

# ARCHITECTURE AND BIM

## BIM Models Contribution to the Exhibition, Representation and Documentation of Architecture

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### Abstract

The influence that architecture draws from scientific, technological, humanities and artistic fields reflects the multiple information that is displayed in the architectonic form, making its communication harder. On the other hand, as it is a fixed constructed entity, one needs to go there. And due to their function or for being privately owned a lot of these architecture objects are inaccessible. In fact, presently, contact with this type of architecture is mostly done through representations and not through originals. Consequently, it is essential to invest in forms of architecture communication, that bring the architecture representation closer to the represented object. For this reason, as a first approach, relevant architectural objects were analysed, with the capabilities and limitations of each of the different traditional communication media – drawing, text, scale model, photography and video – to exhibit, represent, and document the different material and immaterial dimensions of architecture. Furthermore, the technological capabilities of BIM were also assessed whereas, to this end, not only the software's performance was considered, but also the skills of traditional media, which it may be associated with. Lastly, some of the qualities of BIM technology were tested on the practical exercise of modelling the house Albarraque in Revit. Summing up, BIM is a useful tool that can be used to exhibit, represent and document relevant architecture, not only due to its ability to absorb the skills of the traditional architectural media, but also as an alternative with unique valences to experience architecture.

**Keywords:** Architecture; Communication; BIM.

### 1. Introduction

The presented work studies the contribution that BIM technology provides for the qualification of museological treatment of architecture, considering the traditional architecture media. From this wide universe, the investigated question focused on the relevance of the architectural media to the exhibition, representation and documentation of architecture, since contact with the *original* objects is, very often, inaccessible. In this sense, it is reported as necessary to ensure that the architectural media should be described and presented to the observers as close as possible in its *original*.

To this end, it is important to assess this distance, between the *original* object and the different communicative media, from the museological treatment of architecture point of view. Thus, based on the interpretation and adaptation of the International Council of Museums (ICOM) [1] [2] and on the *Direcção-Geral do Património Cultural* (DGPC) [3], it was established a trilogy of analysis to evaluate the media used to communicate architecture (traditional media and BIM) as illustrated in figure 1.



Figure 1: Main vectors for museological treatment of architecture.

To evaluate the quality of the different architecture media, used to exhibit, represent or document architecture it became important to define in advance what are the most defining architecture properties. To this purpose, based on our personal interpretation of Bruno Zevi's works [4] [5] it was established three major qualities that were considered important to be reported when fully describing an architectural project: the sensitive, the physical and the identitarian properties (figure 2).



Figure 2: Architectural qualities.

Based on these three categories, it was then sought to evaluate the ability of the traditional architecture media to exhibit, represent and document these specific properties of a project as illustrated in figure 3.

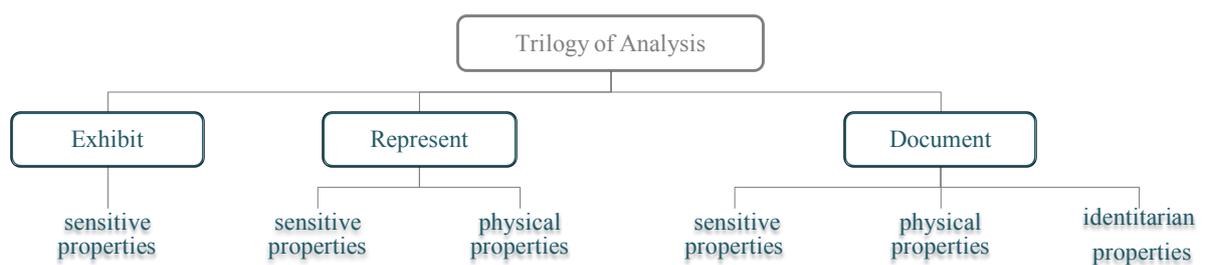


Figure 3- Trilogy of analysis scheme.

From these three categories, it was then assessed the ability of the traditional architecture media – drawing, text, scale model, photography and video – and BIM to exhibit, represent and document architecture (figure 4).

