

A Methodological Approach to Architectural Models as an Integral Part of the Design Process

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Abstract

From ancient times to the present day, architects and engineers have tried to express their designs in materials that allow them to transfer the creations from their mind to the tangible world, bringing them to life through models showing a future or hypothetical constructed reality. There have been more than 5,000 years between the first intuitive representations and the current immersive virtual reality prototypes, over which time the search for a universal graphic representation model has been a constant and three-dimensionality has always played an essential role [1].

Keywords: graphic representation, three-dimensionality, models and mockups.

The first 3D expressions in history

«Jupiter [admiring at the contemplation of an extraordinary theatre] [...], inwardly considered himself to be an idiot or retard, because on planning the model of the future world, instead of going to the architects of such an exceptional work he had gone to the philosophers.»

Leon Battista Alberti, *Momus*, IV, p. 4 [2].

There is no doubt that initially engineers and architects belonged to the same profession and from the very start of civilisation these professionals have faced the same problem: communicating their projects to those who have to execute them, but especially to those who are going to pay for them, almost always civil and religious authorities but also patrons and private individuals.

To overcome this obstacle, they had to use all the graphic media available to them, including scale mockups of their designs. Although it tends to think that the oldest models of buildings that are conserved were not properly architectural, as Gentil Baldric points out: «the mere votive consideration that is usually granted to them does not diminish their significance; whether they represented an ideal building or another constructed one, nothing prevented them from having been used –even to be used later– as a reference for the execution of a real work» [Gentil Baldric 1998, p. 18].

Although mockups have accompanied the development of architecture since ancient times, the first examples that are preserved date from the third millennium BC,

Fig. 1. Above, models of Egyptian houses in terracotta from the Middle Kingdom (ca. 1980-1759 B.C.). Schiaparelli Excavations, 1914, Gebelein. Egyptian Museum of Turin (photo by the author, 2015); bottom left, architectural model found in the ancient city of Assur, Iraq (ca. 2400 B.C.); bottom right, another example of Mesopotamian house from Syria (ca. 1350-1200 B.C.), Louvre Museum, Paris.



highlighting especially the so-called “soul houses” in Egypt, in which the spirits of the deceased were collected during their long journey through the afterlife. We can assume that the equivalent constructions in Mesopotamia had the same purpose, although they could also have been votive offerings to the gods or even domestic altars in the case of those with the form or façade of a temple (fig. 1).

In any case, it does not seem an absurd hypothesis to think that these mockups could have been commissioned to the most specialised professionals at that time, that is, to the architects, or that these architects presented their construction proposals using this type of model, although more elaborate, accompanied by more or less elementary planes on clay or papyri. In fact, «it is more than possible that this practice was, by simple, much more common than that of flat representation» [Gentil Baldrich 1998, p. 16].

In Greece, we know from the well-known work *Constitution of the Athenians*, attributed to Aristotle, that the city’s Council of Five Hundred required architects to present their designs in the form of models or mockups, which should obviously be to scale [3]. Since Roman culture inherited many aspects from Greek culture, it is reasonable to assume that Roman architects-engineers such as Vitruvius also used mockups to convince people of the virtues of their designs.

Fig. 2. On the left, model of the adyton of the temple of Niha. National Museum of Beirut; on the right, ruined temple in 2002 [Aliquot 2009, fig. 42].



In fact, unique and exceptional proof of the existence of mockups as design tools in Roman times has been preserved, namely the entrance to the *adyton*, place reserved for the priests, in the Phoenician temple of Niha, in the Bekaa plain (Lebanon), dating back to the 2nd century AD, today in the National Museum of Beirut (fig. 2). In the building, also known as the Great Temple to differentiate it from the others in the same area, its *adyton* is practically the same as the model used to build it, although with the slight modifications inherent to the constructive reality.

The mockup, in calcareous stone, is built to a 1:24 scale and as Aliquot points out: «*L'inscription gravée dans un des angles de ce monument ne laisse aucun doute sur sa fonction: modèle de l'adyton (προκέντμα αδύ [του]).*» However, according to that same author, and as happens today, the model was not produced by the architect but by one of his assistants and «*semble bien supposer un plan et un plan pratiquement dessiné à la même échelle.*» That is to say, the creation of the mockup is the materialisation of a previous plan produced by the architect that «*illustre le rôle du dessin d'architecture dans l'Antiquité en général et dans l'édification des temples romains du Liban en particulier, celui d'un modèle destiné à être reporté, mais susceptible d'adaptations*» [Aliquot 2009, § 59]. Or in other words, the mockup plays a secondary role to the drawing.

Rabun Taylor holds a similar opinion and considers that the most valuable mockup is one of the least discussed, a 1:30 scale fragment of the Great Altar of Baalbek that stands out for its spatial complexity, the result of a perfect analytical plan. This author states that «*The obvious benefit of the models does not obscure the likelihood that for Roman architects themselves, as opposed to the stonemasons and bricklayers, perspective drawings were the most important creative aids.*» He provides support for his position with the testimony of the Roman lawyer and writer from the second century, Aulus Gellius: «*Fronto's builders presented rival plans and "specimens" for a proposed bath building in the form of paintings on parchment (depictas in menbrenulis varias species balnearum)*» [Taylor 2003, p. 36]. In any case, what we can conclude is that both the perspective drawings and the scale models not only coexisted as tools of representation, but also complemented each other.

As is logical, there are many other examples of architectural models from ancient times, regardless of the motivations for their execution, such as the Neolithic ones of the Germanic or Slavic peoples, the Etruscans, etc. Also

noteworthy are the oriental ones, with unique models of houses or temples in China and Japan, in materials such as bronze and ceramics.

