


VIRTUAL RECON- STRUCTIONS


Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)

 **FREDERICO HENRIQUES**

Universidade Católica Portuguesa,
School of Arts

Research Centre for Science and Technology of the Arts

fhenriques@ucp.pt

 **MÁRIO BRUNO PASTOR**

Universidade Católica Portuguesa,
School of Arts

Research Centre for Science and Technology of the Arts

mbpastor@ucp.pt

**VIRTUAL
RECON-
STRUCTIONS**

Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)

1. INTRODUCTION

The Digital Humanities are a field of study located at the intersection between computing or digital technologies and the humanities, where the application of digital technologies proves to be a powerful tool to support research. Nonetheless, the origin of the concept of the Digital Humanities needs to be clarified. It is known, for example, that the Jesuit priest Robert Busa was one of the first to implement such techniques in his linguistic study of the work of Saint Thomas of Aquino, which using IBM punch cards to process data (Buzzanca, 2021, p. 157).

The "Virtual restitution of the Crystal Palace of Porto (Portugal)" was developed as part of the *[Marca 3D] Project*. The main idea of this project is to explore the local history of *Campo da Marca*, its (industrial) heritage, public art, and botanical heritage, through geographic information systems (GIS) and computer graphics (CG) technologies. This academic Project proposes a transversal viewpoint across those disciplines. The project also sought to value collective memory related to the site where the building was built. As such, its primary goal is to contribute to the understanding of the building in the context of the broader history of the city of Porto, focusing on the period stretching from construction until its demolition (1865-1952).

It is, however, essential to note that the construction of the Crystal Palace in 1865 was not (solely) a product of the desire of the local population. Indeed, King Pedro V of Portugal was the driving force behind the construction of the Palace (Santos, 1989), ceremonially laying the first brick on 3 September 1861. Built to host the 1865 International Exhibition in Porto, the Crystal Palace was officially opened on 18 September 1865 (Fig. 2). The building was demolished between 1951 and 1952, 86 years after its opening, on the orders of the mayor of Porto, Col. Lucínio Presa. The building was then replaced by a new sports arena to host the 1952 World's Roller Hockey Championship (Fig. 4). The Project for the new stadium was assigned to a young and talented architect, José Carlos Loureiro (1925-1922), and to António Augusto dos Santos Soares, an engineer.

Jumping ahead to the present moment, the current building is named *Pavilhão Rosa Mota*, honouring the 1988 Olympic gold medallist in the women's marathon. Its modern architecture is yet to be adequately discussed, partly due to popular attachment to the memory of the former Crystal Palace, which has never afforded the new building its full and deserved recognition.

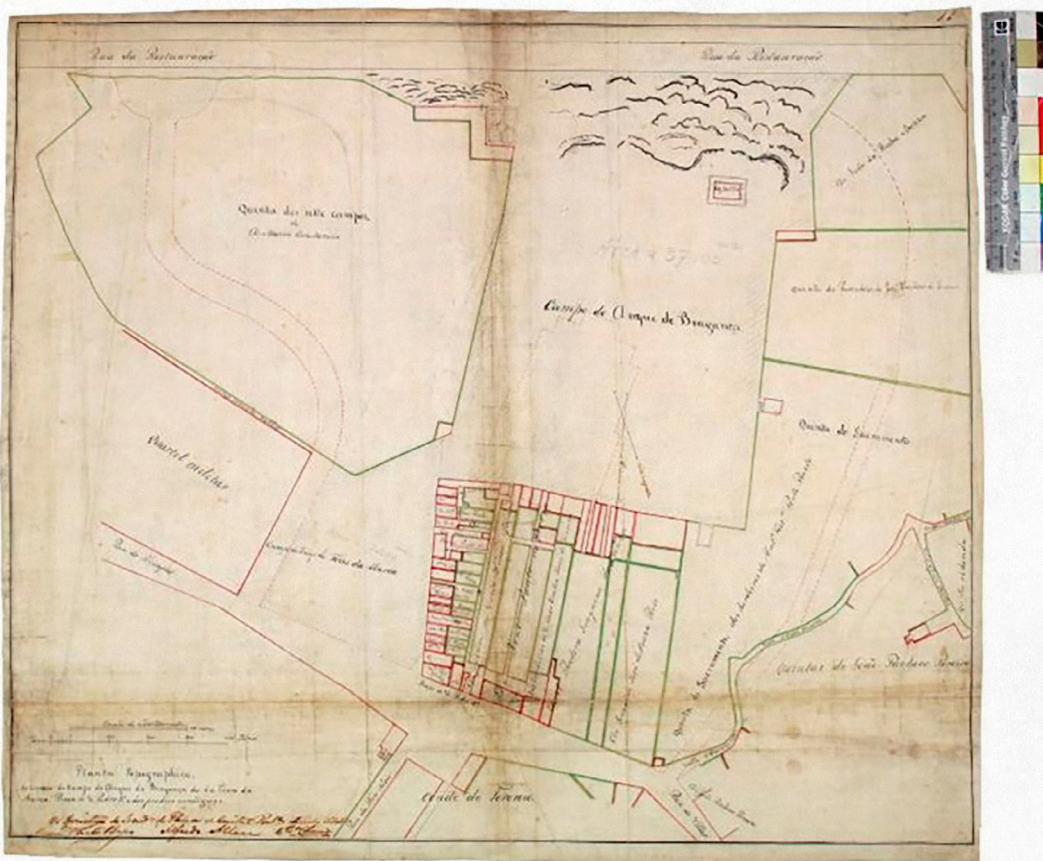


Fig. 1 - First plans for the Crystal Palace (Porto Historical Archives), signed by Francisco Pinto Bessa, Alfredo Allen, and Eduardo Chamiço, founders of the *Sociedade do Palácio de Cristal Portuense*.
© Porto Historical Archives (AMP)

VIRTUAL RECONSTRUCTIONS
Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

The first graphic representation of the Crystal Palace of Porto is an engraving published in 1864 by *Archivo Pittoresco*. It presents a view of the Palace on the first page, and below, in the lower-left corner, the inscription “Nogueira da Silva and Alberto”. The first name, Nogueira da Silva, is the artist, and the second, Caetano Alberto, is the engraver (Afonso, 2007). The engraving, presumably made in wood, could have been produced from a traditional visual drawing. In the same document, dated from 1864, along with the graphic representation, we also find the first known reference to the Crystal Palace made by the Portuguese historian *Inácio de Vilhena Barbosa* (Fig. 2).



Fig. 2 - Frontpage of *Semanario Illustrado Archivo Pittoresco*, 1864, with the first known illustration of the Crystal Palace. © Archivo Pittoresco

**VIRTUAL
RECON-
STRUCTIONS**

Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)

Our virtual reconstruction of the palace was based on two primary sources: the first was José Coelho dos Santos' publication on "The Crystal Palace and iron architecture in Porto in the mid-19th century" (Santos, 1989); the second were archival sources, namely documents and historical photographs of the demolition, available in the repository of Porto's Historical Archives. Although not a primary source, the master's dissertation "*Images and Memories in Reconstruction: From the Crystal Palace Portuguese to the Rosa Mota Pavilion*" (Gonçalves, 2018) was also an excellent source of references about the subject, presenting another 3D model of the building (Vd. *Apêndice F – Gonçalves, 2018, II Vol.*).

The Industrial and Commercial Museum of Porto was installed in 1884 in what was previously known as the "*Circo Olympico*", a private pavilion also inaugurated in 1865, connected to the Crystal Palace (Fig. 3). While the Museum had a short life, having closed in 1899, its collection was preserved until 1914, when the Portuguese government ordered its transportation to the *Industrial Institute of Porto*. The building, however, was only finally demolished in the early 1930s (Leandro, 2019).

