

The Madrid-Delicias Railway Station: between formal and technological innovation in the 19th century Iberian Peninsula

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Introduction

The experience of Modernity is linked to the process of social modernization which takes roots in the development of science and technology, together with the rationalization and industrialization of production [1]. Among other technological developments, the use of iron as a construction material became central in the architectural discussion since the early nineteenth century. Iron brought - on a technological side - new construction techniques and processes, challenging the traditional discipline and inspiring a new aesthetic, made by light structural form with slender proportions [2]. Contrasting the Academic praxis, iron was viewed as a symbol of modernity, particularly because of its ability to permit the creation of large public spaces, promising a technological utopia and a new, modern architecture.

According to Karl Bötticher, iron should have represented the dawn of a new, higher historical level, “a new way of designing”, evolving from the characteristic of material and technique [3]. This link with the physical reality represents the same working premises of architecture, based on “static principles” and “materials relations”. In this way, styles may be considered “evolutionary stages” of an history that would certainly not end with the eclectic style parade shown on the outer shell of buildings by Classicists and Neogothicists [4].

Later on, Walter Benjamin, in his Theory of Cultures [5], pointed out the significance of iron and the importance of new material objects in the experience of modernity as a source of dialectic imagination [6], a precipitator of change in multi-faceted architectural and social phenomena.

It is impossible, in fact, to ignore the larger socio-cultural and environmental implications that iron construction brought about. The modern industrial culture has produced its own landscape vision which, through craft areas, suburbs and residential construction, imposes itself, especially in times of crisis, through terms of emptiness and absence. The contemporary need to rethink the land use leaves an unsolved issue not only spatial, but temporal: the absence of knowledge and memory of a large part of the territory and thus of a part of one's everyday life.

These signs represent the latest stratification of the contemporary landscape, a complex of buildings and newest remains of the Industrial Era that dwell in a void between past and present. The research on the Madrid Delicias Railway Station aims at recognizing the building and its constructive evolution in the overall context of the social, cultural, and economic transformations of the Spanish capital in the second half of the nineteenth century. (Fig. 1)



Figure 1: (left) Exteriors of the Delicias railway station, *Émile Cachelièvre, 1880. Photo by the author* (right) Interiors of the Delicias railway station. Detail of the iron structure, *Émile Cachelièvre, 1880. Photo by the author*

Iron Constructions between Structural and Architectural Composition

While in England the first approach to this new material involved mainly the bridges, in continental Europe roofs were the principal research field of iron technology. Metal covering represented a versatile and cheaper alternative to stout timber sections, together with the guarantee of fireproof performances. Since 1786 it was conceived as metallic solution for Victor Louis' *Théâtre-Français* in Paris, starting a research which would have reached its climax in the pavilions for the Universal Exhibitions of 1878 and 1889.

As a result of the Industrial Revolution, iron in architecture and engineering reached the Iberian Peninsula and, particularly, Spain, in the mid-nineteenth century. Although the first examples were industrial facilities, it was in the architectural design that its application represented a revolution in the construction of large buildings and, among them, of railway stations. These buildings stand out from traditional and monumental architecture, as Felix Cardellach Y Alives [7] argued in one of his numerous writings on the aesthetics of new industrial architecture at the beginning of the 20th century:

"This new architecture will have different aims from the monumental one that can be identified in a strongly industrial and productive character, not limiting itself to the 'factory' alone, but extending this vision to all those buildings constructed or adapted to any branch of industrial production, such as the transport sector, in which the railway stations are located".

A characteristic element of this architecture will be the creation of new construction types, as consequence of the scientific and production processes. Through the use of new materials, it was possible to build architectural skeletons capable of creating diaphanous and flexible spaces, in which the use of the foundry column and the metal carpentry played a key role within the architectural and structural composition. In the same way, it was developed a new language for the exterior, using elements and a formal code which, while relying on classical styles, were detached from the academic architecture of that period.

The Challenge of a New Architectural Typology: the Railway Station

Railway stations, as claimed by Pruneda and Arangoiti [8], represent one of the great typological contributions of the nineteenth century, identifying - in a certain way - the same idea of progress. These constructions can be distinguished generally by terminal and passing stations, although it is also possible to make distinctions based on the number of buildings that make up the station complex and the relationships between the large space of the rails and the façade of the building.

When choosing the construction site for these buildings, bringing them as close as possible to urban centres was a priority, regardless of the need for large open spaces. The railway stations, in this way, usually were built in an almost tangent form to the consolidated urban centres [9]. Stations built in the nineteenth century were generally placed on city limits – as is the case of the Delicias Station – and nowadays, due to the cities' growth, have become central areas of the urban surroundings.

