer, Herculano Galhardo, to several European factories in order to study the latest innovations concerning both knowledge and machinery. In fact, when Galhardo returned, he reported to his sponsors all the latest advancements and novelties in the field of cements and introduced them in the factory.[30]

Going to the Fair

World exhibitions were a unique arena for technological exchange and transfer of knowledge. While the most developed countries displayed their technical superiority, countries from the European periphery, such as Portugal, sent their engineers to the exhibitions to see the myriad of new mechanisms which were presented, how they worked and how could they be useful for the national economic modernization. Coming back home, Portuguese engineers wrote their reports, trying not only to describe what they

30 A. Cardoso de Matos, M. Luísa Santos and M. Paula Diogo, "Obra, Engenho e Arte nas raízes da engenharia em Portugal" in *Momentos de Inovação e Engenharia em Portugal no século XX,* eds. M. Heitor, J. M. Brandão de Brito and M. F. Rollo (Lisbon: D. Quixote, 2004), vol.2, pp. 10-44.

have seen, but also to compare the Portuguese industrial *milieu* with the much livelier European one.[31]

Although it is still a provisional result, we have information on travels made by engineers, either officially or privately, to the World exhibitions of Paris (1855), London (1862), Paris (1867), Philadelphia (1876), Paris (1878), Paris (1889), Chicago (1893) and Paris (1900).[32]

As we have already mentioned, for these men going to a World fair meant a very accurate agenda: when they set out from Portugal, they had already selected their "targets" at the exhibition, according to national political and economic strategies. In 1855 (Paris) and 1862 (London), José Maria da Ponte e Horta, was appointed by the Portuguese government to observe steam machines; in his report he stated the importance of this new source of energy as a pivotal resource for industrialization; José Vitorino Damásio was also appointed by the government to go to Paris in 1855, to establish contacts in order to buy locomotives for the Portuguese railways. In 1855 Joaquim Júlio de Carvalho was commissioned by the municipality of Lisbon to go to the World fair in Paris to collect information on new machines that could be used in urban infrastuctures. In 1862, Carlos Augusto Ferreira went to London (he had been also at the World exhibition in Paris in 1855 at his own expenses) and five years later, together with Alberto Ribeiro, he visited the Word Fair in Paris. In 1878, Bento Fortunato Almeida d'Eça

[31] A. Cardoso de Matos, "World exhibitions of the second half of the 19th century: a means of updating engineering and highlighting its importance", *Quaderns d'Història de l'Enginyeria*, 2004, 6:225-235.

[32] See n. 24.

went to the exhibition in Paris to study railways and stayed there until January 1879 in order to fulfil his mission. In 1889, Afonso Soares, Adolfo Ferreira Loureiro Augusto Carvalho, went to Paris to visit the exhibition and the later was specifically commissioned to record novelties concerning the construction of harbours. In 1900, José de Matos Cid and José Vitor Sequeiro were sent to visit the world exhibition in France.

In all the five exhibitions that took place in Paris, the Portuguese government used the engineers who were in Paris attending the École des Ponts et Chaussés or the École des Mines to get further information or contacts. For instance, in 1867, three of these engineers, Cândido Celestino Xavier Cordeiro, Augusto Luciano Simões de Carvalho and Bento Fortunato Almeida d'Eça, were in charge of collecting information on the "state of the art" concerning railways.

As we reach the end of the century, the power of World exhibitions grows, as they become THE place to see and to be seen. In this context the Portuguese Association of Civil Engineers committed itself to be present, as a showcase of Portuguese engineering. In 1893, they sent to Chicago a set of five *Memoirs* on engineering works in Portugal, twenty eight albums with photographs, drawings and printed pictures of the most important works and monuments of our country, a descriptive catalogue and a collection of all the issues of the *Journal of Public Works and Mines* (the Journal of the Association). Financial problems didn't allow Portugal to have an official representation; however a member of the Portuguese Association of Civil Engineers travel-

led, at his own expenses, to the United States in order "to be present, in flesh and bone, at such an important event and to establish contacts with our fellow American engineers".[33]

In 1900, at Paris, the "capital of the civilized world" the Portuguese representation was impressive. The Portuguese Association of Civil Engineers, the representative of Portuguese engineering, sent once again a significant number of *Memoirs*, albums and catalogues on Portuguese engineering and organized a trip to Paris in which a large number of its affiliates participated. The Portuguese representation, headed by Ressano Garcia, was considered a huge success, wining 21 medals.

