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Manuel Silva Suárez, ed. *Técnica e Ingeniería em España, El Ochocientos, De los Lenguajes ao Patrimonio,* Vol. VI. Zaragoza: Institución 'Fernando el Católico', Prensas Universitarias de Zaragoza; Madrid: Real Academia de Ingeniería, 2011. Pp.832.

The sixth volume of *Técnica e Ingeniería em España: El Ochocientos, De los Lenguajes ao Patrimonio*, is an important contribution to the history of technology in Spain. The volume is substantive, not only for its length (832 pages spread over 16 chapters), but for its narrative of technical and scientific developments as well as the imagistic and rhetorical resources that supported the new epistemology of the eighteenth century. The volume's 16 chapters are structured in two parts of seven chapters and nine chapters respectfully.

Part one gives the reader an account of the 'languages' of technology and science, beginning with a chapter by Cecilio Rodriguez Garriga Escribano and Frances Ortiz that addresses issues of terminology – the new words and their meanings – as the meanings of the new terms were built. 'Accuracy', for example, is defined in qualitative terms. In the second chapter, José Ignacio Morales and Vicente Muro Costa Casals describe the evolution of a different 'language', cartography, and its importance for the development of engineering. The accurate representation of the territory is essential, first in order to get to know it, and second for its inhabitants, through the state, to appropriate it not only conceptually but also practically: what is owned, what can be extracted from it, what can be built on it, how these things are built and finally its value. If Rodriguez and Ortiz assign 'accuracy' a primarily qualitative nature, in Morales and Casals, through the need of measurement, make it a quantitative criterion for reality.

In chapter three, Javier Ortega Vidal combines both the qualitative and quantitative characteristics of architectural design, being the accuracy of design and the beauty of form based on accurate measurement. Mathematics emerges both as a compelling resource and a set of instruments, in particular supporting technical drawing. It is to the latter and the design of machines that Patricia Pérez Zuleta devotes the fourth chapter. The objectives of industrial drawing are precision and universality. Thus, graphic standardisation becomes an imperative and descriptive geometry – metric and projective geometries – gains importance. Architectural principles and a set of coded symbols are adopted, turning this form of drawing into 'engineering's own language', which 'was acquiring a syntax incomprehensible to the unqualified reader' (p. 213). The following two chapters expand on the importance of mathematics in shaping the engineer, backing into an issue already addressed in volumes two and four of this same collection.

In the fifth chapter, Guillermo Lusa Monforte continues the discussion of mathematics. In addition to mathematics being the language of engineering, mathematics has a relationship with power, influence and prestige. Mathematics underlies the professional class of engineers, acting as a tool of selection, and as a social barrier (economic and ideological) at the service of a 'meritocracy' or 'aristocracy of intelligence' that confronted and was affronted by the industrial engineer, who was gaining prominence during the nineteenth century. Following this theme, Fernando Vea Muniesa and M ª Ángeles Velamazán Gimeno, in chapter six, analyse the introduction of mathematical disciplines in various engineering courses, their distribution among the different curricula and the textbooks used in the teaching of mathematics for engineers. Finally, in chapter seven, José Vicente Garcia Aznar looks at chronicles a century of work with units of weight and measurement and its unification and standardisation, to which there was a strong resistance in Spain.

Part two is structured in three groups of chapters focused on different technical and scientific developments in the eighteenth century. The first group of five chapters discusses applied mechanics, with Enrique Alarcón and Alberto Fraile introducing 'The New Science' in chapter eight, and Javier Manterola Armisen tackling construction with metallic materials in chapter nine. In the latter, the revolution of the iron materials construction is described. Iron revealed a hitherto unknown resistance to compression, traction, flexion, and a rather fast fall in iron prices saw its use in building construction multiply quickly. Armisen also describes the processes for smelting iron ore, which were intended to obtain a higher purity steel. Iron architecture is described with considerable detail, starting with an analysis of various examples, such as universal exhibition halls, railway stations, markets, glasshouses and lighthouses. Armisen profusely illustrates his chapter with beautiful pictures of various 'crystal palaces', built mostly in Spain, and he stresses that the knowledge, which supported this construction work, was essentially experimental.

Chapter ten, by Leonardo Amaya Fernández and Sáenz Troyano Sanz, is dedicated to 'bridges: materials, structures and heritage'. The authors argue that the nineteenth century was the most brilliant in the history of bridges because it was the time when most modern bridge-building techniques were developed, both in regard to the knowledge and mastery of materials as well as to the science of the respective structures. In chapter eleven, Juan Ignacio Cuadrado Iglesias and Emilio Bautista Paz inaugurate another issue: 'the theory of machines and mechanisms: diffusion and development of a new science', which the twelfth chapter, written by Manuel Silva Suarez, continues by addressing combustion engines, in particular those of steam and gas. To this end, the author analyses the books published on the subject in

the country, followed by the patents. Finally, he presents the principal national builders and some of their key products, illustrating the narrative with images of the era.

The second group of chapters in part two considers two important branches of physics that acquired maturity in the nineteenth century – thermodynamics and electricity – while continuing the overall discussion of emerging new sciences. In chapter thirteen, Stefan Pohl Valero addresses thermodynamics, emphasising its genealogy from mathematical physics. Moreover, he highlights that, from the 1860s onwards, the science of heat was diffused and then taught in Spain. This narrative aims to demonstrate the degree of modernity of Spanish scientists. In chapter fourteen, Joan Carles Alayo i Manubens and Jesús Sánches Miñana refer to applications of electricity somewhat ambiguously with respect to the relationship between science of electricity and 'electrical engineering'. Unfortunately, they givei no clear account of how experimental uses of electrical current contributed to the evolution of scientific knowledge of electrical phenomena.

Finally, chapters fifteen and sixteen comprise the third group of chapters in part two. Mercedes Tatjer first explores the new occupation of space in the eighteenth century seen in a new geography and new landscape dominated by the factory, using Barcelona as a case study. Then, using Madrid as a case study in the sixteenth and last chapter of the this volume, Josefina Gómez Mendoza sets the factory in an urban space that redefines itself – the bourgeois city. In terms of architecture, aspects related to production spaces, factory life and the role of engineers in the technical organisation and management of factories are analysed. Factories and bourgeois cities share emerging concerns that will reach very different degrees of development, such as mobility (accessibility and speed), safety, hygiene and facilities or infrastructure capacity for their better functioning. Looking away from the factory and gazing at the surroundings, there is a new city, which had its origin in the 'new techniques and building practices' that fulfilled the criteria of order, movement, hygiene and general interest, upon which architects and civil engineers often had disagreed.

De los Lenguajes ao Patrimonio (From Languages to Heritage) ends with an appendix dedicated to a unique album of drawings that the School of Industrial Engineering of Barcelona presented at the Universal Exposition of Vienna in 1783, and which were organised around the theme 'Culture and Education'. Overall, this is a diverse volume, heterogeneous in subjects and approaches. Its meritorious narrative persuades us that the history of technology is not, nor can it be, an individual, linear and homogeneous discourse.

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