Introduction

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The making of nation-states in the nineteenth century is closely related to the rise of national educational systems in Europe and America. In this context, an array of technoscientific schools for higher education emerged in Europe in the form of the *Polytechnique.* Recent scholarship has even shown that the French system of technical higher education had a profound impact on American higher institutions, the models of which were traditionally regarded as dominated by British and German patterns.[1] The Iberian Peninsula was no exception. In Spain and Portugal, the early decades of the nineteenth century witnessed the establishment of technical schools such as *Escuela de Caminos, Canales y Puertos* (1834), *Escuela de Minas* (1835), and the *Escola Politécnica de Lisboa* (1837). This volume aims to present some important cases, which contribute to throw light on the Iberian Polytechnic experience.

Usually vindicating the model of French *grandes écoles*, the nineteenth-century technical schools actually relied largely upon local traditions of higher education. Even when these schools followed consciously the methods and practices employed at the French *grandes écoles*, local constraints often led school administration and educators to change plans and meet real needs. The Lisbon Polytechnic School is a case in point. Traditionally, it has been argued that the creation of the Lisbon Polytechnic School in 1837 adopted as a model the *École Polytechnique*, in Paris.[2] However, recent historical research shows that the origin of the Portuguese institution is

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[1] A. J. Angulo, "The Polytechnic comes to America: how French approaches to science instruction influenced mid-nineteenth century American higher education", *History of Science,* 50 (2012), 315–338.

[2] See, for example: Teófilo Braga, *História da Universidade de Coimbra nas suas Relações com a Instrucção Pública Portuguesa*, Vol. IV, (Lisbon, 1902); Pedro José da Cunha, *A Escola Politécnica de Lisboa. Breve Notícia Histórica* (Lisbon: Faculdade de Ciências, 1937); Fernando Bragança Gil and Maria da Graça Salvado Canelhas, "Ensino e cultura no Monte Olivete até à Faculdade de Ciências" in Fernando Bragança Gil and Maria da Graça Salvado Canelhas (eds.), *Faculdade de Ciências da Universidade de Lisboa: Passado/Presente, Perspectivas Futuras. 150º Aniversário da Escola Politécnica/75º Aniversário da Faculdade de Ciências* (Lisbon: Museu de Ciência da Universidade de Lisboa, 1987).

part of a tradition of military higher education already existing during the Old Regime.[3] Complementing this approach, Ana Cardoso de Matos argues, in her paper, that, concerning teaching methods, the Lisbon Polytechnic followed the model of the Parisien *École de Ponts and Chaussées*, a circumstance resulting primarily from the fact that some of the Portuguese engineers who became teachers in the first had previously studied in the latter. However, teaching methods practiced at the Lisbon Polytechnic failed to meet the objectives sought on the institution's creation namely the implementation of practical teaching of public works in the training of future engineers.

As the paper by Ana Cardoso de Matos reveals, the historiography of science recently has paid particular attention to the processes of circulation and appropriation of scientific knowledge and practices[4] that take place between countries, which often have different scientific traditions. In this context, the concepts of scientific "centres" and "peripheries" have been reassessed[5] in an attempt to overcome the traditional "diffusionist" view according to which scientific knowledge is produced in major scientific centres and passively spreads to the peripheries. The history of science education does not escape from this "diffusionist" model; it is considered many times that countries of the scientific periphery try to "mimic" teaching institutions and educational practices existing in the scientific centres and invariably fail to achieve the same results. The article by Antoní Roca-Rossel is a further contribution to the already appreciable historical literature that contradicts this view.[6] He shows that technical education was organized in Spain in 1850 based both on contributions from engineers who studied abroad, in particular at the *École Centrale des*

[3] Luís Miguel Carolino, "Measuring the heavens to rule the territory: Filipe Folque, the teaching of astronomy at the Lisbon Polytechnic School and the modernization of the State apparatus in nineteenth century Portugal", *Science & Education*, 21 (2012), 109–133; Luís Miguel Carolino, "The making of an academic tradition: the foundation of the Lisbon Polytechnic School and the development of higher technical education in Portugal (1779–1837)", *Paedagogica Historica: International Journal of the History of Education*, 48 *3* (2012), 391-410.

[4] James Secord, "Knowledge in transit", *Isis, 95* (2004), 654–672; Kapil Raj, "Beyond postcolonialism ...and postpositivism: circulation and the global history of science", *Isis*, 104 (2013), 337–347.

[5] Kostas Gavroglu, Manolis Patiniotis, Faidra Papanelopoulou, Ana Simões, Ana Carneiro, Maria Paula Diogo, Jose Ramon Bertomeu-Sánchez, Antonio Garcia Belmar and Agusti Nieto-Galan, "Science and technology in the European periphery: Some historiographical reflections", *History of Science* 46 (2008), 153–75; Kostas Gavroglu "The STEP (Science and Technology in the European Periphery) Initiative: Attempting to Historicize the Notion of European Science", *Centaurus* 54 *4* (2012), 312–327.

[6] Jose Ramon Bertomeu-Sánchez et al (eds.), "Science Textbooks in the European Periphery", *Science & Education* (special issue), 15 *2–3* (2006), 657–880; Faidra Papanelopoulou, Agustí Nieto-Galan and Enrique Perdiguero (eds.), *Popularizing Science and Technology in the European Periphery, 1800–2000 (Science, Technology and Culture, 1700–1945),* (Aldershot: Ashgate, 2009); Antoni Roca-Rosell (ed.), *The Circulation of Science and Technology: Proceedings of the 4th International Conference of the ESHA*, *Barcelona, 18–20 November 2010*, (Barcelona: SCHCT-IEC, 2012); Josep Simon (ed.), "Cross-National and Comparative History of Science Education", *Science & Education*, 22 *4* (2013), 763–866.