Closely related to the World exhibitions, numerous *international meetings* took place. Portuguese engineers, who often attended these international *forums* of debate, regarded them as an opportunity to keep updated with the main issues concerning engineering and to merge in a wide, transnational, "family". Portuguese engineers were present at the most important international meetings that would shape the face of modern Europe, namely those concerning telegraphs, railways and electricity. Just as an example and using some of the leading engineers we have been referring to, in 1878 José Damásio, who later that year was appointed head of the Portuguese Telegraphs, represented Portugal at the Telegraphic Conference in Paris; the International Railways Meeting was attended by Portuguese engineers on a regularly basis: Frederico Ressano Garcia (1887), Manuel

33 Luciano de Carvalho, "Exposição Universal de Chicago", *Revista de Obras Publicas e Minas*, 1895, XXVI: 68.

Espregueira (1889),Joaquim Pires Gomes (1892), António José Antunes Navarro and Angelo Sarrea de Sousa Prado (1895) and Bento Fortunato Almeida d'Eça (1900). In 1895 and in 1897 José Castanheira das Neves was the Portuguese representative in the International Meeting of Structural Analysis.

A large number of the Portuguese engineers, who attended the World Exhibition in Paris at the turn of the century, also went to the international meetings that took place during the major event, namely those concerning steam machines, mechanics, chemistry, electricity, agriculture and technical training. [34]

Exchanging knowledge through professional journals

Portuguese engineers were closely in touch with their fellow engineers abroad. As we have already mentioned before, being part of a professional community with no frontiers, the 19th century version of the "Republic of Letters", was crucial for Portuguese engineers. The Portuguese Association of Civil Engineers tried since its early years to establish steady contacts with European and American professional associations of engineers. In 1872, formal relationships were established with the Institution of Civil Engineers, the Societé des Ingénieurs Civils and the American

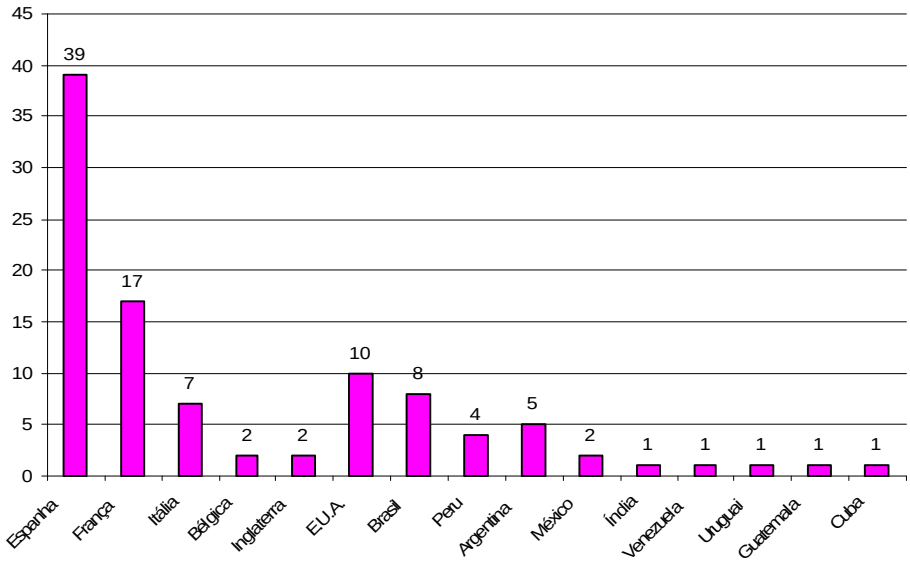
34 An extensive and detailed list of the World Exhibitions can be found in Brigitte Schroeder-Gudehus, Anne Rasmussen, *Les Fastes du Progrès: le guide des Expostions Universelles, 1851-1992* (Paris, Flammarion, 1992).