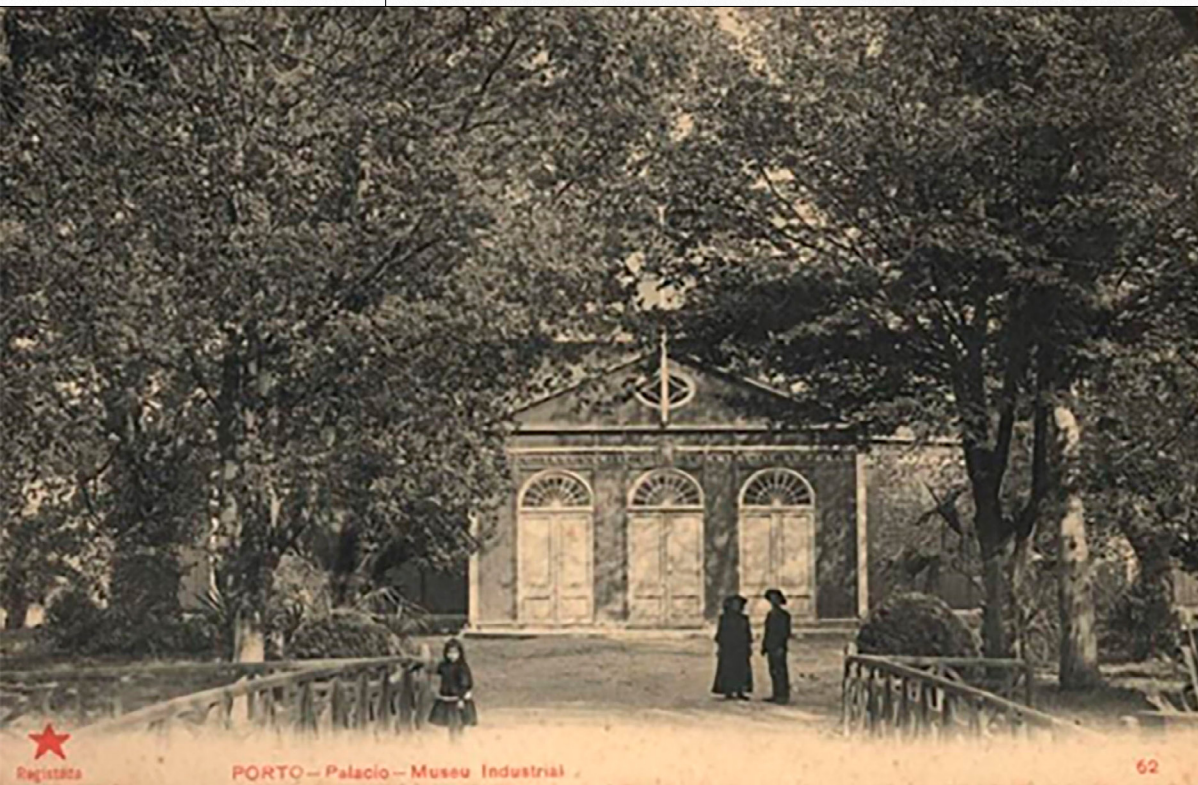


Fig. 3 - Industrial and Commercial Museum of Porto (ICMP), Carlos Pereira Cardoso, c. 1905
© Centro Português de Fotografia.



Fig. 4 - Photograph taken during the Rosa Mota arena's construction in 1952, Domingos Alvão.
© Centro Português de Fotografia.

VIRTUAL RECONSTRUCTIONS

Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

Working with digital reconstructions of Cultural Heritage is an activity which presents multiple challenges and a sense of responsibility towards local communities. According to the London Charter (2009), integrity should be a pillar for virtual reconstruction (Denard, 2009). Virtual reconstruction of heritage buildings requires technical and artistic care, but also a critical analysis, which must be based on historical and scientific integrity. In this sense, and in a simplified way, it could be said that a fair virtual reconstruction should be based on four pillars (Aparício Resco, 2021):

- Documenting what was;
- Reporting what has been lost;
- Interpreting from what is known;
- Supporting the final hypothesis with the documents gathered.

Reliving the past through images has been a way of protecting and promoting people's collective memory. There have been several cases of digital reconstructions associated with local culture that, due to their impact on a national context, have sparked interest in interpreting and representing heritage buildings (Bernardes, 2002; Ramos, 2007; Alvito, 2008; Dias, 2012; Figueiredo, 2010, 2014, 2016; Carpetudo & Lopes, 2015, 2016; Val-Flores 2014, 2019, 2020; Barros et al., 2018).

Regarding 3D modelling of historical places and sites in Porto, it is important to refer to the pioneering research project "*16th century Porto*": *The Cathedral and its surroundings in the 16th century* (2005), led by José Ferrão Afonso and Maria Leonor Botelho, and specifically focusing on the Cathedral of Porto (Afonso, 2005). Other academic studies have been developed after this

**VIRTUAL
RECON-
STRUCTIONS**

Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)

work (Pereira, 2017), including a recently virtual recreation of the city centre which takes us back to the 16th century (Henriques, 2018).

From the point of view of integrity, Pablo Aparicio Resco and Cesar Figueiredo's have made an appreciable contribution to virtual reconstructions by suggesting a "Scale of historical/archaeological evidence", proposing a standardised colour code for each phase of the work associated with virtual reconstructions and different typologies of archaeological evidence (Aparicio Resco, 2016).

Overall, the main aim of the *Virtual restitution of the Crystal Palace*, in the context of the [3D Marca] Project, is to promote a new archaeological view of the building's lost memory in the city landscape. The Project explores the visualisation of several aspects of the spaces that make up the architectural set and its environments. This Project integrates other former assets of *Campo da Torre da Marca*, namely the hill where the Crystal Palace was built. One first practical result of this Project was the presentation of *Tactile and sonorous memory of the Crystal Palace* at the *2nd Accessibility and Inclusion in Art and Heritage* meeting that took place at the Faculty of Fine Arts of the University of Lisbon in 2022. A proposal of a 3D tactile model of the Crystal Palace, complemented with a soundtrack of the original musical theme composed by Charles-Marie Widor for the 1865 Crystal Palace opening, was presented at this meeting. This proposal was designed to provide the visually impaired public with an experience of the historical Crystal Palace building.

2. MATERIALS AND METHODS

The first activity developed to survey the building and its surrounding areas was to create a vast collection of images, providing insights into the now vanished building. This survey was conducted on a municipality platform (GISA), on social media, and online. More than six hundred images and references were acquired during this stage (Figs. 5 and 6).

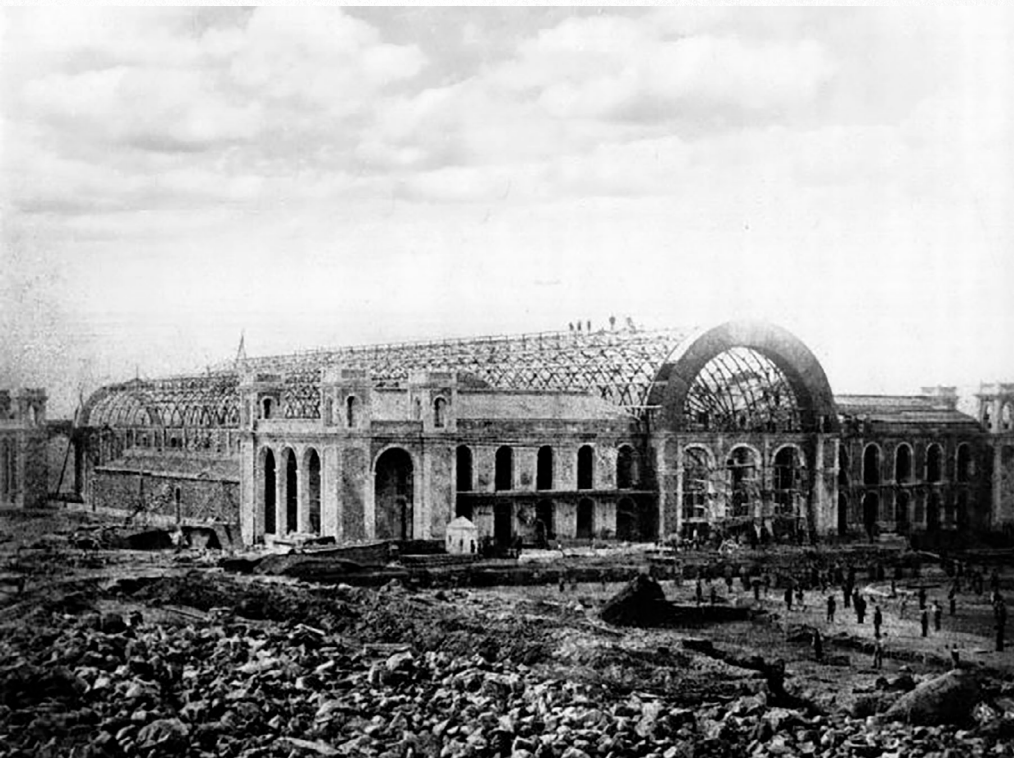


Fig. 5 - Construction, around 1863-64 (Santos, 1989). © DR



Fig. 6 - Photograph dating from before the official opening (M. J. de S. Ferreira). © Biblioteca Nacional do Rio de Janeiro, Brazil

VIRTUAL RECONSTRUCTIONS

Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

The images were then organised into the following categories: aerial views; posters; frames obtained from historical films; photos from the construction; images from the demolition process; historical postcards; journal engravings; watercolours and paintings; interior images (rooms); images from the central room; images from the 1934 exhibition; photos from the garden; other possible parallel references (Crystal Palace in London, *Santa Apolonia* Station in Lisbon, *Gare de L'Este* and *Gare de Nord* in Paris); historical cartography; Industrial and Commercial Museum of Porto; architectural drawings; images from the

VIRTUAL RECONSTRUCTIONS

Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

current *Rosa Mota* arena, and others.

In terms of technological challenges, this work has brought together documentation and insight from a wide range of sources, including cartography and aerial orthophotography, to locate the original implementation of the Crystal Palace and the Industrial and Commercial Museum of Porto. For urban contextualisation, digital georeferencing tools such as Geographic Information Systems (GIS) in the environment QGIS 3.4 were used. In the modelling phase, computer graphics software (Blender) was also used to generate the virtual reconstruction of the buildings and their surroundings. The strategy followed in this stage of the project, which combines with GIS and 3D modelling open-source software, is further described in the following sections.