In what regards architecture exhibition, it is considered the appealing communicative nature, the effective and agile ability to promote the substance of a project, highlighting its most relevant points. For this reason, here it is especially valued the communication of sensitive properties of architecture, namely the sensory and emotional dimensions of any project, revealing the atmosphere and environments that the space proposes.

In what regards architecture representation, it is considered important to fully describe the architectural object. To this end, the description of sensitive and physical properties should include the description of the materiality and geometry of all its elements, approaching thus the representation to its *original*.

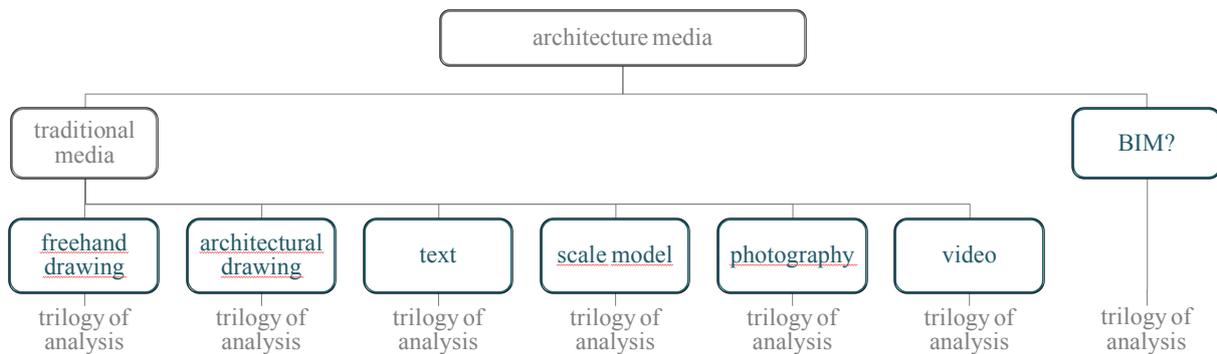


Figure 4 – Trilogy of analysis application.

In what regards architectural documentation, physical, sensitive and identitarian properties are considered especially relevant to communicate architecture. The identitarian dimension of the building concerns the memory and the meanings of the architectural object in its various social, cultural, economic and political contexts.

The assumptions established aim to launch the debate on possible developments in the architecture exhibition, representation and documentation areas. Focusing the discussion on capital gains that BIM can bring to this area of expertise namely the traditional architecture media.

To this end it was applied the trilogy of analysis to each one of the tradition architecture media, to BIM, and finally it was accomplished the results of the practical exercise analysis of a model built in Revit (a BIM tool). This study seeks to highlight some of the BIM advantages to be used for the museological treatment of architecture, and explore the specific capabilities of one of many BIM tools to do so.

In a final phase, based on all the gathered information, it has become possible to identify some of the benefits that BIM adds to the field of architecture communication. Whereas to this end, it is considered not only the ability to include the skills of the traditional architecture media studied, but also the ability to provide an alternative with unique valences of experiencing architecture space.

## 2. Theme contextualization

The work begins to deepen some concepts which, although independent of the investigated matter, relate to it. Highlighting here those which have seemed relevant, namely the museums. This topic and the respective mission deserved special attention, pointing out the issue of digital museums, crucial to understand the scope and complexity of the subject under review [6] [7] [8] [9].

It was also studied the cyberspace, as a platform and vehicle of culture, as well as the ability that its rhizomatic structure offers to the museology of architecture. It was also deepened the knowledge concerning virtual reality and the immersive experience of architecture space [10] [11].

In addition, the acknowledgement of information age has deeply influenced the way how architecture is communicated nowadays. It was studied the existing platforms used to exhibit, represent and document architecture online [12] [13] [14] [15]. Finally, it was considered appropriate to study the problem of architecture communication [4] [5] [16] [17] [18]

### **3. Application of the trilogy of analysis to traditional media**

The research concerning the exhibition, representation and documentation of architecture continued through the study of each of the selected architecture media – freehand drawing, technical drawing, text, scale model, photography and video – to understand their individual role in the exercise, and the subsequent communication of architecture.

After the systematic analysis of the above-mentioned media it was accessed that the exhibition, representation and documentation of an architecture object is as much accomplish as the more diverse are the media used to communicate it. Since all the selected architecture media are closely related to the project development and due to their unique contribution and consequent historical value, all of them are indispensable to rigorously exhibit, represent and document a project.

