See, Touch, Feel: a Cognitive and Educational Journey through Maquettes

Marco Gaiani

Introduction

The Rijksmuseum in Amsterdam has three dolls' houses in its collections.
The most famous was realized between 1686 and 1710 by Petronella Oortman, a well-known wealthy heiress of a Dutch silk merchant (fig. 1). The model was made to 1:9 scale and measured 255 × 190 × 78 cm. For its creation, the lady spared no expense, calling on an inordinate number of artisans, painters, carvers, glassblowers, and cabinetmakers who furnished the house with some 700 custom-made pieces, all functional and made from the same materials that would have been used in the construction of their life-size counterparts. The amount spent would have been enough to buy a large house on a canal. She designed the interiors like real rooms of her own home with miniature masterpieces including oil paintings, Delft pottery, canopies made of the finest Chinese silk, carpets, tapestries, and inlaid furniture. A scenic representation showing how a mansion was laid out, the arrangement of the spaces and furnishings, how rooms were inhabited, the lifestyle: in short, a complete picture of life in a fashionable 17th-century home. Such exquisite and detailed work soon became known and admired not only locally, but also abroad, attracting many visitors, as though it were a work of art. In the 17th century, dolls' houses were not toys, but a hobby, the equivalent for women of the curio cabinets kept by men. Owning a dolls' house was, among the women of Amsterdam, a way to exhibit high social status, and it was important to

This article was written upon invitation to frame the topic, not submitted to anonymous review, published under the editorial director's responsibility.

Fig. 1. Petronella Oortman's dolls' house, Rijkmuseum, Amsterdam, 1686-1710 (photograph from the Rijksstudio collection).

have the most beautiful house to show off to high-ranking guests. Seen through today's eyes, one wonders what prompted Petronella to invest so much money and effort in a miniature model instead of a real house, where she could have received and entertained her guests, and why a small object, inscribable in a volume of just over one and a half cubic meters, was so extraordinarily successful. I think the answer to these questions can be twofold.
A rigorous answer could be sought in the perceptual studies of the past 20 years. However, for our purposes, it is sufficient to note how a scaled physical model allows easy comparison with the real object, exploiting the mnemonic component more than the perceptual one, and at the same time, the model allows us to observe the object as a whole and in its details as a three-dimensional entity. Even this path, it should be pointed out, is not without criticism, as to date there are no proven experimental studies in the field of architecture. More simply, we can answer the question by trying to exploit two concepts that are quite common to architecture: those of analogy and of copy, which are the properties of Petronella's maquette, and of all architectural maquette.
Basically, the creative design process of architecture proceeds inductively and by analogy, rather than deductively as occurs, according to classical logic, in scientific reasoning. One of the best explanations of this aspect of the architect's method is still provided by Leon Battista Alberti. The city, Alberti wrote in the mid-15th century, is like a large house, and the house is like a small city [Alberti 1966, pp. 64, 65]. This phrase did not indicate that the house was the most important building type in the city: rather, it stated that the structure of human settlement, its topology, is so consistent that its two opposites, the city and the house, that is, the maximally public and grandiose and the private and more modest, embody identical, or at least analogous relationships.
One of the clearest examples of this way of proceeding is the La Conica coffee maker designed by Aldo Rossi between 1980 and 1983, which translates a prestigious silver object into a steel product, easy to market, and with new characteristics of sturdiness and manageability. The cone is the symbol par excellence of the dialectical relationship between architecture (or rather, urbanism) and the 'domestic landscape' that this miniature monument fits into.
If we leave aside the result and return for a moment to the process, we find that the relationship between analogy and design is even deeper and closer because the representation itself, that is, the medium with which we produce the design, works by analogy. Indeed, it is, for the designer, not so much an *a posteriori* illustrative means as an active mediating tool that provides the possibility of objectifying ideas in a space structurally similar to real space, through a series of conventions that refer to complex associative systems and identity- and opposition-based criteria that organically order them.
When, with the digital revolution of the 1990s, object design shifted from construction by representation to the direct realization of a mathematics –at the same time representation and final object–, the elimination of the schema left analogy only as a generic design criterion, neglecting its inherent possibilities, such as the reuse of existing objects and the creation of descriptive forms that represent both the idea and the reality in a physical and not just virtual way. In doing so, it overlooked part of the means of architectural representation as they were already indicated by Nikolaus Pevsner's *A Dictionary of Architecture*: "Architectural representation is the depiction of buildings, their parts, and interior environments by pictorial and graphic means or three-dimensional models, for the purpose of theoretical reflection, of elaboration of the project by the architect" [Pevsner et al. 1981, p. 548].
Thus in the digital age, the analog architectural model has often been erroneously declared dead, taking advantage of the progressive development of computational digitization/visualization techniques and methods only for electronic versions very close to the original, except for the materiality. Ultimately, we have forgotten that possessing a miniature analog reproduction of an object and its attributes has always been a basic condition for our learning to perceive and then to re-cognize. However, this forgetfulness does not reflect the characteristics of digital representational techniques. The development of three-dimensional modeling programs, together with CNC (Computer Numerical Control) milling, 3D printers, and robots, has made possible the seamless translation of a virtual model into a physical product. Since in theory the same data can be used to generate a virtual model and to fabricate a physical maquette, the difference between virtual and analog has not only not increased, but has greatly diminished. Therefore, while architectural drawing has gradually been dematerialized and replaced by digital media, digital and physical models can and will continue to exist side by side.