Stations can be divided into different types, regarding their location within the city: central, perimetral or external to the urban centre [10]. These differences can also be founded in the dichotomy between the so-called English and French model. If the former one places the station as close as possible to the city centre, in France, on the contrary, peripheral sites are chosen, connected by a layout of ring roads. It is certain that stations would soon become points of reference for cities, a strategic and focal element, what Kevin Lynch would have called a 'node' or 'nucleus' [11], in his book *The Image of the city*.

The methodological difference between English and French approach was even more evident in the image of the station itself. The façades of the great European railway yards follow two distinct models: the first one, in which railway activities are concealed behind buildings that camouflage themselves in the urban fabric, with offices or hotels in Anglo-Saxon style; and another one, common in France, where the view from the station's patio was implicitly allowed. In this second approach, it seems as if there is a desire to expose the large space hidden inside the station and the life it generates. Paradigmatic examples of such views are the St. Pancras Station in London and the Gare du Nord in Paris.

In Spain, the French trend was predominant – because of the influence of the *École des Ponts et Chaussées* and the work of its technicians in this country – and the Delicias Station represented one of the clearest examples of this approach. Its large glass façade reflected the forms of interior space and the image of a diaphanous, modern dimension, outcome of the technological processes and capturing the *zeitgeist* of the Industrial Era. (Fig. 2)



Figure 2: Exteriors of the Delicias railway station, Émile Cachelièvre, 1880. Photo by the author

In addition to these aspects, Sobrino Simal [12], proposes to add further themes such as the spatial organization and the station's impact on the urban fabric, in relation to its formal social and anthropological contributions. These elements would have produced radical changes on the image of the city, as stressed by the emblematic evolution of Madrid in this period.

Drawing a New Urban Landscape: the Case of Madrid

In the second half of XVIII century Madrid still looked like a centre closed in its fortified walls. It was only during the reign of the King Charles III that the city was enriched by an accurate study of the access roads to the urban area. One of them was the so-called trident configured by the Paseo de las Delicias, the Paseo de Santa Maria de la Cabeza and the Ronda de Atocha. This scheme followed the layout of the baroque trident or 'patte d'oie', used in the reconfiguration of Sixtus V's Rome and passed on to landscape design, as in the case of the Versailles gardens of Andrè de la Notre: in the cartography of that time, it appeared as an organised but nevertheless peripheral and semi-rural area, a popular zone where the transition from the city to the banks of the Manzanares took place. This structure remained unscathed until the mid-nineteenth century: by this moment, urban growth, technological advancement and the arrival of the railroad ensures that the agricultural landscape would be converted into the city's new expansion zone.

In 1857 Carlos Maria de Castro was commissioned to carry out a study for the extension of the capital: the Proyecto del Ensanche de Madrid [13] juxtaposed a large enveloping surface from the north-east to the south-east of the historical city, organizing the space through an orthogonal north-south grid.

The ordering element of the space was the rectangular block alternated with road axes and, in strategic points, squares or public buildings. The de Castro's plan had a strong social logic, identifying distinct zones for different strata of the society. Among the various neighbourhoods designed by de Castro, the Arganzuela-Delicias district would have a predominant industrial and working-class vocation, consolidated by the arrival of the railway fabric that determined its productive development.

The Delicias Railway Station

On 30 March 1880, King Alfonso XII and Queen Maria Cristina inaugurated the Madrid-Delicias station, as reported by the press of the time [14]. This station was built as the head of the railway line from Madrid to Ciudad Real by the *Compañía de los Ferrocarriles de Ciudad Real a Badajoz* (CRB) three years after the opening of the first railway line on Iberian soil, the Barcelona-Mataró, instituted in 1848. (Fig. 3)

This station, together with those of Atocha and Norte-Prince Pio, were an integral part of the so-called triad of stations in nineteenth century Madrid. The Madrid-Delicias station, even if related to the more recent line, was the first monumental station to be built as such - unlike Atocha, which had already been in operation since 1851, but simply as a dock [15].

Delicias became the Lisbon-Madrid line terminal, starting immediately with passenger and freight services and, in 1885, with sleeping cars and large European express trains. The most famous train to run on its tracks was the Sudexpreso, inaugurated in 1887, which connected Lisbon, Madrid, Paris and London on a weekly basis. The influx of passengers was such that, in the following years, the service increased its frequency to three times a week. The Lisbon-Madrid line was in operation for many decades, experiencing great changes but always being the most prestigious service offered by the Delicias Station [16].