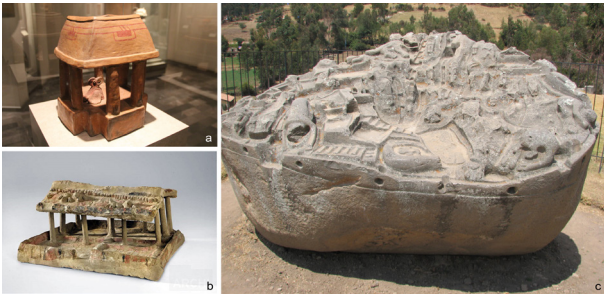
Worthy of a separate mention are the Pre-Hispanic Mesoamerican mockups (fig. 3a), analysed in detail in the work of Daniel Schávelzon, who cites one found in 1932 with the same function as that of Niha: it is a Zapotec temple in Tomb 7 of Monte Albán, which the archaeologist Alfonso Caso identified «as the scale representation of the building that existed on top of it» [Schávelzon 2004, p. 29]. Examining the Mesoamerican architectural representations and numerous scale mockups results in a surprise due to the parallels between them and the Egyptian and Mesopotamian ones. Similar and even more abundant are the pre-Columbian mockups from South America from the same period and, specifically, those of the Andean civilization, such as the Moche ones in modelled clay (fig. 3b).

This civilization reached its maximum splendour with the Inca culture, from which remarkable examples have been preserved. Perhaps the most famous, which has been represented in a commemorative coin, is the Sayhuite monolith in Curahuasi, Peru (fig. 3c), a large block of granite about two and a half metres tall that is believed to date back to the 15th century, the time of the so-called Inca Empire (15th and 16th centuries), at the height of this civilization. What makes it special is that it shows land with people, buildings, staircases and hydraulic works such as channels and ponds, which could be, among other theories, a kind of stone plan or sketch made by Inca architects or engineers to oversee the works they carried out [Garayar 2003, p. 176].

Meanwhile, in Europe the Italian engineer born in Cremona, Giovanni Torriani, known in Spain as Juanelo Turriano, carried out one of the most important engineering works of that time. It is an extraordinary hydraulic machine, reminiscent of those previously designed by Leonardo da Vinci, to raise the water from the Tagus River to the Castle and city of Toledo, overcoming a height difference of over 90 metres. No longer standing today, it can be seen in the View of Toledo by El Greco, ca. 1599-1600 (fig. 4).

It is documented that Turriano made at least two mockups of his artifice, and could have sent one to his country of origin. This model, which was built by Juan Luis Peces Ventas according to the investigation of Ladislao Reti, Ventas, is probably similar to those that have been lost.

Fig. 3. a) Clay model of a Zapotec temple (100 B.C.-100 A.D.), found in Mount Alban II, National Museum of Anthropology, Mexico City; b) clay model representing a complex with a main roofed platform and decorated panels (200 B.C.-600 D.C.). San José de Moro Archaeological Programme; c) the Sayhuite or Saywite monolith, in Curahuasi, Peru.



The renaissance of the arts and the pursuit of spatial depth

Although it tends to think that the humanist architect, often also a painter, used perspective as a main vehicle for the expression of his ideas, in reality it seems that his fundamental design instrument was the mockup, usually made of wood, which has led to few copies have reached our days.

In the Renaissance, the Athenian model continued and patrons demanded mockups, especially when inviting more than one architect to enter a competition such as that for the dome of the cathedral in Florence, which involved Brunelleschi and Ghiberti. The first of these gave us the best example of a mockup as a construction model, which was discovered relatively recently behind the apse of the cathedral. Almost three metres in diameter, even the bricks are to scale, showing the famous herringbone arrangement that the architect was wise enough to hide from his competitors. This well-known and important finding shows that Brunelleschi, in addition to knowing how to make mockups to win competitions (fig. 5a), made “models” to scale to be able to experiment with his new construction techniques, without any risk to the building work.

Fig. 4. On the left, reconstruction of Turriano's artifice, on permanent display in the Provincial Council of Toledo (photo by the author, 2017); on the right, View of Toledo, by El Greco. Metropolitan Museum of Art, New York.