Instead, with the advent of digital, the result of physically 'copying' an existing or merely conceived architecture has changed, therefore the discourse on the 'copy' is a nodal element for making self-aware the entire distance that separates the real from the represented and to also include these new maquette in the long series of attempts, from antiquity to the present day, to produce copies. The development of digitization/visualization techniques has permitted the creation of electronic versions very close to the originals, even in their materiality. A digital copy can express emotions and knowledge, reinterpreting the ideal of the classic serial copy and serving as an analysis and simulation tool for architectural models, with a more strategic role than models before the advent of numerical systems.
In this paper I will illustrate three of my experiences with analog models in the digital age that touch on three distinct and complementary themes: the characteristics of the model derived from digital processes, the use of maquette for educational purposes in an age when the output is practically always numerical, and finally, the use of the analog-digital processing model for both research and communicative purposes.

Analog models, digital models: the copies for the University Museum Network of the University of Bologna

To provide an answer to the great unresolved problem of three-dimensional digitization of museum objects at limited cost and of high quality, my working group at the University of Bologna [1] has been developing, for a few years now, a new approach based on an automated combination of acquisition, making use of smartphone cameras, and visualization in Real-Time Rendering of high perceptual quality, possible on various devices (PC screens, mobile devices such as tablets, large touch screens etc.) and open to different output techniques, up to Virtual and Augmented Reality systems [Apollonio et al. 2021].
The system developed was applied to, among others, four case studies belonging to the collections of the Museum of Palazzo Poggi of the Sistema Museale di Ateneo (SMA) of the University of Bologna. These objects represent some of the most common problems of three-dimensional acquisition and restitution and are also emblematic of the collections: a porcupine fish (*Diodon antennatus*) with a volume of 35 × 19 × 25 cm from the

Fig. 2. Rendering of digital models of museum objects belonging to the collections of the Sistema Museale di Ateneo (SMA) of the University of Bologna (render by F. Fantini).

collection of the naturalist Ulisse Aldrovandi, a globe of the astronomer Guido Horn d'Arturo (1879-1967) with a diameter of 31 cm, a bust of the scientist, soldier and geologist Luigi Ferdinando Marsili (1658-1730) with a volume of 41 × 67 × 99 cm, and a sandstone statue of Hercules with a volume of 100 × 90 × 275 cm.
Of these artifacts, starting from the digital 3D models, in addition to the on-screen visualizations (fig. 2), a series of maquette were also realized. These were obtained by 3D printing with treated gypsum powder (ZetaCorp 310) and FDM (Fused Deposition Modeling) with PLA (Polylactic Acid) with or without carbon fiber reinforcement (fig. 3).
The feature that was attributed to these printed copies is inferred by an observation by Salvatore Settis: the glossary associated with ancient copies refers with great frequency to terms such as '*aemulatio*', '*imitatio*', which indicate how it was not the accuracy of the copy that was crucial, but rather the ability of the copyist to approach a thought [Settis 2015]. Therefore, rather than making pure documentary replicas, new balances were sought between constants and variants destined to provide a new character to the copies, as was done in ancient times.
It is well known how in the testimonies of ancient Mediterranean culture one finds miniatures in every age and in most archaeological contexts. Over time, it has been discovered that most of them were copies of a few selected subjects. We know that casts began to be taken from

