

ASSERTING THE PORTUGUESE CIVIL ENGINEERING
IDENTITY: THE ROLE PLAYED BY THE ÉCOLE DES PONTS
ET CHAUSSÉES¹

Ana Cardoso de MATOS

During the nineteenth century the economic development of Portugal presupposed the creation of a national market [26], which would only become viable with the development of communication means. Only with the greater ease of circulation of both people and goods within the country would it be possible to overcome regional inequalities and ensure a better distribution between producer and consumers. It is in this light that we should understand how the move to modernise the country, a constant theme, particularly from the 1840s onwards, was directly associated with the increase in road and railways networks.

It was in this context that the *Companhia de Obras Públicas* (Company for Public Works)² was founded in 1844 at the initiative of a group of Lisbon entrepreneurs.³ 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'.⁴ Among other works, the company was assigned the building of the road encircling Lisbon and the railway line from Lisbon to the Spanish frontier.⁵

¹ English translation: David Cranmer.

² The Company was founded by public deed on 19 December 1844 and its Statutes were approved by a licence of 30 December 1844.

³ Carlos Morato Roma, Francisco Ribeiro da Cunha, Joaquim Honorato Ferreira, José Maria Eugénio de Almeida, Manuel Cardoso dos Santos, Manuel Gomes da Costa São Romão and Tomás Maria Bessone [29].

⁴ Article No 2 of the Statutes of the Company for Public Works.

⁵ Law of 19 April 1845

The policy of increasing public works that was being encouraged at this time had, however, to confront the lack of civil engineers. However, a number of military engineers were actively involved in the building of the various public works that were essential to the development of the road network in the country. Take, for example, João Crisóstomo de Abreu e Sousa and José Vitorino Damásio, who played a significant role in the Company.⁶

If some of the military engineers did manage to apply the knowledge they had acquired in the area of military engineering to the challenges that public works placed before them, the truth is that the practice of civil engineering demanded specific skills.

This is why the Army School (*Escola do Exército*), created in 1836⁷, included one course in military engineering and another in civil engineering.⁸ The decree of 5 December of the same year determined that the training received at the Mathematics Faculty of the University of Coimbra should be recognised as a sufficient qualification for the posts and tasks that required possession of the Civil or Military Engineers' Certificate.⁹ The training received at this Faculty included the fundamental subjects for engineers, such as Arithmetic, Geometry, Trigonometry, Physics, Mineralogy, Metallurgy, Hydraulics and Civil, Military and Underground Architecture.

The Lisbon Polytechnic School (*Escola Politécnica de Lisboa*) and the Oporto Polytechnic Academy (*Academia Politécnica do Porto*), founded the following year under the auspices of the Ministry of War, included preparatory courses in their curriculum, the contents of which were considered an indispensable theoretical basis for the training of engineers.¹⁰

At the Lisbon Polytechnic School, inspired by the model of the Polytechnic School of Paris (*École Polytechnique de Paris*), a four-year preparatory course was initiated for officials of the Military, military engineers and civil engineers.¹¹ At the Oporto Polytechnic Academy a five-year course for 'all types of civil engineers, such as mining engineers, building engineers and engineers of bridges and roads' was established.¹²

⁶ For details of these engineers, see [23].

⁷ The Army School replaced the *Academia Real de Fortificação, Artilharia e Desenho* (Royal Academy for Fortification, Artillery and Design).

⁸ The civil engineering course, which lasted two years, was organised through a set of subjects taught in military engineering [22].

⁹ 'Carta de Engenheiros Civil ou Militar'. Cf. [28, p.61].

¹⁰ On this subject, see [21-23].

¹¹ Decree of 11 January 1837.

¹² Decree of 11 and 13 January 1837.

Despite the creation of these courses, the number of engineers trained by these schools continued to be insufficient to secure the planning and supervision of works that were wanted in the country. This situation was aggravated by the fact that military training was inappropriate for civil works and also works involving hydraulics. This problem was identified in 1843 by Viscount Sá da Bandeira, who was himself trained as a military engineer:

‘The best military engineer, whose life has been spent on fortification works, if he is put in charge of hydraulic works, which are the most difficult of the science, before attempting them needs to study a good deal; for it is not sufficient just to execute the job, it has to be solidly constructed and done for the lowest possible price’.

Therefore, Sá da Bandeira considered that the contracting of foreign engineers was required, who could train Portuguese engineers:

‘<...> this engineer, while employed in Portugal, will be able to demonstrate the practice of constructions of this kind to a few young men who have already done their theoretical studies, so that at the end of three or four years we can have officials who have had instruction in these matters’.

And he made the point that in Portugal there were:

‘<...> three or four officer engineers, who, by order of our Government, attended the courses at the School of Bridges and Roads, in Paris, where theory and practice are taught, both in respect of works on roads and hydraulics’.¹³

Indeed, just as happened in other European countries,¹⁴ a number of Portuguese engineers sought to complete their training in those countries where technical training in general and civil engineering in particular was more advanced, as was the case in France.¹⁵

The period of political instability and civil war that assailed the country following the Liberal revolution of 1820 contributed to certain military engineers who had been forced to migrate to France to continue their studies there. The same occurred with the revolts of the 1840s, in which several other military engineers were involved. To minimise the effects of the lack of technical training in the country some Portuguese

¹³ [12, Sessão de 12.4.1843, p.272].

¹⁴ On this subject, see [25].

¹⁵ Regarding technical training in France, see [20]. For models concerning the training of engineers, see [24].

engineers were sent to complete their studies abroad at the expenses of the Government.¹⁶

Portuguese engineers at the *École des Ponts et Chaussées* – 1825-1851

Between 1831 and 1851 seven Portuguese attended the Polytechnic School of Paris to complete their training in engineering [27] and between 1825 and 1851 nineteen Portuguese engineers enrolled as students with the status of *auditeurs*¹⁷

In the first half of the nineteenth century the *École des ponts et abaussées* continued to focus principally on the training of engineers who would join the Corps of Bridges and Roads, which directed the building of public works that were being carried out in France under the Ministry of Home Affairs. The reforms introduced at the School between 1830 and 1840 sought to bring into the curriculum subjects that corresponded with the rise of new materials and processes of production and with new construction techniques. Examples included metallurgy and steam-powered earthworks. At this time, teachers such as Bommart tried to reconcile the pragmatism typical of the *École des ponts et chaussées* with the demands of the conceptual rigour necessary for ‘engineering technology’.¹⁸ Despite the controversy over the respective territories and competences of engineers and architects, architecture continued to be considered an indispensable part of the training of civil engineers. Under the tutelage of Léonce Reynaud,¹⁹ architect, engineer and teacher, emphasis was placed on the utilitarian character of architecture linked to the ‘génie civil’²⁰ and his lessons also dealt with the characteristics and resistance of various construction materials.²¹

¹⁶ For example, the law of 31 July 1839 which envisaged sending students to France to study there as state scholars in the area of industrial sciences (especially chemistry and physics), civil engineering, agriculture and surgical operations. We do not, however, know how many students were sent to France.

¹⁷ During this period the Portuguese constituted the third largest group of ‘free students’. Only Poland with 38 students and France with 30 had more. Admission of students was achieved through the authorisation of the general director of the School. From 1832 these students were granted the status of ‘free students’ [31, p.405-406].

