ARCHITECTURAL MODELS AS LEARNING TOOLS

ARCHITECTURAL MODELS AS LEARNING TOOLS

TITLE
Architectural Models as Learning Tools

EDITORS
Juliette D. Bekkering
Irene Curulli
Sjef van Hoof

CREDITS
The Authors of the Chapters

DESIGN
Juliette D. Bekkering
Irene Curulli
Sjef van Hoof

ISBN
978-989-658-666-9

EDITION DATE
10.2020

SUPPORT
MATERIART ERASMUS+ KA203 FUNDED STRATEGIC PARTNERSHIP PROJECT

PUBLISHED BY
Caleidoscópio – Edição e Artes Gráficas, SA
Rua Cidade de Nova Lisboa
Quinta da Fonte do Anjo nº 1-A
1800-108 Lisboa

PRINTED and BOUNDED BY
TEKSES OFSET Matbaacılık Yayıncılık Org. San. ve Tic. Ltd. Şti.
Certificate no: 44186
Kazım Karabekir Cad. Kültür İş Hanı No: 7/11 Zemin Kat İskitler / Ankara
Phone: +90.312.341 66 19

Editors:

Juliette D. Bekkering
Irene Curulli
Sjef van Hoof

Eindhoven University of Technology, Eindhoven, The Netherlands

ARCHITECTURAL MODELS AS LEARNING TOOLS

Co-funded by the Erasmus+ Programme of the European Union

caleidoscópio

CONTENTS

FOREWORD

Architectural models in education

Should the model be physical? And what about a virtual model? A conceptual model or a scale model? A presentation model or a sketch model? … but why should we make models?
These are the most frequently asked questions of the students attending architectural studies for their supervisors. While students expect a one simple answer, a wide range of answers is provided.
This book shows a variety of educational experiments that explore the use and meaning of '*Architectural models as learning tools in education'* both practically and theoretically. This was the theme discussed by university lecturers (established and young generation lecturers) of 5 European architectural schools during a 2-day seminar held at Eindhoven University of Technology in 2019. The event was part of MateriArt, ERASMUS+ project, focused on the Art and Science of Materiality in architectural design education.
Through presentations and vivid discussions, participants exchanged views, explained methods and showed results from their experiences in dealing with 'models' in architectural studio courses. The aim was to analyze all kind of outputs that students might get from architectural models throughout the learning process, in creativity and representational development, in valuing the potential of models, etc.
The use of three-dimensional models in education and by the architects in general dates back in history. Architects have always used models in order to test, to instruct and present their ideas; as a medium for architectural inspirations; in order to represent reality or to explore the complexity of the real world.
Physical models prevailed in the architectural world until the advance of digital technology that has added new meanings and uses. 3D models, renderings and fly-throughs have become commonplace in design, very often replacing physical models. Furthermore, digital tools (3D printers, etc.) have increased the capacity for production and level of precision of physical models.
In short, models are tools to stimulate thoughts and playful tools for understanding, interpreting and imagining the materiality of architecture in its broader meaning of the term.
The papers collected in this book show the opportunities, successes and failures of how architectural models (digital or physical, rough or highly sophisticated ones) enable architectural education to inform students on the variety of ways to think about materiality in architecture.
Many thanks to the authors of these papers and to their students who partook the educational experiments critically discussed in this book.

Juliette D. Bekkering
Irene Curulli
Sjef van Hoof

Sibel Acar
sbl_acar@yahoo.com

TOBB ETU, Ankara, Turkey

Model Architecture: A Brief History Of Models As A Design Tool

The architectural model has always been a versatile instrument for architects to visualize, develop, and define architectural concepts and to communicate ideas. It is a design medium, a means of representation, as well as an essential pedagogical tool. The term model defines both real objects and virtual constructions from unscaled, modest, and rough works to highly finished, precisely scaled, and detailed makings. Models can be classified in various ways consideri-ng their scale, medium, material, and size. Although different categorizations are possible, in this study, architectural models will be classified according to their primary function, basically in two categories: presentational models and working models. The presentational model is a finished work that represents a completed structure. The working model, also called the “process” model, is mostly a temporary object that is made to conceptualize, test, sharpen ideas, and develop design; naturally, it is not a finished work. (Marshall, 2006) This paper aims to present a brief history of how the architectural model has been affiliated with design thinking, architectural imagination, and design development. The analog working models will be discussed, while the presentational model and digital modeling are left out of the scope of this study.

Architectural models have a long history. In ancient times, architectural models were funerary objects, ritual articles, and dedications (Smith, 2004, pp. 5-7). As an aid for construction, ancient Greeks used a specific type of model, the paradeigma, which was the full-scale model of a particular feature of the building such as triglyph or capital. It was a specimen prepared for workers to copy. (Senseney, 2016, p. 223; Smith, 2004, pp. 10-11) In Roman and medieval times, architects made and used small scale models to communicate with their clients in order to get commissions. (MacDonald, 1977, p. 40; Smith, 2004, pp. 14-15) During the medieval era, models were utilized as an aid for the construction of cathedrals. (Kostof, 1977, p. 74) In the Renaissance Era, wax models started to be made as an aid to architectural design. The fifteenth-century witnessed the further development of the architectural scale model in relation to the development of the notion of the architect as an individual creator of

a new design. Filippo Brunelleschi (1377-1446) used small-scale models of his Cupola to test the structural problems as well as geometrical traits of his design. Similarly, to visualize his buildings, Michelangelo (1475-1564) preferred to make small-scale clay models rather than perspective sketches from a fixed point since he considered that the viewer of a building is not static. (Porter & Neale, 2000, p. 4; Smith, 2004, p. 25-28: Stavric, et al., 2013, p. 27)

Leon Battista Alberti (1404-1472) was the earliest writer who clearly defines the notion of the model as an important tool for architectural design. He suggested that by making a model, an architect “will have the opportunity, thoroughly to weigh and consider the form and situation.” (Morris, 2006, p. 16) Alberti also explained how models are useful to refine the initial design. For Alberti, the use of models in developing design was more important than its other uses. He recommended that a model be evaluated by other experts and continuously examined by its own designer. Therefore, Alberti defined the model as a conceptual tool rather than a solely representational medium. (Morris, 2006, pp. 16-18; Smith, 2004, p. 28). However, by the sixteenth century, the model as a design instrument was not as widely used as drawing, plan [ichographia], elevation [orthographia], and perspective [scaenographia]. Models were considered illustrative and informative tools rather than conceptual devices for developing ideas. Indeed, surviving Late-Renaissance and Baroque scale models were mostly presentational. (Porter & Neale, 2000, pp. 6-10; Morris, 2006, p. 17) Nevertheless, during the seventeenth and eighteenth centuries, a new type of full-scale model existed, which was the plaster replica of decorative parts that were used in-situ to decide their façade positions. In the nineteenth century, although there were some uses of models, drawings were mostly preferred as the design tool, mainly because of the invention of projective geometry and the Ecole Beaux-Arts influence on architectural education. In Britain, Sir John Soane was one of the architects who advocated the use of models. Soane saw models as a valuable medium that the architect might use to contemplate all aspects of design, as well as an important medium for teaching. He displayed many models in his house, which he opened to the public in 1833. He also urged his students to craft meticulous models of ancient and Gothic buildings (Morrison & Ostwald, 2006, p. 150) Yet, as Mark Morris states, “the Albertian model and its notion of a three-dimensional design process was not fully realized until the early twentieth century.” (2006, p. 17)

Founded by Walter Gropius, in 1919, Bauhaus was the school aimed to unite the arts and architecture that posed a new pedagogy in architectural education. The foundation course of Bauhaus, *Vorkurs*, fundamentals of design were offered to all students of arts, crafts or architecture. This preliminary course was based on the hands-on method requiring students to make models. Making models was an important part of Bauhaus’ education and praised by its faculty. (Mills, 2011, p. viii; Morris, 2006, pp. 17-20) Johannes Itten who developed the preliminary design course and was one of the influencer teachers of Bauhaus claimed modeling “as a vehicle for pure creativity”. Similarly, El Lissitzky endorsed “don’t read! Take paper, blocks, wood pieces; build, paint, construct!” (Morris, 2006, p. 21) After being closed by Nazi authorities, the faculty of Bauhaus moved to other countries, particularly to the USA. That led to the Bauhaus method spread to a larger world. In the States, the Columbia University School of Architecture was one of the institutions that added model making to its curriculum around 1921. By the 1940s, model making became a part of architectural education in the States and Britain. (Moon, 2005, p. 79)