the statues that adorned shrines and squares in Greece and that these casts then served as models in copyists' workshops, while the original bronze statues were replicated in marble or plaster [Anguissola 2012]. This change of materials indicates that no matter how mechanical the method of reproduction was, the precision of the result was accompanied by some shift in emphasis and taste. Even more frequent and widespread were replicas in small format, a practice that later became commonplace among Renaissance artists, allowing them to carry copies to use as references and to elaborate hypotheses about the missing parts of classical originals. The process of miniaturization was not a simple reduction, but occurred at various semantic levels that ordered the small-scale representations of people, objects, and architecture, identifying the most appropriate categories of materials and levels of detail. Thus, for example, the level of detail of miniatures and the minimum size were decided to fulfill the desired function in terms of content and aesthetics.
In creating the new 3D-printed objects of the artifacts belonging to the museums of the University of Bologna, we followed this path, creating miniature reproductions intended to ingage in dialogue with their references, whether absent or present: "The copy pays homage to the original, and thereby acknowledges its superiority; but at the same time it claims to replace it, and therefore disputes its uniqueness", Settis again explains [Settis 2014]. Of the original, they no longer have the aura [Benjamin 2012, p. 25]: they want to recall it in form and, at the same time, detach themselves from it being as their appearance declares their belonging to the time in which they were created. The synthetic materials they are made of and the colors that characterize them belong to other contexts and processes of chemical synthesis, not biological or found in nature, far removed from the originals (fig. 4). 'Citation', symbol and metaphor of a culture, a taste, a social belonging, they aspire to inscribe themselves in the long path that goes from ancient art to the Renaissance up to the present day, to tell of not only the identity, the pose, and the fame, but also the ubiquity with their new appearance and with the different scale (from 1:2 to 1:20) (fig. 5). Therefore these copies, ephemeral objects born in the immaterial memory of the digital, almost seem, in this spaceless and timeless nature, a logical consequence of the themes that have always belonged to their essence, but also the image of these times in which all certainty has become precariousness. Furthermore, Alessandro

Fig. 3. Analog models of the bust of Luigi Ferdinando Marsili produced from digital models resulting from smartphone-based photogrammetric survey (photograph by G. Bacci).

Fig. 4. Analog models of the porcupine fish (Diodon antennatus) from the Ulisse Aldrovandi collection produced from digital models resulting from smartphone-based photogrammetric survey (photograph by G. Bacci).

Fig. 5. Analog models of the statue of Hercules belonging to the University of Bologna obtained from digital models resulting from smartphone-based photogrammetric survey (photograph by G. Bacci).

Mendini recounted, now almost twenty years ago, how a Murano vase designed by Carlo Scarpa, a symbol of beauty, and a transparent plastic bottle –in the shape of the Madonna– filled with holy water from Lourdes, were resting simultaneously on his bedside table: "The fragility of the Kitch figurine competes on a par with the vase, with *élite* design, posing difficult questions for me. Two contradictory transparencies" [2].

Didactic models

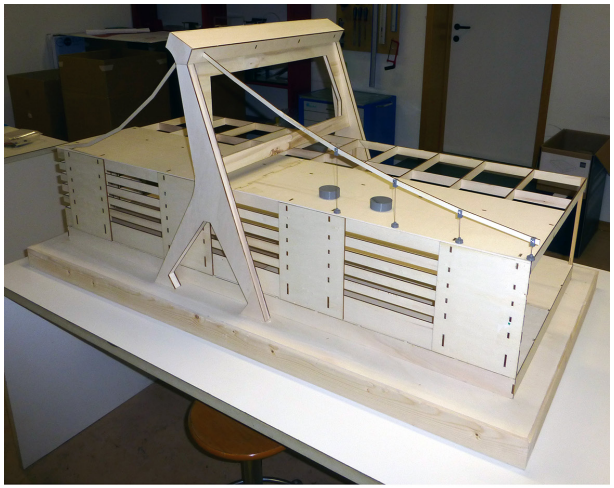
In the 16th century, models began to be used in philosophy and mathematics, and their ability to facilitate access by laymen or children to abstract or mathematical insights began to be recognized [Oechslin 2011]. This pedagogical and didactic value, rooted in the physical visibility of the models, continues to the present day and leads, beginning in the 19th century, to the construction of didactically designed toys for children. It is from the last decade of the 18th century, however, that architectural models gain further importance as tools capable of conveying in physical form the architecture of antiquity and of the Renaissance. This is why the large collections of plaster models and casts were formed, serving as illustrative material for work and educational purposes [Seelow 2017].
Instead, the use of maquette as a means of creative work relative to industrial product design dates back to the late 20th century, as Tomás Maldonado indicates in one of his famous essays [Maldonado 1987, p. 58]. Thus models are no longer used only as a tool of formal and constructive control and presentation but as a means of simulation. "The model is an artifice that is placed in a design process thanks to its (variable) simulation capabilities", explains Jacques Guillerme [Guillerme 1987, p. 29]. Such a process is, in fact, nothing other than "the manipulation of a model in its operation in space and time to allow the perception of interactions that are not immediately apparent" [von Bertalanffy 1975, pp. 149-169]. The 'manipulation' of models allows one to 'experiment with' their reaction to certain changes and to control aspects and behaviors that escape empirical observation. Moreover, models allow for rapid learning of both the experiment and the abstractions underlying traditional schematic design (productivity, scale, contour line drawing, etc.) so that, even within the design disciplines they also prove to be a formidable didactic system.
This ability proper to the maquette to also be an extraordinary didactic tool for the design disciplines was the starting point of my attempt to reorganize the drawing curriculum in the industrial design and architecture degree programs in which I started teaching twenty-five years ago, a reorganization that was necessary because of the progressive replacement of the system of representation by projection and section on a sheet of paper with the completely virtual one based on three-dimensional digital models, that is, the technique that is now progressively more and more used by architects to produce designs.
Riccardo Migliari recalled, as early as the beginning of this millennium, how "the construction of models, which we call 'computer models', is by no means automatic; it originates in the designer's thoughts and is controlled by his ability to shape the three-dimensional forms of architecture and to compose them together" [Migliari 2002, p. 7]. Although many intend to liquidate the problem of training in the knowledge and know-how related to digital three-dimensional models of architecture by reducing it to that of teaching the knowledge related to enabling digital technologies, Migliari's statement clearly indicates how this educational solution is wholly inadequate for a subject that requires formidable manual skills and spatial vision.
This means that there is a need for education based on these models that explains their characteristics, that does

