

## THE ROYAL INDUSTRIAL INSTITUTE OF MADRID (1850–1867). AN HISTORICAL OVERVIEW

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This paper reviews the history, structure, evolution and salient activities of the Royal Industrial Institute of Madrid. This was the first higher engineering school established in Spain and also the key to the teaching system devised by Spain's moderate liberal government of the 1850s to gather the human resources (engineers, intermediate technicians and skilled workers) needed to face the industrialization process under way in the country.

The Royal Industrial Institute was founded with the teachers and material resources of the former Arts Conservatory. Its consolidation was a gradual process. The staff consisted of a little under thirty teachers and assistants including several engineers trained abroad (particularly in France and Belgium), as well as some architects, pharmacutists and mathematicians of diverse origin. The Institute taught the three industrial education levels available at the time, and also a business curriculum. In addition, it trained craftsmen, and provided advice on and issued so-called "industrial privileges" (patents and trademarks). The Institute possessed its own industrial museum, with model machines and a number of product samples.

In its late years, the Royal Institute had few students owing to the existence of several competing higher industrial engineering schools in Spain and the scarcity of public and private jobs for industrial engineers at the time. This led to its closure in 1867. At a time of economic and political crisis, the Industrial School of Barcelona remained the sole teaching institution that trained industrial engineers in Spain until 1899.

The Royal Industrial Institute was studied from a broad perspective almost forty years ago by Alonso Viguera in his work on Spanish industrial engineering in the XIX century.<sup>1</sup> The human and material resources of the institution were examined in a subsequent publication,<sup>2</sup> with special emphasis on the teaching skills of its staff and the adequacy of its means as appraised from the closure inventories.

<sup>1</sup> ALONSO VIGUERA, J.M. (1961) *La Ingeniería Industrial española en el siglo XIX*, Madrid, Publicaciones ETSII.

<sup>2</sup> CANO PAVÓN, J.M. (1997) "El Real Instituto Industrial de Madrid: medios humanos y materiales", *Llull*, 21, 33-62.

### 1.- Historical background

Although the Royal Industrial Institute was a new institution when founded, it was preceded by the Royal Machine Cabinet (1791–1824) and, later on, the Arts Conservatory (1824–1850). In fact, the Institute took over the teaching staff and material resources of the latter.

The Royal Machine Cabinet has been extensively studied.<sup>3</sup> It originated from the activities of Agustín de Bethencourt and his coworkers (Juan López Peñalver, Tomás de Veri, Juan de la Fuente, Joaquín Abaitua and Juan de Mata), who, sponsored by the

Spanish government, took engineering studies in the *École des Ponts et Chaussées* of Paris and produced a collection of plates and machine models of use for public works and industrial bodies. The outbreak of the French Revolution hastened the removal of the plans and models to Madrid; the material was housed in the Buen Retiro Palace and used to establish the Royal Machine Cabinet, the first director of which was the aforementioned Agustín de Bethencourt. The institution led rather a languid life during its early years; in fact, it operated essentially as an industrial museum when the original idea of its founders was to have the models used as references by industrials wishing to construct new machines.<sup>4</sup>

In 1802, the Cabinet was absorbed by the School of Civil Engineering, which was also established in the premises of the Buen Retiro Palace. The Cabinet thus became an additional section of the School. The one where most student practical work was done.<sup>5</sup>

The events of May 1808 led to the closure of the School of Civil Engineering and the Machine Cabinet. The material resources were initially deposited in the Royal Academy of Fine Arts of San Fernando and then transferred to the basement of the Buenavista Palace, which was attached to the Royal Academy. In 1810, the original Arts Conservatory was founded. It was served by well-known technicians such as José María Lanz, Bartolomé Sureda and Mariano Sepúlveda. However, Spain was at war at the time, so the institution was scarcely active.<sup>6</sup> After the war ended, in 1813, the Arts Conservatory was suppressed and the Royal Cabinet attached to the Economic Society of Madrid, which housed its material resources. As shown by the inventories drawn up at the time, part of the resources were missing and a number of machines were deteriorated.