During the twentieth century, new materials and unprecedented forms became ubiquitous and pervasive, bringing with the endless discussions on mass, volume, space, and form. The theory of relativity and the idea of four-dimensional space-time affected the avant-garde movements in art and architecture. As the relationship between space and time was explored, the motion became a design parameter. Avant-garde artists depicted objects from more than one point instantaneously. Accordingly, modern architects designed in a way that their works could be seen through a mobile vision rather than from a static point of ideal perspective. This conception of architecture also led to the consideration of the bird-eye view of architecture, so the roof plane came to be an important spatial element of modern architecture. This new way of seeing architecture was similar to seeing a sculpture, in how it affected the conceptualization of volume and mass in architecture. (Stavric, et al., 2013, pp. 29-30) The attained emphasis on three-dimensionality and mobile vision let models become a vital tool for explorations of mass, volume, and other tectonic features of design as well as for challenging materials and structural systems. Antonio Gaudi was one of the pioneers who designed unusual architectural forms by experimenting with models. He explored self-generated forms under gravitational forces. By attaching small weights to a wired system, he obtained the forms in which only the axial forces act. (Morrison & Ostwald, 2006, p. 150; Stavric, et al., 2013, p. 28)

When a greater number of architects started to be interested in non-orthogonal and more complex geometric forms, the use of the model as an exploratory tool became more prevalent. In the design process, models started to play an active and investigative role rather than passive and supplementary. (Moon, 2005, p. 80) Traditionally the materials of sculptures, clay, and plaster were used as materials for modeling to create fluid lines of Art Nouveau and later expressionist architecture. Gaudi, Rudolph Steiner, Herman Obrist, Hans Poelzig and Eric Mendelsohn designed with models by active manipulation of moldable and malleable materials. (Moon, 2005, p. 81) In the first half of the twentieth century, prominent modernist architects such as Vladimir Tatlin, Gerrit Rietveld, Theo van Doesburg, Le Corbusier, Frank Lloyd Wright, Walter Gropius, Mies van der Rohe relied on scaled models of different materials to test material and immaterial qualities of their designs. (Stavric, et al., 2013, p. 30) For instance, Le Corbusier produced a plaster model of his Citroen House in 1920. He also worked with cardboard models. Gropius made card models of his projects. (Emmons & Mindrup, 2008) Mies wrote, “my efforts with an actual glass model helped me to recognize that the most important thing about using glass is not the effects of light and shadow, but the rich play of reflection.” (Stavric, et al., 2013, p. 30) Frederick Kisler designed his conceptual project Endless House (1959) by making clay models or plaster coated models on a mesh framework. In the fifties, Berlin Philharmonic Hall (1959) by Hans Scharoun, Sydney Opera House (1957) by Jørn Utzon, TWA Terminal at New York International Airport (1956) by Eero Saarinen, and the chapel of Ronchamp (1950) by Le Corbusier were designed in expressionist unprecedented forms, and the design processes for all these buildings advanced from models. Le Corbusier used plaster working models by designing the chapel at Ronchamp. Saarinen worked with cardboard models to develop the shape of the concrete shell of TWA terminal. (Moon, 2005, pp. 80-82; Stavric, et al., 2013, p. 31) Through the second half of the twentieth century, ingenious structural solutions were found and applied. In the 1960s, Pier Luigi Nervi was inspired by the organic forms whose structures were shaped by the courses of forces acting on them. He invented ribbed concrete structures. By using prefabricated concrete items, Nervi could build large halls. Felix Candela advanced curved concrete shells in the form of hyperbolic paraboloids. In the 1970s, Frei Otto

developed some self-generating forms and membrane structures. Otto used a method, similar to Gaudi, by using physical models, Otto sought solutions for complex mathematical and structural problems. In the 1990s, Santiago Calatrava was also inspired by structural systems of living organisms. His audacious designs based on a perfect and ingenious balance of forces on the system. As the first stage of his design process, Calatrava used models on which the basic geometrical principles constituting the form and its structural system can be seen. As the starting point of his designs, Frank Gehry has also exercised on scaled process models, usually made of paper. In these given examples, their origins of creative forms are not theories of mathematics and physics but mainly observation and experimentation with models. (Stavric, et al., 2013, pp. 33-35) Accordingly, by advancing the design from models to technical drawings, the traditional design process was reversed.

In 1976, Peter Eisenman arranged “Idea as Model” exhibition that was the first exhibition merely on the notion of the model. The exhibition intended to open the ground for questioning of representational models. At the same time, the potential of models as a conceptual tool of the design process, and as a medium for an inquiry was emphasized. (Morris, 2006, p. 23; Morrison & Ostwald, 2006, p. 152) After thirty years, the “Homo Faber, Modeling Architecture Exhibition” (Melbourne, 2006) posed questions on the use of models. Both exhibitions examined and opened the ground for discussions on models by considering different forms of modeling as a fragment and instrument of the design process. (Marshall, 2006)

Today, as unprecedented, sculptural, and expressive forms have become more possible ever than before, architects feel free to explore new forms to express conceptual assets of their designs. During the design process, architects want to be open to further possibilities of their creativity. Therefore, the models do not need to represent the reality of the building because it is so restrictive for premature design. Although models portray the rules of reality, they have to be detached from the physical world that can be further developed in an abstract realm. As Moon poses, the model became an expression of the dynamism of the design process that they “look beyond the rules of reality into the realm of the imagination.” (Moon, 2008, p. 100-103) Moreover, since architecture is also accepted as a branch of the fine arts, designing became the self-justifying activity, regardless of it is buildability. Architects look for expressing their vision by underlying, mostly by overplaying the idea that by freeing from all the material constraints, the model becomes a visualization of the concept, not the architecture. As Michael Graves argues, in an interview with Moon, a model does not have to simulate a building, “any more than a paper cutout or a collage of a Cubist guitar by Picasso should look just a guitar.” (Moon, 2008, p. 101) In the same vein, Patrick Healy refers to Eisenman, “the model is an idea, and an object; it is about the project but also about itself.” (Healy, 2008, p. 51)

Therefore, modeling is a creative and contemplating act. The whole dimensions of design are investigated and manipulated simultaneously in the search of form and structure. It is not to be realistic and complete, yet, it is expressive, personal, and open-ended. It expresses and even formulates the architect’s vision and perception. It extends between the visionary realm of the mind and the physical world of gravity and materiality. Through the design process, models keep track of original intention, explorations, and development. In this regard, they become a journal of an architect’s journey.

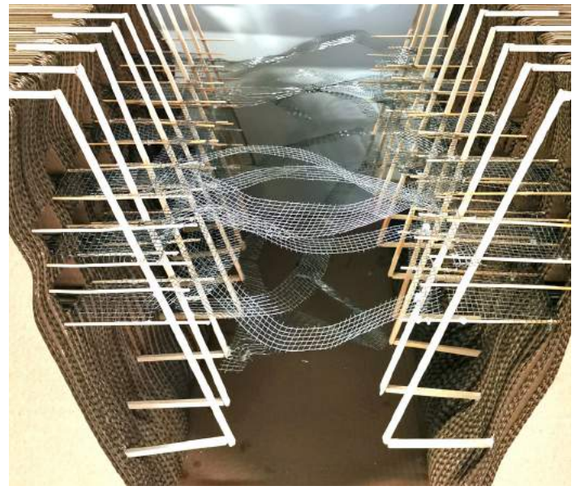


Fig. 1: Working model made by students. TOBB ETU Department of Architecture

In schools of architecture, the model is the first practical experience of constructing. Starting with the design by creating conceptual models, students interact with the form in a physical space that they realize potentials or constraints of the form. By creating a sketchy model, by crafting with materials, by making objects by hand, they advance from conception to realization. Models offer a versatile medium of exploration and experimenting through the design process. What is more, at every stage of the design process, the hands-on engagement with models provides students thinking and making at the same time. While doing that they need to find answers to the question of how a vision can be materialized as a building that would be constructed and be lived in. Since the 1990s, the ongoing advancement in computational technology has let digital design models, a regular part of architectural design processes. Digital media offer many advantages, such as quick prototyping and editing of digital models. Yet, analog models require and provide bodily involvement in real space by providing richer sensational exploration and experience of form still offer more to designers.