2.1. GEOLOCATION

The first cartographic representation of the Crystal Palace, the *Circus*, and the first edification of the Industrial and Commercial Museum of Porto, which inspired the reconstruction, appear in Perry Vidal's plan, published in 1865 (Vidal, 1865). This representation presented several errors, including the absence of Crystal Palace Street, which had already been completed that year. Similarly, the Palace Gardens and the back of the military buildings are placed contiguously in this representation (Fig. 7).

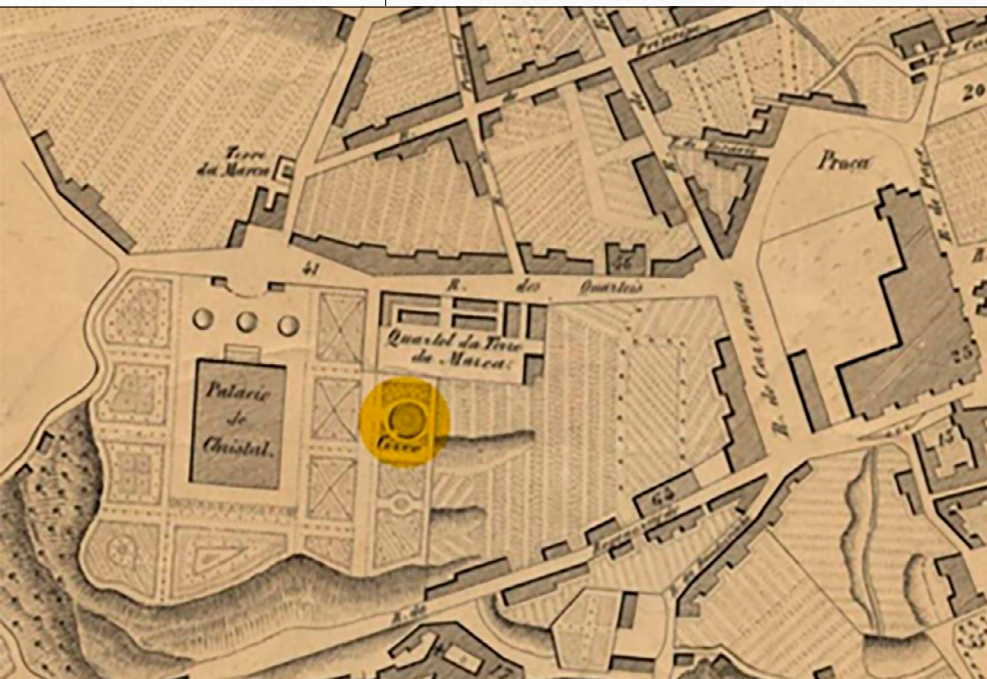


Fig. 7 - Snippet from Perry Vidal's map (1865) highlighting the Circus area.
© Perry Vidal

VIRTUAL RECON- STRUCTIONS

Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)

It was therefore necessary to get to the end of the 19th century to access more detailed cartography, namely Augusto Gerardo Telles Ferreira's map of the city of Porto. Only by recurring to this source it was possible to find an accurate representation of the geographic implantation of the buildings, streets, and other urban structures (Fig. 8). The Topographic Map of Porto City (1892) is a rare document of urban cartography with priceless historical value, composed of two survey versions on a scale of 1/500. The black and white version featured 453 sheets (of which 446 have been preserved). Both can be found in Porto Historical Archives (Tavares, 1992).



Fig. 8 - Georeferencing of squares 198 and 216 of Teles Ferreira's plan, 1892, referring to the Crystal Palace, the gardens, and the Industrial and Commercial Museum, overlapping a current Google Map® image.
© The authors

Furthermore, the precise location of the building was verified by a historical aerial photograph acquired in 1944 by Sociedade Portuguesa de Levantamentos Aéreos Lda. (SPLAL). The georeferencing operation was performed in a GIS environment to define the precise coordinates and gauge measures of the architectural structures (Fig. 9). It is important to note that, in this image, an aerial photograph taken in the 1940s, the building of the Industrial and Commercial Museum of Porto is not visible. A photo of the two buildings was indeed found, but presented a view from too far away and from a different perspective, taken circa 1865 in the city of Vila Nova de Gaia. While aerial photographs were taken in the 1930s during the Colonial Exhibition, they provided no evidence of the architectural structure of the Museum, only of military constructions (Fig. 10).

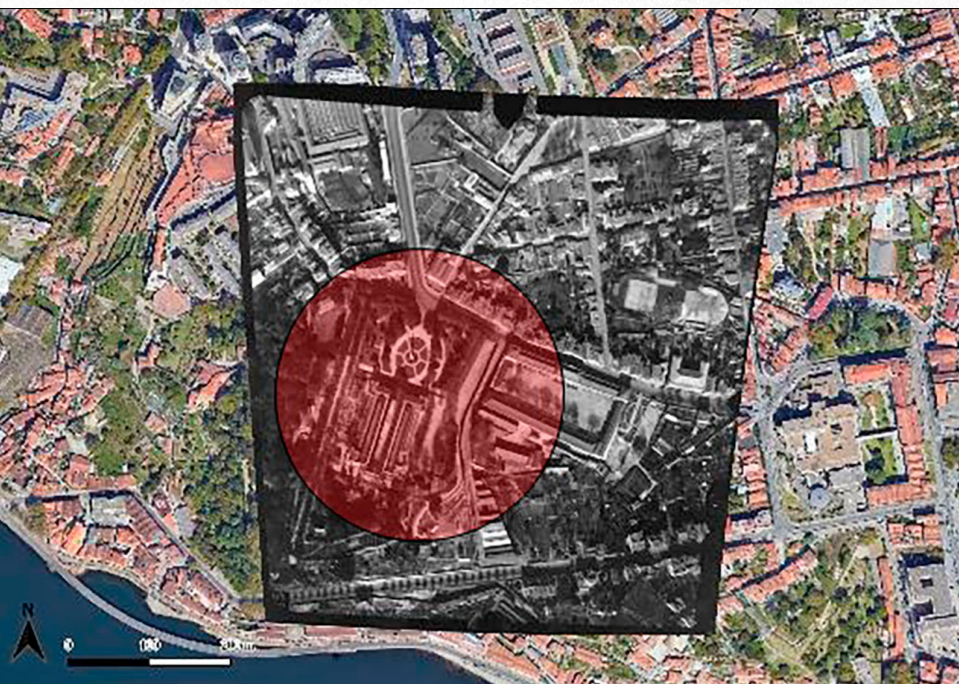
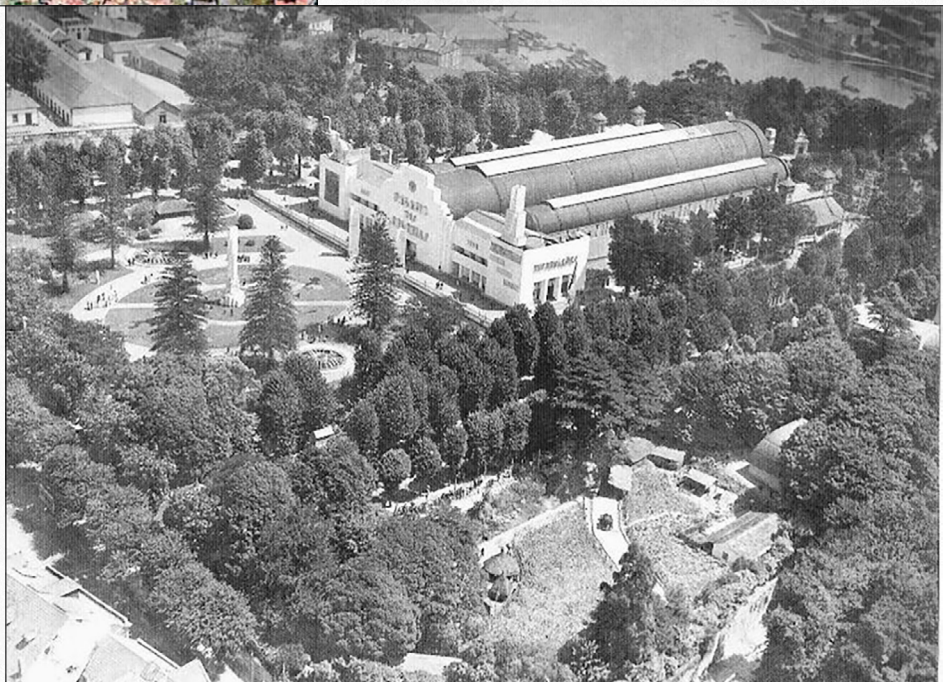


Fig. 9 - After georeferencing process with aerial photo acquired by SPLAL in 1944.
© The authors

Fig. 10 - The aerial photograph taken in 1934 during the Colonial Exhibition. It is essential to note the presence of the Monument to the Colonising Effort in the centre of the central garden. Today, the work in granite is located in *Praça do Império*, next to the premises of the Portuguese Catholic University in *Foz do Douro* (Porto).