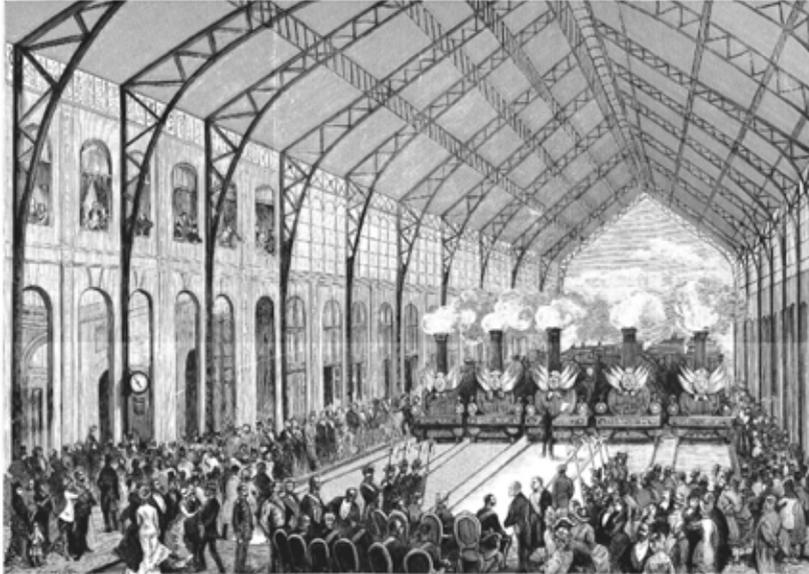


Figure 3: Engraving of the Delicias railway station's inauguration, March 30, 1880. Author: Juan Comba. *Spanish and American Illustration Magazine*, 8-Apr-1880. *Archivo Historico ferroviario, Madrid*

The project was designed by the French engineer Émile Cachelièvre, *Ingeniero Jefe de la Costruccion*, according to the archival documentation, in collaboration with Spanish engineers José Antonio Calleja, Santiago Bausá and Bonifacio de Espinal [17].

The first documentary references to the Madrid-Delicias Station - also defined as 'Madrid Station' or 'Ciudad Real Station' - will be found at the *Archivo General de la Administración* di Alcalá de Henares (AGA). In the memorandum of 1875 - approved, with conditions, on 16 August 1877 - in addition to simple data on the location and site, were recorded two calculations showing the estimated costs for the station, respectively of '1,574,532 pesetas' and '224,980 pesetas for the material' [18], an amount proved to be underestimated during the construction phase. Nevertheless, the most interesting aspect reported by the document stresses the role of Delicias, for which "the status of Royal Court station, the most important on the Madrid-Ciudad Real line, implies the need for a specific project".

By the report of 22 January 1878, approved on 23 July of the same year, it can be deduced that it was finally decided to place the station near to the Paseo de las Delicias, which gave the station its name [19]. Several factors were taken into account regarding this choice: firstly, its proximity to the ring road that linked Atocha and Principe Pio stations since 1863; secondly, that it had good passenger and facilities transports; and lastly, its proximity to the city centre and Puerta del Sol.

The railway yard organisation was divided into three areas, according to their use: passenger service, freight service and operational service. These included, in terms of importance, the construction of the Passenger Building or '*Nave de viajeros*', which was the most representative of the entire complex.

The group of drawings [20] at the *Archivo Historico ferroviario-Museo del Ferrocarril* dated on 12 October 1878, confirms the correspondence of the present building with the original project. On 2 December 1878 the engineer Santiago Bausá reported a general description and a memorandum on the construction materials defined as "materials imported from abroad, free of rights". According to the *Diario Ilustrado* "On 28 December 1878, construction began on this

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remarkable work, the first of its kind in Europe, comparable only to that of Orleans, in France, but not quite as beautiful” [21].

In turn, the *Annales de la construccion y de la Industria* informs us that in February 1879 the station was under construction, adding that the “metal skeleton is already in Spain and will start to be assembled in a few days” [22], referring to the metal trusses reinforcing the central nave of the passenger building. This information can be corroborated by Hebert's photograph entitled “1 June 1879”, in which it is possible to see how the construction of the station was already advanced on that date, particularly regarding the covered platform No. 1, which appeared to be almost finished, unlike the passenger building which was still under construction. The metal elements of the central structure, which would support the double-pitched roof would, were already standing, as well as the iron pillars visible in the lateral areas. (Fig. 4)

