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Silva Suárez, Manuel, ed. *Técnica e Ingeniería en España: El Siglo de las Luces. De la ingeniería a la nueva navegación*, Vol. II. Zaragoza: Institución 'Fernando el Católico', Prensas Universitarias de Zaragoza; Madrid: Real Academia de Ingeniería, 2005. Pp. 624.

_____. *Técnica e Ingeniería en España: El Siglo de las Luces. De la industria al ámbito agroforestal*, Vol. III. Zaragoza: Institución 'Fernando el

Católico', Prensas Universitarias de Zaragoza; Madrid: Real Academia de Ingeniería, 2005. Pp. 576.

As part of the very ambitious multi-volume publication *Técnica e Ingeniería en España* promoted and directed by Manuel Silva Suárez, volumes II and III are devoted to the Spanish Enlightenment. Professor Silva started publishing this great work in 2003, with the first volume dedicated to the Renaissance.*

These two volumes form a unitary work that addresses the connections between technology and society in Spain during the Enlightenment from a polyhedral perspective. It is, in fact, a collective work carried out by recognized and prominent specialists. Although there are a few contributions by French and Italian scholars, most authors are historians of science and technology from Spanish universities.

With the subtitle 'From engineering to new navigation', volume II focuses largely on the technical corps of the State, its institutionalization, expertise and achievements. An extensive introduction to this volume, written by Manuel Silva, provides an overview that shows the consistency of the twelve chapters within. These chapters are structured in three parts: the first part deals with general issues that provide an overall framework (chapters 1–6); the second is dedicated to the civil and military public works (chapters 7–10); and the last part deals with the role of the navy and navigation (chapters 11 and 12).

Víctor Navarro Brotons opens the first part with a chapter entitled 'The renewal of scientific activity in seventeenth-century Spain and physico-mathematics subjects'. Navarro discusses the transmission and assimilation of physical and mathematical sciences developed by the 'novatores' at a time of decline. In Chapter 2, Siro Villas reflects on the connections between science, technology and power, showing the policy instruments used for modernizing the scientific and technical level of the kingdom. From Paris, Irina Gouzevitch and Hélène Verin, provide some fresh insights into the situation of European engineering in the third chapter. They analyze the institutionalization of engineering as a state corps and pose interesting considerations on the construction of the identity of the engineer in the eighteenth-century. In the next chapter, Manuel Silva tackles the institutionalization of engineering in Spain and related technical professions. He analyzes the creation of the engineering corps, subsequent jurisdictional conflicts and the differences among the regulated training mechanisms thereof. The first part closes with a chapter written by Pedro Álvarez de Miranda, which explores the evolution of technical language, and another by Arturo

* Other volumes of this work are scheduled for review in *ICON*.

Ansón, which studies the evolution and diversity of architectural language, with special regard to the conflict of jurisdiction between military engineers and architects.

The renowned historian Horacio Capel launches the second part of Volume II, which is dedicated to public works. He focuses on the extensive work done by the Army Corps of Engineers on defence, control, management and territorial development, showing the relevance of the contributions of military engineers to the urban morphology of cities in Spain and America. The involvement of engineers in the setting up of infrastructures (e.g., roads, channels and harbours) and in building design (e.g., hospitals, houses and palaces) is evident. The next chapter, written by Juan José Arenas, focuses on civil engineering and public works: roads, channels, aqueducts, locks, dams and harbours. Arenas stresses the coexistence of a rational attempt to structure the territory with a sort of operational disorder, especially in the case of the channels. In Chapter 9, Guillermo Pérez Sarrión deals with hydraulic works by Arenas by analyzing the policy used in the construction of three major waterworks channels. He points out that the interest in promoting commercial pathways and irrigation works also entailed mistakes in planning and execution. Fernando Cobos closes this second part with a chapter devoted to the art of Spanish fortification in the seventeenth and eighteenth centuries, which links this chapter with his contribution to the initial Renaissance volume Silva's *Técnica e Ingeniería*.

Finally, in the third part of volume II, devoted to the Navy, Manuel Sellés describes the situation of the Spanish Navy in the eighteenth century (Chapter 11). Sellés discusses the importance of the establishment of the School of Marine Guards in Cadiz, along with the gradual renewal of nautical training. He also highlights the efforts to transform and modernize the Navy, the improvements in instrumentation and mapping, the assimilation of modern methods to determine the longitude and the promotion of hydrographic expeditions to open new routes. The last chapter (Chapter 12), by Julián Simón, deals with the complexity of shipbuilding and how engineering allowed the passage from an artisan and empirical conception of a ship to another one based on scientific knowledge. In this sense, Jorge Juan epitomizes this transition in the Spanish case.

Volume III, subtitled 'From industry to agroforestry field', contains ten chapters. According to his introduction, Silva suggests that this volume can also be structured into three parts. The first deals with issues of industry, mining and machinery (chapters 1–5); the second focuses on the training of artisans, the renewal or innovation programmes in the country and the diffusion of technology among professional groups (Chapters 6–8); and the third studies the field of agro-forestry (chapters 9 and 10).