© Porto Historical Archives (AMP)



2.2. MODELLING THE CRYSTAL PALACE

In 1865, one of the engineers responsible for organising Porto's International Exhibition, Dinis Kopke de Sousa Lobo, drew a set of sketches that helps us understand the organisation of the space around Crystal Palace. Specifically, the *Circus* and the adjacent upper passage, or bridge, connecting both buildings (Fig. 11). The original sketches belong to the private collection of Viscount Villar de Allen library (Santos, 1989).

VIRTUAL RECONSTRUCTIONS

Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

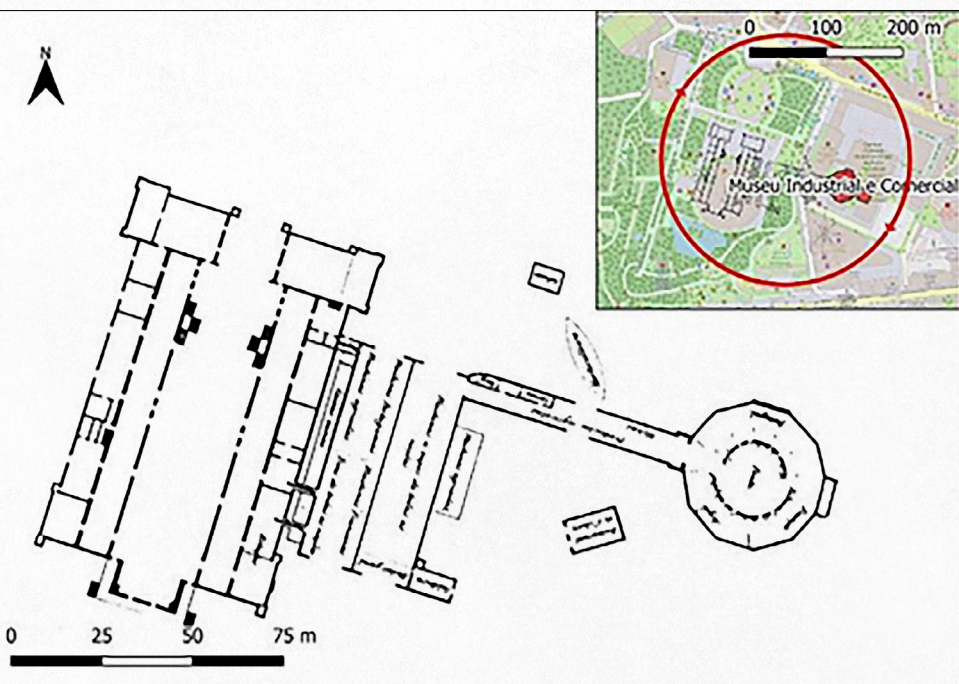


Fig. 11 - Georeferencing the plan of the Crystal Palace, annexed pavilions, and Olympus Circus in 1865 and its current location. © The authors

VIRTUAL RECONSTRUCTIONS
Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

At the same time, in 1952, when the demolition of Crystal Palace took place, the municipal council documented other plans for the building (Santos, 1989). Those plans were essential to modelling its structure in our virtual restitution (Fig. 12).

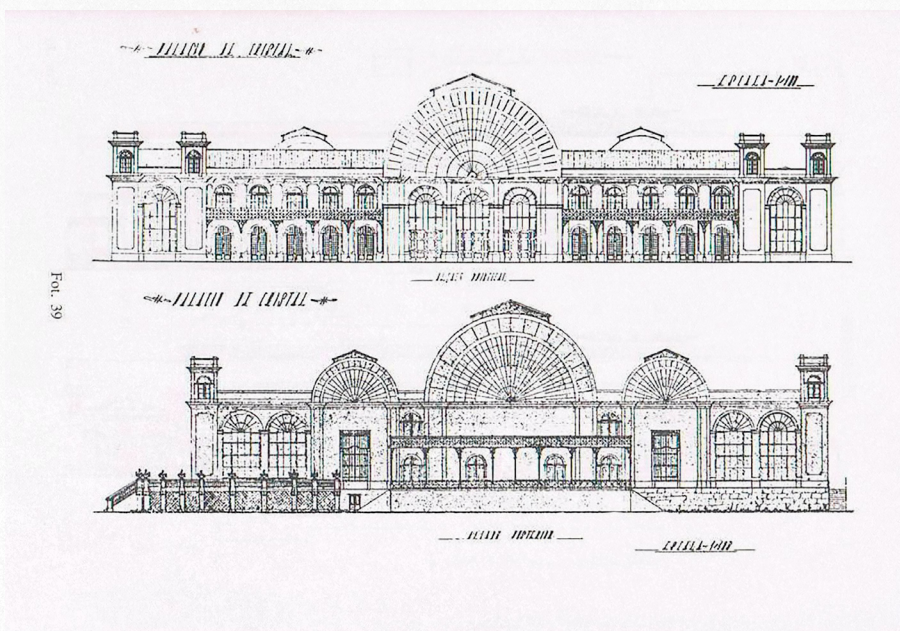


Fig. 12 - Architectural drawings made by the technicians of the Municipal Council of Porto at the time of the building's demolition. (Santos, 1989, p. 215). © DR

Before describing the modelling process, it should be clarified that modelling is a different technical process than data acquisition. In technical literature, the term "3D modelling" is often associated with the survey's actions, where, for instance, "data acquisition" is made through geomatic techniques, laser scanning, or

VIRTUAL RECONSTRUCTIONS

Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

photogrammetry. In survey processes, data is recorded using direct or indirect techniques that involve physical instruments (Di Cosola, 2020). This operation is fundamental for many areas of knowledge when recurring to Geographic Information Systems (GIS) or Remote Sensing. After data acquisition, data can be edited, filtered, removed, or processed via other operations. Sometimes this process is conducted using algorithms or other functionalities provided by specific software. While the acquisition process creates 3D models, these models are quite different from those that result from traditional 3D modelling solely using computer graphic operations. 3D modelling can be done by combining various techniques: parametrically, with hard-surface modelling, or organically. Parametric modelling requires instructions, commands, or scripts to create a model that is produced semi-automatically. Hard-surface modelling is applied to objects, buildings, and other miscellaneous objects. Organic modelling is done when dealing with the representation of living things, plants, trees, or other animal motifs.

Generally, it is possible to say that 3D modelling is always an act of interpretation based on a set of criteria or options subjectively chosen for analysis. 3D modelling uses software functionality, but is not automatic. 3D modelling is a rational and unique process that depends on variables, points of view, and the skills of the analysts.

The [*Marca 3D*] Project used the hard-surface method for the 3D modelling of the Crystal Palace architecture. From a technical point of view, we generated the model from a set of images imported into the Project (Fig.13). After the correct alignment of the images, the architectural elements were built using a point-by-point editing system (Fig. 14).

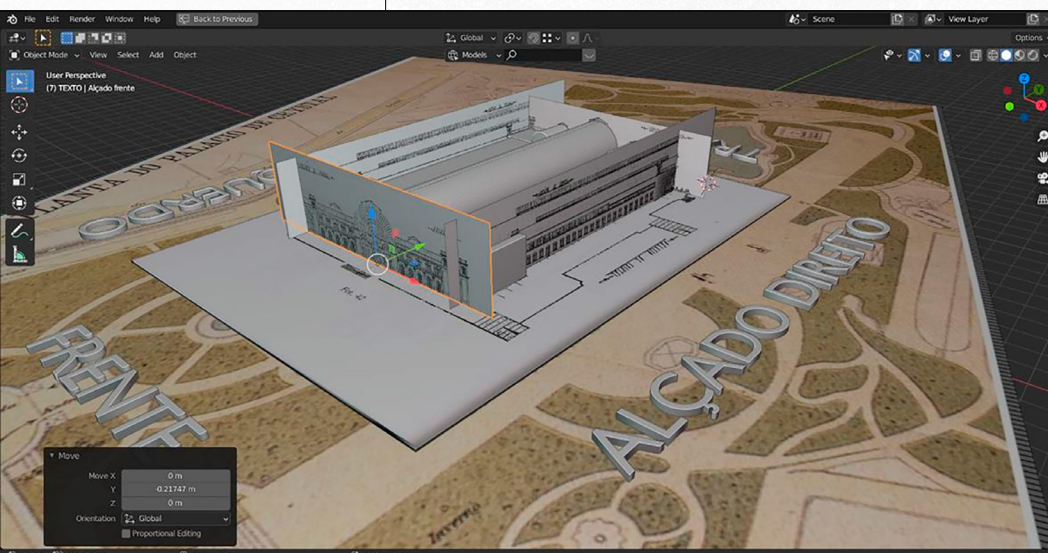


Fig. 13 - Alignment and orientation of planes during 3D modelling (Blender v. 2.91). © The authors