Therefore, to communicate accurately the different sensitive, physical and identitarian properties of architecture it is necessary to use heterogeneous media that, in this way complement their individual limitations.

Even today, one of the biggest challenges of the architecture discipline lies in the communication of space, being this a problematic claimed even by Bruno Zevi [19].

Actually, it is not just a limitation of available resources or the ineffectiveness of their use. Indeed, there is still no full use of the potential that the information age offers – more digital, intelligent, interactive and above all in network.

### **4 BIM: State of Art**

Being the BIM technology oriented to the design and management of new buildings, it is in this direction that investigations have been promoted and consequently the development of its technology. However, a few investigations have been developed to use BIM to model pre-existing buildings, namely the ones with historical importance [20].

In the last two decades there was a growing digitization process, management and creation of virtual platforms in order to provide and enable access to historic heritage information. The scanning process used initially 3D virtual models to document the geometry and visual properties of architectural objects, through laser scanning and photogrammetry. However, the surfaces description of an architectural object does not regard any architecture information beyond the description of the building "envelope" [21].

In this sense, the first implementation of BIM technology targeted to model pre-existent buildings, it was developed within the framework of a research carried out by Yusuf Arayci in 2008. The author claimed the need to overcome the barrier of 3D graphics modelling and adopt BIM tools, in order to provide multi-functional information models - interoperable, intelligent and multi-representational ones. This investigation focused on the adoption of BIM to model pre-existent buildings, combining it with laser scanning technology [22].

In addition to the information built within BIM system, the inclusion of heterogeneous information, such as free-hand drawing, text, photography and video, attest the vocation of BIM models to work as a database to store the information related to the architectural object virtually simulated (inventory model) [22].

It was later developed by the *Dublin Institute of Technology* a new concept, the *Historic Building Information Modelling* (HBIM). The HBIM is a *plug-in* of BIM which enables to produce a library of parametric objects constructed as from historical information. For such purpose, it is combined BIM technology with the information collected through laser scanners and photogrammetric surveys [23, pp. 369-370].

The HBIM was used in a restoration project in 2014 due to the destruction caused by an earthquake. This technology simulated and analysed the structural behaviour of that building as well as for budgeting and support the development of the restoration project [24, p. 1].

Ramtin Attar et al. have developed the BIM model of the Autodesk Office. The goal was to build a model that would work as a database of all information about the building (inventory model). In this way, the BIM model records the different interventions that the building suffered over time and operates as an information repository able to describe the geometry and semantics associated with the architectural object. The author adds that one of the motivations for the BIM adoption was the possibility of centralizing the information related to the building and allowing the production of a wide range of analysis from the model [25, p. 3].

In 2011, Stephen Fai et al. warns that, despite the proliferation of the BIM adoption to design and manage the new building life cycle, somehow it is still reduced the investigations number carried out with the aim of exploring the implementation of BIM to the information management relating to pre-existing buildings of cultural relevance [20, p. 1].

Despite the developments till then, Logothetis et al. reinforced this idea in 2015 in the article regarding state of the art review on the implementation of BIM technology to cultural heritage [26, p. 177].

Stephen Fai et al. studied the construction of BIM models incorporating quantitative data – as in the case of intelligent objects and their structural performance information – and qualitative data – such as the inclusion of images (drawing and photography) and textual elements. The authors also identified the BIM's ability to organize information in a navigable timeline, enabling the registration of tangible and intangible changes throughout the building life cycle and any future projections [20, p. 1].

These capabilities can be explored to exhibit, represent or extensively document a relevant architectural project, in what concerns its design process and its outcome. In this sense, the BIM adoption can be useful as a working tool for the treatment of museological architectural estates or architectural offices, lodged in museums.

#### **4.1 BIM: Identified Difficulties**

The modelling of pre-existing buildings in BIM used to exhibit, represent or document architecture is still at an embryonic stage. Investigations in this BIM application field have as common denominator to use the available technological capabilities of BIM designed to serve the production and management of new buildings, and adapt them to the study area goals.