¹⁸ Therefore, the teaching of mathematics and mechanics played an important role in Bommart’s course on bridges and railways [31, p.512-513].

¹⁹ Léonce Reynaud was the brother of Jean Reynaud, an engineer who was responsible for a number of important works in the city of Paris.

²⁰ With regard to many of his architectural conceptions, he was in opposition to the architect Viollet-le-Duc, the major French architectural theoretician of the second half of the nineteenth century.

²¹ For example, new materials such as Vicat cement.

Of the nineteen engineers who attended the *École des ponts et chaussées* between 1825 and 1851 it has been possible to identify seven.²²

Portuguese engineers who attended the *École des Ponts et Chaussées*,
Paris, up to 1851 [1]

Name	Training in Portugal	Attendance at the <i>École des Ponts et Chaussées</i>	Age at which they entered the School
Joaquim Simões Margiochi	Academia da Marinha e Fortificação (1833)	Before 1840	
Joaquim Nunes de Aguiar (1812-1872)	Estudos de comércio	1846 (?)-1849	34
Francisco Maria de Sousa Brandão (1818-1892)	Academia Politécnica do Porto	1844-1847	26
Joaquim Tomás Lobo d'Ávila (1818-1892)	Escola Politécnica de Lisboa.	1844 (1845?)-1848(1849?)	26
José Anselmo Gromicho Couceiro (1822-1895?)	Escola do Exército (1842-1843)	1846 (?)-1848	24
Joaquim Júlio Pereira de Carvalho (1819-1871)	Coimbra University, where he received a doctor's degree in 1840	1845-1849	26
Jaime Larcher (1826-1889)	Escola Politécnica de Lisboa (1849-1850)	1851-1853	25

When they enrolled at the school, the majority of these engineers were between 24 and 26 years old. The exception was Joaquim Nunes de Aguiar, who began to study engineering at a later stage, since his family wanted him to go into business. It was only in 1841, when he was already 29, heir to a small fortune, that he was in a financial position to go to Paris, where up till 1849 'he dedicated himself industriously and profitably to the exact and physical sciences, and the specialised areas of the profession of engineer, following the civil engineering course at the *École*

²² I would like to acknowledge my indebtedness to Dimitri and Irina Gouzévitch for the information they gave me on the Portuguese who attended the *École des ponts et chaussées*. Thanks to this information it has been possible for me to discover the grades obtained by the different students and the exact dates that some of them attended the School.

des ponts et chaussées, Paris'.²³ Joaquim Nunes de Aguiar was also the only one not pursuing a military career.

The factors that led these engineers to attend this school were diverse; among them were the social and economic status of their respective families and the training of their fathers. Joaquim Simões Margiochi was son of a reputed mathematician, who was a teacher at the Royal Navy Academy and distinguished himself through his involvement in politics.²⁴ Similarly, Jaime Larcher belonged to a family that owned important woollen factories in Portalegre. His father, Joaquim Larcher, who, following the Liberal Wars had emigrated to France, knew and was well-connected to several of the most important Portuguese families. Indeed, it was his father's social and political connections that enabled Jaime Larcher to obtain permission to attend the *École des ponts et chaussées*.

In the case of Francisco Maria de Sousa Brandão and Joaquim Tomás Lobo d'Ávila, the position of military engineers and their involvement in the military revolt of Torres Novas in 1844 obliged them to flee the country, but their families' economic situation must have contributed to enabling them to attend the School during the years they spent in Paris. The former belonged to a traditional 'family', while Joaquim Tomás Lobo d'Ávila was the son of a property owner in the province of Ribatejo.

Enrolment at the *École des ponts et chaussées* presupposed the undertaking of preparatory studies in engineering and, therefore, the Portuguese engineers who attended the school had all received prior training in this field at one or other of the various schools where it was taught: the Army School, the Lisbon Polytechnic School, the Oporto Polytechnic Academy and the University of Coimbra. Only Joaquim Nunes de Aguiar had no training in engineering when he left for France, which explains why his stay there was so extended. Probably, before entering the *École des ponts et chaussées*, Nunes de Aguiar attended a number of other teaching institutions.

When they returned to Portugal these engineers were employed in the public works which were being carried out in the country and in the technical teaching institutions. The training they had received provided them with the skills and competences necessary to direct public works.

²³ [16, t.4, n°39, 1873, Março, p.95].

²⁴ His father, Francisco Simões Margiochi (1774-1838), had graduate in mathematics and philosophy at the University of Coimbra and was an illustrious mathematician and member of the Royal Academy of Sciences. In politics he was a member of parliament, peer of the realm, member of the Council of State of King Pedro IV, and Naval Minister (1833-1834). In his military career he rose to the rank of lieutenant-colonel.

Their knowledge of state-of-the-art techniques in the field of engineering and the nature of the teaching they had received, in which practical fieldwork played a fundamental role, enabled these engineers to introduce new understandings and teaching methods to Portuguese teaching institutions.

It was therefore not a matter of chance that the Portuguese *Companhia de Obras Públicas*, formed, as has already been stated, in 1844 with the aim of developing the country's road network and of making a start on the first stretch of railway track, recruited Joaquim Simões Margiochi to its staff.²⁵ The theoretical training and the study missions that Margiochi had undertaken in France meant that he knew all the theory and practice required for the public works that were being carried out. The introduction of the most modern construction techniques in the works that were being executed was one of the preoccupations of the Company's board and they implemented a series of measures conducive to this end: they contracted the French engineer, Du Pré, as the Company's engineer-in-chief; they instructed the foreign technicians to give courses to the Portuguese engineers they employed; and they sent Portuguese engineers on study visits abroad.

In 1845, under the auspices of the *Companhia de Obras Públicas*, Du Pré gave a course on Descriptive Geometry and Construction with practical applications in the field [1b]. The same year, the Company's board sent José Vitorino Damásio to study the principal industrial firms in Belgium and Paris, and to select the most appropriate machines and processes for the Arsenal of Public Works, which the Company wished to establish.²⁶ During his stay in Paris, José Vitorino Damásio attended the *École des ponts et chaussées* to update his knowledge. Here he probably attended the supplementary lectures on '*sujets techniques d'actualité*' (present-day technical subjects), for example, roads, bridges and railways, which were given by teachers from outside the School. In 1844 Frimot gave a number of sessions on the making, maintenance and use of locomotives, sessions which were repeated by Clapeyron the following year [31, p.395].

João Crisóstomo de Abreu e Sousa was another of the engineers whom the board of the Company sent to study the development of construction techniques and processes abroad. Abreu e Sousa studied road, canal and railway works that were being undertaken in England, France and Belgium [17, p. 24].

²⁵ Joaquim Simões Margiochi joined the Company on 19 April 1845.

²⁶ This Arsenal never came into existence, as the Company was wound up shortly afterwards.