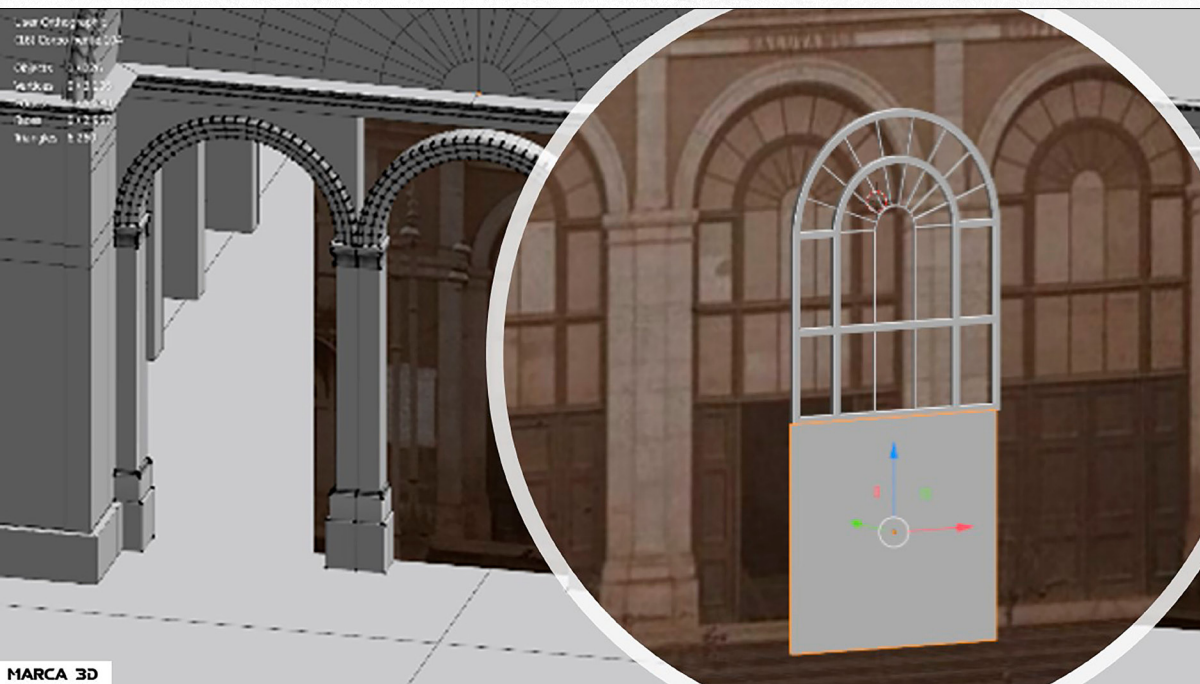


Fig. 14 - Modelling phase of the arches, the iron frames, and the doors of the front elevation.
© The authors

VIRTUAL RECONSTRUCTIONS

Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

The modelling of the interior spaces of the Crystal Palace raised questions about how the areas were originally articulated. While the architectural drawings from the Municipal Council of Porto provided reasonable indications, some questions remained around the access to the second floor of some of the building sections. Nonetheless, the main spaces were identified, notably the *Gil Vicente Theatre* and the restaurant *O Bem Arranjadinho* (Fig. 15).

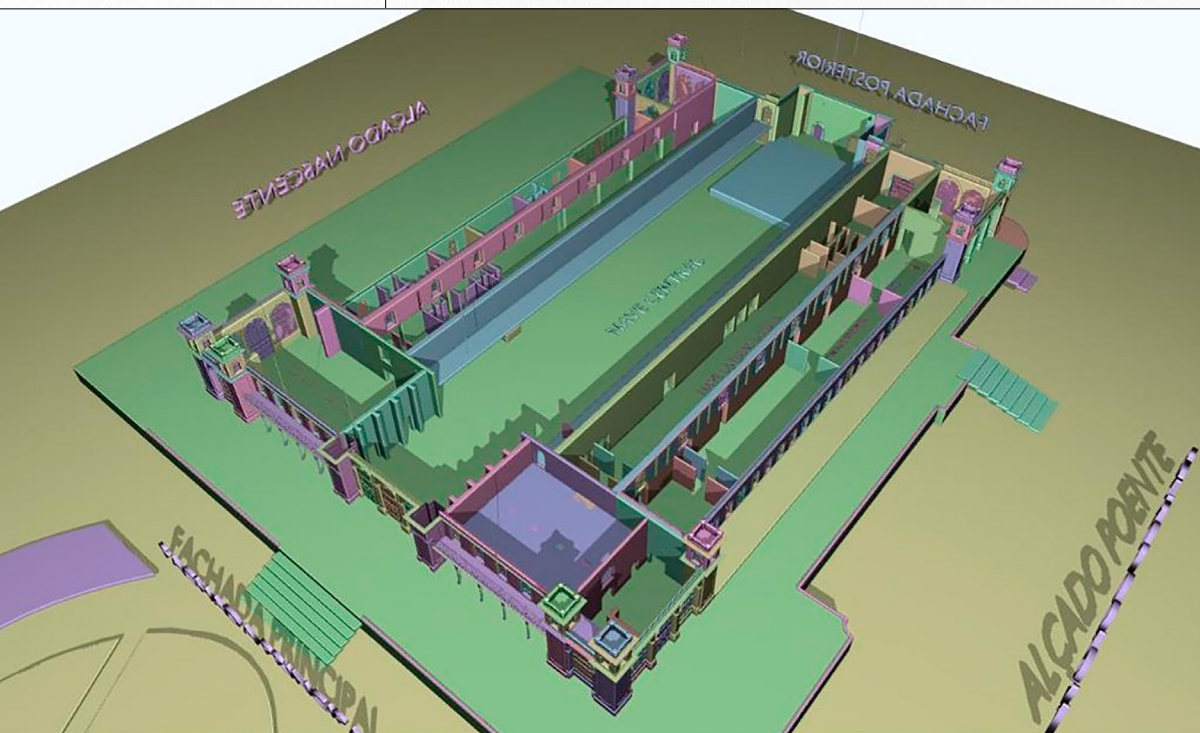


Fig. 15 - Interior spaces of the main building.
© The authors

VIRTUAL RECONSTRUCTIONS

Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

Overall, the Project allowed us to reconstruct all the main elements of the original building, including their metric proportions and volumetry. The Project also revealed several peculiar features of the Palace's façade: the cradle vault, the odd number of doors in each section, the two balconies on the second floor, the small windows in both towers, as well as the large iron frame in the centre and at the ends (Fig. 16).



Fig. 16 - View of the original façade of the Crystal Palace modelled in the context of [Marca 3D] Project. The image shows a transition from a wireframe to a solid view to understanding the computer graphics process involved. © The authors

2.3. MODELLING THE INDUSTRIAL AND COMMERCIAL MUSEUM OF PORTO

We adopted a similar a process for modelling the Industrial and Commercial Museum of Porto. It was possible to recover and identify the following images of the Museum:

- Two photos and one engraving of the interior of the *Circus* (*Arquivo Pittoresco*, 1866);
- Two postcards featuring the Museum (*Estrela Vermelha* no. 62 and *Arnaldo Soares*);
- One photograph of the façade featuring an illegible monogram (Aurélio da Paz dos Reis?);
- Three photographs taken from the other side of the river, in Vila Nova de Gaia (Fig. 17);

**VIRTUAL
RECON-
STRUCTIONS**

Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)

- One drawing of the opening, accompanied by a satirical commentary (*Um Passeio pelo Museu Industrial*), *Maria da Fonte*, 6-04-1886, 174, by *Almeida e Silva*;
- A textual description of the Museum (*A Atualidade*, 19-03-1886) (Costa, 2006);
- Two museum plans drawn with annotations by the historian *Joaquim de Vasconcelos*, 1886 (Biblioteca Geral da Universidade de Coimbra).



Fig. 17 - South view of the Crystal Palace and Industrial and Commercial Museum from Vila Nova de Gaia, 1865. © Porto Historical Archives (AMP)

As secondary sources, it was possible to identify a schematic reconstitution of the distribution of the Museum display cases, projected by the architect Nuno Tasso de Sousa (1983), and a former proposal of 3D modelling with volumetric features, published by Sandra Leandro and produced by the architects Paula Jardim and André Maranhã in 2009.

The first phase, geolocating the building, was conducted to understand its articulation with other surrounding architectural elements (Fig. 18).



Fig. 18 - The Museum georeferenced (2021).
© The authors

The 3D modelling of the architecture was produced following the schematic drawings by Nuno Tasso de Sousa, with the support of all of the references indicated above (Fig. 19).