Society of Civil Engineers, the three most important world associations as far as engineering was concerned. The list kept growing all along the life of the Portuguese Association of Civil Engineers. The prestige value of these contacts, which implicitly meant the recognition of specialized knowledge and training, allowed Portuguese engineers to assert their professional identity both in the national and international arenas. In addition to these institutional contacts, exchanging journals was also a key strategy for Portuguese engineers to keep in touch with the main issues concerning engineering all over the world. The Portuguese Association of Civil Engineers exchanged its journal, the *Journal of Public Works and Mining*, with a very large number of European and American professional associations of engineers and even subscribed some of them.

It s difficult to assess the impact of the journals received by the Portuguese Association of Civil Engineers on Portuguese engineers, as the information published by the *Journal of Public Works and Mining* is not always clear or detailed. However, some general trends may be drawn upon a rough statistical analysis.[35] Using the information publicshed by the *Journal of Public Works and Mining*, from 1870 to 1900, it is possible to get the following picture:

35 This statistical analysis is a very preliminary and rough approach to the information published by the *Journal of Public Works and Mining*, The detail of the information varies from annual report to annual report, it is not possible to be sure of how many issues of a particular journal were received and for how long. It is possible that some journals are counted for several times. Nevertheless we think it is still worthwhile to use this data in order to define general trends.

Graphic 3: Journals received by the Portuguese Association of Civil Engineers (1870-1900)



Source: "Relatorio e Contas da Associação dos Engenheiros Civis Portuguezes com referencia ao anno de 1878", Revista de Obras Públicas e Minas, 1879, X(111/112): 113; 1881-1910, XIII-XLII; 1923, LIV(627):110-111; 1932, LXIV(680): 61-62.

Not surprisingly Spain and France are clearly the main partners of Portuguese engineers in their international network. The Spanish strong presence is the result of both the geographical proximity and the close relations between the Portuguese and the Spanish engineering communities, which often worked together. One should recall that it was D. José de Salamanca, a Spanish aristocrat and businessmen that founded in 1860 the Companhia Real dos Caminhos de Ferro Portugueses (Portuguese Royal Railway Company)

that ruled the Portuguese railway system during the second half of the 19th century. Together with Salamanca came other Spanish engineers, namely Eusebio Page chief engineer of the Portuguese Royal Railway Company, and Adolfo Ibarreta who was in charge of the Northern line.[36] When the Portuguese Association of Civil Engineers was founded Eusebio Page was appointed its only foreign honorary member. Recent studies also show the strong similarities between the urban renewal of Lisbon and Madrid.[37]

The French strong position mirrors the French powerful influence on the overall design of the Portuguese engineering community, both concerning its training and its professional models. It is understandable that Portuguese engineers tried to keep pace with their French fellow engineers whose reputation was well known all over Europe. On the opposite side, it is remarkable that only two British journals were received by the Portuguese Association of Civil Engineers.[38] In fact the British engineering model based on an informal training of engineers and anchored in a much more private driven economy was little influential in the Portuguese engineering community.

It is also worthwhile to look at the main thematic areas covered by the journals, as they mirror the main interests of Portuguese engineers and give us some clews on which themes they sought in foreign journals. Engineering