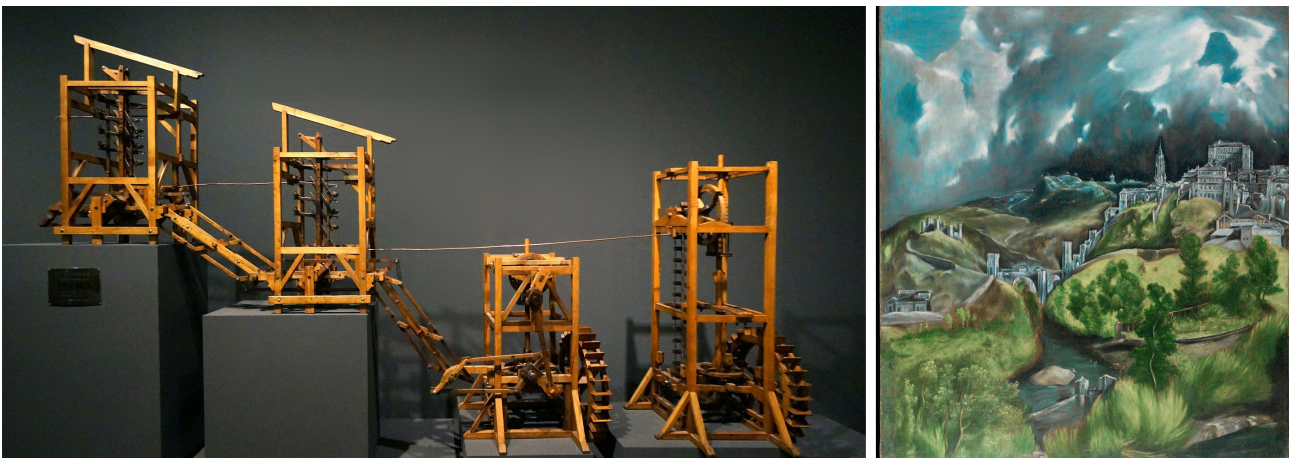


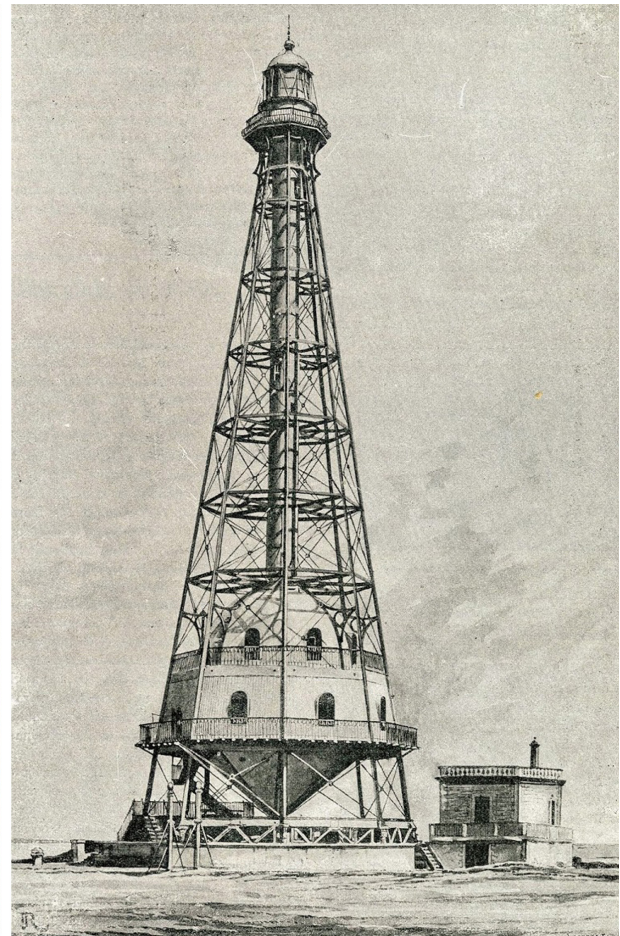
Fig. 5. a) Brunelleschi's wooden model of the dome and sections of the apse of Florence Cathedral; b) above right, the "Great model" of St. Paul's Cathedral in London, 1672-1673; c) wooden model of the Filippo Juvara design for the reconstruction of the castle of Rivoli by Carlo Maria Ugliengo in 1718. Palazzo Madama, Turin (photo by the author, 2015).



In the following centuries architects perfected their graphical representation systems and techniques, including mockups, which continued to be their main resource, such as the one that Sir Christopher Wren produced in 1669 for St Paul's Cathedral, London (fig. 5b). As John Wilton-Ely states, «Wren brought to architectural design a scientific cast of mind that found its expression in such experimental and explanatory aids as models» [Wilton-Ely 1977, p. 186].

Wren thus continued with the tradition begun by Alberti, for whom architectural mockups were not a means to present an idea to a client, but an instrument for the study and development of a design, which could only be completed by using them [Millon 1996, pp. 24, 22]. We find one possible example of their use for explanatory purposes at the Palazzo Madama in Turin, in which one room is practically dedicated to the large mockup that

Fig. 6. On the left, model of the Buda lighthouse. Leonardo Torres Quevedo Museum of the Technical University of Madrid (photo by the author); on the right, engraving based on a photograph published in the magazine *El Mundo Naval Ilustrado*, No. 51, June 15, 1901, p. 256.



Filippo Juvara made for the reconstruction of the castle of Rivoli in the 18th century, to a scale of approximately 1:50. According to that institution, which houses the collection of the Civic Museum of Art, the order of assembly of the pieces respects, as far as possible, the logic of the steps for the construction of the castle, which could suggest that it was used as a guide during the building work (fig. 5c).

During the 19th century, and as Millon points out, the use of mockups was scorned by the programme of the École des Beaux-Arts, which led to this ancestral tradition declining in popularity [Millon 1996, p. 72]. However, this period saw the start of iron or metal architecture as a direct consequence of the Industrial Revolution and this was also used in the scale representations, with such important projects as the Crystal Palace of Joseph Paxton for the Universal Exhibition of London in 1851 or the Eiffel Tower for the one of Paris of 1889. One example of some importance in Spain was the Buda Lighthouse in the Ebro delta, designed by the engineer Lucio del Valle, whose model made by a precision instrument workshop in Barcelona, was presented at the Universal Exhibition of Paris in 1867 (fig. 6). Given that the lighthouse was destroyed in a storm in 1961, its 150-year-old mockup is even more important.

From modernity to the information age

“Functional architecture” prioritised axonometric representation, and therefore mockups, whose vision is very close to that, over linear perspective. Therefore, the modern movement did not change technicians’ methods of bringing their projects life. However, it might have simplified their elaboration in both two and three dimensions, in line with the new architecture, which continued to use the mockup as a fundamental tool to communicate ideas and resolve structural or construction problems.

Antonio Gaudí stands out among the pioneers of the first waves. He took a step forward in the use of mockups for this purpose with the inverted models of his works, in which he used strings and small weights to achieve the anti-funicular of the loads so that the structure essentially worked under compression (figs. 7a, 7b).

In Spain, the mockups produced by Antonio Palacios[4] also stand out. Together with his partner Joaquín Otamendi, he won the 1904 international competition for the new post office in Madrid, known as the “Palace of Communications”.

The building is clearly influenced by both late Gothic Spanish architecture and by the sublimation of this style developed by Viollet-le-Duc and, conceptually speaking, by the Vienna Secession. Its most original feature is perhaps its metal structure, which in some parts of the building is exposed in the style of Viollet-le-Duc (fig. 7c).