<sup>3</sup> RUMEU DE ARMAS, A. (1990) *El Real Gabinete de Máquinas del Buen Retiro*, Madrid, Castalia.

<sup>4</sup> Ibidem, pp. 31-39

<sup>5</sup> Ibidem, pp. 69-74.

<sup>6</sup> GUERE\_A, J.L. (1990) "La formación técnica en la primera mitad del siglo XIX. El Conservatorio de Artes". En: OSSENBACH SAUTER, G; PUELLES BENÍTEZ, M. (eds.) *La Revolución Francesa y su influencia en la educación en España*, Madrid, UNED.

By initiative of Minister López Ballesteros, a new Royal Arts Conservatory was established in Madrid in 1824. The Conservatory was to provide practical training for workers, improve factory operations, propitiate the invention of new instruments and provide advice on industrial installations. It was directed by Juan López Peñalver, a former coworker of Bethencourt's. The Cabinet was attached to the Conservatory and its material resources transferred to its new premises in the Royal Glass Warehouse, in Turco Street.<sup>7</sup>

Changes did not stop here as the refoundation of the School of Civil Engineering in 1834 raised the need to distribute the Cabinet's resources in order to meet the School's needs for training equipment. The material was eventually made available to students in 1847, when the Arts Conservatory was moved to a new location: the ground floor of the former Trinity Convent. The plans and models of industrial machines remained a possession of the Arts Conservatory, whereas the models of hydraulic machines were deposited in the School of Civil Engineering.<sup>8</sup>

The Arts Conservatory initially served a dual purpose: (a) as a museum and deposit of machines and (b) as a workshop for practical training in the construction of all sorts of devices. Its teaching activities were projected over the following two years and included geometry, physics, mechanics, chemistry and drafting; because of the lack of qualified professionals, however, only the first two could be taught (by Antonio Gutiérrez and Bartolomé Sureda). The Conservatory also held several exhibitions of industrial products.<sup>9</sup>

In 1832, the Conservatory's teaching activities were expanded and the studies split into three levels: elemental, general and special. The elemental level, which was covered in one year, encompassed three different subjects, namely: (1) arithmetics, geometry and mechanics; (2) chemistry as applied to arts; and (3) drafting. The general level (two years) encompassed another three subjects: (1) fundamentals of mathematics and art mechanics, dynamics and machine building; (2) art chemistry (*i.e.* industrial chemistry); and (3) drafting as applied to construction. Finally, the special level was intended to provide expanded, deeper knowledge about specific subjects of a more markedly applied nature. Simultaneously, a number of chairs dependent on the Conservatory were established at several Spanish cities including Valencia, Sevilla, Málaga, Granada, Oviedo, Santiago de Compostela and Zaragoza. These chairs, which operated with varying success, were finally controlled by the respective local economic societies. By exception, those in Málaga were under the auspices of the local Trade Board.<sup>10</sup>

<sup>7</sup> RUMEU DE ARMAS (1990), pp. 75-79.

<sup>8</sup> Ibidem pp. 79-81.

<sup>9</sup> RUMEU DE ARMAS, A. (1980) *Ciencia y tecnología en la España Ilustrada. La Escuela de Caminos y Canales*, Madrid, Turner.

<sup>10</sup> BEJARANO, F. (1847) *Historia del Consulado y de la Junta de Comercio de Málaga*, Madrid, CSIC.

The Arts Conservatory was reformed in 1839 with the suppression of the director and secretary positions, and its attachment to the General Directorate of Studies of the Home Office. This reform – possibly intended to cut costs – was unfortunate and threw the Conservatory into a period of decline. An attempt at refloating the institution was made by appointing a director (the physics professor Joaquín Alfonso). Substantial funding by the influential Director-General of Public Instruction over the period 1845–1852<sup>11</sup>, Antonio Gil de Zárate, helped the Conservatory survive for a few additional years. Before it was eventually transformed into the Royal Industrial Institute, the Conservatory's staff comprised seven teachers.