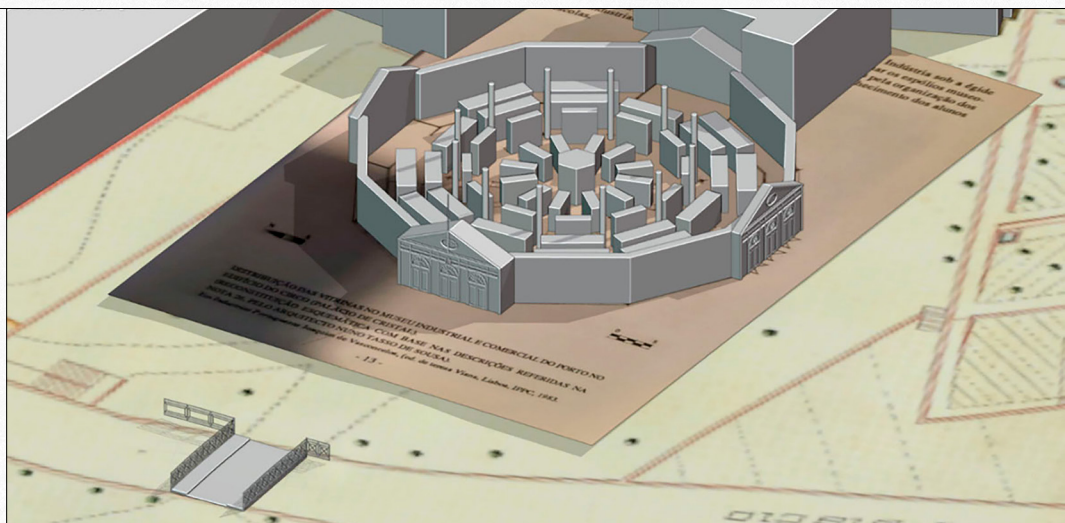


Fig. 19 - During 3D modelling with the reference image.
© The authors

VIRTUAL RECONSTRUCTIONS
Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

Generally speaking, it was possible to document most of the museum's elements (Fig. 20). However, due to the absence of reference images, some details could have been improved. Textual references to a staircase access to the circular balcony of the second floor were found, but it was not possible to identify its precise location. The façade on the east side needed to be better determined, but given the symmetry of the building, it has been assumed that it presented similarities with the west front. The former administrative services, a drawing room, and a library were located at the back of the building. However, given the scarcity of references, it was impossible, at least at this moment, to model these rooms in detail (Fig. 21).

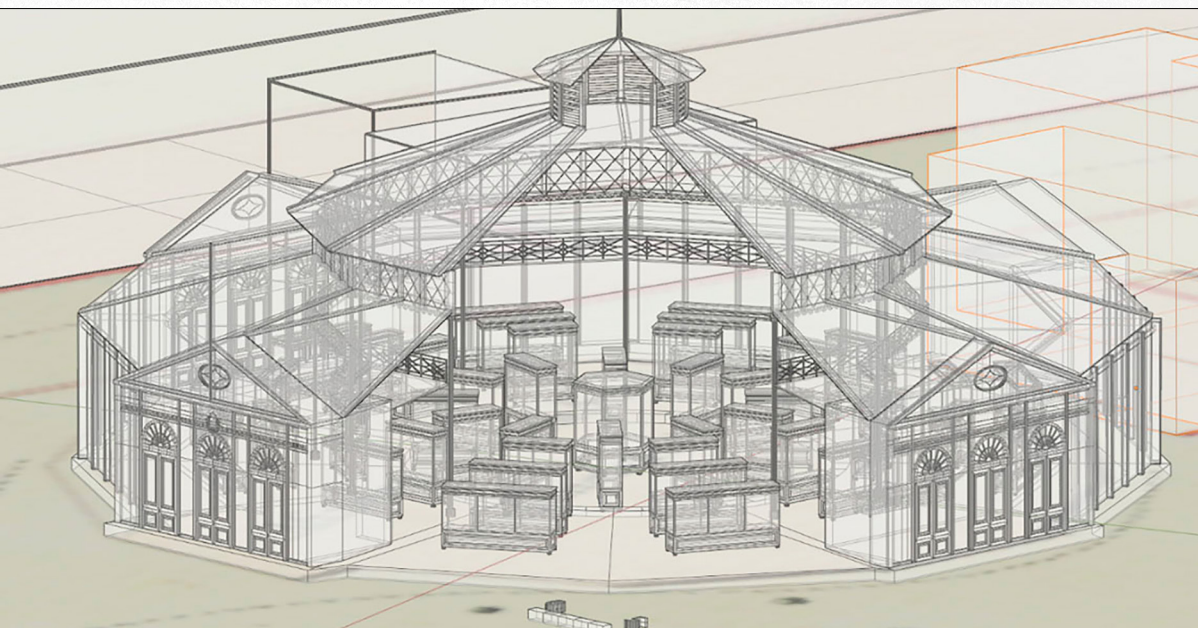


Fig. 20 - 3D
modelling with
transparency and
wireframe view.
© The authors

Fig. 21 - The
infographic image
presenting the
Museum's interior
with a hexagonal
plan, a balcony on
a higher floor, and
the room (without
showcases).
© The authors



VIRTUAL RECON- STRUCTIONS

Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)

¹ According to the
consortium, the multiscale
model can be described
using five Levels of Detail
(LOD): LOD0 - regional,
landscape; LOD1 - city,
region; LOD2 - city
districts, projects; LOD3
- architectural models
(outside), landmarks; LOD4
- architectural models
(inside), landmarks.

3. RESULTS

In both situations, it was possible to understand the volumetry of the buildings and its main structures in some detail. Compiling with the level of detail (LOD) classification determined by the CityGML standard (Open Geospatial Consortium, 2008), the *Museum* reconstruction scored LOD4 and the *Palace* LOD3¹.

Furthermore, the final model of the Crystal Palace provided an "ambient occlusion", enhancing the volumetric perception of the building (Fig. 22).

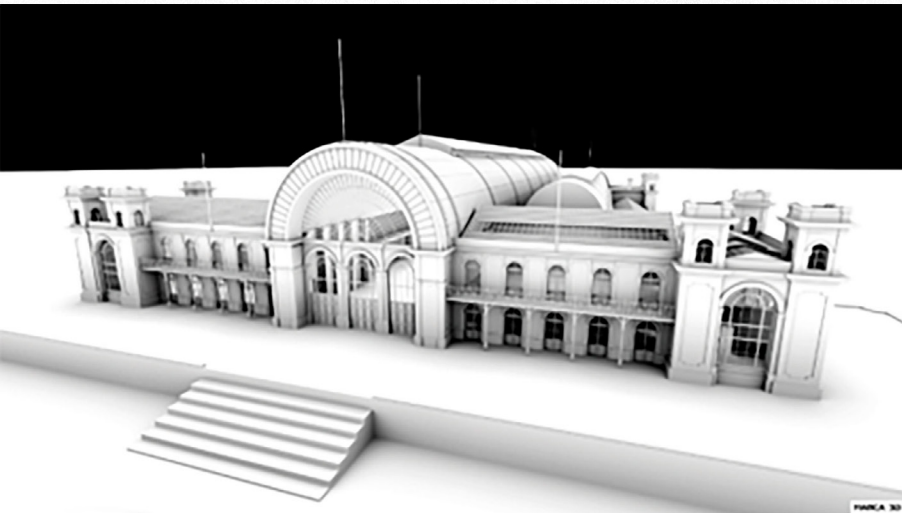


Fig. 22 - Front view of the Crystal Palace 3D model (Ambient occlusion). © The authors

VIRTUAL RECONSTRUCTIONS

Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

While a new model presenting a broader study of materials and constructed technologies used in the buildings has already been produced as part of The [Marca 3D] Project, it has not been possible to determine the precise materials used in the original coverings. As such, it was considered wiser, at this stage, to avoid advancing with chromatic proposals for the building (Figs 23 and 24).