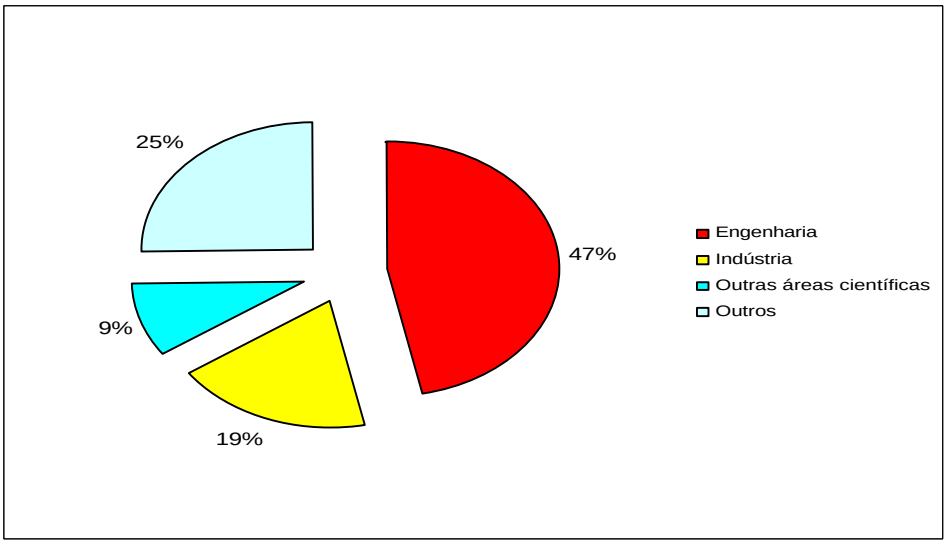
36 Both the Northern and the Eastern lines were soon under the responsibility of the Portuguese engineer João Evangelista de Abreu, a former student at the École des Ponts et Chaussées.

37 Saraiva, *Ciencia y Ciudad* (cit. n. 27).

38 The British journals were the *Mechanic's Magazine* and the *Minutes of Proceedings of the Institution of Civil Engineers.*

journals were by far the most representatives, followed by economic/industrial journals. The interest on industrial issues is quite interesting as it confirms that although Portuguese engineers had a difficult relationship with the industrial milieu, they were nevertheless fully aware of its importance.

Graphic 4: Thematic areas covered by the journals received by the Portuguese Association of Civil Engineers (1880-1900)



Source: "Relatorio e Contas da Associação dos Engenheiros Civis Portuguezes com referencia ao anno de 1878", Revista de Obras Públicas e Minas, 1879, X(111/112) 113; 1881-1910, XIII-XLII; 1923, LIV(627):110-111; 1932, LXIV(680): 61-62.

Concluding remarks

From the mid 19th century onwards, going abroad to improve one's education or to visit and "study" a factory or an exhibition became more and more common among Portuguese engineers.

These "travels of learning" and the networks they allowed engineers to build were powerful tools in promoting technical exchange within the European space and in building a professional identity back home.

In a country of the European periphery such as Portugal the pursuit of new and updated technological knowledge relied deeply on the efficiency of a network of formal and informal channels, which acted has vehicle for learning and spreading new skills, new machines and new expertises. Travelling abroad was part of this overall strategy aiming to appropriate foreign knowledge and to adapt it to local needs and expectations.

The geography of these professional pilgrimages shaped the face of Portuguese engineering, ascribing France a strong role. The Portuguese engineers trained at the École des Ponts et Chaussées, the quintessential institution for engineering training, or at the École des Mines, brought to Portugal the French approach to engineering. Senior engineers travelled frequently to France to catch up with the more recent technical novelties and the world exhibitions held in Paris were the most successful as far as the presence of Portuguese engineers was concerned. Moreover, the

French model fitted the Portuguese state driven agenda of modernization in which the state was itself an economic agent and main employer.[39]

To study at the École des Ponts et Chaussées, to go to a World exhibition, to attend an international congress, to visit a factory or to read a specialized journal must be understood as part of the wider political agenda leading Portugal to modernity. Portuguese engineers were leading actors of this complex play, bringing back home the new trends of technological knowledge and practise

[39] M. P. Diogo, "Engineers", *The Dictionary of Transnational History*, eds. Akira Iriye & Pierre-Yves Saunier (Palgrave Macmillan , 2007); I. Gouzevitch, I, Inkster eds., *History of Technology*, 2007, 27 (special issue); Grelon et al, *Jogos de Identidade*, (cit. n. 20); K. Chatzis, *A Lasting Exception: Training French Engineers from the Ancien Règime tio the Present Day*, Unpublished paper presented at INES 1st Meeting, Virginia Tech, Blacksburg, U.S.A., 2006.