## 2.- Structure of the Royal Industrial Institute

The Institute served a number of functions of the teaching, dissemination and bureaucratic types (the above-mentioned issuance of industrial privileges). As a result, its organizational chart was rather complex and the activities of some staff members overlapped. Basically, the Institute comprised the following bodies:

- (a) The Industrial School, which taught the three levels (elementary, intermediate and higher) of these studies.
- (b) The Business School, which provided commercial education.
- (c) The Teacher Training School, which produced teachers for other Spanish industrial schools between 1851 and 1854.

- (d) The Arts Conservatory, which was assigned to the Institute and provided basic practical training for workers and craftsmen (with special emphasis on drawing and mathematics) in evening classes. In addition, the Conservatory housed an industrial museum with plans, models and industrial products on display, and the bureau of (invention and introduction) patents and industrial trademarks.<sup>12</sup>

The bureau collected substantial amounts of money that virtually covered the institution's personnel and operating expenses.<sup>13</sup>

### 3.- Teachers

The teachers of the Royal Institute were of highly varied origin; all, however, were acceptably qualified. According to origin, the teachers can be classified into the following

<sup>11</sup> RUMEU DE ARMAS (1980), pp. 419-421.

<sup>12</sup> SAÍZ GONZÁLEZ, J.P. (1995) *Propiedad industrial y revolución liberal. Historia del sistema espa\_ol de patentes (1759-1929)*, Madrid, Oficina Espa\_ola de Patentes y Marcas.

<sup>13</sup> CANO PAVÓN (1997), p. 55.

<sup>14</sup> Ibidem, pp. 41-51.

groups<sup>14</sup>:

- (a) Engineers trained at the *École Centrale d'Arts et Manufactures* of Paris and the *École d'Arts et Manufactures* of Liège, including Joaquín Alfonso Martí, Cipriano S. Montesino, Eduardo Rodríguez, Julián Bruno de la Peña and José Canalejas Casas. Montesino and Canalejas taught only briefly at the Institute as they soon joined railway companies.
- (b) Architects such as Manuel María Azofra, Federico Aparici Soriano and Isaac Villanueva.
- (c) Mathematicians of diverse origin such as Angel Riquelme, Fernando Bocherini Gallipoli and Agustín Monreal García.
- (d) Former students of the Institute's teacher training school such as Félix Márquez and Ignacio Sánchez-Solís.
- (e) A teacher trained at schools sponsored by the Trade Board of Barcelona: Mariano Borrell Folch
- (f) Pharmacutists such as Constantino Sáenz Montoya, Miguel Maisterra Prieto and Magín Bonet Bonfill, who were basically in charge of the chemistry subjects.
- (g) Business teachers such as Luis María Utor Sánchez, Benigno Carballo Wänguement and Joaquín María Sanromá.

These teachers were helped by assistants who substituted them when absent and were in charge of practical lessons and discipline. Although the Institute's staff included a number, the longest-lasting and most prominent among them were Bernardo Cañizares García, Joaquín de Salas Dóriga, Gabino Máiz González and Antonio Márquez Canelo. Some obtained an engineer degree from the Institute.