The training received in Paris was also decisive in the requisitioning of the military engineers Francisco Maria de Sousa Brandão and Joaquim Tomás Lobo d'Ávila by the Ministry of Home Office to undertake public works. The former was put in charge of the public works in the province of Trás-os-Montes and in the district of Viseu. The latter, after a short time working for the Ministry, was made teacher of the supplementary subject of Railways at the Army School. According to the Report of the Secretary of State for Trade and War, dated 1851, this subject, which was

“aimed at developing notions relating to public works, including roads and railways, and which was directed <...> by one of the most distinguished experts in the field, who was in France for many years, completing his studies while also practising, has achieved its objective, giving thorough instruction on notions that were previously only superficially covered”.²⁷

In 1855, Lobo d'Ávila gave up teaching in order to dedicate himself to works on the railways, being nominated Government Inspector of the Western railway line on 29 November 1856.

The training in geology that was given at the *École des ponts et chaussées* must have been an important factor in the choice of Joaquim Júlio Pereira de Carvalho to undertake a series of geological studies; he later became inspector of fires and roads in Lisbon.²⁸ He also held a position as member of the Committee for Steam Engines to which he was appointed in 1851. His commitment to this must have contributed to his appointment as teacher of mechanics at the Lisbon Industrial Institute (Instituto Industrial de Lisboa), upon its creation in 1852. As teacher of this subject, he became an Engineer of the Institute, which required him, among other obligations, to be a member of the School's Technological Council,²⁹ to direct the workshops and to design machines which were then ordered privately or by the State.³⁰ The importance of mechanical engineering to the development of communications in the country was recognised by the Director of the Industrial Institute, José Vitorino Damásio: ‘mechanical engineering is absolutely indispensable to metallurgy; it is indispensable to the railways and steam shipping’ [11, p. 252].

²⁷ Report of the Secretaria de Estado dos Negócios da Guerra of 7 January 1851, annexed to [12, 1851, vol. 1].

²⁸ Joaquim Júlio Pereira de Carvalho remained as inspector of fires and roads in Lisbon until 1864.

²⁹ This Council also included the teachers of: Chemistry Applied to the Arts; Industrial Economics, Descriptive Geometry and Machine Design; and Chemistry and Physics.

³⁰ Provisional Regulation for the Industrial Institute of Lisbon and the Industrial School of Oporto, approved by the Decree of 1 December 1853.

In 1851, Joaquim Júlio Pereira de Carvalho was also contracted by the Lisbon City Council, which sent him to study ‘new inventions that might be of interest to the service of the municipality’ [1f] at the World Exhibition held in Paris in 1855. Working simultaneously at the Lisbon City Council and teaching at the Industrial Institute of Lisbon, Pereira de Carvalho had to ask permission of the latter’s Director to undertake the visit to Paris. The Director gave a favourable response to the request, considering that ‘this teacher will gain much through the study and observation he will undertake at the Paris Exhibition and with his investigations into industrial teaching, especially with regard to design’ [1f]. Recognition of the qualities and competence of this engineer was decisive in his appointment in 1859 as Director of the Industrial Institute of Lisbon, a post that he held to the end of his life (1871), while at the same time he remained a technical official of the Ministry of Public Works.

Upon his return to Portugal, Joaquim Nunes de Aguiar was placed in the public works services of the City Council at Funchal, Madeira. The work that it was possible to undertake there, however, fell far short of his ambitions, for which reason he moved to Lisbon in 1850, although, since he was unable to find a post there as engineer, he was forced to accept the post of secretary to the Civil Governor of Santarém. Probably the fact that he did not belong to the military and had no connections with public administration made it difficult for him to be contracted as an engineer. It was only from 1852, with the creation of the Ministry of Public Works, Trade and Industry (Ministério das Obras Públicas Comércio e Indústria) that this engineer was able to find the necessary framework within which to put his knowledge of civil engineering into practice.

Jaime Larcher, who was at the *École des ponts et chaussées* from 1851 to 1853, while studying at the School undertook two study missions on the works on the Paris-Bordeaux railway line. The notes and studies that he made were written down in two notebooks, which he presented to the school and which later constituted one of the proofs he provided for recognition of his attendance at the School as a ‘free student’ [1g]. On his return to Portugal, following the creation of the Ministry, his professional activity was undertaken under the Ministry’s auspices.

The policy of promoting public works and the growing recourse to engineers

In 1851, the new political regime which took command of the country,³¹ regarded the development of public works and the construc-

³¹ This political regime was known as *Fontismo*.

tion of a railway network as two of its priorities. To accomplish these objectives the government underwent an administrative reorganisation and in 1852 created the Ministry for Public Works, Trade and Industry, headed by the engineer Fontes Pereira de Melo. At this Ministry the technical skills required for the pursuance of material improvements and the implementation of a railways network throughout the country began to receive considerable attention. Engineers were well represented within it, for example, in the overseeing of works and within the actual structure of the Council of Public Works and Mines, whose responsibility it was to pronounce on the various works that were planned or in progress and which was largely made up of engineers. It was this Council that drew up the 'General Plan of Communications of the Realm' on 17 January 1854, which envisaged how the various forms of transport should be linked: railways, roads and rivers.³²

The construction of the railways network, which demanded not only massive investment of capital, but also engineers with competence in this area, forced the government to turn to foreign companies which, possessing both the capital and the technology, were interested in investing in the country. These companies imported technological know-how, models of management, materials and engineers [32]. Thus, at first Portuguese engineers intervened to only a limited extent in these private companies. Their involvement was principally in the approval of plans and in inspection, by virtue of the positions they held at the Ministry of Public Works, Trade and Industry.

In any case, in the middle of the nineteenth century the number of engineers in the country continued to be insufficient to respond to the policy of public works and material improvements initiated by Fontes Pereira de Melo. To mobilize as many Portuguese engineers as possible in public works, the Law Charter of 7 August 1854 authorised the government to employ army officials qualified with an engineering degree in any service that depended on the Direction of Public Works of the Ministry.³³

Thus a substantial proportion of the public works being undertaken in the country were directed by engineers who had a training in military engineering obtained at the Army School, a training that was inappropriate for the new challenges presented by the construction of the sophisticated works of the railways, the infrastructures of basic sanitation or the new equipment required by urban modernisation.

³² The Council at this time was made up of the Baron of Luz, José Feliciano da Silva Costa, and the engineers Albino de Figueiredo Almeida, José Vitorino Damásio, João Crisóstomo de Abreu e Sousa, Francisco António Pereira da Costa and Joaquim Thomas Lobo d'Ávila.

³³ For the purpose of progression in their military careers the time spent on commissions for this Ministry was also counted.

Some of these engineers had also passed through the Polytechnic Schools, but the training here did not cover all the areas of civil engineering. Furthermore, practice in the field had a secondary role in these schools and the fact that the major engineering works in Portugal were only begun in the middle of the nineteenth century made it difficult for the students of civil engineering to have direct experience of construction techniques.