The enormous plaster and wood model produced for the competition shows the ambition and complexity of the project, as well as the importance of this form of representation, which has been a constant in the history of architecture and other disciplines such as engineering.

Fig. 7. a) Reconstruction of Gaudí’s structural model for the church (not built) of the crypt in Park Güell (Barcelona), displayed in the Gaudí Centre in Reus (Tarragona). In the lower mirror, you can see the final form the building would have had (photo by the author, 2010); b) sketch of the exterior of the Church of Colònia Güell, by Gaudí (1898-1908); c) plaster model of the “Palace of Communications” in Madrid, work of Antonio Palacios. *Mundo gráfico*, Year II, No. 35, 26 June 1912.



In this latter field, mockups have been particularly useful, both to inform and to demonstrate the operation of certain engineering works, especially those that are as ahead of their time such as the Niagara Aero Car, which is still in operation and has just celebrated its “first centenary” (fig. 8). At 549 metres long and 76 metres tall, it was inaugurated in 1916 and is the only one of its kind still in operation. Its creator, «Leonardo Torres Quevedo (1852-1936) was an ingenious Spanish engineer. Among his creations were algebraic machines, remote control devices, dirigibles and the world’s first computer», as the plaque at the entrance says.

Beyond their function, as either tools of representation or constructive or experimental models, some mockups have transcended their own field, becoming part of the history of architecture in their own right. Adolf Loos’s unbuilt design for the house of the famous dancer and singer Josephine Baker would hardly be remembered if it were not for his 1927 mockup currently in the Albertina Museum in Vienna (fig. 9b). The vibrant alternating of the parallel bands of the façades of its upper floors remind one of the ancestral images from thousands of years ago of the façades of Minoan houses, but above all bring to mind the more recent ones from medieval Tuscany. According to Benedetto Gravagnuolo, the “Mediterraneanness” of the image, confirmed by its flat roofs, architectural introversion, recovery of two colours and plastic reduction are evident [Gravagnuolo 1982, p. 191]. Except for the two colours, we could also apply these observations to designs such as the villa for Venice Lido, from 1924, which reminds us so much, with rationalist language, of the ancient “soul houses” (figs. 1, 9a).

In contrast to the still present modernity of Loos’ works, we have the design by the English architect Sir Edwin

Lutyens, presented in 1933 as a proposal for Liverpool’s Catholic Cathedral, which did not end up being built (fig. 9c). It is one of the most elaborate wooden mockups seen in Great Britain, surpassed only by Wren’s “Great model”. At the same time as Antonio Palacios and Sir Edwin Lutyens were still designing in the beaux-arts style, in 1932 the architect Philip Johnson and the historian Henry-Russell Hitchcock organised the first International Exhibition of Modern Architecture at the Museum of Modern Art in New York, MoMA. In this, the models replace the real and impossible experience of the architecture, complementing the photographs and drawings. The exhibition was organised as a touring exhibition visiting the main cities in the United States to give maximum possible publicity to the “good news” of the recently baptised “international style”, which Johnson described as follows: «The ‘International Style’ is probably the first fundamentally original and widely distributed style since the Gothic» [5].

This exhibition represented a turning point in the use of mockups, greatly influenced by the fact that architects such as Antoni Gaudí, Mies van der Rohe, Le Corbusier and Frank Lloyd Wright had used these models in very varied ways, thus contributing to the revival of this ancestral tradition [Millon 1996, p. 72].

However, the use of scale models, before the development of computer systems to calculate structures through graphic design interfaces such as Rhinoceros, has its greatest exponent in the model that Frei Otto (1925-2015), a student of Gaudí, produced for the calculation of works such as the Olympic Stadium in Munich in 1972 (fig. 10a).

In the great exhibition about his work held in Karlsruhe, which closed in March of this year, given the expressive

Fig. 8. Scale reproduction of the aero car made of brass and steel in 1915. Leonardo Torres Quevedo Museum of the Technical University of Madrid (photo by the author).

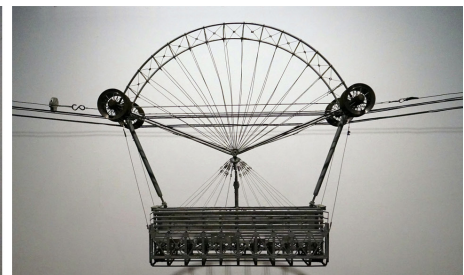
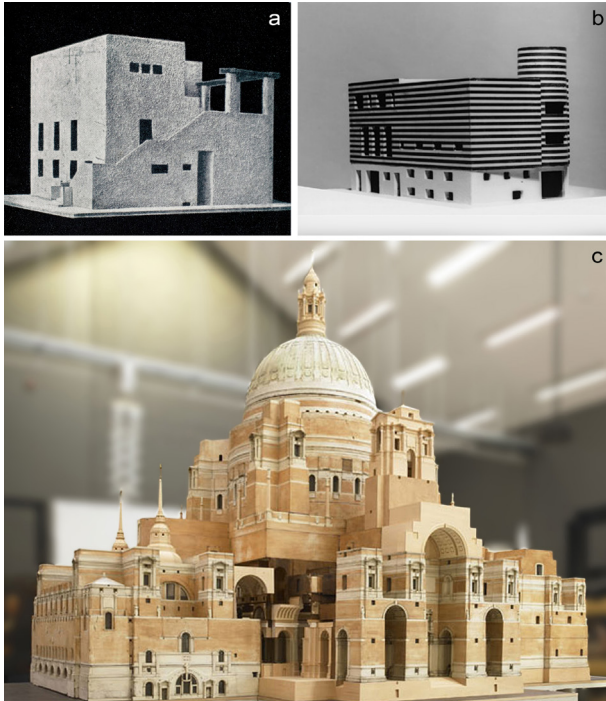


Figure 9. a) Venice, Lido, Villa by Adolf Loos, 1924 [Sartoris 1932, p. 60]; b) Josephine Baker's house, Paris, 1927; c) model of the Lutyns design, 1933.



title *Frei Otto Thinking by Modelling*, it can be seen that in his work, mockups and models represent a renewed attention to the world of craftsmanship. In the line dictated by the principles of the Bauhaus: «This consideration of physical and craftsmanship aspects has also placed a renewed focus on the history of models and its experimental function in architecture, art and science. The question concerning materialization of information is of great significance in this context» [6].