Since the pre-existing buildings of historical significance often present irregular geometry elements, their modelling in BIM is still very difficult. On the other hand, the materials also undergo changes in their morphology and unique properties, showing the wear from use and time. Therefore, to document the

heterogeneity of the building morphology or wear thereof, is it necessary to seek analysis mechanism such as laser scanners or photogrammetry tools [26, p. 179].

For the construction of a model of this nature the BIM modelling must be produced manually, since there is not yet the ability to recognize plans through the points cloud of laser scanning or photogrammetric surveys, which renders this method not very effective. Actually, it is only possible to overcome the difficulties presented by the lack of primitives of BIM libraries through the use of HBIM mentioned above [26, p. 179].

#### **4.2 BIM: Contribution to exhibit, represent and document architecture**

Although there is a lack of specific tools and software to take the most advantage of BIM, it is already possible to identify the added value of some of the existing tools for this studies field. Some of the benefits that BIM has proven to bring to this research field are further highlighted [26] [27]:

- Allow virtual access to the interior and exterior of a project, enabling the virtual consultation of inaccessible architectural works;
- By providing this relevant information disclosure, allows students and researchers to study and analyse buildings, thus enabling to promote and develop more knowledge;
- Allow to record the building evolution over time through the chronological organization of information of the model;
- Allow to estimate the whole structure of the building using images to consider texture, volume and form thereof;
- Allow to virtually simulate different proposals for rehabilitations, reconstructions or adaptations to the original building;
- Allow for a 3D modelling to communicate information to a broader audience, since it is easier to interpretate then the 2D information;
- Allow to consult detailed information associated with each model element.

It is also added the ability to integrate different types of heterogeneous data, such as drawing, text, photo, video, sound and the possibility of extracting renders walkthroughs from the 3D models.

And finally, it is also open the potential that a set of BIM models can come to represent, not only for the construction of immersive virtual architecture museums but also for the construction of BIM data base models, where it is possible to take advantage of cross-checking information between the different models.

### **5. Application of the trilogy of analysis to the BIM Model: House Albarraque**

Within the presented research one has tried to explore some of the capabilities that a specific BIM software – Revit Architecture – has to exhibit, represent, and document architecture. After the practical exercise of modelling the House Albarraque from Raúl Hestnes Ferreira, there were identified the main features of this tool to exhibit, represent and document architecture. A distinction is made between two types of information retrievable from the model: the generated and the associated.

About the generated information is worthy of mention:

- The full description of the house geometry allowing to produce all possible technical drawings – plans, elevations and sections – of the architectural object.

-The 3D model allows the user to explore the spatiality of the house in different visualization styles, and control the information one wants to show or hide. So, they are represented in the model all possible perspectives on the house.

-The naming and quantification of areas of the house.

-The materials identification of the different design elements with a name, visual qualities, physical properties, and quantification of the respective units or volume.

-The ability to associate links, descriptions and set properties to the different elements of the project.

- The possibility to create rendered images from the model.

-The ability to produce videos from the model, walkthroughs.

-Create two-dimensional sheets, where it is possible to present the information from the model, and from exterior sources in an organized manner.

In what concerns the associated information:

- It highlights the model's ability to include qualitative data in the model, through the inclusion of images of photographs, free or technical drawings on the model.

-It is also possible to include written and numerical information to the BIM model.

### 5.1 BIM Models: Exhibit

The model communicates in a fast, intuitive and appealing way the sensitive properties of a space through the manipulation of the model and consultation of its sheets.

The Albarraque House model takes advantage of the attractive qualities of the 3D manipulation and exploration, by allowing the user to explore and interact with the model.

In a second point, and since the 3D model waives a three-dimensional vision, trained to imagine modelled spaces, this format presents a more intuitive way to communicate three-dimension space to a non-specialist audience.

The produced renders and walkthrough from the model allows to exhibit the house project without the trace of time marks, the imperfections of the *original* object and without furniture and natural appropriations of the space. This media allows to focus visitor's attention just in architecture. It also allows to present perspectives of the project which may not exist in other information supports, such as aerial perspectives.

It was also explored the ability of inserting different architecture media – images and text – organizing this information in the file sheets and taking advantage of these unique media supports to complement the project documentation.