### 4.- Budget and material resources

The Royal Institute was based in the building of the former Trinity Convent, in Atocha Street (close to Relatores Street). It occupied the ground floor as the rest of the building constituted the premises of the Ministry of Development. Available space for the Institute was inadequate, as repeatedly reflected in the Director's annual reports and petitions to the Ministry. However, all attempts at having it expanded or moved to a new

building failed owing to the Government's political unwillingness and the budgetary restrictions of the time.<sup>15</sup>

The annual running cost of the Institute in the 1860s (staff, teaching materials and maintenance included) was in the region of 618 000 reals, 562 000 being spent by the industrial

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<sup>15</sup> Ibidem, pp. 39-41

branch and 56 000 by the business branch. This budget nearly doubled that of the industrial schools of Barcelona and Seville, for example, basically as result of the increased number of teachers of the Royal Institute. The annual income was about 48 000 reals from enrolment and degree issuing fees, and about 400 000 reals from the issuance of industrial privileges. The institution therefore self-financed about 70% of its budget.<sup>16</sup>

The material resources of the Institute are known with precision from the inventories compiled following its closure in 1867. There were 267 gas lamps and 30 office desks of varying size, as well as a wide assortment of shelves and pictures. The physics cabinet was very well equipped, with about 600 objects. The chemistry laboratory had 5 benches and 14 large cabinets where glass, porcelain and metal objects – 11 platinum crucibles included – were stored; it also had nearly one thousand bottles containing chemicals, 238 holding natural products and a hundred more containing different solutions. There was also a mineralogical and geological cabinet that held a collection of minerals, rocks, fossils and crystallographic models.

Workshops were the most poorly equipped section as they had only a few, hand-operated tools and a single lathe. The modelling and drafting classrooms had 4 large desks, 20 smaller ones, a hundred benches, 150 pictures and diverse drawing instruments. The crafts classroom was better equipped, with 14 benches, nearly five hundred pictures and 300 plates.

The Institute's industrial museum held a large collection thanks to the incorporation of additional material since 1824. There were 312 models of machines and parts. Also, there were more than 3300 specimens of natural and industrial products of all kinds. Virtually all industrial branches – large machines excluded – were represented in the museum, which was thus a comprehensive display of use to both students and interested visitors.<sup>17</sup>

## 5.- Evolution of the Royal Institute

The Institute flourished in the 1850s, when it housed the first – and, at the time, also the only – higher industrial engineering school in Spain and classes boomed with students.

The reform of industrial studies brought about by the Moyano Law in 1857 and subsequent regulations, which extended higher engineering to several regional schools and confined the elementary level to secondary education institutes, resulted in a decay in the number of students enrolled at the Institute. Although data are scant, the Institute had an estimated 100–150 students each year from 1858, when industrial studies were reorganized. The Institute retained its former

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<sup>16</sup> In 1859, 1 spanish real = 0.263 french francs = 0.0104 sterling pounds = 0.049 US dollars.

<sup>17</sup> CANO PAVÓN (1997), pp. 51-54.