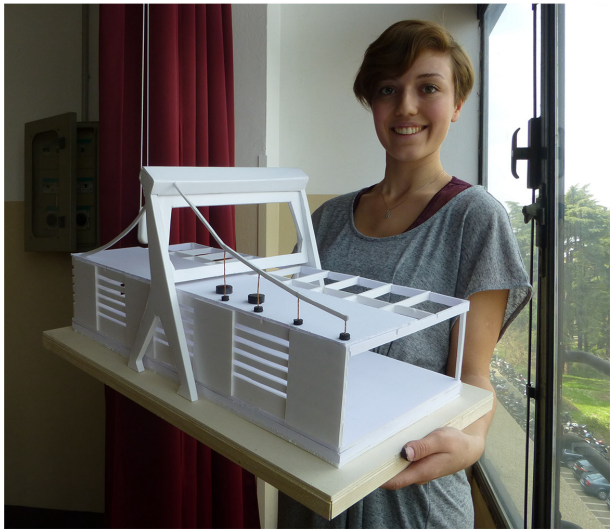
not take for granted means and degrees of virtualization of processes and results, and that considers representation as a form of knowledge within a broader cognitive process that also includes all that knowledge that in the pre-digital design and construction workflow was distributed among the different actors and the various workers.
Within this framework, outlining a program for teaching representation using models means addressing four fundamental issues:

- the virtual/material relationship, that is, the relationship between the physical model (maquette, photograph, but also simple handwriting) and the digital model (going back to the question of models in the broader sense);
- the human/technology relationship, that is, the use of the model as an active design tool;
- the metric/perceptual relationship, that is, the problem of the representative form used to design;
- the designer/interface relationship, that is, the question of tools for representing and their use as design tools.

This overall program clearly places the digital model at the center of the representational process, but at the center of the educational system is the model in all its forms: digital, full-scale analog, but especially small-scale because of its characteristics of easy manipulability, its ability to allow us to fully define an architectural object (which is difficult to construct, manipulate, observe, and communicate at 1:1 scale), and above all because of its characteristic of allowing a multimodal experience, involving combinations of sight and touch in a single perceptual experience. And because we respond more strongly to multimodal stimuli than to the sum of each individual modality (an effect called the 'superadditive' effect of multisensory integration), it is clear how learning using analog scale models is faster and its quality far better [Meredith 2002].
Operationally, this model-based study plan has as its general guide the principle of learning by doing and an interactionist-constructivist pedagogical approach that takes as its central dimension the student's active participation in learning and thus in the construction of meanings from experience [Reich 2010].
The purpose of this study plan is to increase students' ability to observe, think, and represent objects in three dimensions.
The activities (lectures, workshops, seminars) were aimed at stimulating the skills of critical observation of reality through the study of some objects on which operations of decomposition, recomposition, and reproduction are carried out with particular attention to the scales of representation, the materials, and the executive techniques, within a discourse of understanding the finalization of the model (for study, control of volumes, presentation to the client, production purposes…).
These activities require teachers to build a few reference models, 'objects' always at hand in the learning phase.
Thus various maquette were built over time. Initially, they were actual objects in 1:1 scale (for example, Gerrit Thomas Rietveld's two chairs, Red Blue (1918) and Crate (1938), re-constructed by Paolo Padova), later they became reduced-scale models of architecture reconstructed by Giovanni Bacci. These architectural maquette were not realized according to a canonical reduction scale, nor did they faithfully represent the original. Rather, they were models designed to summarize the elementary problems of the architect's technical drawing that drew from the original the basic formal characteristics and static strategies. Students were then required to construct their own small-scale models, the equivalent of Renaissance artists' pocket models, so that they were obliged to understand the forms, measure them correctly, and think of the best technique for 'reconstructing' them, experientially learning the basics of semantic modeling. The change of material (cardboard instead of the wood of the original models) placed the student before a real re-design of the object, so that between original and copy there remained only a relationship of similarity that allowed the operativeness and degree of reflections to be freed from the minimal ones of the identical replica. Later, this model of the model was the subject on which students first experimented with the graphic techniques of architects by reproposing it in orthogonal projection, axonometry, perspective etc. Similarly to the small statuettes of subjects from antiquity that Renaissance artists carried with them, it always accompanied the student-architect, designer or engineer-architect, as a reminder of what had been learned and a reference for experimenting with the new object to be verified collectively with the rest of their colleagues in the course.
Of these experiences, I would mention the extraordinary models (extraordinary not for their beauty but for their ability to be a synthesis of the problems related to the architect's education in representation) inspired by Pierluigi Nervi's Burgo Paper Mill in Mantua (whose 'large' model was in 1:70 scale and the one reproduced by the students,