These problems were referred to by the engineer Silvério Augusto Pereira da Silva, who was placed in charge of the works of improving the Aveiro breakwater:

“I did not possess the theoretical and practical knowledge about this branch of civil engineering, essential for executing this job properly; however, it is perfectly well known that at the schools we attend we only study superficially and very imperfectly matters that have to do with the works in question, there being nowhere in practice to go, either, in order to gain the understanding that you only get completely by seeing the constructions”.³⁴

The lack of Portuguese engineers with the necessary technical knowledge to carry out the public works policy had already been stressed by Joaquim Thomas Lobo d'Ávila in 1854 in a speech in the Chamber of Deputies:

“Public works are still in their infancy here. We have made a start – yesterday, so to speak; and so, to expect perfection, whether in terms of personnel, or from other perspectives, is to expect the impossible. <...> Everybody knows that we have a serious lack of staff, both in terms of numbers and qualifications. The engineering that is taught here is primarily military. There has been no complete reform of study programmes, and what happens is that many individuals who are qualified in military engineering, do not, nevertheless, have the necessary knowledge to direct public works. There are, however, some who, because of their private studies and their intelligence, do useful work for the direction of public works. Some have also appeared that have studied abroad, though rather few in number. So we cannot expect perfection at the present time, when there are not yet sufficient personnel qualified to employ in every kind of works; but in spite of this difficulty, we are trying in every possible way to move forward on the building of means of communication”.

To resolve this situation, he defended the urgency of:

“properly organising the individuals involved in this branch of public service. Today the staff involved in public works are, so to speak, a hybrid bunch, made up of heterogeneous elements, with no consistency of quali-

³⁴ [18]. This engineer was Director of Public Works of the Aveiro district at this time.

fications, with no remuneration and no career”.

The importance of practice in the training received at the *École des ponts et chaussées* led him to place particular emphasis on the importance of apprenticeship in works.

“I notice that in the more advanced nations, a student of the School of Bridges and Roads, in Paris, for example, studies a certain time each year in the schools, and then does practical work, and what happens is that the students leave the schools in a state ‘to direct’.”³⁵

It was perhaps because of their recognition of the French model of training that the Portuguese government, in December 1855, decided to commission Watier, who belonged to the French Imperial Corps of Bridges and Roads, to present a study on the guidelines that should be followed by the Portuguese railways and on the costs of building these infrastructures.³⁶

The Portuguese engineers at the *École des Ponts et Chaussées* – 1852-1870

To provide the Portuguese engineers with the theoretical and practical know-how necessary for the public works that were being undertaken in the country, from 1852 onwards the Ministry of Public Works, Trade and Industry supported engineers going to schools abroad. At first the engineers were selected without any kind of competition. Only from 1855 did the Ministry begin to use public competition as a basis for selecting the engineers that the government would assist to study at the School of Mines, in Paris, or the *École des ponts et chaussées*.³⁷

The 1850s saw restructuring at the latter institution, which brought it in line with the logic of the industrial era, since

“the new openings offered to the *ingénieurs des Ponts* thanks to the development of the railways, the close cooperation to which they are driven, by the force of things, with the Mining engineers, civil engineers as well as

³⁵ [12, Sessão de 10.7.1854, p. 171-189].

³⁶ [4, 1860, p.76]. This study was essential at the time, since the Portuguese government wanted to contract a private firm for the railways.

³⁷ Under article 30 of the Law Charter of 17 July 1855.

the driving forces themselves, mark decisive breaks with regard to the old mode of functioning of the administration”.³⁸

With the reform of 1851, the preparation of drawings, accompanied by a study of the calculations relating to the design and its economic viability, as well as fieldwork continued to be stressed at the *École des ponts et chaussées*. These aspects were decisive in the choice of this school as the place of training for Portuguese engineers. Furthermore, through the studies undertaken in the course of their study missions, these engineers came not only to have a good knowledge of the developments in civil engineering in France, but subsequently to become important vehicles for the transfer of this knowledge.

The importance of drawing up designs for works was recognised in Portugal. As the engineer Albino Francisco de Figueiredo stated in 1854:

“Technical description and graphic designs are an essential part of any Project, because they not only complement and support each other, but to a great extent they justify each other. There is a decided tendency among us to suppress the technical description; and for us to realise the grave error we commit in omitting it, suffice it to remember that in the engineering of the French, and of others who like them are well organised, it is the technical description that is considered the keystone of a design, and through it we see the character of the engineer who drew it up” [13].

Preparation of an estimate for the work was another aspect that Albino Francisco de Figueiredo considered indispensable in undertaking any kind of public work.

In the course of the second half of the nineteenth century, twenty-seven Portuguese engineers enrolled at the *École des ponts et chaussées* (see tables appended). Up to 1866, sixteen studied at this school, a cohort being sent every three years after 1855; in other words, new trainees were sent only as those that had undergone training returned. Between 1866 and 1878 no Portuguese engineers were trained there. In the years that followed, the number attending each year is uneven. The majority of these students attended the *École des ponts et chaussées* at the expense of the government, but some did so privately.

In 1852, at the recommendation of the Portuguese Minister and with the approval of the School Council, Ricardo Júlio Ferraz was admitted to the *École des ponts et chaussées*, followed next year by Ricardo Fre-

³⁸ “Les nouveaux débouchés offerts aux ingénieurs des Ponts grâce au développement des chemins de fer, la coopération étroite à laquelle ils sont conduits par la force des choses avec les ingénieurs des Mines, les ingénieurs civils ainsi qu’avec leurs propres conducteurs, marquent autant de ruptures décisives par rapport à l’ancien fonctionnement de leur administration” [31, p. 611].

derico Guimarães. The former completed the course in 1856 and the latter, after being authorised to repeat the *third Classe* (first year of the course), gave up on 23 May 1856. In 1854, another engineer, Eduardo Ferreira Sampayo, enrolled at the school, but in this instance at his own initiative, and he did not complete the course. In 1855, Manuel d'Almeida Ribeiro was admitted by recommendation of the Portuguese Minister but, though authorised to repeat the second year, he did not succeed in obtaining the minimum qualifications and was forced to leave the School.

It was probably the disastrous outcome for the majority of these engineers that led to the change of selection procedure for those sent to France. The opening of public competitions made it possible to select those who, because of their commitment shown at Portuguese schools and/or the practice they already possessed, demonstrated that they had the necessary aptitude to benefit from the *École des ponts et chaussées*. The fact that their stay in Paris became the responsibility of the Portuguese government also meant that the economic status of the candidates was not intrinsically decisive. Upon their return, they had to provide the Ministry with a report of the studies they had undertaken and the establishments they had visited.

In 1856, João Evangelista de Abreu, Pedro d'Alcântara Gomes Fontoura and José Joaquim de Castro were selected. The last of these, however, gave up the idea of studying in Paris, and he was replaced by Valentim Evaristo do Rego.

At the time they left for Paris all these engineers had both received training in engineering and had a few years' practice in public works or teaching in this field.

João Evangelista de Abreu, who held a bachelor's degree in Mathematics from the University of Coimbra, was essentially involved in the teaching profession: in 1852 and 1853 he taught Geometry and Mechanics applied to the Arts [i.e. industry] for the Lisbon National High School. Between 1854 and 1856 he was teacher for courses on roads and railways run by the Army School [1h].