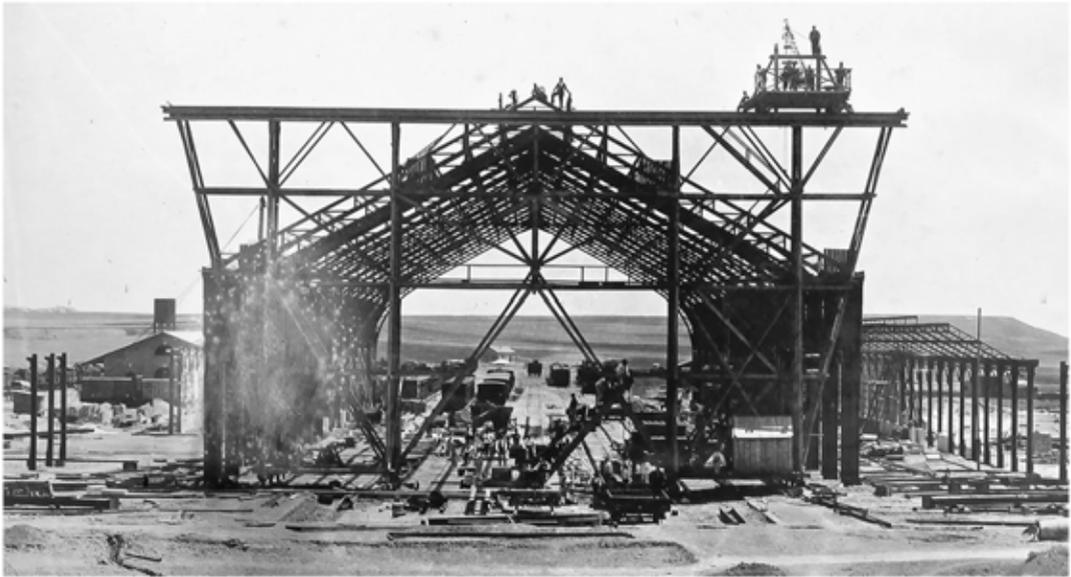


Figure 4: Status of the construction works on 1 June 1879. Photo: Pedro Martínez de Hebert. Archivo Historico ferroviario, Madrid

The Passenger Building suffered some modification during the construction phase in terms of materials, in order to achieve greater economy. Thus, for example, pressed bricks were used only in the exteriors, preferring ordinary bricks, finished with plaster, in the interiors. This fact produced a contrast between the polychrome brickworks of the urban façades and the minimalism of the railway's area, creating a contrast with the polychrome brickworks in exterior façades. The zinc ornaments were also replaced by wrought or cast-iron ones, while the slate roof planned for the large central nave was substituted by a simple roof of corrugated and galvanised metal sheet. Although this last material was more expensive than slate, the construction process resulted easier in terms of time and work. The slate covering was kept just in the side pavilions, whose elevations became examples of the rational use of materials and structural clarity.

These changes did not affect the functional organization and the general layout of the Passenger Building, whose architectural type consisted of two parallel side pavilions, one for departures and one for passenger arrival, divided in the middle by rails and docks covered by a steel and glass structure from the Fives-Lille factory. (Fig. 5)

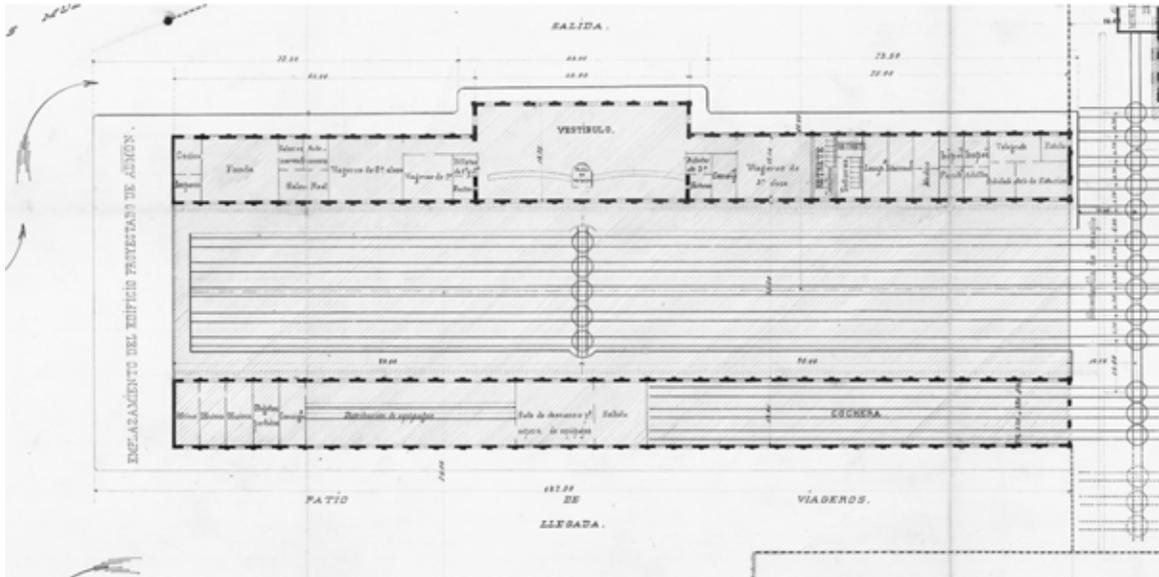


Figure 5: Plan of the Delicias railway Station, 2 Aug.1879. Author: Émile Cachelièvre. W_1001_001, Archivo Historico ferroviario, Madrid

This building, which was created with an industrial and functional character, is part of the iron and glass construction culture of the nineteenth century, recognisable in the structural clarity and employed materials. It became a clear example of the historical, artistic and cultural heritage of nineteenth century Spanish industry, combining the harmony of forms with functionality and technological innovation for which it was built.