Fig. 2: Working model made by students. TOBB ETU Department of Architecture

References

Emmons, P. & Mindrup, M., 2008. Material Models and Immaterial Paradigms in the Rietveld Schröder House. *Journal of Architectural Education*, 62(2), pp. 44-52.
Healy, P., 2008. *The Model and Architecture*. Rotterdam, Delf School of Architecture.
Kostof, S., 1977. The Architect in the Middle Ages, East and West. In S. Kostof, ed. *The Chapters in the History of Profession*. New York, Oxford University Press, pp. 59-95.
MacDonald, W. L., 1977. *Roman Architects*. New York, Oxford University Press.
Marshall, B., 2006. *Homo Faber. Architecture Exhibition*. Exhibition Catalogue. Melbourne, RMIT School of Architecture and Design.
Mills, C. B., 2011. *Designing with Models. A Studio Guide to Architectural Process Models*. New Jersey, John Wiley and Sons.
Moon, K., 2005. *Modeling Messages: The Architect and the Model*. New York, The Monacelli Press.
Morris, M., 2006. *Architecture and the Miniature. Architecture in Practice. Models*. West Sussex, John Wiley and Sons.
Morrison, T. & Ostwald, M. J., 2006. Shifting Dimensions: The Architectural Model in History. In B. Marshall, ed. *Homo Faber: Modelling Architecture*. Exhibition Catalogue. Melbourne, RMIT School of Architecture and Design, pp. 142-157.
Porter, T. & Neale, T., 2000. *Architectural Supermodels.* Oxford, Architectural Press.
Senseney, J., 2016. Scale, Architects and Architectural Theory. In M. Miles, ed. *Companion to Greek Architecture*. Oxford, John Wiley and Sons, pp. 228-238.
Smith, A., 2004. *Architectural Model as Machine: A New Models from Antiquity to the Present Day*. Oxford, Architectural Press.
Stavric, M., Sidanin, P. & Tepavcevic, B., 2013. *Architectural Scale Models in the Digital Age*. New York, Springer.

Burak Delikanlı
burak.delikanli@itu.edu.tr

The Role of Digital Model-Making for Design Education

Abstract: This study aims to examine and draw attention to the interaction issues among designers, digital models, and digital model-making environments. The paper explores the historical developments of the analog model and model-making, and emphasizes its significance for designers. Besides being a representation tool for designers, models are also design artefacts and interaction tools, which increase the importance of the model-making process for design education. Digital turn in architecture environments via information and communication technologies (ICT) have also digitized the architectural model-making process. However, since digital tools are still in development, their impact on the design process is not fully understood. Understanding the role of digital model-making environments on the design process and developing those environments are issues that also concern design educators. Consequently, this study draws the attention of digital model-making environments in design teaching context.

Keywords: *Architectural Models, Model-Making, Digital Environments, Design Education*

1-Introduction

Analog models are traditionally used as a representation tool in architectural design (Dunn, 2014). The analog models are more descriptive than graphic drawings, thereby they become an essential medium for the relationship between designers and clients. As Smith (2004) says in his seminal book Architectural Model as Machine:

“It may be cliché to state that a picture is worth a thousand words, but it could be argued that a model can be worth at least a thousand pictures.”

This expression draws our attention to the importance of architectural models because architectural models enable designers to view complicated interactions, relations between the masses, shadows and a variety of other issues concerning the designers (Smith, 2004).

Architectural models, in addition to being a representation tool, are also the interaction tool in which designers contacts with their own embodiment. Embodiment of ideas helps design students, who have difficulty imagining objects in 3D space, to inspect more easily what is on their minds. As a consequence, this ease of conceptualization of the spatial layout increases the value of models in the early phases of the design process and design education. Furthermore, as architectural model-making can be considered as a phase of the design process itself, architectural model, now is no longer solely a resulting product of representation. The model-making process has also gained much more importance. Accordingly, efficiently handling the model-making process becomes the concern of design education.

Within the digitized architectural design environments, the use of digital models is becoming more popular day by day in academia, education, and practice (Aktaş, 2014). However, digital models are relatively new and their impact on the design process is still being investigated. Digital model-making environments offer more possibilities than physical environments. The limitlessness of 3D space, and breaking the laws of physics are examples of these possibilities in the digital environments. But they may be limited in terms of sensorial and perceptual interaction options (Cannaerts, 2009). As a result of this, the digital model-making environments turn into a design issue itself. Identifying the interaction possibilities of digital model-making environments with designers and proposing solutions can strengthen with interaction between digital models and designers.

There are challenges to overcome with human perception to provide an effective experience in digital model-making environments. Notwithstanding, there are studies discussing the advantages of digital existence in design environments (Gül, 2008) that is named as presence. According to The International Society for Presence Research (2000): Presence is defined as “a psychological state or subjective perception in which even though part or all an individual’s current experience is generate by and/or filtered through human-made technology, part or all of the individual’s perception fails to accurately acknowledge the role of the technology in the experience”

Kalay (2004) has drawn our attention to the three determinants of presence: the richness of sensory data communicated by the digital environment, the user’s level of control over the simulated environment and the degree of engagement. He says that if these are provided, users will feel that part of the digital environment, rather than being a passive observer. There are also important issues investigated such as immersion, interaction, consistency of the sensorimotor loop and emotions to provide the feeling of presence in digital environments (Bouvier, 2008).

Besides, the importance of the sensations and perception in architecture has been noted by theoreticians such as Merleau-Ponty (2013) and Pallasmaa (2005). Digitally generated senses

are one of the fundamental things to provide the feeling of presence in digital environments. Digital environments can be considered as limited in terms of senses compared to physical environments. But those limitations of the digital environments that appeal to the human senses can be overcome with the new information and communication technologies. Now, vision in digital environments can be provided in a similar way to the working system of vision in physical environments. Therefore, the observer not only looks at the image from the outside but is also presented inside of the image and s/he becomes the user, not the observer anymore.

Haptic devices are being developed that give artificial touch sense so that digital environments can appeal to more senses. Besides, the vision combined with 3D sound technologies will strengthen the feeling of presence in digital environments. Identifying and eliminating deficiencies of digital senses reduces the perception problems of digital models. As we understand, digital interactions among digital model-making environments, digital models, and designers can be effectively achieved within digital 3D space.

2-Development of The Concept of Architectural Model: From Analog to Digital

Firstly, we will focus on the developments and current position of the concept of architectural model in three historical periods that are important in terms of education and practice: The European Renaissance (14th-17th Century), The Académie des Beaux-Arts (1795-1968) and The Bauhaus (1919-1933). Examining the changes in these periods is significant for understanding the point where the concept of architectural model has come today.

In an etymological search, the origin of the word ‘model’ based on French ‘modele’, Italian ‘modello’ and Latin ‘modellus’. The Latin word ‘modellus’ means to measure (Smith, 2004). As seen as, model-making is highly related to measuring. Referencing to Herodotus, in Book V, the first recorded use of models as an architectural tool is a model of a temple at the fifth century BC (Dunn, 2014). Although there are similar examples of architectural models in Ancient Egypt, Classical Greek, and Imperial Rome, there is no evidence that it was used as a representation tool related to design (Smith, 2004).

Despite these historical uses, the first important records of the effective use of models as a design tool that we know them today point to the fourteenth century. Two important examples for this period were the domes of Brunelleschi at the Cathedral of Florence, and the domes of Michelangelo at The St. Peter’s Basilica in Rome (Dunn, 2014). With these examples, the architectural models became the main design tool of the designers during The European Renaissance.

In the eighteenth century, it was claimed that the designers and craftsmen were different from the influence of The Académie des Beaux-Arts in art and architecture (Reynolds, 2015). In conjunction with this change of mind, architectural drawing displaced architectural models as the favoured mode of architectural representation. An obsession with architectural drawing, particularly the perspective, during this period caused the model’s exclusion from the academic curriculum (Reynolds, 2015). In architectural design, such disparagement of the architectural models led to the ocularcentrism in architectural representation.

