

# FROM THE ÉCOLE DE PONTS ET CHAUSSÉES TO PORTUGUESE RAILWAYS: THE TRANSFER OF TECHNOLOGICAL KNOWLEDGE AND PRACTICES

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In 19th century Portugal, the concept of modernization is closely related to the construction of the railway network. In this context, in 1845 the Count of Tomar charged the *Companhia das Obras Públicas de Portugal* (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.

The year 1850 saw the beginning of *fontismo* which brought about a substantial change in the structure of the Portuguese economy, with the development of roads and railways becoming a clear priority. Foreign companies were invited to participate in this infrastructural project by applying both their capital 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.

In 1852 tenders were finally invited for the construction of a railway line between Lisbon and Santarém and, in a second stage, from Santarém to the border with Spain. The *Companhia Central e Peninsular dos Caminhos de Ferro em Portugal*, a railway company headed by Harry Hislop, put the project in the hands of an English engineer, Thomas Rumball, whose plans were subsequently reviewed and slightly altered by two Portuguese engineers, João Crisóstomo de Abreu e Sousa and Joaquim Tomás Lobo d'Ávila, both members of the *Conselho de Obras Públicas e Minas* (Public Works and Mining Board).

The line between Lisbon and Carregado was opened on 28<sup>th</sup> October 1856. The development of the railway network continued, gathering pace in the 1880s and covering a total of 2 358 km by the end of the century. In technological terms, this focus on the railways fostered the development of a specialised professional community engaged in technical activities.

The role of Portuguese engineers changed as a result of their involvement in the building of the railways. Contact with foreign technological communities and, above all, the opportunity to establish the importance of their specific skills and to apply them on equal terms with their European peers made it possible for Portuguese engineers to see themselves as professionals. The training of these men involved specialising in civil engineering and a consequent mastery of practical know-how on a par with their foreign counterparts.

Although civil engineering was clearly perceived as the most promising working area for Portuguese engineers, most of them were hardly familiar with it. In fact, most of them had only been trained as military

engineers at the *Escola do Exército* (Army School) and just a very small group had been sent to abroad to study theory and practice, namely to the Ecole des Ponts et Chaussées in Paris.

During the second half of the 19<sup>th</sup> century, 27 Portuguese, both senior engineers and promising students, enrolled in courses at the École des Ponts et Chaussées. Some of the senior engineers went to Paris at their own expenses, but most of them applied for a grant from the Ministry of Public Works. This Ministry was also bound to send at least three students per year to study abroad. When returning to the motherland, all of them would present a detailed report and would dedicate themselves to public works, that is to say, to the modernization of Portugal, thus “paying” back the government investment.

By 1881, around 11% of the Portuguese engineers affiliated at the *Associação dos Engenheiros Civis Portugueses* (Portuguese Association of Civil Engineers) were trained abroad. France was the favourite choice, reaching almost 70% of the preferences of the students; 41% of those who went to France chose the École des Ponts et Chaussées. Among these graduate and undergraduate students we will focus on two cases, João Evangelista de Abreu and Cândido Xavier Cordeiro, both deeply engaged in the railway network.

## FROM LISBON TO PARIS

João Evangelista de Abreu was selected to go to the Ecole de Ponts et Chaussées in 1856 and Cândido Xavier Cordeiro in 1864. Both of them had a specific training in engineering and had a few years practice both in public works and in teaching.

João Evangelista de Abreu, held a bachelor's degree in Mathematics from the University of Coimbra. From 1852 to 1853 he taught Geometry and Mechanics applied to the Arts [i.e., industry] and Professions, at the Liceu Nacional de Lisboa (Lisbon National High School); from 1854 to 1856 he was responsible for the course on roads and railways at the Army School. Cândido Celestino Xavier Cordeiro held also a bachelor's degree in Mathematics from the University of Coimbra. Although he was invited to teach at the University, at the age of 22 he decided to go to Paris.

Both João Evangelista de Abreu and Cândido Xavier Cordeiro were diligent students at the *École* and their skills as engineers were often praised. At the École des Ponts et Chaussées they had the opportunity to improve both their theoretical and practical training. Together with the more conventional classes, the *École* encouraged its students to have a close contact with the main engineering works in France and abroad, promoting fieldwork trips to important building sites.

In 1857, after having completed his first year at the École de Ponts et Chaussées, João Evangelista de Abreu (together with two other Portuguese students, Pedro d'Alcântara Gomes Fontoura and Valentim Evaristo Rego) went to Pau and Marseille to study roads, railways and harbours. At the end of their fieldwork trip they wrote a report, in which they praised this kind of training. In fact, before leaving to their fieldwork assignment, the students received a set of letters of recommendation that opened them the doors for the “real” world of public works: «Thanks to the letters of recommendation it was easy for us to contact with different engineers who welcomed us warmly. Drawings, memoirs, reports and documents of every kind were made available to us.» Just two examples: concerning the bridge over the Adour, they received «all the documents, both drawings and texts,

as well as notes concerning the details»; in Marseille, where they studied the harbour under construction and the railway to Toulon, they were allowed to examine in detail different types of bridges.

At the end of his second year, João Evangelista de Abreu went on a fieldwork trip to Bordeaux. His aim was to study the Gironde estuary, the new iron bridge over the Garonne, that linked the two railway lines of Orléans and the Midi, the procedures for fixing dunes and its economic results, and the network of water distribution. Commenting on the warm reception he had at the bridge building site he wrote:

«I have twenty-three large drawings on the design of this important work; in addition, thanks to the warm welcome by M. Régault, engineer of bridges and roads, and both the designer and the chief engineer of this project, I was allowed to participate in the definitive estimates of the project.»