The Delicias station would be in operation for about a century, until the suspension of passenger and freight services in 1969 and 1971, the year in which the railway yard closed definitively, diverting the rail services to Extremadura and Lisbon to the Atocha station.

Critical Realism: Constructive Interpretation of a New Industrial Approach

The main and central area of the station was accommodated the tracks, where the arrival and departure of trains took place. The smoke generated by coal-fired steam locomotives demanded high and appropriately ventilated spaces. This gave rise to the large metal covers protecting trains and passengers from the inclemency of weather and which, at the same time, achieved a diaphanous and luminous space, becoming a topical element of the 'station' concept. These iron and glass constructions avoided the use of massive load-bearing structures in favour of large spaces and clear elements, left visible, acquiring a formal dignity.

The possibility of huge, open spaces represented a real challenge for the technicians of the nineteenth century, who experimented new forms of iron frameworks in the great Exhibitions held throughout those years. The first structural system to be tested was developed by the French engineer Camille Polonceau in 1839 and then used for the pavilions of the Universal Exhibitions in 1855 and 1867. The gable roof consisted of two inclined beams and a central tie, in tension. This scheme, characterised by its lightness and simplicity of construction, represented one of the most interesting ideas introduced in the design of wide span structures. (Fig. 6)

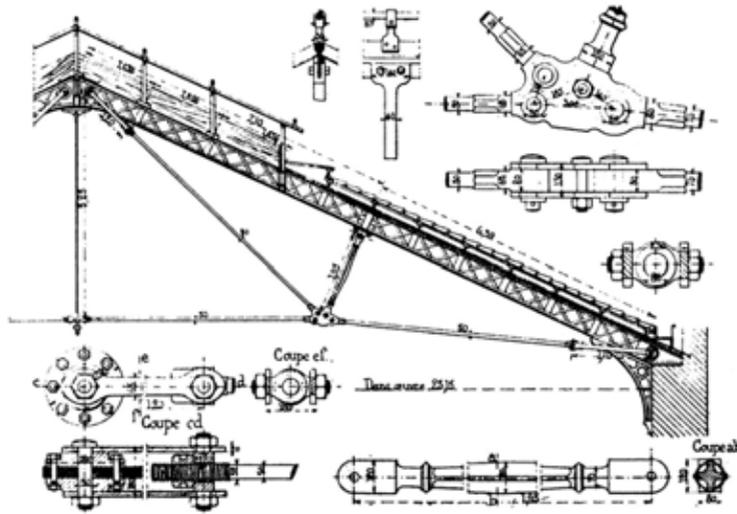


Figure 6: The Polonceau truss beam, in *Architecture et Constructions civiles: Charpenterie métallique, Volume 2*, 1894, p. 236. Author: J. Denfer

Afterwards, a leap forward was made by the engineer Henry De Dion -at that time president of the *Société des Ingénieurs Civils*- who highlighted the rapid evolution of iron technology in structures by proposing a calculation model in 1877 which achieved a new constructive solution. His project for the Galerie des Machines at the Paris Exhibition in 1878 superseded the classic Polonceau system for a truss made by iron prefabricated elements which formed a whole with the supporting structure, constituting a unique framework linked to deep foundations. (Fig. 7)

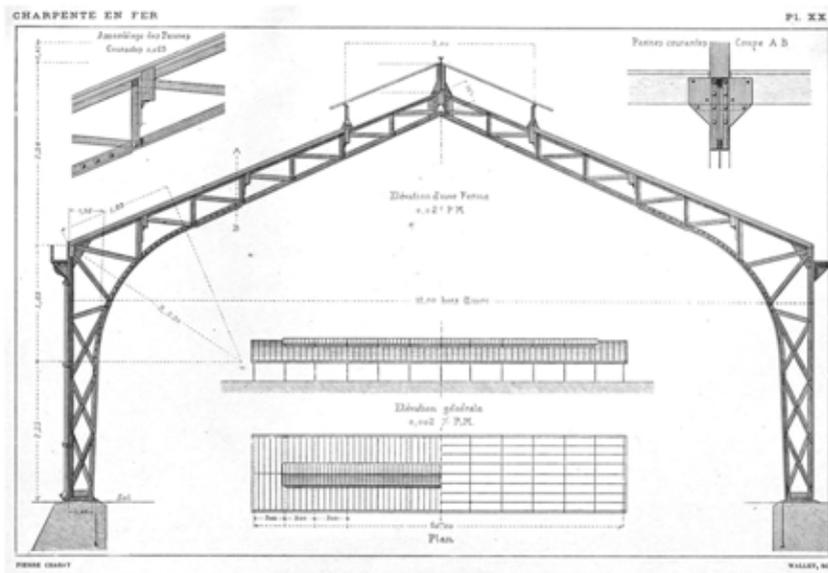


Figure 7: The De Dion truss beam, in *Cours de dessin géométrique*, 1885, p. 423. Author: Pierre Chabat

This constant research continued, culminating in the revolutionary construction of the *Galerie des machines* of the great Paris Exhibition in 1889 realized with a complex of articulated arches by the architect Charles Louis Dutert and the engineer Victor Contamin.