In the early twentieth century, The Bauhaus was to place itself in opposition to The Académie des Beaux-Arts and there was a major resurgence in the use of architectural models as a design tool in architecture, its new curriculum resurrects lost connection between designers and craftsmen (Porter and Neale, 2000). From this point, architectural models continued to develop as a powerful communication tool for description, exploration and evaluation phases of design (Dunn, 2014). It can be inferred that architectural models have been one of the most significant tools of representation, communication, and exploration in architectural design for over five hundred years.

Considering the concept of architectural model in the twenty-first century, the increment of computers, digital tools and model-making software has enabled designers and architects to make various models that would be difficult to do using traditional methods (Dunn, 2014). Although digital tools are now used extensively in architectural design, they have not fully completed their transformations, and so we can say that digitalization of the architectural models has not been fully completed. Nevertheless, digital tools have already become an essential part of the design process, and architectural education today (Mitchell, 1998). To examine the effects of digital tools on the architectural model-making process, we consider the functions of the physical model, and the differences of the digital model-making environments.

3- Functions and Types of Architectural Models

When the architectural models are mentioned, the first function of the models is to communicate the design idea to designer himself or herself and to others. While architectural models are overviewed, it is observed that there are various types of models in terms of their performativity (Arpak, 2008). Models have served as an interface between the mental and physical realm. In short, the models are used not only as a method of interaction describing to others what is in people's minds, but also to explore their own minds through the visual inspection and perception.

Examples of architectural models that architects use to develop a design are conceptual, working, massing, spatial, structural and lighting models (Dunn, 2014). Conceptual models can be described as a production of 3D initial sketches of design ideas at the very beginning of the architectural design process (Arpak, 2008). Working models are an extension of conceptual models (Arpak, 2008). Throughout the design process, architects work cyclically by exporting the design ideas to the physical realm and then importing from there to the mental realm again. Massing models describe a simplified relation of various components of masses rather than detailed information (Dunn, 2014). Spatial, structural and lighting models, as can be understood from their names, are useful models for examining the relationship between spaces and masses, structures and possibilities, lights and shadows in the architectural design.

As consider from types of models, the word "model" can be said to be a very flexible word for an architect and a designer with its many functions (Morris, 2006). Architectural models have four different functions according to their applications: descriptive, predictive, evaluative and explorative (Dunn, 2014). Unlike the other model types, the most prominent feature for the conceptual and working models in the design process is ambiguity and explorativity. For this reason, working models are essential for architecture students to describe their own thoughts as well as to describe others. Consequently, the conceptual and study models are the main focus of this study.

At the end, it is valuable that architectural models are ambiguous and explorative, so that they can contribute to the design process. Designers and architects are provided these functions through their interaction with physical model-making environments. So that the digitization of model-making environments does not affect the functions of the architectural models, design educators may focus on the difficulties of digital model-making environments. The elements that may be valuable for effective model-making in digital environments will be discussed in the next section.

4- Digital Presence for Efficient Model-Making Process

Human beings communicate with the physical world through many channels (touch, sight, vision etc.) as a physical entity. Therefore, human interaction with analog model-making environments is a familiar activity than the interaction with the digital model-making environments. The feeling of presence in digital environments has a potential to increase the interaction between designers and digital models. Digital presence is not only related with the ability to directly interact or perform actions within the physical field, but also with many factors (Bouvier, 2008).

Bouvier (2008) says five pillars are needed to reach the presence in virtual worlds. He defined these five pillars as immersion, interaction, consistency of the sensorimotor loop, emotions and cognitive sciences. According to him, to provide a sense of presence these pillars are like the primary colors, any other factor may arise from a mixture of them.

The immersion is the feeling of presence provided by interaction with living environments in real-time (Grau, 2003). While the most obvious issue of the immersion may seem to be a matter of realism. However, Bouvier (2008) claims it is more associated with credibility. The user's immersion in the virtual environment is associated with his credence in the virtual environment. He also says that interaction devices should be as transparent and natural as possible to ensure effective communication between users and the virtual environment. According to Bouvier (2008), two significant points to provide consistency of the sensorimotor loop or the action-perception loop. These are to maintain the causality link between the user's actions and the system's feedback, and the time and place consistency between senses and objects. Emotions make it easier to reach the presence, and then the presence allows to feel more intense emotions. However, it is difficult to convey emotions using only technology, so must be associated with art to make emotions feel more intense. Cognitive science, on the other hand, investigates the mechanisms of perception, attention and learning processes and makes studies on the presence in virtual reality from the human center.

Furthermore, the richness of the sensory data communicated by the digital environment is important in providing the feeling of presence (Kalay, 2004). As in the physical realm, sensations must be provided through different channels at the same time. Interaction devices, mentioned in the introduction section, are getting better with the development of technology. The user's control in the digital environment should also be increased (Kalay, 2004). Increment of interaction and control in digital environments allows the viewer to transform to the user. Besides, the degree of engagement directly affects communication with the digital environment (Kalay, 2004).

From a different point of view, there are also studies that the use of avatars in digital environments will enable designers to be present in digital environments with a character that designers can identify with themselves (Nowak et al., 2008). Designers who are involved in the digital environment through an avatar can increase their feeling of presence. In particular, this study shows us that the deficiencies of digital environments can be achieved in different solutions.

Oxman (2004) and Gül (2008) discussed the role of presence in digital environments during the design process. The number of studies related to the relationship between digital environments and the design process is increasing. As we understand, it can be said that the feeling of presence in digital model-making environments strengthens the interaction between the model and the designer. As a result of all this, there is a digital presence as an alternative to a physical entity in model-making environments that would provide many possibilities to its user as such, interactive visual inspection, embodiment, etc.

5- Conclusion and Recommendations

It is clear that the architectural models are one of the most favourite modes of representation and communication tools in the design process. The developments of ICT is rapidly digitizing the model-making process along with architectural environments. The benefits of digital environments attract design students and accelerate this change. Non-euclidean geometries, which are very difficult to produce in physical environments, can be produced easily by computational design methods in digital environments. In digital environments, model making materials such as cardboard, etc. are not needed because the substance is not something that runs out. In addition, one of the biggest advantages of digital design environments is that breaks the rules of physics. With this advantage, digital models offer modelling possibilities that would enhance imagery of spaces not possible to even imagine for the real environments. In addition, designers can have more control over the model-making environments with the possibility of being in the same space with the design artefact that is 'designing in a design' situation.

In spite of all these advantages, we can say that digital model-making environments come with their own difficulties as well. It is important to identify these difficulties so that architectural models can provide their functions. Aktaş (2014) examines the transformation process of architectural models from analog to digital, and draws attention to some difficulties related to the process. She says that the most challenging aspect of physical model-making that needs to be transferred to the digital environments is tangibility. In digital environments, the feeling of presence can reduce abstraction of the digital models, and enable perceived as tangible. Therefore, digital model-making environments that interact effectively with designers can play a major role in the future of design education.

For the future of this study, experiments can be done with different levels of design students comparing physical and digital model-making environments. Observations during the model-making process can help us to investigate the challenges of digital environments. Moreover, it would be possible to better understand the influence of the feeling of presence in digital environments with a participatory workshop. An integrated approach with design education, technology, and cognitive science can solve interaction problems in digital modelling environments.

References

Aktaş, E. (2014). Exploring Model Making: Translating Intuitive Aspects Of Conceptual Models into Digital Realm. *A Matter Of Design. Making Society Through Science And Technology*, 261.

Arpak, A. (2008). Physical and virtual: transformation of the architectural model. (Unpublished master's thesis). *Middle East Technical University, Turkey*.

Bouvier, P. (2008). The five pillars of presence: guidelines to reach presence. SPAGNOLLI, A. et GAMBERINI, L., éditeurs: Proceedings of Presence, 246-249.

Cannaerts, C. (2009). Models of/Models for Architecture: Physical and Digital Modelling in Early Design Stages.

Dunn, N. (2014). Architectural modelmaking (No. 2nd ed). Laurence King.

Grau, O. (2003). Virtual Art: from illusion to immersion. MIT press.

Gül, L. (2008). Affording embodiment in collaborative virtual environments: What is the role of presence in collaborative design. In *PRESENCE 2008-Proceedings of the 11th Annual International Workshop on Presence*.

International Society for Presence Research. (2000). *The Concept of Presence: Explication Statement.* Retrieved <10.09.2019> from https://ispr.info/

Kalay, Y. E. (2004). Contextualization and Embodiment in Cyberspace.