Fig. 6. Teaching model inspired by Pier Luigi Nervi's Burgo Paper Mill and a model of the teaching model of a student at the University of Bologna (photographs by G. Bacci).



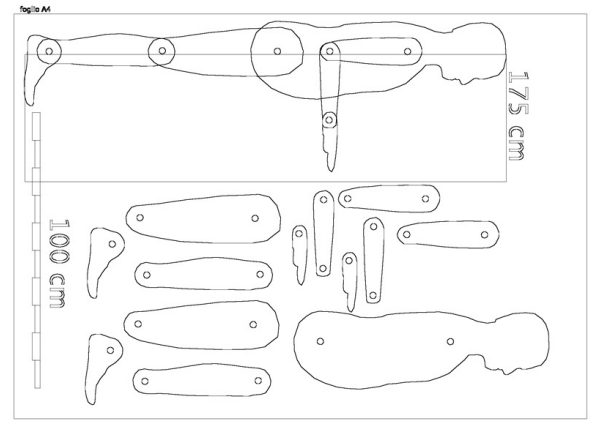


in 1:2.5 scale in relation to the wooden maquette) (fig. 6) and by Le Corbusier's Ville Savoy in Poissy (whose 'large' model was in approximately 1:20 scale, and the one reproduced by the students was in 1:4 scale in relation to the wooden maquette).
Alongside this exercise, the student was required to complete two other lab works: cardboard models of a chair and a table in a scale of 1:10 and a representation of their living spaces in a scale of 1:20.
The first model addressed the theme of proportions, ergonomics and small-scale analysis of the load-bearing features of architectural elements. Students were given a paper pattern with templates representing a middle-aged person 175 cm tall. The cut-out pieces were to be assembled into a mannequin, which was used to test the constructed models: it had to sit naturally on a chair and under a paper table, without causing deformation to them (fig. 7).
Instead, the representation of one's living spaces was an exercise that required the student to understand three-dimensionally the space in which he lived and become aware of the level of detail of a given scale of representation and of the dimensions, both absolute and in relation to the human body, of a space.
These are in each case study models, miniature objects like Petronella Oortman's dolls' house, able to form an awareness of what human architectural space is made of and what it is like (fig. 8).

The models for the *Palladio designer* exhibition

Andrea Palladio is universally known for his architecture, but few know that he was also the designer of the 'little things' inside his buildings, such as fireplaces, washbasins, sinks, wellcurbs, and even a cabinet for the coin collection of his friend Alvise Mocenigo, for whom he designed two villas, a palace, and the family chapel.
The exhibition *Palladio designer*, staged at the Palladio Museum in Vicenza from April 12 to May 5 2024 in conjunction with Milan Design Week and curated by Guido Beltramini and the writer of this paper, told the story of Palladio as a designer of micro-architectures by presenting scale models of 46 fireplaces, two washbasins and a sink, alongside drawings, videos and interactive applications based on digital models rendered in real-time (fig. 9).

Fig. 7. Body measurement paper pattern and cardboard model of a chair and table by a student at the University of Bologna (drawing and photographs by G. Bacci).