In Spain the technological evolution of the stations also hides a strong rivalry between the train concessionary companies, which tried to propose on each occasion more daring solutions than those known up to that time. In a certain way, they recall the struggle of the medieval cities through the heights reached by their cathedrals which acquired, in the industrial city the iron expression of the railway station [23]. Exemplary, in this sense, is the case of Madrid with its three main stations of Delicias, Norte-Principe Pio and Atocha, in which is effectively possible to trace that attempt to overcome allowed only by a constant update in the application of construction techniques. These three stations belonged to different companies and, as such, each one tried to develop its own unique image, and to reflect the economic potential of the line.

The French engineer Émile Cachelière, who worked for the Madrid-Ciudad Real Company, conceived for the Delicias Station the latest innovation in construction techniques of the time. The structure was made by a sequence of 18 De Dion metallic truss beams which forms a whole with the supporting pillars, realizing for the very first time in Spain a covered large space without any kind of braces or buttresses. (Fig. 8)

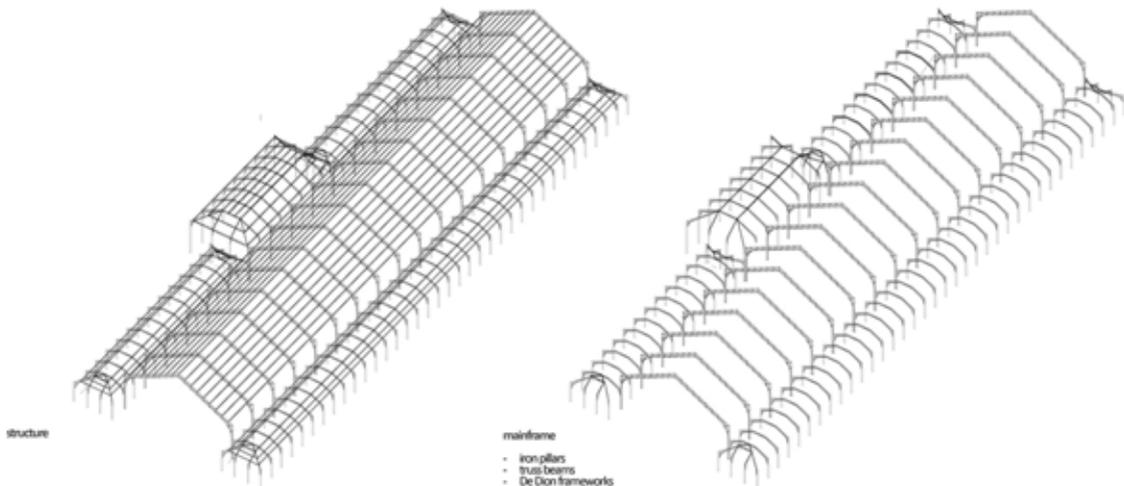


Figure 8: Scheme of the general iron structure (right) and of the mainframe (left) of the Delicias railway station. Drawing by the author.

The sequence of the De Dion's experience in the *Galerie des machines* (1878) and the Cachelière's project for the Delicias railway station (1879), increase even more the historical and constructive value of the Madrid example, especially if we consider the loss of the Parisian model. The parallel between the two buildings extends up to the spatial dimension: both the two halls have a span of 35 m and a very similar height, being 25m in Paris and 22.5m in Madrid. These similarities were also founded in the construction process, if we take into account that the Spanish frameworks - as well as the 1878 *Galerie* - were made in France by the well-known company Fives-Lille and assembled under the direction of the same engineer, Paul Vazeille [24]. According to the documents of that time, the building was described as "completely stable and solid (...)" and it can also serve as a guarantee that the construction company that will realize the structure is the same one that did it in the Exhibition Palace (1878) and that, therefore, already has the necessary experience" [25]. (Fig.9)