Merleau-Ponty, M. (2013). *Phenomenology of perception*. Routledge.

Mitchell, W. J. (1998). Anti tectonics: the poetics of virtuality. *The virtual dimension: architecture, representation and crash culture. Princeton Architectural Press, New York*, 205-217.

Morris, M. (2006). *Models: Architecture and the miniature*. Chichester: Wiley-Academy.

Nowak, K. L., Pandžić, I. S., Zorić, G., Šmid, K., Grundnig, S., Petri, T., ... & Reinecke, L. (2008, January). The Psychology of Avatars: Real Life Effects of Virtual Communication. In *Proceedings of the 11th Annual International Workshop on Presence, Padua, Italy*.

Oxman, R., Palmon, O., Shahar, M., & Weiss, P. L. (2004). Beyond the reality syndrome: Designing Presence In Virtual Environments. *Proc. ECAADE, Copenhagen*, 15-18.

Pallasmaa, J. (2005). The eyes of the skin. Architecture and the Senses. Chichester.

Porter, T., & Neale, J. (2000). *Architectural supermodels: physical design simulation*. Architectural Press.

Reynolds, C. (2015). The Fourth Register of Architecture: 'Model As...'. (Unpublished master's thesis). *The Bartlett School of Architecture UCL, United Kingdom.*

Smith, A. (2007). Architectural model as machine. Routledge.

3

Leman Figen Gül
fgul@itu.edu.tr

ITU, İstanbul, Turkey

Digital Architecture Studios as Constructivist Activity in Design Teaching: Exploring New Ways of Model Making

INTRODUCTION

With the intense use of information and communication technologies in the 21st century, our everyday life, our habits, the cities we live in and our surrounding environments have been transformed into a new kind of built environment. As a result of this transformation, fundamental parts of our existence and built environment have been conquered by digital technologies in the form of smart and ambient technologies in building interiors, animated, reflective and kinetic surfaces, media facades, projectors and illuminated surfaces, just to name a few. In this new digital design culture the boundaries of the virtual and the real are becoming blurred and changes in design processes, representations and teaching are inevitable.

Within the process of architectural design, models are suggested as an essential tool in the materialisation of habitable built form and “play a vital role in the practice of architecture” (Williams, 2002). Models represent the concretisation, or materialisation, of ideas by getting as close as possible to the actual construction and appearance of a design concept. By using a model, the investigation of the overall form, structure, colour, surface and lighting becomes easy. In addition, models can help with the creative process of visualising three-dimensional space and spatial layout, as well as helping to shed light on complex visual relationships, so “models outperform drawings”(Porter and Neale, 2000). Many designers use models for different purposes (Ratensky, 1983) and construct them with different materials, ranging from cardboard, string, paper, wooden blocks or other materials. Working with these physical models, designers are able to develop, reflect, and communicate design ideas between themselves and with others (Peng, 1994). Kvan and Thilakaratne (2003) have pointed out that models offer the benefits of approachability, tangibility, manipulability and collaborative engagement.

This paper looks at one particular change which is new, the use of the digital model in computer mediated platforms. According to Achten and Joosen (2003), the digital model could be considered as the “design” rather than a representation of the design [although technically speaking it is still a representation]. In other words, to take a “designerly stance towards the digital model”. We advocate that this new understanding of the digital model can be translated into a new design teaching platform, providing us with opportunities for constructivist learning in which students would explore the conceptual design of spaces within digital architecture environments.

The design studios of digital architecture can be divided into three settings:

1. the employment of advance fabrication and 3D modelling applications
2. 3D modelling in virtual design studios, and
3. the employment of embodied applications of emerging design technologies, known as augmented reality.

The constructivist learning approach rests on the assumption that knowledge is constructed by learners as they attempt to make sense of their experiences. “Learners, therefore, are not empty vessels waiting to be filled, but rather active organisms seeking meaning. Regardless of what is being learned, constructive processes operate and learners form, elaborate, and test candidate mental structures until a satisfactory one emerges” (Perkins, 1991, as cited in Driscoll, 2005, p.387). There have been many applications of constructivist theory, since the reflective practitioner approach of Schön (1983) was developed from Bauhaus principles and directed initially by Woods (1985) to introducing problem-based learning for undergraduate engineering design education.

In this paper, using digital architecture studios for teaching as the implementation of constructivist approach is discussed within emerging design technologies. Digital architecture studios would make it possible to explore and experiment with new design possibilities, and suggest exciting new languages, complex structures and resources for exploring alternative place designs. The changes in these new place designs will further influence the way people work, communicate, interact and collaborate. This paper first identifies the concept of digital architecture and then discusses the constructivist assumptions about learning, providing examples of our teaching experiences in digital environments.

DIGITAL ARCHITECTURE

Concepts such as cyberspace and digital architecture emerged in the 1990s. For architects and designers, they are valuable tools, allowing the user to study and visualise the full implication of 3D spaces, as well as allowing them to experience the space through immersion and an enhanced sense of presence. The emerging concept of digital architecture was beyond the existence of physical materiality, such as stone, glass, brick, concrete and so on, but instead made of bits and databases — sets of numbers stored in electromagnetic format — and experiences. The bits could create representations as visual simulations of architecture, providing a perfect correspondence between the digital model and the built environment.

Digital architecture also serves as a metaphor for the creation of places in cyberspace. The term “cyberspace” to signify an artificial environment inside a computer was introduced by

William Gibson in his science fiction novel *Neuromancer* (1984). Unlike Gibson’s cyberspace which was largely an illusory and fantastic space, today we use the term in a dual sense: indicating “virtual reality”, “mix-reality” or “augmented reality” that allows interaction within a computer-generated 3D space; or indicating any type of space generated by a computerised information medium. Cyberspace, namely digital architecture, distinguishes itself from other networked technologies by having characteristics of place. The future will see an increasing use of digital architecture as an important extension of our physical world that will become the “ultimate destination” where we shop, are entertained and educated (Kalay and Marx, 2001). We have been spending increasing amounts of time inhabiting digital architecture and participating in activities in digital architecture. Consequently, designing in and within digital architecture will become an important design topic. It deserves better understanding and in-depth exploration.

Designing in Digital Architecture

The implications of digital technologies are vast, as “architecture is recasting itself, becoming in part an experimental investigation of topological geometries, partly a computational orchestration of robotic material production and partly a generative, kinematic sculpting of space,” as observed by Peter Zellner in *Hybrid Space: Generative Form and Digital Architecture* (1999, as cited in Kolarevic, 2001). This would emphasize both adaptive and flexible spaces that respond to the users’ behaviour and are cut loose from the expectations of logic, perspective and the laws of gravity — spaces that do not conform to the rational constraints of Euclidean geometries. Such concepts of “transarchitecture” or “liquid architecture” (Novak, 1996) as a fluid, imaginary landscape would only exist in the digital domain until the integration of advance information technologies into buildings, providing us with smart and reflective spaces. In addition, the concept of “virtual worlds” in 3D spaces adapted the architecture metaphor, providing unique experiences for visitors who can interact with the objects in the space.

Designing within Digital Architecture

Based on technological and conceptual developments and the growing relationships between computer scientists, structural engineers and architects, a new design materialisation approach also emerged. The traditional sequential development of architecture — first the development of a form by an architect, then the structure and materialisation of the form in collaboration with an engineer — began to change. The early examples of this change can be seen in the construction of the Sydney Opera House (by Jørn Utzon, Sydney). The complex seashell-like forms of the building could not be calculated and constructed by traditional means. The traditional thinking process of material, structure and form was reversed with the construction work of these buildings and led to new structuralism. New structuralism requires incorporating CAD/CAM processes and tools into the design process, increasing its expressive and geometric power as well as enabling a digital model that can be used throughout the whole process to realise the design. In this new design process digital models are considered as new design representations that have a consistency and long life-span and which do not require continued reconstruction (Achten and Joosen, 2003).