When applied to mockups, the term “experimental” acquired a new dimension with the exhibition held by the Royal Academy of London in 1986, called *New Architecture: Foster, Rogers, Stirling*, dedicated to these three architects, which in addition to bringing together their most recent works, offered them the possibility to show new ideas or unconstructed “provocations” [7]. The best known is that of Rogers, who presented a large mockup entitled *London as it could be*, which aimed to reinvent central London, reintegrate the city with the Thames and give priority to pedestrians instead of cars (fig. 10b). It is clearly a utopian design that emphasises the possibilities of the model to influence the future of architecture.

Mockups became increasingly important throughout the twentieth century, to the extent that they were even considered historical-artistic monuments in themselves. An example of this can be found in one of the pieces in the *Frank Lloyd Wright at 150: Unpacking the Archive* exhibition, held between 12 June and 1 October 2017 at MoMA. This is the mockup of St. Marks Tower, an unbuilt design developed between 1927 and 1931, which was presented

Fig. 10. a) Frei Otto working on a model of the pavilions of the Olympic Park in Munich; b) Richard Rogers at the *New Architecture* exhibition at the Royal Academy in London, 1986 (photo by Tim Mercer).

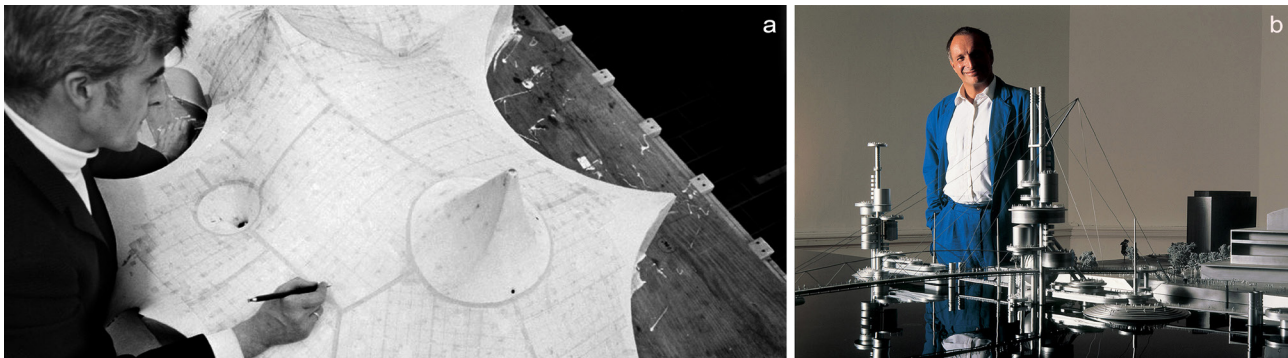
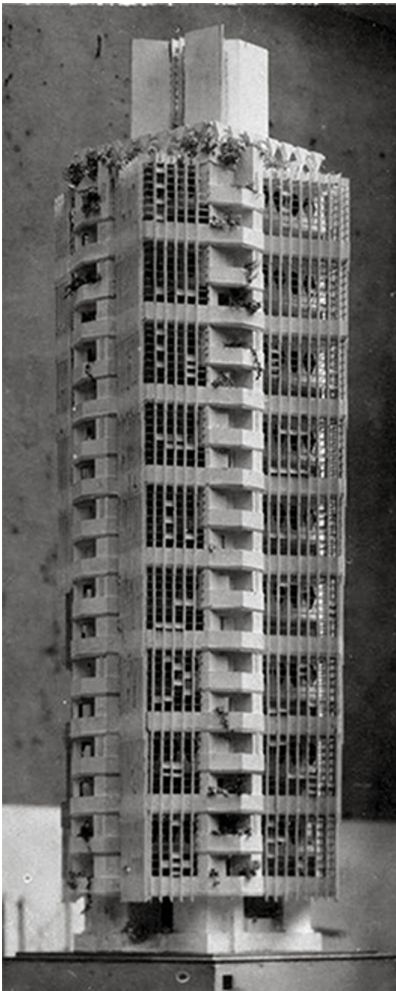


Fig. 11. On the left, historical image of the model of St. Mark Tower, Art Institute of Chicago, 1930; in the middle, model state before restoration, 2013; on the right, during the process.



not only as a representation of an architectural design, but as a work of art in itself (fig. 11). On the Museum's website about the exhibition one can find information about its conservation and watch a video about the restoration process, which give an idea of the time and resources involved in this. This demonstrates the importance of these models beyond their historical value, especially in the case of a design that was never implemented, in which the mockup to some degree replaces the unbuilt work.

The new millennium: the example of Herzog & de Meuron

The end of the 20th century saw the accelerated development of computer drawing programs. Since then, when the promoter faces 3D images from what could be called "digital" or "electronic" mockups, which due to their realism seem to reflect the work already finished, his ability to imagine it suffers. It is at that moment when they become photographs in the sense that Susan Sontag gave them in her famous essay *In Plato's Cave* of 1973, when graphic computing had not yet been developed: «A photograph is both a pseudo-presence and a token of absence» [Sontag 1981, p. 12]. If we consider, for example, Takehiko Nagakura's black and white infographic of the inside of the Palace of Soviets, designed by Le Corbusier for Moscow in 1931 (fig. 12), only our intellectual knowledge that this building was never built forces us to abandon the idea that this is a photograph taken from a magazine at that time.