Valentim Evaristo do Rego began his engineering training at the Lisbon Polytechnic School, where he obtained his diploma in 1845. The same year, he was employed in the Company for Public Works and attended the course in Descriptive Geometry and Constructions with field application taught by the engineer Du Pré. In 1853, he received his certificate from the Army School, where he attended the course in Civil and Military Engineering. Before going to the *École des ponts et chaussées*, Evaristo do Rego had held various posts: in 1852, he was working for the Central and Peninsular Railway Company (Companhia Central e Peninsular dos Caminhos de Ferro), under the supervision of the engineer Thomaz

Rumball; he helped the engineer Albino Francisco de Figueiredo e Almeida in the studies for the railway from Lisbon to Santarém; in 1855, he was requisitioned by Filipe Folque to be employed in the Committee for Geodesic and Topographic Works of the Realm; in 1856, he worked with the engineer Joaquim Nunes de Aguiar on the committee dealing with the railway from Santarém to the Spanish frontier [1b].

While they were at the *École des ponts et chaussées* de Paris, the Portuguese engineers were in touch with some of the leading French engineers, and the studies and projects they undertook gave them the necessary skills to intervene in various areas, from the construction of bridges to agricultural hydraulics. On the other hand, the fieldwork they did, which complemented their theoretical training, provided them with direct contact with various public works.

During their theoretical training these engineers undertook various design projects. Valentim Evaristo do Rego, for example, made four engineering designs (an arcade, a building for the Customs, another for a town hall and a railway station), three designs for roads, four mechanical designs (including one for a steam engine), a design for a large stone bridge, a design for inland navigation (regulation of the Seine between Paris and Bezons), an agricultural design for improvement of a large property, and a design for a maritime construction (dyke) [1b].

In 1857, when they had completed the first year of study at the *École des ponts et chaussées* of Paris, João Evangelista de Abreu,³⁹ Pedro d'Alcântara Gomes Fontoura and Valentim Evaristo Rego did fieldwork at Pau and Marseille to study road building, railways and ports, writing a subsequent report. The direct contact with the works that were being carried out and the information with which they were provided enabled these engineers to learn about the construction techniques that were being used in France. As they tell us in their fieldwork report:

“Thanks to the fieldwork mission letters with which we were provided, it was easy for us to establish contact with the various engineers, by whom, as everywhere, we were warmly received. Drawings, written documentation and indications of every kind were made available to us”.

Thus, for example, in relation to the bridge over the Adour, they were given

“all of the documentation that made up the design, both drawings and a copy of the written documents, and as well as that all the notes and indications of details, which were provided us by the engineer with the greatest of good will”.

³⁹ For more about these engineers and the year spent in France, see [6].

In Marseille, they studied the construction of the harbour, the works being carried out for a new residential area and the works on the railway to Toulon. Here they were also able to visit the railway workshops and examine

“in particular detail the bridges made of iron and sheet metal. We had the kinds of bridges for a variety of gaps, and both for the passages over them of ordinary roads (*ponts en dessus*), and for the railways, (...) (*ponts en dessous*)” [19, p. 360-380].

The fieldwork mission undertaken in 1858 by Pedro de Alcântara Gomes Fontoura took him to Italy to study the railway from Genoa to Turin. Following the studies he did at the time, he wrote in his report:

“What my experience has given me of the exploitation of steep-incline railways should provide a valuable lesson for the future of our own railways. I think, therefore, that it will be not without its use in this account to present the results of the study on this matter that I made in the Kingdom of Sardinia” [14, p. 469].

The notes that Gomes Fontoura made on the port of Genoa, together with explanations about the work given to him by the engineer Dionysio, who was directing it, enabled him to write an account of the port, accompanied by four water-colour sketches [15].

At the end of the second year, João Evangelista de Abreu went on a fieldwork mission to Bordeaux with the aim of studying the mouth of the Gironde, the building of a new iron bridge over the Garonne, aimed at linking the two lines of Orléans and the Midi, the procedures for and economic results of fixing the dunes, and the distribution of water at Bordeaux [2, p.112]. With regard to the bridge to link the stations of the Orléans and the Midi Railways, he stated:

“I have in my power twenty-three large drawings relating to the design of this important work; in addition, I have had occasion to work on the calculations and definitive estimates for the project, thanks to the warm welcome I received from M. Régnauld, engineer of bridges and roads, employed on the Midi project and creator of the design” [2, p. 117].

His report on the distribution of water at Bordeaux ‘was full of detail’ and as a result he possessed in his album ‘numerous diagrams representing a series of interesting details regarding the setting-up of steam engines that power the pumps that raise the water, the reservoirs and the pipes, etc.’ [2, p.147].

Manuel Afonso Espargueira, who held a bachelor’s degree in Mathematics from the University of Coimbra and was a licentiate of the Lisbon

Polytechnic School, although he was an army man, was requisitioned by the Ministry of Public Works, Trade and Industry in June 1857. While working for the Ministry he directed the works involving the breakwater at Viana do Castelo. By ministerial decision of 25 February 1859 he was sent to the *École des ponts et chaussées*, where he began in October that year by recommendation of the Portuguese Minister and approval of the School Council.

In 1860, four candidates were chosen to study at the *École*: Joaquim Pires de Sousa Gomes, Álvaro Kopke de Barbosa Ayalla, Pedro Inácio Lopes and Eduardo Augusto d'Oliveira. The first two obtained their diploma on 20 June 1863, the third, having to repeat the first year, only obtained his the following year. Eduardo Augusto d'Oliveira, having been authorised to repeat the first year, decided to give up.

When they were chosen to complete their training in Paris, Pedro Inácio Lopes and Álvaro Kopke de Barbosa Ayalla had only recently finished their course in Mathematics at University of Coimbra. Joaquim Pires de Sousa Gomes had done the same course at Coimbra and had gone on to do the general staff course of the Army School. At the time he was selected to continue his studies in Paris, he was a Mathematics teacher at the Lisbon Polytechnic School.

When he finished his course at the *École des ponts et chaussées*, Barbosa Ayalla was commissioned to carry out a study visit to various works being undertaken in France and in the ports of England, Scotland and Ireland [16, t.26, 1895, p. 5-6].

In 1864, another competition was held to select engineers to complete their training in Paris, for which there were sixteen candidates. The engineers chosen were Cândido Xavier Cordeiro, Augusto Luciano Simões de Carvalho and João Veríssimo Mendes (do Castanheirinho).

During the years they spent at the *École des ponts et chaussées* these engineers had for their professors some of the most prestigious names in French engineering: Mary, for the course on rivers and canals, Bazaine, for railways, Chevalier, for mechanics applied to the resistance of materials, Mangon, for agricultural hydraulics, and Léonce Reynaud, for architecture [1c]. As well as these, they had

“Moradière, for the subject of bridges, a proven builder, who had left his mark and his competence in the most difficult works on the Orléans line, in the stretch from Tours to Bordeaux, “là-bas, au chantier” [down below, at the works], as he would say, warm and sure, at each step of his course” and “Baron, teacher on roads, the most formidable, not because of the essence of the contents, but because of the way he taught” [7, p. 544].

According to Augusto Luciano Simões de Carvalho,

“The oral course of ordinary road building is supported simultaneously by three associated projects set by the teacher of the subject, M. Baron, and terminates with work done in the field, with the added element of a visit to the Paris sewers. Hence, it is certainly one of the most complete in the school. The three associated projects consist of a series of studies that are practical in nature, following on from each other, and with programmes that take in almost all the kinds of task that an engineer can do in his office in this branch of work: the 1st on methods of measuring the volume of hollows and their filling, the 2nd on determining routes and estimating the costs, the 3rd on the realisation of the same routes” [5, p. 348].