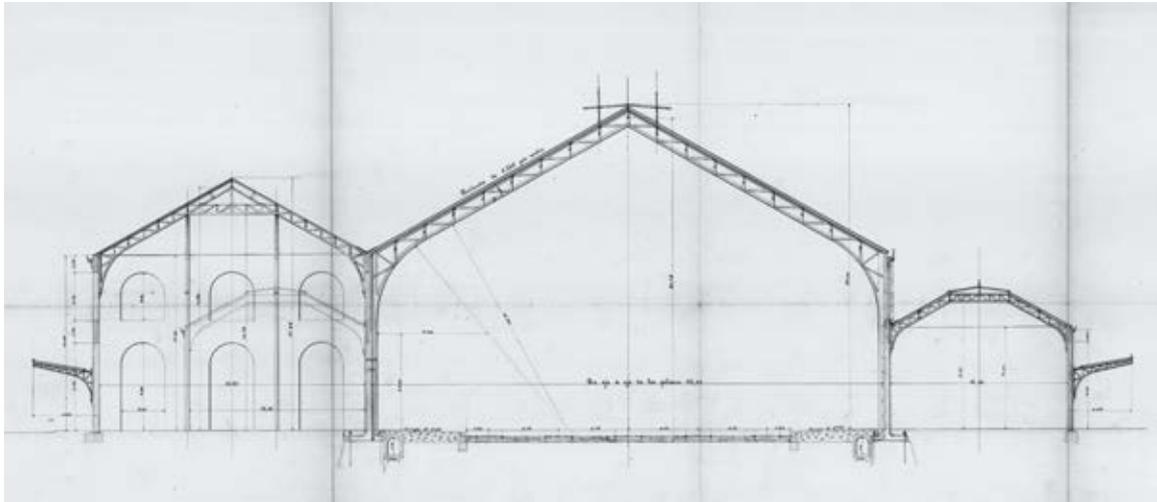


Figure 9: Constructive section of the metal framework in the Delicias railway station, 2 Aug. 1879. Author: Émile Cachelièvre. W_1001_005, Archivo Historico ferroviario. Madrid

This project had a great impact on the Madrid railway industry of that time. The introduction of De Dion system in Delicias led to a modification in the initial project of the Northern Iron Road Company for the Norte-Principe Pio Station (1888) carried out by the French engineer Mercier. Here the classical Polonceau scheme was abandoned, transforming the pairs as well as the ties into bolted reinforced beams with a curved development which joined the iron pillars that supported it, achieving forty metres of span.

Finally in the project of the Atocha Station (1892) - terminal of the Madrid-Zaragoza-Alicante company - the Spanish architect Alberto de Palacio built a large framework which bears a great resemblance to the 1889 *Galerie des Machines*, but with a parallel which remained merely formal. He still used, in fact, De Dion system to build an inner diaphanous space that exceeded any other ones of Spanish pre-industrial architecture becoming one of the last and extreme experiences of this system, before the revolution of the articulated trusses by Contamin.

Between Past and Present. The Architecture of the Engineers

The shapes and volumes of the nineteenth century stations were based on clear aesthetic principles such as proportion, rhythm and symmetry: a minimalist composition that would also be reflected in the façades, characterised by repetition and sequence, recurring throughout the so-called 'architecture of engineers'. While the large metal roof was one of the main fields of engineering experimentation at the time, the architects' contribution would be focused, in many cases, just on the stylistic approach of the forms given to this new typology.

From a formal point of view, the need to find a language for the new architectural typology meant the attempt to reach a compromise between the simplicity of industrial forms or the complexity of styles borrowed from the repertoire of eclecticism prevailing at that time.

This dichotomy also manifested itself in the choice of the exterior cladding, especially in the case of buildings that conveyed their innovative scope and productive vocation in the elevations through the combination of iron with bricks. Once again, France saw the birth of this trend: the brick - used until then as a structural element inside the load bearing walls, covered with stone slabs - emerged on the outside, acquiring a marked formal character. The renewed interest in

the possibilities of this material was definitively confirmed by one of the most important buildings of the time: the *Les Halles* market in Paris.

Designed by the architects Victor Baltard and Felix Callet in different phases - between 1854 and 1866 - the complex consisted of a series of large rooms supported by metal structures and paired externally by brick walls with red and yellow blocks arranged in lozenges. The use of bricks had a double reason: on one hand it allowed a rapid execution and guaranteed excellent fireproof properties, while on the other hand it allowed 'the structural rationalism' theorized by many authors of the time. Viollet-le-Duc himself, inside his *Entretiens sur l'architecture* [26], inserted numerous schemes of iron and brick buildings, basing his theories on the constructive clarity embodied in Gothic architecture, laying the foundations for the architecture of the future. This multiplied the manuals [27] in which, through brightly coloured illustrations, architects tried to promote a new style combining polychrome surfaces with different materials in distinct shapes.