Another highlight rests on the possibility of the House Albarraque model be easily consulted and shared over the internet. Thus, unlike the scale model, the model can use this important tool to share information. As aforesaid, the communicative support compatibility with the cyberspace is at present a *sine qua non* condition to exhibit architecture in a society increasingly informed, with intelligent information access, networked and more conservative in the use of natural resources.

On the other hand, the model of the House Albarraque gathers multi-disciplinary information such as visual (renders and videos), spatial (3D model), technique (technical drawings, materials, different lists) and the historical one (imported documents). This information gathering renders the model an appealing exhibition media to a broader public with different interests among themselves.

Model interoperability also ensures the possibility of users to isolate information in order to only consult the content in which they are interested in.

## **5.2 BIM Models: Represent**

The Albarraque House model beyond the description of the sensitive properties of architecture it also aims to fully describes its physical properties. Thus, it allows to describe three-dimensionally the whole geometry of the project, allowing to extract all the plants, sections and elevations that one may wish.

The house model also represents the materiality of the different elements of the project as well as the visual characteristics associated with each material. For the representation of the physical properties of the project, the model records the different properties associated to each material, such as: thermal, mechanical behaviour and the resistance of the material.

Since the model can be navigable, some of the sensations and emotions that the space raises to the user may be experienced through the model exploration in a virtual reality environment. This kind of experience can only be compared with the consultation of Albarraque model. which hardly reach the level of detail and realism of the produced BIM model.

The house model developed is a representation tool that can be updated accordingly to future changes to the building and can be used as analyses production support as well as for the management and maintenance throughout its life cycle. It also allows to inform and rehearse various proposals for amendments to the *original* project in the context of reconstruction, rehabilitation or restauration projects of the building in an informed and rigorously way.

## **5.3 BIM Models: Documentation**

As stated previously the House Albarraque model describes sensitive, physical and specially reflects the identitarian properties of the architectural project.

The communication of a project identitarian properties, concerning the collective memory of a population or the symbolisms and meanings of a building identifies the need to develop a model with heterogeneous and multidisciplinary data. Rendering it possible to function as an inventory model, archiving historical documentation regarding the House Albarraque. This fact is evident in the file sheets where one can find images (such as drawings or photographs) and text, demonstrating that is possible to take advantage of the benefits of these media for documentary purposes.

Secondly, the objects description or integration of annotation symbols permits to associate URLs or descriptions to the various elements in the model. So, it is possible to include additional and external information to the model.

Thirdly, under the documentation scope it is considered useful the model ability to present a large amount of information in an organized manner.

Finally, it seems particularly beneficial to the documentation field, the portability of rvt format, digital and therefore easily storable, shareable and preserved.

## **6. Conclusions**

The work development made it possible to access the added value that BIM represents to exhibit, represent, and document relevant architecture.

Indeed, after the systematic analyses of selected traditional media used to communicate architecture, it has concluded that all of these tools are unique and indispensable to this field of study due to their relation with architecture production, and the original way in which they express architecture properties. But, it was accessed too, that these tools present limitations to exhibit, represent or documentation architecture.

In the other hand BIM presents itself as a relevant tool to exhibit, represent and document architecture. Since it contributes in a unique way to communicate architecture projects and because it can include the different architectural Media, assimilating their qualities to communicate architecture.

It was concluded that BIM has the ability to exhibit architecture, proposing an interactive way to manipulate and experience architecture, distinct from the other traditional media, and though immersive reality experience, bringing the user closer to the experience of visiting the real architectural *object*. Providing in this way the viewer a richer sensory experience, informative and interactive with the architecture.

It was demonstrated too that BIM allows to represent architecture as rigorously as the more information is inserted in the model, thus preserving the building physical record and allowing to establish management strategies to maintain the modelled relevant architecture projects.

Finally, it allows to document more fully relevant architecture projects than the other traditional media, since it can support the inclusion of extensive data from different formats (as historical documents of the building) insinuating itself even to be used as an inventory model of multidisciplinary and multi-functional and intelligent information in an organized and interoperable support. In fact, because it is a digital tool, it allows the organization of a very wide range of information and makes it possible to make this model available to consult in the Web.

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