As for the architecture course, he stated that

“for the students of the third class, because of the preliminary lessons that the school offers in its amphitheatres *specially* for external students and because of the associated projects carried out in the study rooms, it serves as an introduction to the large-scale works that have to be proposed for the following years; an introduction, however, in which the rigour of the final marks, both in terms of execution and composition, reflects the weight placed on this element in the teaching, made illustrious by the name of M. Reynaud, whose work may be considered masterly in architectural terms” [5, p. 352].

At the end of the first year, Augusto Luciano Simões de Carvalho carried out his first fieldwork mission at Grenoble under the supervision of M. Berthier, chief engineer, who let him see various documents and information, and offered every kind of help with his studies. What he found most interesting was the hydraulic works overseen by the engineers Margot and Nestor Brizac. At the end of the second year, his fieldwork study was at Bordeaux and at the end of the third at the World Exhibition held in Paris and in the south and south-east of France and in Spain, especially on the coast where he studied the lighthouses.

During the course, Cândido Xavier Cordeiro was remarkable for his application and knowledge.⁴⁰ The competence that this engineer showed in his fieldwork surprised Baron, and his laboratory work ‘merited the praise of Hervé Magnon’ [7, p. 544].

At the end of the first year, Xavier Cordeiro chose fieldwork in Savoy and in Grenoble, but the former was offered to Picard, so he took on the latter.⁴¹ In the second year, he made his final travels

⁴⁰ About the years Cândido Xavier Cordeiro engineer spent in France see [8]. Xavier Cordeiro and the Polish engineer Eustachi Thomaz Skrochowski were the two most outstanding students on their course.

⁴¹ The report of this study trip was published in [9].

“to Bercy, with Jaqmin, to visit the general workshops of the Paris-Lyon-Méditerranée; to Creil and to Epone, with Bayle, on geological trips, also visiting in passing the famous foundries at Montataire; to Auteuil, with Morandière, to see the works on the railways round the city and especially the work yards of the viaduct placed on top of the bridge of the Point du Jour” [7, p. 547].

His second-year fieldwork was done at Marseille with Agnellet and Mendes Guerreiro.

When World Exhibitions were held in Paris, the Portuguese Government charged the Portuguese engineers who were in Paris of studying the progress in industry and transport presented at these exhibitions. It was in this context that Cândido Xavier Cordeiro and Augusto Luciano Simões de Carvalho visited the exhibition of 1867 [30]. After the World Exhibition, Xavier Cordeiro and Augusto Luciano Simões de Carvalho undertook the third-year fieldwork at Bretagne, where they studied the ports and the railways, particularly the railway from Rennes to Nantes [10].

In 1866, Frederico Ressano Garcia was admitted to the *École des ponts et chaussées*. He had finished his course at the Lisbon Polytechnic School the previous year, receiving the school’s diploma on 12 June 1869.

Up to 1878 no other Portuguese engineer enrolled at the *École des ponts et chaussées*. That year, Carlos Alberto de Oliveira began there and the following year Miguel José Raio. Only nine more Portuguese students enrolled there up to the end of the century (see table).

The Ministry of Public Works, Trade and Industry: a new framework for the involvement of engineers

With the creation of the Ministry of Public Works, the engineers trained at the *École des ponts et chaussées* joined their technical staff and throughout the second half of the nineteenth century played an important role in the building of railways and direction of the works in various districts, serving on various technical committees. Indeed, in attending the school at government expense, the engineers that completed their training in Paris undertook to work for the Ministry in the years that followed their return to Portugal.

The works carried out by these engineers made it possible to say that, thanks to the ‘foreign study of the science and art of construction carried out by our engineers’, in 1861 already existed a group of technicians capable of executing many of the public works that the country needed [4, 1861, l, p.12].

Shortly after the creation of the Ministry, João Crisóstomo de Abreu e Sousa entrusted the engineers José Anselmo Gromicho Couceiro and Joaquim Simões Margiochi with the works on the railway line from Lisbon to Carregado, which thus far had been in the hands of Waring Brothers & Shaw. Taking on the task of directing the works, the two engineers put into practice the knowledge they had acquired in Portugal and at the *École des ponts et chaussées*, and ‘reorganised work yards and instructed workmen’, tackling the works necessary for the building of this stretch of railway. At the end of the nineteenth century the *Revista da Associação dos Engenheiros Cívicos Portugueses* (Journal of the Association of Portuguese Civil Engineers) made reference to these works:

“Today perhaps someone might look with disdain at the smallness of the stretch and the unimportance of the workmanship. In those days and in those circumstances the thirty-six kilometres from Lisbon to Carregado were the equivalent of an entire line, and any railway bridge rose as something formidable with the proportions and difficulties of a great work of art” [16, 1899, p. 13].

Later, Joaquim Simões Margiochi was put in charge of monitoring the building of the Western and the Southern railways, and was made inspector of the public works in the districts of Leiria, Lisbon, Santarém and Castelo Branco. In 1852 José Anselmo Gromicho Couceiro became a member of the committee set up to determine the route for the Northern railway: in 1856 he was made chief engineer of the Central and Peninsular Company of Portuguese Railways and the following year took on the task of directing the works in the district of Castelo Branco.⁴²

After finishing his training in Paris in 1856, Ricardo Júlio Ferraz immediately joined the *Companhia das Águas de Lisboa* (Lisbon Water Company) and ‘was employed in studies in France, commissioned by this Company, until January 1857’ [1d]. Upon his return to Portugal, he interrupted his work for the Company in order to go to Funchal, his birthplace. This trip, which was originally supposed to be quite short, was prolonged owing to the loss of an arm following an accident with a steam engine applied to a sugar mill. He returned to work at the Water Company in January 1858 and the following year was made director of Public Works in the district of Ponta Delgada, on the island of São Miguel in the Azores.

When they returned to Portugal, the engineers who qualified at the *École des ponts et chaussées* in 1859 took on responsibilities at the Ministry. João Evangelista de Abreu was made head of the second inspection

⁴² In 1868 he was called to serve the King’s command and in 1883 he was made tutor to the Princes Carlos and Afonso.

division for the railways. From 2 October 1866 he also took on the task of directing the railway studies for south of the River Tagus [4, 1866, 11, p.330]. Valentim Evaristo do Rego, after directing various public works, such as the improvements to the Port and breakwater at Figueira da Foz, in 1867 was made director of the General Direction for Telegraphs and Lighthouses [1b].

The engineers Joaquim Pires de Sousa Gomes, Pedro Inácio Lopes and Álvaro Kopke de Barbosa Ayalla, on returning to Portugal, were considered to be civil engineers in the service of the Ministry of Public Works, Trade and Industry with the rank of 'first-lieutenant engineer'. In 1864 the first of these was seconded to work with Joaquim Nunes de Aguiar on designs and works for the Lisbon water supply, while Pedro Inácio Lopes and Álvaro Kopke de Barbosa Ayalla were seconded to work for the engineer Francisco Maria de Sousa Brandão on studies and designs for the railways from Oporto and Coimbra to the border with Spain.⁴³ It is possible that the initiative for employing engineers who had recently arrived from Paris came from Joaquim Nunes de Aguiar and Francisco Sousa Brandão, who, having themselves been students at the *École des ponts et chaussées* in former years, were in a position to assess the skills acquired by engineers coming from this teaching institution in the various branches of civil engineering.