In the opening of the volume, Manuel Silva reflects on the languages of the new technique (language and neologisms, technical drawing and mathematics). Juan Helguera's opening chapter begins with the introduction of new techniques in eighteenth-century Spain. His is a study about technology transfer through the policy of hiring foreign technicians and the practice of industrial espionage. Helguera illustrates this with the project to introduce the steam engine to the mines of Almadén. In Chapter 2, Aurora Rabanal offers a case study on the typology of industrial architecture and the new type of construction that the factory represents. She analyzes the most important buildings of the Bourbon monarchy, namely, the royal manufactures, which she classifies into four areas: textiles, luxury goods, metallurgy and state monopolies (including tobacco, liqueur and saltpetre). Juan Ignacio Cuadrado and Marco Ceccarelli show an overview of innovation in the design of machines and classification of mechanisms (Chapter 3). They emphasize the impact of the work of Lanz and Betancourt, *Essai sur la composition des machines*, and the new Theory of Machines. They also analyze the contributions of Betancourt to the problem of dimensions of the articulated quadrilateral in Watt's mechanism to achieve the rectilinear guidance. In the next chapter, Antoni Roca examines the role of scientific and technical training in Barcelona, a city with no university at the time. Roca emphasizes the role of the Board of Commerce of Barcelona, which established a collection of free technical schools. Two of these are studied in depth in the chapter: the school of Chemistry (1805), directed by Francesc Carbonell, and the school of Mechanics (1808), promoted and directed by Francesc Santponç. The former enhanced winemaking and contributed to the improvement of dyeing substances, which turned out to be fundamental in the Catalan calico industry. The latter appeared as a consequence of the construction of the first double-acting steam engine in Spain, designed by Santponç. This first section ends with a study by Julio Sánchez Gómez of mining and metallurgy in Spain and Spanish territories in America during the Enlightenment (Chapter 5). Gómez shows major technical innovations introduced in the mining-metallurgical field, such as the use of steam to bail water, the transportation of ore wagons on rails, the protection of lighting fixtures, the improvement of planimetry underground and the use of gunpowder. He studies a number of mines, renewal attempts, accidents, faulty approaches and difficulties encountered in Spanish mining.

The second part of Volume III begins with Chapter 6, written by Siro Villas and devoted to guilds, that is, artisan corporations. Villas addresses social and economic patterns developed by the guilds, as well as the differences between the guilds in the Crown of Aragon and those in Castile. He examines their history until their first administrative extinction in 1813. In Spain, the guilds were restored during the absolutist period but were

definitively abolished in 1836, three years after the death of Ferdinand VII. In the next chapter, Jose Francisco Casals and Antonio Manuel Moral study the *Sociedades Económicas de Amigos del País* (Economic Societies of Friends of the Country). Taking the *Sociedad Bascongada* (Bascongada Society), founded in 1764, as a model, the state fostered the creation of similar societies throughout the Spanish territory. The aim was the development of industry, agriculture and trade, but it was met with unequal success. The authors pay special attention to the *Sociedad Matritense* and examine the attempts to structure an educational system during the reign of Carlos III. In Chapter 8, Julio Sánchez Gómez focuses on technical publications for professional communities. He compiled and analyzed Spanish publications of Enlightenment related to agriculture, livestock, fisheries, mining, metallurgy industry, machinery, construction and public works. Among them, those related to agriculture and textiles were notable.

The last part of volume III is carried out by Jordi Cartaña and Vicente Casals. While the former analyzes the agronomy in eighteenth-century Spain (Chapter 9), the latter studies scientific and technical innovations with regard to forestry and promotion of mountains (Chapter 10). Cartaña focuses his research on technological change and the establishment of institutions for the promotion of agriculture in Spain, in keeping with the European agricultural revolution. His work delves into the mechanisms for disseminating and teaching new agronomic ideas (publications, botanical gardens, schools, introduction of new crops, modern farming methods, proposals for mechanization, etc.) and into the technical contributions of Spanish agronomists. Meanwhile, Casals focuses on the policy for forests and plantations, based on the Bourbon programme of reforms and its subsequent legislative impact. In addition, he shows the French influence on Spanish forestry (especially of the work of Duhamel du Monceau), and he gives a full account of the slow introduction of silviculture, based on the science of botany, which replaced the 'arboriculture', based on peasant traditional practices.

It is unfortunate that the two volumes do not include indices other than one for illustrations. However, at the end of Volume III, there is a remarkable section on 'Biographical Notes'. The reader finds here the biographies of 179 important figures that appear throughout both volumes. Furthermore, it is worth stressing the rich graphical content of both volumes, which contain many colour illustrations. This magnificent iconography proves to be very useful since it adds, in many cases, valuable information to the work.

In short, these two volumes comprise a documented, rigorous and collective work that presents a new approach to the history of technology and engineering in the Spanish Enlightenment. They include chapters on topics that have been little studied before, thus making a very innovative work. In

addition, the fact that these volumes refer to the Spanish context and its American territories makes them unique. Finally, these volumes are quite homogeneous despite being written by 23 different specialists. This is clearly the result of the thoroughness and permanent supervision of the director-editor. Through carefully thought-out presentations, Manuel Silva manages to show the interconnection of the different parts and to articulate them into a consistent unit.

To sum up, these two volumes have the necessary ingredients to become an indispensable reference work for historians of Enlightenment technology. The volumes not only have an undeniable interest for historians of technology, but it will also be appreciated by engineers and a large segment of the public interested in connections between technology and society. The publication of this book is good news for the history of technology and engineering.

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