CONSTRUCTIVIST ASSUMPTIONS IN DESIGN TEACHING

There are many approaches to determining the basic goals and strategies of education. However, the most common conception is that education is an endeavour of “the retention, understanding and active use of knowledge and skills” (Perkins, 1991) and there is a consensus that “learning is a continuous, life-long process resulting from acting in situations” (Brown et al., 1989, p.33). We consider that this can only be done in the context of meaningful activity. The constructivist approach to identifying learning goals also emphasizes learning in context; Brown et al. (1989) argued that knowledge that learners can usefully deploy should be developed. Specifically, the term constructivism refers to the idea that learners construct knowledge for themselves, each individual constructing meaning as they learn (Hein, 1991). In other words, “knowledge does not come into its own until the learner can deploy it with understanding” (Perkins & Unger, 1999, p.94). There is a consensus that the constructive view of the learning process includes the following two concepts:

1) Knowledge is obtained and understanding is expanded through active (re)constructions of mental frameworks (Piaget through Bransford et al., 2000; Abbott and Ryan, 1999) and the learner’s previous knowledge constructions, beliefs and attitudes are considered in the knowledge construction process (Murphy, 1997); and,
2) Learning is an active process involving deliberate progressive construction and deepening of meaning (Spady, 2001). Learning situations, environments, skills, content and tasks are relevant, realistic, authentic and represent the natural complexities of the ‘real’ world.

Researchers have argued that the constructivist learning theory can be applied in design studios (Gül et al., 2012). Powers (2001) stated that the design “studio is an excellent place for the outgrowth of constructivism”. Typical constructivist goals are the ability to solve ill-structured problems (Jonassen, 1999), to acquire content knowledge in complex domains along with critical thinking and collaboration skills (Nelson, 1999), and to develop personal inquiry skills (Hannafin, Land & Oliver, 1999). These match the typical goals of any design studio context.

In our teaching practice we explore the inclusion of the constructivist view of teaching within design studio courses to establish theoretical credibility for digital architecture studio teaching practices and, most importantly, to increase learning and advance construction of knowledge. Based on some of the principles of the constructivist view of design teaching (see Gül et al., 2012, for more detailed review), we have summarised our findings from several digital architecture studios conducted over the years, focusing on the studio’s context and the opportunities the advanced tools and technologies offered for modelling.

The principles are as follows:
1) Ownership of learning — learning must be active,
2) Complex and relevant learning environments — establishing relevance to a real-life design situation,
3) Developing clear objectives to provide direction to learning,
4) Articulating knowledge and learning experience,
5) Providing effective feedback mechanisms,
6) Employing effective ‘scaffolding’ in the organisation of the learning experiences, and
7) Encouraging collaborative learning.

New Structuralism: Digital Composition and Physical Assembly

The developments in CAD/CAM technologies and fabrication-based design techniques have provided the potential to accommodate new demands, opportunities and processes, resulting in substantial changes in architectural curricula. With this demand, new subjects have been introduced into architectural curricula, assisting the investigation of free-form or complex design modelling, building components and material attributes (see, Gül et al., 2019, for some other attempts). These new subjects include both the components of experiencing the composition of form in digital space and the processes of physical assembling the 3D model. In most of the design briefs an ill-defined problem was given to the students and the materialisation of the design idea was also required. The students did not have previous knowledge of how to operate the special modelling software (Rhino and Panelling Tools) or how to prepare files for the subtractive fabrication techniques. Thus structured lectures to develop conceptual knowledge and tutorial sessions to develop hands-on experience and skills using CAM tools were provided.

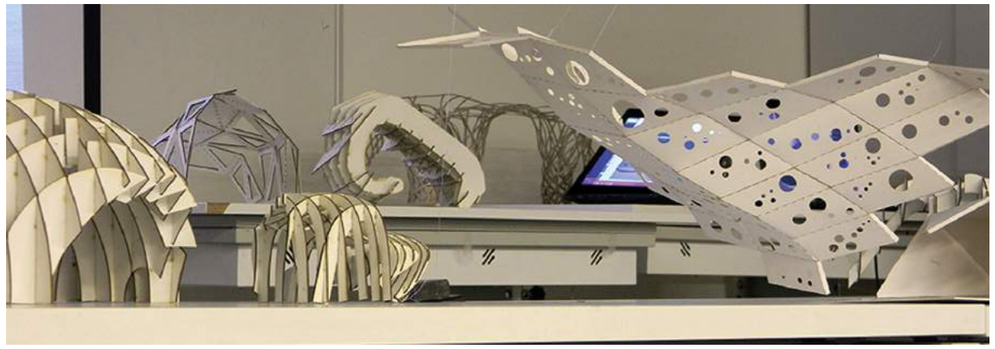


Figure 1: Design outcomes of a short-term intensive workshop at the Department of Architecture in the TOBB University of Economics and Technology in 2014. The theme was design of a space for gathering.

Designing within Design: Opportunities of Co-modelling in Virtual Design Studios

Collaborative virtual environments used for educational purposes obviously have the potential for innovative and effective education. From the mid 1990s virtual design studios have been set up by architecture and design schools around the globe intending to provide a shared ‘place’ where remote design collaboration, especially synchronized communications and design activities, can take place. Virtual design studios provide a ‘place’ for debate, simulation, role-play, discussion, problem-solving and decision-making in a group context. Many researchers have pointed out the importance of collaboration and communication (Gül, 2012), and have experimented with virtual design studios that would provide experiential and situated learning (Clark and Maher, 2005; Dickey, 2005) and encourage collaboration and constructivism (Kvan 2001).

We conducted a collaborative virtual design studio in the 3D virtual world Second Life which provided students with a virtual island for building their model for interactive experiences and gaming in the Architectural Design Computing graduate program at Istanbul Technical University (ITU) in 2016, some outcomes are shown in Figure 2. From our experience, the virtual design studios demonstrated that the curriculum should be organised in a spiral manner

studios starts with intense tutorials focussing on how to operate the modelling commands in Second Life. The design problem-solving activity requires extra attention in virtual worlds, such as detailing the model in advance in memory and then considering “who is doing which part” to co-model it. This new modelling behaviour certainly requires students to be active and to have ownership of their learning, as it requires knowing what to learn and how to learn.

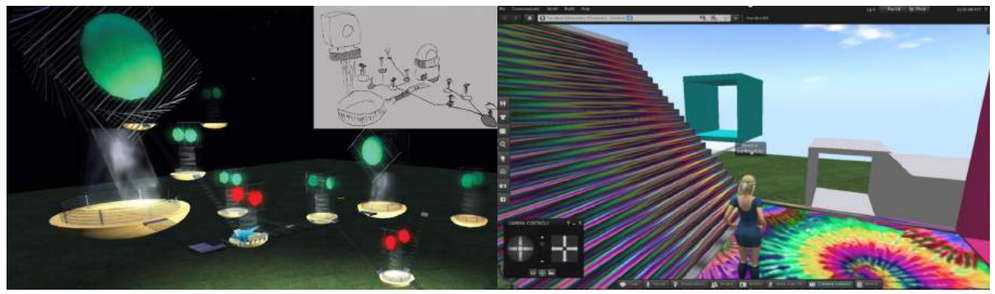


Figure 2: Outcomes of virtual design studios. Not only 3D modelling but also interaction design took place. When the avatar comes near the object, it turns to red, providing interactivity with the object in the virtual world (left). The direction of the stairs changes when the avatar steps on them (right).

Opportunities of Embodied Design Modelling — Massing — in Enhanced Augmented Reality

The third opportunity we investigated was the employment of a marker-based mobile augmented reality (MAR) application that was enhanced with a physical model and a wide-shared visual display for supporting design activity (as shown in Figure 3, see Gül et al. 2016 for more information about MAR). Designers were provided with the basic geometries (cube, sphere, cylinder etc.) and manipulation commands (move, rotate, copy, scale etc.). The MAR environment affords visual analysis and the considerations of three dimensions of a building envelope in the form of volume or bulk of a solid body or a grouping of individual parts or elements. In order to understand the potential of MAR in design activity, a comparison study was conducted (see Gül, 2018, for more details of the MAR’s system architecture). The results of the study showed that:

1. an additive massing approach that includes managing small parts to make a whole building was supported, and
2. the main regulating elements were the boundary lines at the periphery of the neighbouring buildings, park and road boundaries.

In addition, the MAR environment allows visual analysis of the spatial relationship of design objects through bodily movements (gestures, bending, leaning etc.). Thus we consider that with the employment of augmented reality in design, the modifications of real architectural space would be maximised by enhancing design activities in the built environment and providing new ways of designing by articulation, testing of 3D space and understanding and inspecting the spatial layout. Augmented Reality will be further tested in a wider educational setting.