In the years that followed, these engineers took on the task of directing and monitoring the various railway lines and other public works that were being undertaken under the Ministry's auspices. For example, in the 1870s Álvaro Kopke de Barbosa Ayalla was assigned to produce studies and designs for the ports of Viana do Castelo and of Ponta Delgada, and to direct the works at both ports.⁴⁴

The engineers who were trained in Paris in 1862 and 1864 played an important role not only in the railways but also in the hydraulic works that were being executed in the country. Joaquim Pires de Sousa Gomes, who joined the Ministry in 1864, was given the task of directing the works of the Lisbon water supply. Álvaro Kopke de Barbosa Ayalla, having worked with the railways, was named director of Ponta Delgada harbour in 1872 and director of the harbour of Horta, on the Azorean Island of Faial, in 1875, posts he held simultaneously. From 1886 he undertook various jobs in hydraulics, showing 'great professional aptitude especially in the extremely important works of maritime ports, which he directed and to which he dedicated most of his public life' [16, 1894, p. 5-6].].

⁴³ Decree of 27 August 1864.

⁴⁴ He published on the work at the port of Ponta Delgada [3].

Considered a hydraulics specialist on returning to Portugal, Manuel Afonso Espergueira occupied various posts connected with this area. On 29 December 1865 he was made director of the breakwater at Figueira da Foz and the works regulating the Mondego plain. On 2 October 1866 he was given the task of directing the first flood-defence project. He was also asked to direct the works at the ports of Lisbon, Viana do Castelo, Figueira da Foz and Ponta Delgada and the breakwater at the entrance to the Douro.

In 1872, Espergueira asked for leave of absence from the Ministry and became an important engineer at the *Companhia Real dos Caminhos de Ferro* (Royal Railway Company), of which he was made Director at the instigation of the Paris administration which represented the interests of foreign capital invested in the Company.⁴⁵

Pedro Inácio Lopes had a similar career. In 1868 he replaced Manuel Afonso Espergueira in directing the works on the Mondego and the breakwater at Figueira da Foz, then joining the *Companhia Real dos Caminhos de Ferro*, where he was put in charge of the building of the Northern railway line from Vila Real to the station at Campanhã, on the outskirts of Oporto. This included the Maria Pia Bridge over the River Douro. The contract had been awarded to Eiffel on 5 January 1876 and the works were monitored by Espergueira and Pedro Inácio Lopes. In 1890, Inácio Lopes returned to the Ministry and became Director of the Southern and South-Eastern Railways.

The three engineers who qualified in Paris 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 help with the building of the Minho Railway. Joaquim de Matos had ‘recognised [their] commitment while carrying out an official commission when they were in Paris visiting the World Exhibition of that year’ [7, p.554].

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, and the Bridge over the River Lima, with ten great sections each 60 metres long, ‘the pillars of which applied for the first time in this country foundations of compressed air in massive iron caissons, the system first used at the Kehl Bridge [over the Rhine]’ [7, p.558]. In 1885 he was a member of the committee commissioned to draw up plans to improve the Port of Lisbon and between 1885 and 1902 he worked for the *Companhia Real de Caminhos de Ferro*.

In 1869, Augusto Luciano Simões de Carvalho was made chief engineer at the district section of public works at Beja. In the course of his

⁴⁵ He was Director of the Company from 1872 to 1885 and from 1890 to 1894.

life he occupied a number of posts connected with the various railways, but his professional activity also included other areas: in 1888 he became director of the second flood-defence project; in 1899 he became a member of the *Conselho Superior dos Monumentos Nacionais* (Higher Council for National Monuments); in 1900 he joined the *Comissão Superior de Comércio e Indústria* (Higher Committee for Trade and Industry); in 1906 he was made inspector of public buildings.

When he returned to Portugal, Ressano Garcia put into practice the know-how he had acquired in undertaking various designs that 'earned the approval of the *Junta Consultiva de Obras Públicas e Minas* (Consultative Board for Public Works and Mines)' [1e]. In 1872, he was appointed teacher of Descriptive Geometry Applied to Industry at the Industrial Institute of Lisbon and engineer of the Town Council of Belém. In 1874, after a public competition, he accepted the post of engineer to the Lisbon City Council and undertook major projects to modernise the capital. He was also involved in important work on the railways and the modernisation of the country's ports.

Over the years, these engineers were contracted to undertake various studies on the railway network. Examples of these are the 'Report on the result of the survey of the terrain between the Northern railway line and the Western border, with a view to assessing the possibility of a railway line in that direction' presented by José Anselmo Gromicho Couceiro on 9 October 1859, and the 'Report on the survey of the railway line through the Beira', presented the same year by Francisco Maria de Sousa Brandão [4, 1860, 1, p. 74-75 and 3, p. 261-280].

Many of them represented the country at international exhibition congresses. They included: Augusto Luciano Simões de Carvalho, Ministry delegate to the International Railway Congress at Berne; Valentim Evaristo do Rego, who attended the International Telegraph Congresses as Portuguese delegate at Vienna (1868), Rome (1871-1872), St Petersburg (1875) and London (1879); and Joaquim Pires de Sousa Gomes, who was government representative at the World Exhibition of 1889 and charged with studying matters relating to hydraulic works, in 1892 participating in the International Congress of Maritime Works and the Railway Congress at St Petersburg.

Conclusion

In the nineteenth century the modernisation of Portugal was directly associated with engineers. They possessed the technical skills necessary to put into practice the building of roads and railways which made it possible to create a national market.

The state of engineering teaching in Portugal did not permit the country to have a body of civil engineers in a position to respond to the public works that needed to be done, though various military engineers played a role in these works. When, however, the railways became a government priority, training in civil engineering was patently insufficient to respond to the new challenges that faced engineers. Hydraulic works were another area that demanded knowledge of specific skills.

To try to overcome this situation various engineers completed their training abroad, for example, at the *École des ponts et chaussées* of Paris. Although they represented only a tiny proportion of Portuguese engineers, they played an important role in the progress of Portuguese engineering: on the one hand, because they designed and directed several of the most important public works that were built in the course of the second half of the nineteenth century; and on the other, because the work they did had repercussions for the engineers who worked under their supervision and who learnt modern methods from them for planning and executing roads, railways and maritime ports. Indeed, the publication by the Ministry of Public Works, Trade and Industry in their *Bulletin* of the reports of the studies undertaken by these engineers during their training in Paris was a means of making available to other engineers a range of information that might be of use to them.

The activity of some of engineers graduated in Paris as teachers in Portuguese technical schools enabled them to transmit the theoretical and practical knowledge on the various branches of civil engineering they had acquired in France to their students. The fact that the majority of them belonged to the *Associação dos Engenheiros Cívicos Portugueses* (Portuguese Civil Engineers Association), founded in 1869, meant that there was a platform for this professional fraternity to give lectures and discuss various problems that assailed Portuguese engineering.