The most emblematic example of this technological development is the Hamburg Elbphilharmonie (fig. 13), by the Swiss architects Jacques Herzog and Pierre de Meuron. The evolution of the project from the first drawings in 2001 to the completion of the work in early 2017 ran almost hand-in-hand with the century and with the great advances in graphic representation systems and techniques, many of which –if not all–, were used before, during and after its conclusion.

This new icon of the city –already popularly known by the nickname *Elphie*– has had to overcome a raging sea of negative criticism because of the huge delays in its construction and the disparity between the initial budget of €77 million and the final cost of €789 million, criticism that was somewhat akin to the gigantic wave it evokes.

To overcome these difficulties, those involved in the project had to convince not only their institutional client but also those supporting it, that is, the public. For this, they

used the classic weapons of the architect, the drawing and mockup, but took them a step further with the help of technology.

Among the mockups used we can emphasise the scale model of the auditorium or "Great Hall" of the Elbphilharmonie, reproduced in wood, weighing 4.5 tons and built at a cost of €200,000. This mockup was used by the world-renowned expert Yasuhisa Toyota to design the acoustics and to calculate the shape and surface of each of the more than 10,000 tiles that line the room, all different so that they reflect the sound in a certain way.

This characteristic "white skin" [8] –as it has been called–, together with the soft shapes of the room, mean that the space «looks a bit like a limestone cave», as described by Toyota when he visited in 2014 [Mischke, Zapf 2017, p. 180]. Interestingly, this description coincides more with the vision of Jacques Herzog, who expressed his desire that «the 'white skin' would in the future no longer be known by this name», since it reminded him «far more of something mineral, of a cave, of a sense of 'nurturing containment'» [Mischke, Zapf 2017, p. 177].

In addition to physical mockups, the architects used other virtual ones with hugely realistic 3D representations, virtual reality visits or a spectacular tour with drones inside and outside the building starting with a flight over the endless escalators that remind us, of course, of those in London's Tate Modern, by the same authors[9].

The resources spent on the promotion of the project were supplemented, during the building phase, by the creation of the Elbphilharmonie Pavilion, an elementary and elegant cubic construction where, as a type of "interpretation centre", the final outcome of the work in progress was explained to visitors (fig. 14a).

Inside the cube was hidden the mockup of the "Great Hall", which people could access by climbing a ladder and putting their heads through a small circular hole located in the centre of this reproduction on a 1:10 scale. This position gave a 360° view, like a virtual-real panorama: «Looking at the model, one can get a good spatial impression of the concert hall» [10] (figs. 14b, 14c).

Despite the amount of resources involved, the modern BIM technique was the most overlooked element in the first phase of this gigantic construction (fig. 15). According to the German Ministry of Transport, this was the cause of the immense gap between the €77 million originally budgeted and the €789 million that it ended up costing (people are already talking about 860), declaring in 2014

that the modern construction must first be virtual and then real: «*Erst virtuell und dann real bauen*» [11]. BIM techniques were subsequently implemented and thousands of conflicts were found such as inadequate connections of facilities and structural problems that fortunately could be resolved, but at a high price. However, it was undoubtedly the appeal of the drawings and models used by the architects what allowed them to finally overcome so many difficulties and finish what surely will end up being the symbol of modern Hamburg.

The future

Perhaps the main lesson that can be drawn from the history of representation is that however advanced and innovative the method used to bring a project to life, and however seductive or appealing its result, this may not be sufficient. Technology must be used to support construction in the most classic meaning of the word: “doing something using the right elements”, and not just to put on a good show. J. C. Golvin and R. Vergnieux affirmed, in relation to the

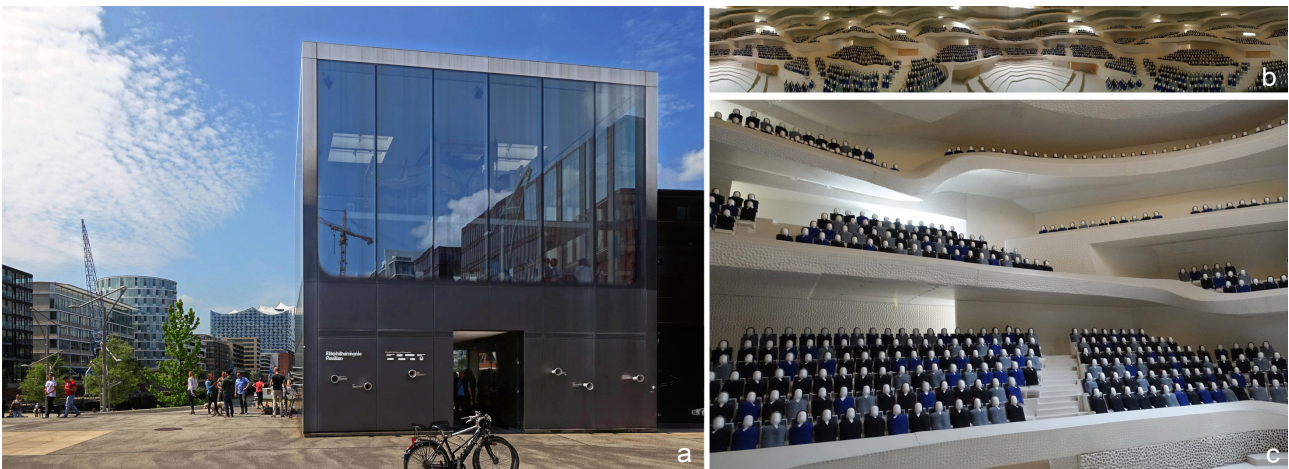
Fig. 12. Virtual reconstruction of the interior of the Palace of the Soviets, designed by Le Corbusier for Moscow in 1931 (infographic by Takehiko Nagakura, 1997-1998).