Figure 3: Additive massing strategy was observed in the MAR environment.

CONCLUDING REMARKS

Observations show that many designers work in a quite mixed manner. They produce diagrams, sketches to generate and elaborate design ideas suggested during model-making, and make models to better understand the design solution (Peng, 1994). This mixed manner exists at the “heart of influential architects’ design thinking” such as that of Frank Gehry, Nigel Coates and Will Alsop (Porter and Neale 2000). Using 3D scanning and rapid prototyping techniques, designers are able to go back and forth between digital and manual mode, thus taking advantage of each one. This new understanding of the design process requires the geometry of the design to be clearly and unambiguously defined. The NURBS surfaces and solid modelling are the most common techniques to define the geometry. The complete digital workflow is also required to define the dimension and properties of elements parametrically, allowing effective testing and optimising. A well-defined model of a building can be transformed to a CNC machine for mass-customization. The application of mass-customization for the creation of complex forms includes a large number of similar but not identical elements that need to be assembled in a precise way. This is a completely new way of thinking and construction which generates new synergies in architecture, engineering and construction. Architects now need to consider the information flow between conception and production.

This paper presents examples of digital architecture studios as constructivist activity in design teaching, exploring new ways of model making as the materialisation of design ideas. We summarise our findings as follows.

Firstly, our experiences in digital settings illustrate that in studio contexts learning continues and increases from the known to the new. This ‘scaffolding process’ requires the construction of knowledge and skills beginning from level zero, building on the foundation of what is already

known. The new is developed on top of the known. The curriculum of digital architecture in a constructivist view should be organised in this manner, similar to all design activities. It should emphasise problem-solving through the setting of an ill-defined design problem that students need to work through thoroughly to identify the nature of the problem, assigning of tasks to be completed, the reasoning required to understand the problem as data and resources are gathered and consulted, arrival at a solution, and then evaluation of the adequacy of the solution. Once the problem is established and students have identified their strategies for information gathering, they propose solutions and reflect on their reasoning, the building of the model and so forth. The tasks should be real problems and also require the accumulation of knowledge of the operation of the software applications in self-regulated phases.

Secondly, the learning needs to be considered as a social activity in which individuals are engaged in a design problem as an intellectual process, receiving feedback from each other and the tutor. Such social learning facilitates arising at solutions synergistically and enabling knowledge construction by providing an interactive context for students that also assists them develop multiple perspectives and improve collaboration and negation skills.

Finally, our experiences with digital architecture studios demonstrate the changing roles of students and teacher. Students are no longer the passive recipients of instruction that has been presented for them. Instead, they are active learners. The constructivist view permits learners to make accustomed choices in carrying out design activity and to reflect on the consequences of their decisions. Learners are provided with the opportunity and the skills to refine their work following reflection. In this constructivist approach to teaching, the teacher departs from the more traditional didactic role and takes on the role of a facilitator, mentor, coordinator or leader.

All these approaches to employing advanced digital technologies in architectural curricula have the potential to reveal interesting ideas, concepts and possibilities for built environment designs. We are already starting to see interesting examples of the practice in architecture. We can speculate whether the use of digital technologies has enhanced the quality of the spaces that we live in. However, there is one consequence which cannot be disputed, and that is the conceptual shift involved in using digital technologies in teaching and learning goes beyond the traditional understanding of learning and cognition. There is no doubt that the three approaches elucidated above showing the use of emerging digital technologies in design teaching will serve as a starting point for further research, practice and validation of digital technologies in innovating built environment designs.

References

Abbott, J., & Ryan, T. (1999). Constructing knowledge, reconstruction schooling. Retrieved, May 7, 2007, from www.21learn.org/publ/edleadership1999.html

Achten, H. and Joosen, G. 2003,The Digital Design Process - Reflections on a Single Design Case, Digital Design, 21th eCAADe Conference Proceedings Graz, Austria.

Bransford, J., Brown, A., & Cocking, R. (Eds.). (2000). How people learn: Brain, mind, experience and school. Washington, DC: National Research Council.

Clark, S., & Maher, M. L. (2005). Learning and designing in a virtual place: Investigating the role of place in a virtual design studio. Proceedings of eCAADe 2005 (pp. 303–310). Technical University of Lisbon.

Dickey, M. D. (2005). Three-dimensional virtual worlds and distance learning: Two case studies of active worlds as a medium for distance education. British Journal of Educational Technology, 36, 439–451. doi:10.1111/j.1467-8535.2005.00477.x

Hannafin, MJ, Land, SM & Oliver, KM. 1999, Open Learning Environments: Foundation, methods and models, Instructional-design theories and models (Volume II), Publisher: Erlbaum, Editors: Reigeluth, C.

Hein, GE, 1991, Constructivist Learning Theory, The museum and the needs of people, retrieved:3.08.2019 https://www.exploratorium.edu/education/ifi/constructivist-learning.

Gibson, W. 1984, Neuromancer, ISBN: 0441012035, Ace Hardcover.

Gül LF, Gu N, and Williams A, (2012), Constructivist Learning Theory in Virtual Design Studios, Gu, N and Wang X (eds), Computational Design Methods and Technologies: Applications in CAD, CAM and CAE Education, Chapter 9, ISBN13: 9781613501801, IGI Global, p.139-162.

Gül, LF, Halıcı, SM, Uzun, C, Esengün, M, (2016), Understanding the Impact of Mobile Augmented Reality on Co-design Cognition and Co-modelling, Yuhua Luo (ed.), Cooperative Design, Visualization, and Engineering, 13th International Conference, CDVE 2016, Sydney, NSW, Australia, October 24–27. Lecture Notes in Computer Science, Volume 9929 2016, pp. 362-370, ISBN: 978-3-319-46770-2 (Print) 978-3-319-46771-9. DOI.10.1007/978-3-319-46771-9_47

Gül L.F. (2018). Studying gesture-based interaction on a mobile augmented reality application for co-design activity, Journal On Multimodal User Interfaces, no.November, pp.1-16.

Gül, LF, Özkar, M, Yağmur Kilimci, ES, Kanan, A, (2019), Introducing the Computation in Architectural Design: An Example of a First Year Course with Parametric and Visual Programming Tools, Couceiro da Costa, M, Formiga, B. Abbas, GM, (eds.) Materiality as a Process, ISBN: 978-989-658-557-0, pp.303-312 Caleidoscópio – Edição E Artes Gráficas, SA, Portugal.

Jonassen, D. H. (1999). Designing constructivist learning environments. In Reigeluth, C. M. (Ed.), Instructional design theories and models.Mahwah, NJ: Erlbaum Associates.

Kalay, Y.E. and Marx, J. 2001, Architecture and the Internet: Designing Places in Cyberspace, Proceedings of Association for Computer Aided Design in Architecture Conference (ACADIA 2001), Buffalo, pp. 230-240.

Kolarevic, B. 2001, Digital Fabrication: Manufacturing Architecture in the Information Age, p.268-277.

Kvan, T. (2001). The problem in studio teaching- revisiting the pedagogy of studio teaching. Proceedings of the 1st ACAE Conference on Architecture Education, National University of Singapore.
Kvan, T. and I. Thilakaratne (2003). Models in the design conversation: Architectural vs Engineering. Proceedings of AASA conference, Melbourne, Association of Architecture Schools of Australia.
Murphy, E. 1997. Constructivism: From Philosophy to practise. Retrieved from https://files.eric.ed.gov/fulltext/ED444966.pdf. 3.09.2019.
Nelson, L.M. (1999). Collaborative problem solving. In C.M. Reigeluth (Ed.), Instructional design theories and models: A new paradigm of instructional theory (Vol. II) (pp.241–267). Mahwah, NJ: Lawrence Erlbaum Associates.
Novak, M. 1991,Liquid Architectures in Cyberspace, Cyberspace ISBN:0-262-02327-X p.225-254, MIT Press.
Novak, M. 1996, TransArchitecture, http://www.heise.de/tp/artikel/6/6069/1.html
Peng, C. 1994, Exploring Communication in Collaborative Design: Co-operative Architectural Modelling, Design Studies,15(1): 19-44.
Perkins, D. (1991). Technology meets constructivism: Do they make a marriage? Educational Technology, 31, 18–23.
Perkins, D.H., & Unger, C. (1999). Teaching and learning for understanding. In C.M. Reigeluth (Ed.), Instructional design theories and models: A new paradigm of instructionsl theory (vol. II) (pp. 91–114). Mahwah, NJ:Lawrence Erlbaum Associates.
Porter, T. and Neale, J. 2000, Architectural Supermodels. Oxford, Architectural Press.
Powers, M 2001. Applying a constructivist pedagogy to design studio education. ARCC Spring Research Conference, Virginia Technique.
Schön, D. A. (1983). The reflective practitioner. New York: Basic Books.
Spady, W. G. (2001). Beyond counterfeit reforms: Forging an authentic future for all our learners. Lanham, MD: The Scarecrow Press.
Ratensky, A. (1983). Drawing and model making. New York, Watson-Guptill Publications.
Weinstock, M. 2005, Terrain Vague: Interactive Space and the Housescape, Architectural Design, Vol 75, No 1 Jan/Feb, ISBN 0470090928.
Williams, A. (2002). "Architectural modelling as a form of research." Architectural Quarterly 6(4): 337-347.
Woods, D. (1985). Problem-based learning and problem-solving. In Boud, D. (Ed.), Problem based learning in education for the professions (pp. 19–42). Sydney: Higher Education Research and Development Society of Australasia.
Zellner, P. 1999. Hybrid Space: New Forms in Digital Architecture, New York: Rizzoli.