At the end of his first year, Cândido Xavier Cordeiro wanted to go to Grenoble or to Savoy for his fieldwork. However as the former was offered to Picard, he took on the latter. In his second year he went to Bercy, with Jaqmin, to visit the Paris-Lyon-Méditerranée railway workshops; to Creil and to Epone, with Bayle, on a geological trip that included the famous foundries at Montataire; to Auteil, with Morandière, to see both the works on the railway line around the city and the building site of the viaduct on the top of the bridge at the Point du Jour.

At the end of the second year, Cordeiro went to Marseille with Agnellet and Mendes Guerreiro.

Furhermore, in 1867, Cândido Xavier Cordeiro was charged by the Portuguese government of collecting information on the “state of the art” concerning railways at the Paris World Exhibition.

## FROM PARIS TO LISBON

When they returned to Portugal the engineers trained at the École des Ponts et Chaussées joined the technical staff of the Ministry of Public Works. Throughout the second half of the 19<sup>th</sup> century they played an important role as leaders of the railway network and of public works all over the country and also as experts in technical committees.

The training these engineers had received abroad on «the sciences and arts of construction» was the core of a corps of technicians able to free the country from reliance on foreigners to plan or carry out every project in civil engineering.

When João Evangelista de Abreu returned to Portugal he was appointed as head of the 2<sup>nd</sup> inspection division for the railways; from 2<sup>nd</sup> October 1866 he also took on the task of directing the railway studies south of the River Tagus. When D. Eusébio de Page (the successor of D. José de Salamanca, the famous Spanish engineer who directed the Northern and Eastern railway lines in Portugal) decided to appoint two engineers to direct the works in the Northern railway line and in the Eastern railway line, he chose Adolfo Ibarreta for the first one and he asked the dean of the École des Ponts et Chaussées to chose another highly competent engineer for the second one. João Evangelista de Abreu was the dean’s choice. After just one year he was already in charge of directing both lines.

All the three engineers who ended successfully their French studies in 1867 – Cândido Xavier, Augusto Luciano Simões de Carvalho and João Veríssimo Mendes Guerreiro – were requisitioned on their return by the engineer João Joaquim de Mattos to work in the Minho railway line. Joaquim de Mattos wanted to «reward [their]

commitment while carrying out an official commission when they visited Paris the universal exhibition of that year.»

Cândido Xavier Cordeiro, who was one of the best students of his year at the Ecole des Ponts et Chaussées, became one of the most active engineers in the Portuguese railway system, namely in Oporto and Braga, using his foreign training and expertise to enrich Portuguese engineering.

In 1878 (as in 1867) Cândido Xavier was sent to the World Exhibition in Paris to «study the narrow-gauge railway system, both concerning the use of locomotives and carriages and the use of steam in roads with or without rails».

From 1855 to 1902 he works as chief engineer at the Royal Railway Company. Among the works designed and/or directed by Xavier Cordeiro up to the late 1870s, were the Durães Viaduct, 180 metres long and 22 metres high; the Bridge over the River Lima, with ten huge sections each 60 metres long, «which pillars had in their foundations, for the first time in our country, compressed air in massive iron caissons (the system was first used at the Kehl Bridge over the Rhine)»; in 1885 he was a member of the committee commissioned to draw up the plans to improve the Lisbon harbour. Later on, in 1889, his work at the Rossio tunnel (in Lisbon) was also praised and presented as the perfect example of the «technical proficiency of our [Portuguese] engineers».

The *Gazeta dos Caminhos de Ferro de Portugal e Espanha* (*Portuguese and Spanish Railway Journal*) acknowledged Xavier Cordeiro's high expertise in engineering and, particularly in railways, by inviting him as consultant.

## CONCLUDING OBSERVATIONS

Despite frequent but minor changes concerning the *curricula* of the courses, civil engineering, continued to be considered during the 19<sup>th</sup> century as part of military training, having no autonomous *status*. Thus, public works kept being carried out by military engineers, who were part of the whole embracing “technical services”, which were in charge of «the defence of the country, civil works, roads, geological and other surveys, draining, improvement of ports and the supervision and management of arsenals.»

However, this hybrid profile was increasingly inadequate to the country's needs. In the Portuguese modernization agenda, which was largely based on public works (in particular railways, roads, sanitation and hygiene, and ports), civil engineers embodied the idea of progress, thus playing a decisive role in the “new” Portugal. Soon civil engineers were able to lobby in order to create the Corps of Civil Engineers and Assistant Engineers (1864) and later the Portuguese Association of Civil Engineers, founded (1869).

Oddly enough the question of how to train civil engineers remained an unsolved business. In 1848, Albino de Figueiredo, an engineer who worked at the Minister of Public Works, emphasised the importance of the civil engineering, considered as a powerful weapon to «consolidate a *corpus* of knowledge specific to civil engineers, a professional group without which any nation is deprived of its public works.»

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, namely by creating 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). This highly controversial project, especially regarding the poor role played by polytechnic schools was not approved.

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 our best students. The Ministry of Public Works was bound to send at least three students per year to study abroad. The *Ecole des Ponts et Chaussées*, the *Ecole 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.»

Although the choice of “buying” foreign scientific and technological knowledge in the European market-place had evident costs to Portugal, namely by delaying the implementation of national centres for developing expertise and skills, the role played by Portuguese engineers that went abroad to attend foreign schools was crucial to the modernization agenda of the 19<sup>th</sup> century. In a peripheral country such as Portugal the quest for new and updated technological knowledge relied deeply on the efficiency of a network of formal and informal channels, which acted as vehicles for learning and spreading new skills, new machines and new expertises. Studying abroad was part of this overall strategy aiming to appropriate foreign knowledge and to adapt it to local needs and expectations.