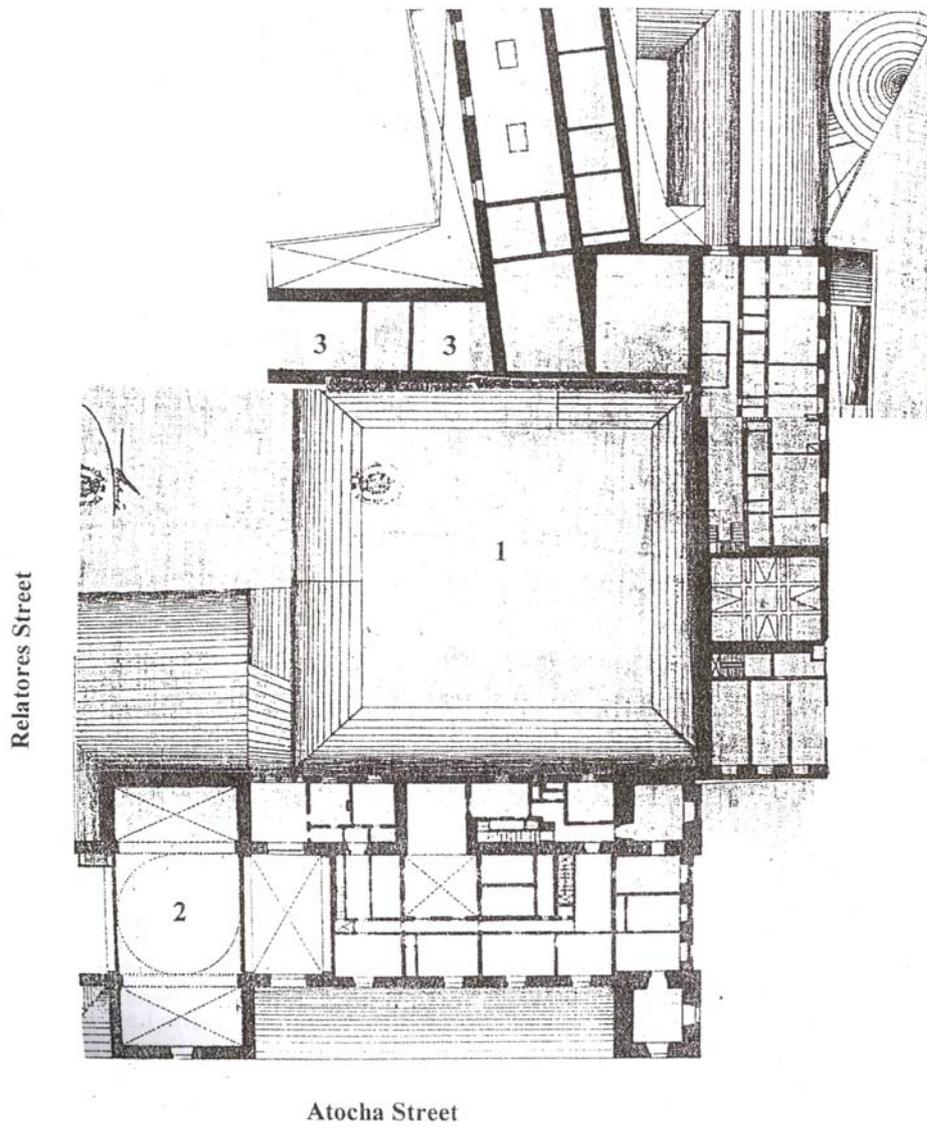
classes for craftsmen, who were basically taught drafting; enrolment among them was 400–500 on average each year, but attendance was rather uneven as students were largely youths who worked during the morning and afternoon and came to classes in the evening. By May, nights were shorter and the working day longer, so many ceased to attend classes altogether.

One other reason for the decline in the number of industrial engineering students at the Institute was the requirement in force between 1858 and 1865 that, unlike other engineering studies, access was only granted to students having taken three years at the Science Faculty. This led to the absence of new enrolments in the 1861–82 year, even though the number of students in the higher levels remained acceptable (*viz.* 17 in second year, 28 in third, 27 in fourth and 24 in fifth, which totalled 96); this distribution, however, is only an estimate as many students did not take every subject each year. The situation of the Royal Institute and industrial education on the whole led some bodies and individuals to consider the need for a change in the existing system. Thus, the student council of the institution proposed that higher engineering studies be confined to Madrid and that provincial schools be exclusively concerned with crafts courses. On the other hand, Juan Mercader, Director of the Industrial School of Valencia, proposed returning to the system established back in 1850, with industrial engineering studies of three different levels: elementary for craftsman training, intermediate for technicians and higher for engineers<sup>18</sup>; as a result, the higher level was confined to the Royal Industrial Institute and the lower two were provided by the regional schools. The Association of Industrial Engineers put forward more ambitious ideas; in a letter to the Minister of Development<sup>19</sup>, they reviewed the situation of industrial engineers, who, in their opinion, were being ignored by the Government, who had made no provisions for their hiring by public bodies (the telegraphic service excepted). For example, teachers at industrial schools need not even be engineers. Their status was rather different from civil and mining engineers, for whom official corps existed. The letter proposed that industrial engineers be in charge of provincial inspections in order to examine existing factories, control invention patents, conduct industrial statistical surveys, *etc.* They should also be concerned with the inspection of state-run industries and facilities of public interest such as railways and gas factories. This empowerment would, to their minds, increase the private demand for industrial engineers, which would in turn boost enrolment at industrial schools.