Fig. 13. On the left, canonical image of the Elbphilharmonie design by Herzog & de Meuron, exhibited in the Elbphilharmonie Pavilion (photo by the author, 2009); on the right, image of the Elbphilharmonie (Photo by María Martul, 2017).



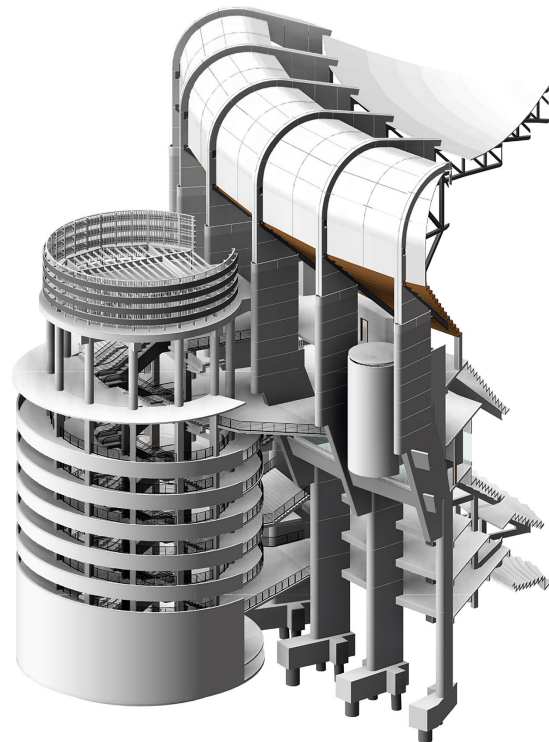
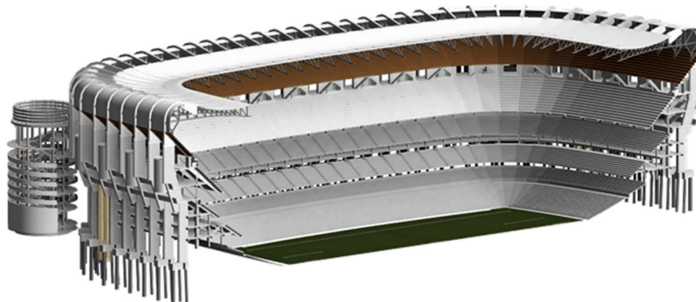
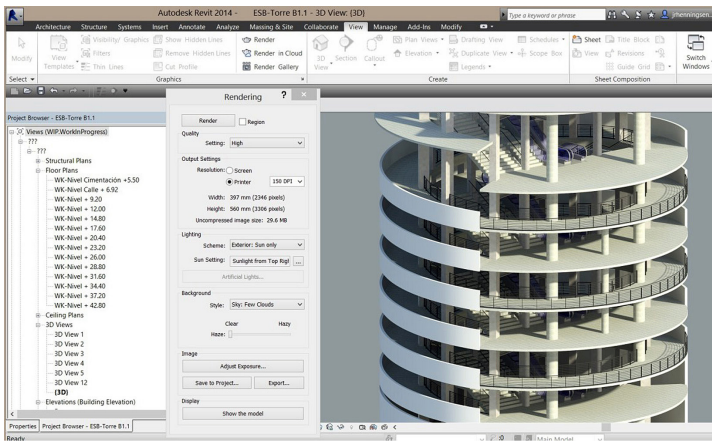
Fig. 14. a) Elbphilharmonie Pavilion with its exterior speakers playing music from the Philharmonic; b) cylindrical 360° virtual reality image of the scale model of the auditorium; c) partial detail with dummies dressed in felt for the sound study (photo by the author, 2016).



constructions of the past, that «the restored image constitutes an important and indispensable stage between the scientific analysis of the documentation and the production of the research instrument which is the electronic mockup of the ancient buildings» [12]. However, what the Elbphilharmonie example demonstrates is that this statement is as applicable to constructions that no longer exist as it is to those yet to be created, that is, to the future.

Digital models allow us to reconstruct buildings that no longer exist, but also to determine how the ones in our imagination should look, which does not imply that other forms of representation such as traditional mockups are no longer valid. The above is clearly demonstrated by the scale model of the “Great Hall” and the work of current architects such as Frank Gehry, in which the alternation of “analogue” and “digital” mockups constitutes a feedback

Fig. 15. BIM model of the “Santiago Bernabéu” stadium with structure, architecture and facilities, based on drawings made in CAD and 3D scans (photomontage made with images from the DEMO Group).



process that gradually leads to the proper definition of the architectural design.

In any case, and as Henry Millon points out [Millon 1996, p. 72], «A history of architectural models as an integral part of the design process has yet to be written».

«What happened in the past is no longer; the future is not yet lived; what is present is not here, because movement is its essence.

What is unknown is only the certain, this world, republic of wind, which has an accident for a Monarch.»

Gabriel Bocángel, *Sonetos* [13]

Notes

[1] This work is included in the Consolidation and Structuring Programme READS 2016 (ED341D R2016/023) of the Government of Galicia; and the project HAR2016-76097-P (AEI/FEDER, UE), affiliated to the National Programme for Fostering Excellence in Scientific and Technical Research, State Subprogramme for Knowledge Generation. This article develops the introductory presentation of the author in the XXXIX Convegno Internazionale dei docenti della Rappresentazione *Territori e frontiere della Rappresentazione*, Naples, 14-16 September 2017.

[2] The edition *princesps of Momus* can be consulted and downloaded at: <https://ia800700.us.archive.org/1/items/ita-bnc-mag-00000703-001/ita-bnc-mag-00000703-001_text.pdf> (accessed 2018, November 17).