Arts et Manufactures in Paris, and in the model of organization of technical education existing in Berlin. It was in this context of appropriation and integration of different aspects of foreign teaching traditions of technical education that a degree in industrial engineering was created in Spain. These industrial engineers became by-and-large free professionals who had to look for a job in the marketplace. Industrial engineers eventually played a role in many economic activities more or less connected with industry, this being their activity particularly significant in Catalonia. Contrary to what happened with the Spanish industrial engineers, students who enrolled at the Lisbon Polytechnic School aimed at pursuing a career in technical and scientific activities, in particular in military and civil engineering. In fact, the large majority of the Portuguese polytechnicians became civil servants and part of the Portuguese State technical staff. In France, the polytechnicians became what Bourdieu called a "noblesse d'État."[7] But was the Lisbon Polytechnic, just like its French counterpart,[8] the *alma mater* of the national technical *intelligentsia*? And did the major political actors of the second half of the nineteenth century get their education in the Lisbon Polytechnic?[9] These are the main questions that Luís Miguel Carolino, Teresa Mota and Dulce Figueiredo propose to answer through the analysis of the career paths of students who took the preparatory course for engineering in the Lisbon Polytechnic between 1837, the year the school was created, and the establishment of the First Republic, in 1911.

Regardless of the answer given to those questions by the authors of the article, engineers no doubt took part in the process of intervention in the Portuguese territory that led to the construction of a technoscientific landscape in the course of the nineteenth century.[10] And they also had a word on the construction of a new social and political order in the country. For some

[7] Pierre Bourdieu, *La Noblesse d'État: Grandes écoles et Esprit de Corps* (Paris: Les Éditions de Minuit, 1989).

[8] Bruno Belhoste, *La Formation d'une Technocratie. L'École Polytecnique et ses Élèves de la Révolution au Second Empire* (Paris: Belin, 2003).

[9] On the role of the *École Polytechnique* as a training centre for the French political and social *élite*, see, among others: Terry Shinn, *L'École Polytechnique, 1794–1914* (Paris: Presses de la Fondation Nationale des Sciences Politiques, 1980).

[10] See, for instance: Tiago Saraiva, *Ciencia y Ciudad, Madrid y Lisboa: 1851–1900* (Madrid: Ayuntamiento de Madrid, 2005); Marta Macedo, *Projectar e Construir a Nação – Engenheiros e Território em Portugal (1837–1893)* (Lisbon: ICS, 2012); Maria Paula Diogo and Isabel Maria Amaral (coord.), *A Outra Face do Império. Ciência, Tecnologia e Medicina nas Colónias Portuguesas (Secs. XIX–XX)* (Lisbon, Colibri, 2012); Ana Cardoso de Matos, *Paisagem, Caminho-de-ferro e Património: Espaços, Estruturas, Imagens e Narrativas* (in publication).

years now, this issue has been the subject of historical research[11] and the contribution to this volume by Maria Paula Diogo fits into this context. It explores the relationship between the late industrialisation process that took place in Portugal during the nineteenth century and the emergence of a professional community of civil engineers. The author develops her arguments around the response given by Portuguese military engineers to the process of modernisation of the country, especially after the Regeneration. This process of modernisation was based on the conviction that the economic and social development of Portugal was closely linked to technological advancement. One of the results of these circumstances was the emergence of civil engineering.

The article by Pedro Raposo is dedicated to another type of engineers with a history that is somehow different from the one shared by civil engineers: hydrographic engineers. Trained during the second half of the nineteenth century in a multiplicity of institutions, from the Lisbon Polytechnic to the Navy School, passing through the Army School and the Astronomical and Meteorological observatories, the hydrographic engineers' main function was the survey and mapping of maritime and fluvial borderlines in Portuguese mainland and in the colonies. However, as the article reveals, the interests and agenda of Portuguese hydrographic engineers stretched well beyond their official duties and many of them eventually developed their careers in a plurality of areas and activities. Pedro Raposo uses a biographical approach to develop his arguments, following the professional and scientific path of three hydrographic engineers — Ernesto de Vasconcelos (1852–1930), Ramos da Costa (1865–1939) and Hugo de Lacerda (1860–1944) — during the troubled times of the Portuguese First Republic.

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[11] See, among others: Maria Paula Diogo, *A Construção de uma Identidade Profissional: a Associação dos Engenheiros Civis Portugueses (1869–1937)*, PhD thesis, (Lisbon: New University of Lisbon, 1994); Pedro Tavares de Almeida, *A Construção do Estado Liberal. Elite Política e Burocracia na "Regeneração" (1851–1890)*, Ph.D. thesis, (Lisbon: New University of Lisbon, 1995); Pedro Tavares de Almeida and António Costa Pinto, "Os ministros portugueses, 1851–1999. Perfil social e carreira política" in Pedro Tavares de Almeida, António Costa Pinto and Nancy Bermeo (org.), *Quem Governa a Europa do Sul?,* (Lisbon: ICS, 2006); Maria Filomena Mónica, *Fontes Pereira de Melo*, Lisboa, Aletheia, 2009; Macedo, *Projectar e Construir a Nação*...