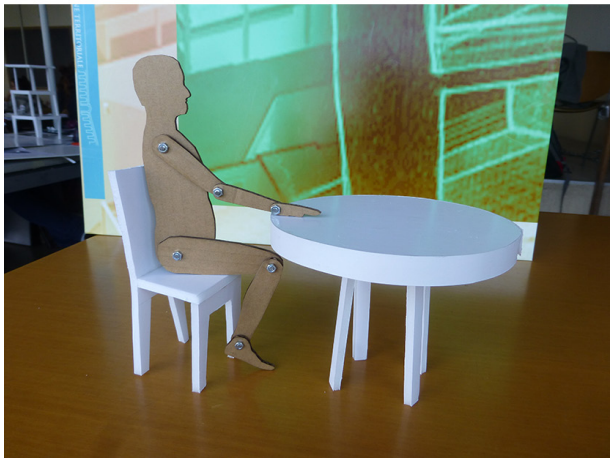


Fig. 8. Two models by University of Bologna students inherent to the representation of their living spaces (photographs by G. Bacci).

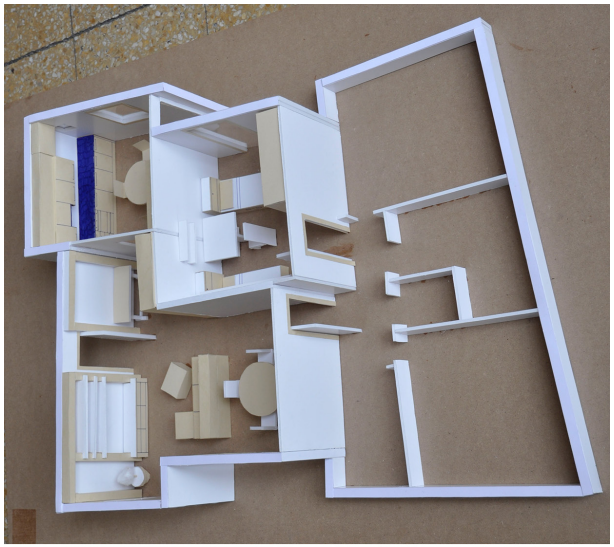


Fig. 9. Analog maquettes of 49 design objects by Andrea Palladio displayed in the Palladio designer exhibition (photograph by S. Garagnani).

Underlying the exhibit was the work of the students attending the *Fotogrammetria per l'architettura* (Photogrammetry for Architecture) course at the University of Bologna, who captured in 3D various artifacts scattered throughout thirteen buildings –from the Rotonda to the Doge's Palace in Venice– using a commonly used tool, a smartphone, and photogrammetric techniques [Kingsland 2020]. By using a workflow and software developed by the University of Bologna, it was possible to reconstruct the three-dimensionality of the objects with millimetric accuracy (fig. 10).
As regards our specific interests, the exhibition had two fundamental themes with the aim of creating knowledge in order to examine Palladio's micro-architectures: the construction of 3D models and 2D drawings from measured data and the making of analog models, copies of real objects.
Here we will focus on the latter topic, which is most directly related to the exhibition's overall theme of making architectural research engaging and understandable.
No models of Palladian buildings or designs have come down to us, nor did Palladio use them as design techniques for the construction of his many palaces and villas [Puppi 1987]. However, several Palladian models are documented: for example, a probable drawing of a model for San Giorgio Maggiore in Venice and a painted representation of another model for the Church of the Redeemer. These were basically meant to illustrate construction problems (an observation by Inigo Jones in his notes to the Palladian treatise, *The Four Books of Architecture*, published in Venice in 1570, also suggests that Palladio, on at least one occasion, carved sample details for masons to follow, thus providing a 1:1 three-dimensional model for capitals and the like) as well as communicative problems (the Vicentino City Council had a life-size wooden model of a bay of the future Basilica built as the basis for a final decision on the project) [3]. Because of their effectiveness in these uses, Palladio used them as a complementary system to drawing, his design tool par excellence.
This complementary use of models and drawings was a common practice in the 16th century and had received theoretical consecration from Leon Battista Alberti. In his *De re aedificatoria* Alberti advises novice architects to thoroughly study all significant buildings and even to have them close by at all times in the form of models [Alberti 1966, pp. 96, 97]. And, even while indicating the use of orthogonal representations as the only rigorous design procedure the architect should have used, he referred to the wooden model as the surest guarantee for developing a design to its fullest extent. For Alberti, only the model could provide the definitive information about the position and layout, the thickness of the walls and vaults, or the cost of the building [Frommel 1994].
In *Palladio designer*, instead of using models and drawings as alternative systems, it was decided to use them as complementary illustrative techniques. Therefore, next to 3D prints of the digital models resulting from photogrammetric survey, all at the same scale (1:20) so that they could be compared (fig. 11), drawings with dimensions in feet and *once vicentine* (Vicenza ounces) were displayed, in 1:20 scale for the general views, and 1:2.5 for the details, that is, the same kind of output that Palladio proposes in *The Four Books* (fig. 12). Unlike the volume in which the details are reproduced in Book I, while the plans of private houses and mansions are found in Book II, in this case it was decided to display the general views and the details of each object side by side, thus favoring the comprehension of each object in a capillary manner.
The exhibition then focused on fireplaces, objects mostly disregarded by historiography except for their decorative apparatus [Attardi 2002], but of great interest because they are perfectly realized micro-architectures. In fact, they consist of the basic elements of a construction: two

Fig. 10. Analog maquettes of the fireplaces of Villa Garzoni in Pontecasale (Padova) displayed in the Palladio designer exhibition (photograph by S. Garagnani).