These attempts at reforming industrial education, however, were unsuccessful; the country's low level of industrialization, the scarcity of industrial students, the high maintenance costs of schools and the inadequate support of province and town councils led to the Ministry gradually closing them: Vergara and Gijón in 1860, Valencia in 1865 and Sevilla in 1866. Eventually, the Royal Institute was also closed down, in the summer of 1867.

In the parliamentary debate that followed the Institute's closure, Minister Manuel Orovio provided this answer to a question of a senator:

*Let me say just a few words about the Royal Industrial Institute. I was confronted with an Industrial Institute that cost over half a million reals and had only 5 students per class; one that, following suppression of other industrial schools, had twenty teachers and a little over fifty students. I found that the Industrial School of Barcelona, equipped by the province and town councils, and funded by the State, sufficed to meet the demand for industrial engineering studies. In this situation, should I have kept the Institute open in a time where saving was a necessity and it only had the students I mentioned before when the Industrial School of Barcelona*



**MAP OF THE ROYAL INDUSTRIAL INSTITUTE OF MADRID**

1. Court, 2. Draw Room, 3. Patent Office

The number of higher engineers produced by the Institute was indirectly estimated by Alonso Viguera to be 165<sup>21</sup>. An official roll compiled by the Institute itself listed an overall 107 engineers as of June 1864; the names coincided largely with those cited by Viguera, so his estimate must be very accurate<sup>22</sup>.

<sup>20</sup> ALCOVER, J. (1867) "Supresión del Real Instituto Industrial", *La Gaceta Industrial*, 229-231. Cited in CANO PAVÓN, J.M. (2000) "El informe de Agustín Monreal la enseñanza industrial en España y Europa (1861)", *Quaderns d'història de l'enginyeria*, in the press.

<sup>21</sup> ALONSO VIGUERA (1961), pp. 267-271.

<sup>22</sup> CANO PAVÓN (1997), pp. 56-57.

## 6.- Concluding remarks

The Royal Industrial Institute gathered acceptable human and material resources. Workshops excepted for its time. As with other special schools and, in general, with universities and institutes, its premises were inadequate. Its activities reached beyond teaching; in fact, the Institute was frequently involved in industrial counselling, reporting and patent and trademark issuing activities. It possessed its own industrial museum and a worker training centre.

Difficulties arose in the early 1860s, with the transformation into higher schools of the intermediate-level schools of Barcelona, Sevilla and Valencia. This and the facts that elementary level studies was confirmed to secondary education institutes, and access was restricted to students having taken preliminary studies at the Science Faculty, decreased enrolment at the Royal Industrial Institute. The problem was worsened by the lack of job opportunities for industrial engineers in Spain, both in the public sector. Unlike other engineers, no special corps had as yet been established for industrial engineers and in the private one. As a result of the country's poor industrial development. In the eyes of authorities with little foresight, the low enrollment and the relatively high cost of the Institute at a time of economic crisis and political unrest that led to a revolution the following year justified its closure in the summer of 1867. This initial failure of industrial education in Spain can readily be associated to failure in the first attempt at industrializing the country, a result to some extent of the fact that the massive construction of railways from 1855 was entrusted to foreign firms that brought the rolling and fixed parts in from other European countries. Particularly France and Belgium; this delayed the development of the Spanish iron and steel sector until the last quarter of the XIX century.

It is rather surprising, however, for such a centralist country as XIX century's Spain that the engineering school of the capital came to be suppressed. Although Madrid was not an industrial city at the time, it was the starting point and junction for the main railway lines. Having the schools of Madrid and Barcelona coexist peacefully would probably have been possible had each been oriented in a different direction. This, however, took no less than thirty years.