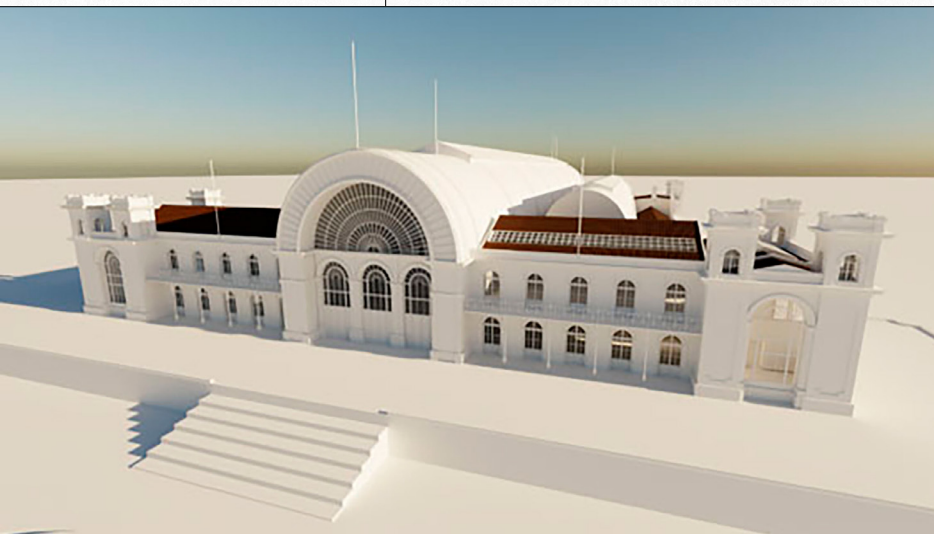
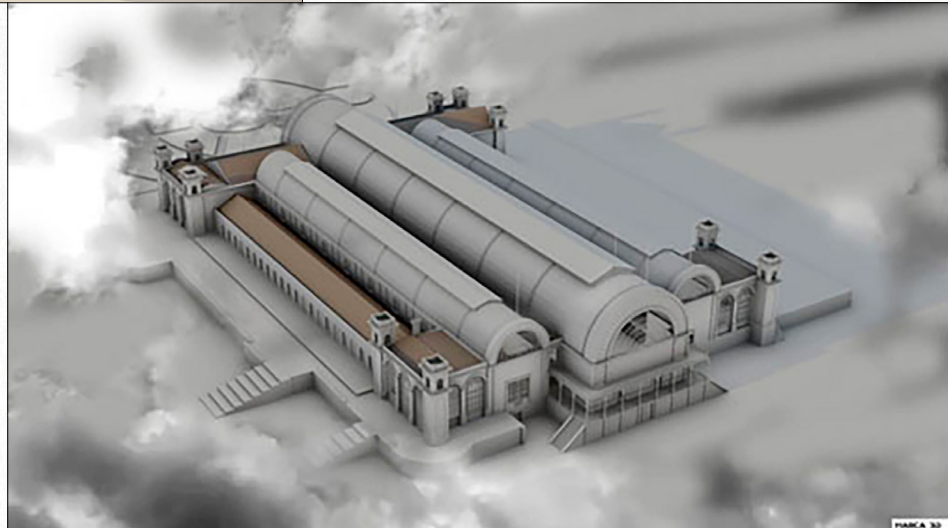


Fig. 23 - Front view of the Crystal Palace 3D model. Image visualisation with computer graphics technique, namely "clay material". © The authors

Fig. 24 - Back view of the Crystal Palace 3D model. Image visualisation using computer graphics technique, namely "clay material". Some clouds have been added in post-processing, to enhance the depth of the representation. © The authors



**VIRTUAL
RECON-
STRUCTIONS**

Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)

Several questions about the Museum's coating materials still need to be answered. However, to better visualise the work, it was decided to give the façade a reddish chromatic tone. The original metallic structures were allegedly green, as seen in some urban furniture used in the garden (lamps) and some metal sculptures. Sheet metal elements were probably not painted, but we are not sure. As for the display cases, it is known that they were made of unpainted wood (Fig. 25).



Fig. 25 - Final rendered image. The aperture in the building is an infographic means of showing the interior with the set of display cases museum disposed of by Joaquim de Vasconcelos in the 19th century.
© The authors

4. DISCUSSION AND CONCLUSIONS

The original Crystal Palace was designed in close harmony with the surrounding area, specifically the gardens, which still preserve their initial Romantic configuration. While the most commonly cited iconic and referenced source of inspiration for Porto's Crystal Palace is London's Crystal Palace, this articulation has recently been refuted (Gonçalves, 2016, 2017). Other sources of inspiration can be found in industrial and functional structures dating from the mid-19th century, namely the *Exhibition Hall* in Manchester (Gonçalves, 2017). In this regard, the *Gare du Nord* of Paris, built in 1846, offers a very close similarity with the volumetry of Porto's Crystal Palace. At the same time, another Parisian Gare, dating from 1849, *Gare de l'Est*, closely resembles the Crystal Palace pediment and glass tympanum (Fig. 26).



Fig. 26 - Gare de l'Est (2009).
© Google Street View

Moreover, some elements used in Santa Apolonia station in Lisbon, built precisely in 1865, are very similar to those used in the Crystal Palace, specifically on the doors and windows (Fig. 27).

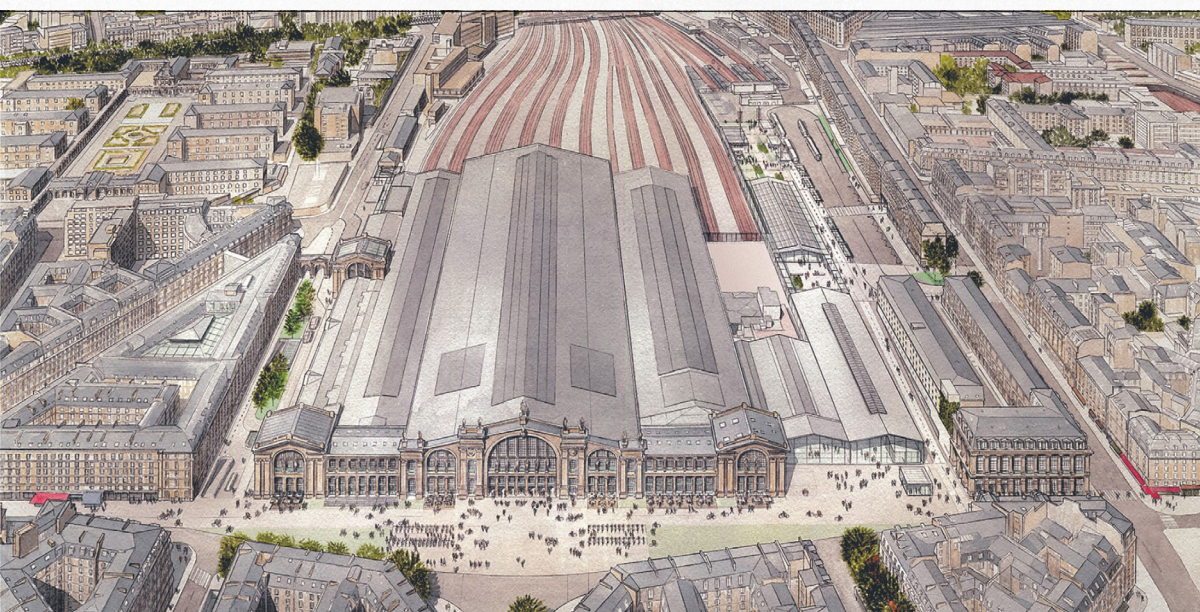


Fig. 27 - Santa Apolonia station, c. 1865, Lisbon.
© Municipal Archive of Lisbon (AML)

VIRTUAL RECONSTRUCTIONS
Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

Santa Apolonia station adds a new level of relevance to the study of the Crystal Palace, especially considering issues around the original colouring of the building. Several sources such as illustrations and painted postcards from the late 19th century show us that the Crystal Palace featured a garnet or dominant burgundy colour, used recently in Santa Apolonia station. A contemporary scale model of the Palace also features that colour (Fig. 28).

VIRTUAL RECON- STRUCTIONS

Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)



Fig. 28 - Crystal Palace model, c. 1900. © Santa Maria de Lamas Museum, Portugal

The relationship between the Crystal Palace and railway infrastructure gains a new level of interest when we realise that no railway station could be found in Porto at the time of its construction. The first was only opened ten years later, in Boavista, and the next in 1877, in Campanhã.

This correlation between the Crystal Palace and industrial architecture highlights the concept of functionality as embedded in the original Project. In this sense, the materials used in the Crystal Palace were, from the beginning, of poor quality. Just 25 years after its opening, in around 1890, there were several complaints about the degradation of the building (Santos, 1989).

By the late 1940s, severe structural problems with the Crystal Palace had become aggravated, leading to its demolition. The new building, *Rosa Mota Arena*, by José Carlos Loureiro and António Augusto dos Santos Soares (Fig. 29), introduced a new dynamic to the area, replacing the previous iconic building with another one, more modern, and featuring new architectural values. At the same time, Loureiro's Project was somewhat disconnected from the original Romantic Crystal Palace and gardens. It is possible to establish a relationship between the *Rosa Mota Arena* and the 1880 Belgium greenhouse in Laeken (Fig. 30), presenting a bold oval structure built for King Leopold II and establishing a compromise between the Romantic tradition and the modernistic and industrial impulse of the late 19th century. Nonetheless, the project also brought a new centrality to the area which has endured to the present day.