Some of these engineers participated actively in the political life of the country. Several of them were elected deputies, and some even became ministers, as was the case with Joaquim Tomás Lobo d'Ávila and Ressano Garcia.

Through their professional and political activity, the engineers trained at the *École des ponts et chaussées* allowed themselves to be a major factor in the affirmation of Portuguese engineering and a means of transferring know-how and technology associated with civil engineering, which contributed to its modernisation.

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Portuguese engineers at the *École de Ponts et Chaussés* (EPC) between 1852-1870

Name and date of birth	Education before going to the EPC	Professional activity before going to the EPC	Admission at the EPC	Dates of attendance to the EPC	Grades	Observations
Ricardo Júlio Ferraz (1826-1880)	He held a bachelor's degree in Mathematics from the University of Coimbra		He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 27 th October 1852	1852-1856	53/54-191,8 54/55-212,2 55/56-187 Total – 591	Because he was ill in 1852-53 he was authorised to repeat the 3rd class in 1853-54
Ricardo Frederico Guimarães (1831-1877)	He held a bachelor's degree in Mathematics from the University of Coimbra (1847-?)		He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 22 th October 1853	1853-1856	He had no grades so probably he did not conclude any discipline.	After being authorised to repeat the 3 ^a Classe (1 st year of the course) he gave up on 23 May 1856
Eduardo Ferreira Sampayo (1837-			Admitted by proposal of the examination jury and the approval of the School Board in 27.10.1854	1854-1855	He had no grades	Resigned in 8 th January 1855
Manuel d'Almeida Ribeiro (1832-			He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 13 th November 1855	1855-1858	55/56 – 184,5 57/58 – 168,3	He was authorised to repeat the second year, but he did not succeed in obtaining the minimum qualifications and was forced to abandon the school (by the application of the decree of 1851)

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Name and date of birth	Education before going to the EPC	Professional activity before going to the EPC	Admission at the EPC	Dates of attendance to the EPC	Grades	Observations
João Evangelista de Abreu (1827-1869)	He held a bachelor's degree in Mathematics from the University of Coimbra (1850) and a degree in Military Engineering from the Escola do Exército (Army School) (1854)	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 a set of disciplines on roads and railways at the Army School	He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 31th October 1856.	1856-1859	56/57 – 241,1 57/58 – 251,1 58/59 – 213,3 Total – 705,3	He received his diploma in 16th June 1859
Pedro d'Alcântara Gomes Fontoura (1828-			He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 31th October 1856.	1856-1859	56/57 – 206,4 57/58 – 230,8 58/59 – 189,1 Total – 603,1	He received his diploma in 16th June 1859
Valentim Evaristo do Rego (1825-1884)	He study at Escola Politécnica de Lisboa (Polytechnic School of Lisbon), where he obtained his diploma in 1845. In this year he attended the course in Descriptive Geometry and Constructions with field application taught by the engineer Du Pré.	In 1852 he worked for the Companhia Central e Peninsular dos Caminhos de Ferro (Central and Peninsular Railway Company).	He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 31th October 1856.	1856-1859	56/57 – 200 57/58 – 195,7 58/59 – 184,4 Total – 580,1	He received his diploma in 16th June 1859

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Name and date of birth	Education before going to the EPC	Professional activity before going to the EPC	Admission at the EPC	Dates of attendance to the EPC	Grades	Observations
	In 1853 he received his certificate from the Army School, where he attended the course in Civil and Military Engineering	In this year he also helped the engineer Albino Francisco de Figueiredo e Almeida in the studies for the railway from Lisbon to Santarém. In 1855 he was employed in the Comissão de Trabalhos Geodésicos e Topográficos do Reino (Committee for Geodesic and Topographic Works of the Realm). In 1856 he worked on the railway from Santarém to the Spanish frontier				
Manuel Afonso Espergueira (1833-1917)	He held a bachelor's degree in Mathematics from the University of Coimbra. He also held a diploma from the Polytechnic School of Lisbon and a diploma from the Army School.	Since June 1857 he worked at the Ministry of Public Works, Trade and Industry. While working for this Ministry he directed the works involving the breakwater at Viana do Castelo.	He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 20th October 1859	1859-1862	59/60 – 212,4 60/61-244,4 61/62 – 108,6 Total – 665,6	He received his diploma in 15th de July 1862

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Name and date	Education before going to the	Professional ac-	Admission at the	Dates of at-	Grades	Observations
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of birth	EPC	tivity before going to the EPC	EPC	tendance to the EPC		
Alvaro Kopke de Barbosa Ayalla (1838-1894)	He held a diploma of Mathematics at Coimbra University (1860).		He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 31th October 1860	1860-1863	60/61 – 233,6 61/62 – 228,4 62/63 – 193,5 Total – 655,5	He received his diploma in 8th July 1863
Pedro Inácio Lopes (1840-	He held a diploma of Mathematics at Coimbra University.		He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 31 October 1860	1860-1864	60/61 – 61/62 – 202,4 62/63 – 204,7 63/64 – 187,6 Total – 594,7	He was authorised to repeat the first year. He received his diploma in 15th de June 1864
Eduardo Augusto d'Oliveira (1835-			He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 31 October 1860	1860-1862	60/61 61/62	He was authorised to repeat the first year. Resigned in 20 th June 1862
Joaquim Pires de Sousa Gomes (1836-	He held a diploma of Mathematics at Coimbra University (1856) He also held a diploma from the Army School in 1860.	In 1860 he was a Mathematics teacher at the Polytechnic School of Lisbon.	He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 31 October 1860	1860-1863	60/61 – 231,2 61/62 – 230,1 62/63 – 197,3 Total – 658,6	He received his diploma in 17th June 1863

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Name and date of birth	Education before going to the EPC	Professional activity before going to the EPC	Admission at the EPC	Dates of attendance to the EPC	Grades	Observations
Augusto Luciano Simões de Carvalho (1838-1912)	He held a diploma of Mathematics at Coimbra University (1863) He also held a diploma from the Army School in 1864.		He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 7 October 1864	1864-1867	64/65 – 200,2 65/66 – 234,2 66/67 – 198,6 Total – 633	He received his diploma in 21th June 1867
Cândido Xavier Cordeiro (1842-1904)	He held a bachelor's degree in Mathematics from the University of Coimbra (1861). Between 1861 and 1863 he studied at the Army School where he enrolled the disciplines related to civil engineering.	After received his Army School diploma he began his professional career at the Public Works division of Castelo Branco.	He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 7 October 1864.	1864-1867	64/65 – 210,9 65/66 – 263,6 66/67 – 199,9 Total – 674,4	He received his diploma in 21th June 1867
João Veríssimo Mendes Guerreiro do Castanheirinho (1842-)			He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 7 October 1864.	1864-1867	64/65 – 221,8 65/66 – 244,7 66/67 – 213,6 Total – 680,1	He received his diploma in 21th June 1867
Frederico Resano Garcia (1847-1911)	In 1865 he also held a diploma from the Polytechnic School of Lisbon.		He was admitted at the recommendation of the Portuguese Minister and with the approval of the School Council in 31 October 1866	1866-1869	66-67-234,4 67/68 – 260,3 68/69 – 207,9 Total – 702,6	He received his diploma in 12 th June 1869