Fig. 11. Analog maquettes of fireplaces by Andrea Palladio and Vincenzo Scamozzi at the Doge's Palace in Venice displayed in the Palladio designer exhibition (photograph by G. Streliotto).

pillars supporting a lintel. However, these three elements are often interpreted in different ways. Fireplace mantels can replicate systems of entablature on pillars or corbels, or form a continuous motif around the fireplace.
In the fireplaces, the moldings, different for each of them, represent the artist's 'imprint' and are the expedient for shaping chiaroscuro in material form. Their study, focusing mainly on their two- and three-dimensional comparison, allows for a deeper investigation of the theme and links it to the sources of Palladio's history and design drawings, which may contain references to as yet unidentified mantels. Alongside this investigation, the analysis of proportions, dimensions, and the relationship between decoration and mantel, especially by comparison of the various fireplaces in the series, provides fundamental elements for trying to provide answers to the many still unresolved questions. Which fireplaces had Palladio actually designed? Were there recurring types or was each fireplace a source of autonomous design? What archetypes did they have? What was the formal, dimensional, and proportional relationship between one fireplace and another?
For this reason, the small analog models, all realized with a stereolithography photosensitive resin printer (MSLA), were not conceived as finished artifacts, but rather as mock-ups in three dimensions capable not so much of providing an image but, thanks to an abstract and simplified appearance given by a simple coat of matte white paint, of being fundamental tools for making formal comparisons and serial analyses.

Conclusions

Architectural analog models are distinguished by their essential connection to the physical reality of the object, generally of a building, which they envision. They are physically 'visible' and 'manipulable' artifacts, thus they are objects that multiply sensory perception. They are therefore representative systems central to 'architectural discourse'. Beginning with Alberti, this central position is intentional, including the (desired) flexibility that accompanies it. 'Exemplary' (indicating the model as an exemplary and singular archetype) and 'module' (indicating the model as authoritative and fundamental) are the terms by which he defines them, recognizing their ability to enable close cooperation between speculative-abstract and empirical-material approaches [Oechslin 2011, p. 131].

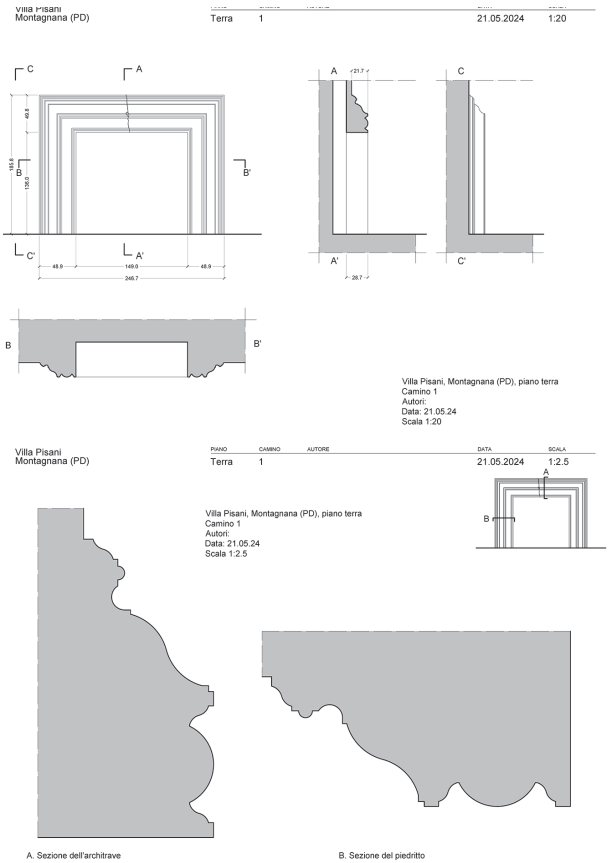


Fig. 12. General views and details of the mantel of a fireplace by Andrea Palladio at Villa Pisani in Montagnana (drawing by E. Angeletti).

This Albertian thought has guided theoretical observations and practical experiences described in this paper, simple episodes in a much more complex story, because in architecture the model has a special significance: it serves, like the drawing, as a simplified image from a representational or theoretical point of view that mediates between the abstract and reality, but with a far greater level of iconicity and with greater possibilities for manipulation than the graphic apparatus. Which is why the analog model will remain indispensable for a long time to come.