Fig. 29 - Rosa Mota arena, 1968.
© Porto Historical Archives (AMP)

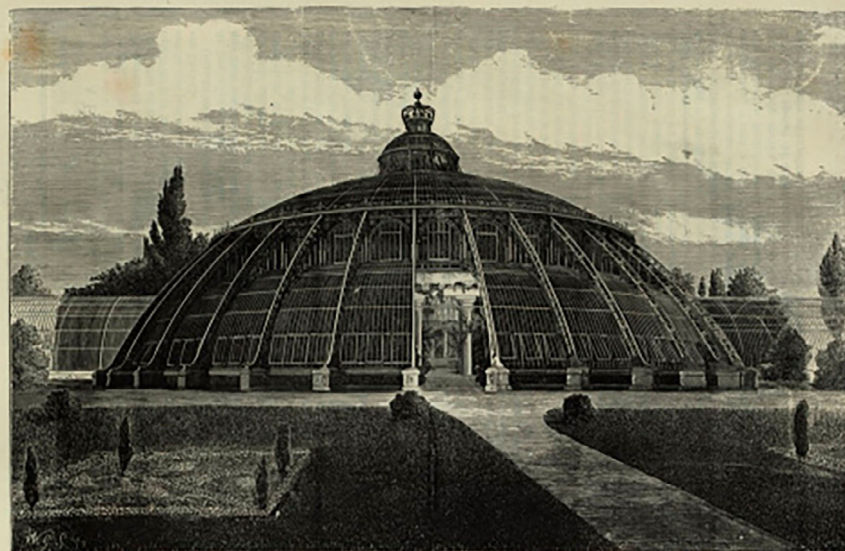


Fig. 30 - Leopold II gardens in Laeken, Belgium, *À Volta do Mundo* magazine, 1880.
© *À Volta do Mundo*

VISTA EXTERIOR DA ESTUVA DE SUA MAJESTADE EL-REI LEOPOLDO II, EM LAEKEN — BELGICA

VIRTUAL RECONSTRUCTIONS

Of the Iconic Crystal Palace Building and the Industrial and Commercial Museum of Porto (Portugal)

REFERENCES

- Afonso, G. (2007). O Archivo Pittoresco e a evolução da Gravura de Madeira em Portugal. In *Ciclo de Conferências “Arquivo Pittoresco, 150 Anos Depois (1857-2007)”*, 2a Conferência (Hemeroteca Municipal de Lisboa, 20 Setembro 2007).
- Afonso, J. F., Botelho, M. L. (2005). *Memória justificativa: Projecto Porto século XVI - A Sé e a sua envolvente no Século XVI*. Centro de Investigação em Ciência e Tecnologia das Artes (CITAR).
- Alvito, P. (2008). *Viver o Passado: Modelos tridimensionais e realidade virtual como ferramentas de apoio à Arqueologia e à Reconstrução do Património. O caso de estudo da villa romana do Casal de Freiria*. Master thesis, Instituto Superior Técnico.
- Aparicio Resco, P., Figueiredo, C. (2016). El grado de evidencia histórico-arqueológica de las reconstrucciones virtuales: hacia una escala de representación gráfica. *Revista Otarq*, 1, 235-247.

**VIRTUAL
RECON-
STRUCTIONS**

Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)

- Aparicio Resco, P. (2021). Guide for documentation of virtual reconstructions on heritage assets. *Revista Schema*, 2, 129-146.
- Arquivo Histórico Municipal do Porto. *Plataforma GISAWEB*. <http://gisaweb.cm-porto.pt>.
- Barbosa, I. de V. (1984). Palácio de Cristal no Porto. *Arquivo Pittoresco. Semanário Ilustrado*, 7, 2-3.
- Barros, F., Val-Flores, G., Schiavottello, N., Silva, A. (2018). Project Évora 3D: research, methodology, reconstruction and visualisation. In *Cities In The Digital Age: Exploring Past, Present And Future* (pp. 11-28). Centro de Investigação Transdisciplinar Cultura, Espaço e Memória.
- Bernardes, P. (2002). *Arqueologia Urbana e Ambientes Virtuais: um sistema para Bracara Augusta. Braga*. Master thesis, Instituto de Ciências Sociais, Universidade do Minho.
- Blender. (n.d.). <http://www-blender.org>
- Buzzanca, G. (2021). Digital Humanities ovvero impiego di strumenti informatici nell'ambito del mondo del restauro. *OPD Restauro*, 33, 157-164.
- Carpetudo, C., Lopes, G. (2015). The old parish church of Montemor-o-Novo in the 16th century - a manuelino example and its virtual reconstruction. *Digital Heritage*, 741-742.
- Carpetudo, C., Lopes, G. (2016). Paço dos Alcaides – Uma proposta de reconstrução virtual. *Revista de Cultura Almansor*, 2, 3.ª série, 155-187.
- Costa, P. (2006). *Os Museus e o ensino industrial: Percursos e coleções*. Faculdade de Letras da Universidade do Porto.
- Denard, H. (2009). *The London Charter for the Computer-based Visualisation of Cultural Heritage*. King's College.
- Dias, R. (2014). *Reconstituição digital em Património - Os castelos de Vimioso e Monforte de Rio Livre*. Faculdade de Letras da Universidade do Porto.
- Di Cosola, I. (2020). *Dal rilievo alla ricostruzione 3D: il chiostro francescano presso il Palazzo Municipale di Grumo Appula (Bari)*. Università del Salento.
- Figueiredo, C. (2010). Proposta Arquitectónica do Templo Octástilo. *Bracara Augusta (Apêndice I)*, 163-169. Câmara Municipal de Braga.
- Figueiredo, C. (2014). *Relatório de projecto de arqueologia virtual para o documentário "Fundeadouro romano em Olisipo". Reconstituição de Olisipo e de um Navio Romano do tipo de Corbita*.
- Figueiredo, C. (2016). A Reconstituição Arqueológica – uma tradução visual. *Almadan online*, II série, n. 20, tomo 2, 6-13.
- Gonçalves, V. (2016). Progredior: The Porto Crystal Palace and the 1865 International Exhibition. *Book of Abstracts 9th Meeting of Young Researchers of University of Porto*, 11160.
- Gonçalves, V. (2017). Progredior: O Palácio de Cristal Portuense. *Genius Loci – Lugares e significados – Places and Meanings*, 2, 359-370.
- Gonçalves, V. (2018). *Imagens e Memórias em Reconstrução: Do Palácio de Cristal Portuense ao Pavilhão Rosa Mota*. Master Thesis, Vol I e II, Faculdade de Letras da Universidade do Porto.
- Henriques, F. (2021), Historic Centre of Oporto (Portugal). In *ArtStation*. <https://www.artstation.com/artwork/vewrY>.
- Leandro, S. (2019). *Museu Infinito - Joaquim de Vasconcelos (1849-1936) e o Museu Industrial e Comercial do Porto*. Câmara Municipal de Lisboa/MUD.

**VIRTUAL
RECON-
STRUCTIONS**

Of the Iconic Crystal Palace
Building and the Industrial
and Commercial Museum of
Porto (Portugal)

- Pereira, R. (2017). *Uso de Realidade Aumentada aplicada ao Património: o século XX na Sé do Porto*. Master Thesis. Instituto Superior de Engenharia do Porto.
- Ramos, D. (2007). *Utilização de Modelos Virtuais na Reconstrução e Reprodução de Edifícios e Monumentos. Realidade Virtual aplicada à conservação e restauro*. Master thesis, Instituto Superior Técnico.
- Santos, J. C. (1989). *O Palácio de Cristal e a arquitectura do ferro no Porto em meados do séc. XIX*. Fundação Engº António de Almeida.
- Shirley, P. (2005). *Fundamentals of Computer Graphics*. A. K. Peters.
- Tavares, R. (1992). A Carta Topográfica da Cidade do Porto de 1892 – Uma base Cartográfica para a Gestão Urbanística Municipal. In *Uma Cartografia exemplar. O Porto em 1892. Exposição Comemorativa do 1º Centenário da Carta Topográfica de A. G. Teles Ferreira*. Câmara Municipal da Cidade do Porto.
- Val-Flores, G. (2014). O Paço Real de Évora. Da periferia à centralidade – percurso de um espaço simbólico. In *Evolução da paisagem urbana: cidade e periferia*, 247-270. Centro de Investigação Transdisciplinar Cultura, Espaço e Memória, Instituto de Estudos Medievais (FCSH – Universidade Nova de Lisboa).
- Val-Flores, G., Sarmento, R., Rodrigues, P. S. (2019). Da historiografia à recriação: o caso da(s) Freiria(s) de Évora à entrada do século. In *Antologia de Ensaios. Laboratório Colaborativo: dinâmicas urbanas, património, artes*. In *V – Seminário de investigação, ensino e difusão, DINÂMIA CET-IUL*, 17-43.
- Val-Flores, G. (2020). Firmitas vs Venustas. A Reconstituição digital enquanto ferramenta de reflexão entre forma e função: O exemplo do Projecto Évora 3D. *A Cidade de Évora*, III série, 3, 218-238. Câmara Municipal de Évora.
- Vaughan, W. (2012). *Digital Modeling*. New Riders.

ACKNOWLEDGEMENTS

The authors would like to thank the Eng. António de Almeida Foundation (Porto, Portugal) for kindly offering the book “Crystal Palace and Iron Architecture in Oporto in the mid-nineteenth century” by José Coelho dos Santos (1989), an academic work of immeasurable value for the study of the Crystal Palace in Porto. Although the work is not a rarity, at least in our understanding, simple actions provide stimuli for outstanding achievements.