In Spain this architecture took the forms of the so called Mudejar art, characterized by exposed brickwork which created consistent geometric motifs. In 1859, in a speech at the San Fernando Royal Academy of Fine Arts, archaeologist José Amador de los Ríos used the term 'mudéjar' for the first time to describe Christian churches and palaces built using techniques and decorative elements reminiscent of those of Hispano-Islamic architecture (like tiles, plasterwork, horseshoe arches, etc.) [28]. Since then, its status as a composition of all the styles that co-existed on the Iberian Peninsula by the end of the Middle Ages has led intellectuals to consider it as the only purely Spanish style.

With the construction of the Spanish Pavilion by Agustín Ortiz Villajos for the 1878 *Exposition Universelle* in Paris, the Neo-Mudéjar architecture began to be associated with Spain's particular idiosyncrasies. The pavilion's façade combined elements from the Alhambra's Court of Lions with elements from important Christian buildings such as the Royal Alcázar of Seville, Puerta del Sol gate in Toledo and the Cathedral of Tarragona, in an extreme synthesis of the Iberian art [29]. The external aesthetic code of the Delicias Station fully responds - with its complex decorative patterns - to the principles of this style. In this period, in fact, Neo-Mudéjar emerged as the style that best suited industrial architecture [30]. It turned necessity into a virtue by embracing the beauty of exposed brick and its enormous range of practical and decorative possibilities, building an entire imaginary for the new bourgeois class. (Fig. 10)

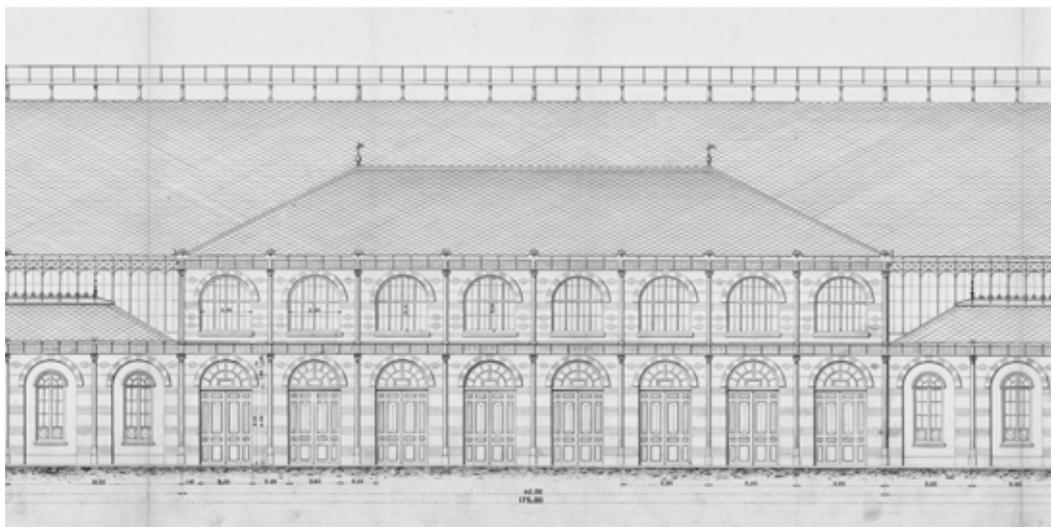


Figure 10: Detail of the north elevation. Delicias railway station, 2 Aug.1879. Author: Émile Cachelièvre. Archivo Historico ferroviario, Madrid

Conclusion

Thus, iron construction brought about fundamental changes in the traditional architectural production and thinking as well as in the disciplinary boundaries within architecture. It could even be argued that the development of iron construction and the transformation of architectural discourses on iron since the nineteenth century literally represented the history of modernity in architecture.

There are several conclusions to be drawn from this study. Thanks to the organization of great events like the Universal Exhibitions we witness a real 'cultural globalization' that involved the iron construction field during the nineteenth century. This transmigration of knowledge is strictly connected with the spread of construction manuals at that time - in which the construction systems appeared in detail, including tables and calculations of the profiles, depending on the spans – together with the work of technicians and companies that operated in different countries throughout Europe, sharing their know-how. Moreover, it is necessary to underline the continuous overcoming of models, a constant search of more innovative and effective solutions in a positivist confidence to the progress that drove the technicians of that time in their research. The improvement in the use of iron through a new truss morphology puts the Delicias Station into an international perspective, stressing on its importance in the definition of a construction history of the building techniques in the nineteenth century.

As argued by Giedion, "History is not simply the repository of unchanging facts, but a process, a pattern of living and changing attitudes and interpretations, deeply part of our nature... For planning of any sort our knowledge must go beyond the state of affairs that actually prevails. To plan we must know what has gone on in the past and feel what is coming in the future. This is not an invitation to prophecy, but a demand for an universal outlook upon the world" [31].

The knowledge of these spaces appears to us fundamental in the study and conception of the future cities: they must be studied in their material and social essence, in the construction of new relationships with the urban space.

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