[3] Adam, J.P. *Dibujos y maquetas: la concepción arquitectónica antigua*. In Azara 1997, p. 31.

[4] Between 1930 and 1932 Antonio Palacios created a major town plan for the Spanish city of Vigo, which had it been carried out would have led to the disappearance of its historic centre. In any case, the large scale model he presented was crucial to gaining its initial approval, although it was then halted by the outbreak of the Spanish Civil War in 1936.

[5] Even if it was generally attributed to Philip Johnson, this sentence seems to come from Alfred H. Barr, director of MoMA at the time of the vernissage of the exhibition *Modern Architecture* in 1932, February 10. See press release about the exhibition in <https://www.moma.org/documents/moma_press-release_324965.pdf> (accessed 2018, February 4).

[6] *Architecture as a presumed future. Symposium Frei Otto. Thinking by Modelling*. Thu, 26.01.2017-Fri, 27.01.2017, ZKM_Media Theater: <<http://zkm.de/en/event/2017/01/architecture-as-a-presumed-future>> (accessed 2018, November 17).

[7] In the words of Owen Hopkins, manager of the Royal Academy's architecture programme, who also tells a curious anecdote about the inaugura-

tion, according to which Jim Stirling smuggled a live fish into Rogers' model (in the comments on his article people confirm that the fish was absorbed by the whirlpool created by the circulating pumps of the mockup and instantly cut into a thousand pieces). Hopkins, O. (2014). How do you make an architecture exhibition? In *Royal Academy of Arts* 11/01/04: <<https://www.royalacademy.org.uk/article/how-do-you-make-an-architecture>> (accessed 2018, November 17).

[8] This unique inner lining was developed through complex 3D calculations and using the microshaping technique, which according to the definition of the company producing it is the calculation of the individual surface structure of each piece of the "white skin". No panel is identical and the honeycomb structure is not repeated. The 3D CAD data became machinable CNC programs in the production planning process of Hasenkopf: <<http://www.hasenkopf.de/en/projects/elbphilharmonie-hamburg>> (accessed 2018, November 17).

[9] <<https://www.elbphilharmonie.de/en/worldwide/slow-and-motion>> (accessed 2018, November 17).

[10] Kämpermann, M., Hotes, K. (eds.) (2014). *Elbphilharmonie Hamburg*. Hamburg: HamburgMusik gGmbH and Elbphilharmonie und Laeiszhalle Betriebsgesellschaft, p. 15.

[11] Kammholz, K. (2014). So will Dobrindt Debakel wie die Elbphilharmonie verhindern. In *Hamburger Abendblatt* 15/05/14: <<https://www.abendblatt.de/politik/deutschland/article128026556/So-will-Dobrindt-Debakel-wie-die-Elbphilharmonie-verhindern.html>> (accessed 2018, November 17).

[12] Golvin, J.-C., Vergnieux, R. Primer análisis para la elaboración de una maqueta electrónica del santuario del gran templo de Atón en Amarna. En Azara 1997, p. 40.

[13] Gabriel Bocángel (1603-1658), was a Spanish poet and writer of Genoese ancestry and chronicler of the court of Philip IV of Spain.

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References List

Aliquot, J. (2009). *La Vie religieuse au Liban sous l'Empire romain*. Beyrouth: Presses de l'Ifpo. [Online edition 2012, December 12].

Azara, P. (1997). *Las casas del alma. Maquetas arquitectónicas de la antigüedad (5500 a.C./300 d.C)*. Barcelona: Centre de Cultura Contemporània/ Institut d'Edicions, Diputació de Barcelona.

Garayar, C. et al. (2003). *Atlas departamental del Perú: imagen geográfica, estadística, histórica y cultural*, vol. 1. Lima: La República/Peisa.

Gentil Baldrich, J.M. (1998). *Traza y Modelo en el Renacimiento*. Sevilla: Instituto Universitario de Ciencias de la Construcción-Universidad de Sevilla, pp. 190.

Gravagnuolo, B. (1982). *Adolf Loos, theory and works*. New York: Rizzoli. Translated by C.H. Evans. [Ed. orig. *Adolf Loos: teoria e opere*. Milano: Idea books Edizioni, 1981].

Kostof, S. (1977). *The Architect in the Middle Ages, East and West*. In Kostof, S. (ed.). *The Architect. Chapters in the History of the Profession*. New York: Oxford University Press, pp. 59-95.

Millon, H.A. (1996). *Models in Renaissance Architecture*. In Millon,

H.A. (ed.). *Italian Renaissance Architecture: from Brunelleschi to Michelangelo*. London: Thames and Hudson, pp. 19-74. [Ed. orig. Millon, H.A., Magnago Lampugnani, V. (eds.). (1994). *Rinascimento. Da Brunelleschi a Michelangelo: La rappresentazione dell'architettura*. Milano: Bompiani].

Sartoris, A. (1932). *Gli elementi dell'architettura funzionale. Sintesi panoramica dell'architettura moderna*. Milano: Ulrico Hoepli.

Schávelzon, D. (2004). *Treinta siglos de imágenes: maquetas y representaciones de arquitectura en México y América Central Prehispánica*. Buenos Aires: Ediciones Fundación CEPPA.

Sontag, S. (2005). *On photography*. New York: RosettaBooks. Edición electrónica: <<http://writing.upenn.edu/library/Sontag-Susan-Photography.pdf>> (accessed 2018, February 4).

Taylor, R. (2003). *Roman Builders: A Study in Architectural Process*. Cambridge: Cambridge University Press.

Wilton-Ely, J. (1977). *The Rise of the Professional Architect in England*. In Kostof, S. (ed.). *The Architect. Chapters in the History of the Profession*. New York: Oxford University Press, pp. 180-208.