Notes

[1] Fabrizio Ivan Apollonio, Giovanni Bacci, Filippo Fantini, Simone Garagnani.

[2] Mendini, A., *Storielle di design (con morale). Lectio laurea ad honorem*, Politecnico di Milano, April 5, 2006. <http://www.ateliermendini.it/index.php?mact=News,cntnt01,print,0&cntnt01articleid=98&cntnt01showtemplate=false&cntnt01lang=en_US&cntnt01returnid=164> (accessed 10 June 2024).

[3] Burns, H. (2009). *Palladio's use (and non-use) of architectural models, in the context of architectural practice in the Veneto and his own approach to architecture*. Intervention at the colloquium *Models and Architecture*. Technischen Universität München, 6-8 November 2009.

Author

Marco Gaiani, Department of Architecture, Alma Mater Studiorum University of Bologna, marco.gaiani@unibo.it

Reference List

Alberti, L.B. (1966). *De re aedificatoria*, I, 9. P. Portoghesi (a cura di). Milano: Edizioni il Polifilo (orig. ed. 1452).

Anguissola, A. (2012). *Difficillima imitatio. Immagine e lessico delle copie tra Grecia e Roma*. Roma: L'Erma di Bretschneider.

Apollonio, F.I., Fantini, F., Garagnani, S., Gaiani, M. (2021). A Photogrammetry-Based Workflow for the Accurate 3D Construction and Visualization of Museums Assets. In *Remote Sensing*, vol. 13, n. 3, 486, pp. 1-39. https://doi.org/10.3390/rs13030486.

Attardi, L. (2002). *Il camino veneto del Cinquecento. Struttura architettonica e decorazione scultorea*. Vicenza: Angelo Colla Editore.

Benjamin, W. (2012). Che cos'è l'aura? In W. Benjamin. *Charles Baudelaire. Un poeta lirico nell'età del capitalismo avanzato*. G. Agamben, B. Chitussi, C.-C. Härle (a cura di). Vicenza: Neri Pozza.

Frommel, C.L. (1994). *Sulla nascita del disegno architettonico*. In H.A. Millon, V. Magnago Lampugnani (a cura di). *Rinascimento da Brunelleschi a Michelangelo*. Milano: Bompiani, pp. 101-121.

Guillerme, J. (1987). Il modello nella regola del discorso scientifico. In *Rassegna, (Maquette)*, No. 32, pp. 29-37.

Kingsland, K. (2020). Comparative analysis of digital photogrammetry software for cultural heritage. In *Digital Applications in Archaeology and Cultural Heritage (DAACH)*, Vol. 18. https://doi.org/10.1016/j.daach.2020.e00157.

Maldonado, T. (1987). Questioni di similarità. In *Rassegna, (Maquette)*, No. 32, pp. 57-61.

Meredith, M. (2002). On the neural basis for multisensory convergence: a brief overview. In *Cognitive Brain Research*, No. 14, pp. 31-40.

Migliari, R. (2002). *Modelli grafici e modelli informatici per l'architettura. Corso di Scienza della Rappresentazione*. Roma: Edizioni Kappa.

Oechslin, W. (2011). Architekturmodell. «Idea materiale». In W. Sonne (Ed.). *Die Medien der Architektur*. Monaco di Baviera: Deutscher Kunstverlag, pp. 135-141.

Pevsner, N., Fleming, J., Honour, H. (1981). *Dizionario di architettura*. Voce *Rappresentazione architettonica*. Torino: Einaudi.

Puppi, L. (1987). Modelli di Palladio, modelli palladiani. In *Rassegna, (Maquette)*, No. 32, pp. 20-28.

Reich, K. (2010). *Systemic-Constructivist Pedagogy*. Weinheim: Luchterhand, Beltz.

Seelow, A.M. (2017). Models as a Medium in Architecture. In *Preprints*, No. 2017120071, pp. 1-10. https://doi.org/10.20944/preprints201712.0071.v1

Settis, S. (2014). La lunga storia delle copie. *Il sole 24 ore*, 13 aprile 2014. <https://st.ilsole24ore.com/art/notizie/2014-04-13/la-lunga-storia-copie-081533.shtml?uuid=ABuNVcAB> (accessed 10 June 2024).

Settis, S. (2015). Sommamente originale - L'arte classica come seriale, iterativa, portatile. In S. Settis, A. Anguissola, D. Gasparotto (a cura di). *Serial / Portable Classic - The Greek Canon and its Mutations*. Milano: Fondazione Prada, pp. 276-278.

von Bertalanffy, L. (1975). *Perspectives on General Systems Theory. Scientific-Philosophical Studies*. New York: Braziller.