Günsu Merin Abbas
gmabbas@etu.edu.tr

Building Information Modelling as an Exploratory Learning Alternative to Conventional Architectural Drawing Courses

Abstract: In this paper, two consecutive courses of the second-year curriculum of TOBB University of Economics and Technology, Department of Architecture are presented. The courses are structured to create a setting for students to explore both intermediary knowledge and conventions on architectural drawing, the construction process and the basic principles of sustainability. In this regard, the Building Information Modelling (BIM)-based course model is proposed as an alternative to conventional architectural drawing courses. Within this process, BIM models are regarded as an exploratory learning tool for sustainability, building physics, for developing effective environmental control strategies and for visualising the construction process.

Keywords: *Building Information Modelling, Sustainability, Architectural Drawing Course, Architectural Design Curriculum*

1 Introduction

With the proliferation and integration of information-communication technologies (ICT) in architectural design and construction industry, there appeared a demand for architects to be well-equipped with the tools in support of well-informed, collaborative and integrated decision-making. As architectural design and construction are information-intense acts by their nature, the architects must be able to manage the complexity of the process in order to successfully lead the design and construction.

Currently, the environmental crisis and climate change increased the design complexity by introducing a number of parameters to the process such as carbon footprint, sustainability and energy performance. The building industry, having over one-third of the total energy consumption, is one of the largest contributors to the negative impact on the environment,

which results in increased carbon emissions, and the scarcity in natural resources (Pérez-Lombard, Ortiz, & Pout, 2008). However, the changing needs of society and the increase in the population make design and construction activities inevitable. Despite the abovementioned negative impact on nature, the architectural design has a great potential to reverse this environmental damage. There are a number of strategies to cope with such a crisis in the field, and architectural design education could be one of the primary actors to raise awareness and develop strategies in this respect. Within this scope, this paper discusses the architectural curricula as one of the prominent actors to develop strategies in this regard. Revising and expanding the architectural education curricula with the sustainability strategies/methods/tools could be the first step to prevent construction-based environmental damage. At this stage BIM-based learning model focusing on integrated modelling and analysis is proposed as an alternative to conventional technical drawing courses in architectural design curriculum.

2 BIM-based Model for Architectural Representation and Representation Techniques Course

The 'Architectural Design, Presentation and Research Methods and Techniques (ADPR) III and IV' are compulsory courses courses that are delivered in twelve weeks during two consecutive academic semesters for the second-year students at TOBB University of Economics and Technology, the Department of Architecture. The objective of the courses is to provide students with a ground to learn and practice (1) architectural drawing conventions, (2) the workflow of the design and the construction and (3) the sustainability and energy efficiency principles/ strategies/tools.

Sharing BIM as a common model, the courses have complementary but different scopes. ADPR III aims at developing skills for the architectural, engineering and construction (AEC) industry by presenting students (1) the architectural elements, (2) architectural drawing conventions (2D-3D) and (3) the BIM process. ADPR IV aims at developing skills and awareness on sustainability and the lifecycle of the building in an interdisciplinary and collaborative design environment by presenting students the basics of (1) building physics, (2) in-built simulation tools in BIM software, and (3) the sustainability and energy efficiency in buildings.

Two different scopes within a single tool, the BIM software offer architects to conduct simultaneous design, drawing/modelling and analysis platform (Jung, Rekola, & Häkkinen, 2018). Such integrated environment prioritizes the process rather than the product and has the potential to prevent the design process from fragmented and missing data. In this respect, BIM tools offer a coupled design and simulation processes, in contrast to the conventional understanding of building simulation as a post-design analysis tool (Aksamija, 2012). The coupling of design and simulation is crucial to support the architects during the design decisions with data, which also prevents premature design decisions (Aksamija, 2012). In this respect, BIM does not only provide a ground to practice coupled design modelling and analysis, but also has the potential to promote the holistic, cyclic and collaborative understanding in design and construction.

2.1 ADPR III: The Basics of Architectural Drawing, BIM and Building Construction

The ADPR III is structured on three parts as (1) introductory, (2) hands-on practice and (3) the term project. The introductory sessions present the collaborative relationship of the architect with other disciplines, the basics of BIM, AEC industries and the developing technologies in the field such as big data, file-to-factory (F2F) process, CAD-CAM technologies.

The one third of the semester is allocated to the hands-on practice sessions for the architectural drawing basics while addressing the building elements, their functions, construction materials and their details. The sessions are structured in three parts as (1) the exploration of the building element(s), (2) demonstration of the drawing methods in BIM environment, and (3) hands-on practice. ADPR III could be regarded as an introductory course for the construction basics complementing to the building technologies course module in the curriculum.

In line with the architectural drawing conventions, the content of ADPR III is expanded with free-form and parametric modelling environment in BIM tool, which enables the generation of adaptive geometries and mass models. The exploration of the tool capabilities is crucial particularly for the students in their early design education. It is observed that in their freshman years, students are attached to the capabilities of the tools, and they tend to design what they are able to model/draw with the tool, which brings them design-limitations. It is identified that students become more motivated to engage with BIM environments as they have explored the flexibility of the tool.

The rest of the semester is allocated to the term project. The students are asked to form groups and conduct brief research on an architect/architecture office and their works. They are also asked to select one building of the architect/architecture office and to find the drawings of the selected buildings. The architects and their selected buildings are presented by the groups. The research phase does not only enable students to explore the architects and their buildings but also to practice on the orthographic set and review the architectural drawing conventions. From the drawings and the images of the buildings, students generate the BIM models and simultaneously the orthographic set, renders and the animation for their selected building (Fig.1).

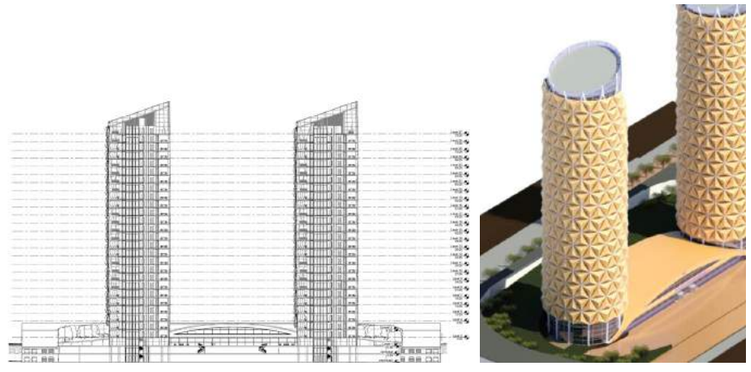


Fig.1: Section and model views from the generated BIM model of Al Bahar Towers by Azime Ecrin Akkaya- ADPR III

2.2 ADPR IV: The Basics of Sustainability, Building Energy Simulation, and BIM

The ADPR IV is structured in three parts as (1) a review of ADPR III, (2) hands-on analysis and (3) the term project. The ADPR IV starts by reviewing the ADPR III to corroborate the previous semester. The first task of the students is to evaluate and revise their ADPR III term project assignments. It is observed that reviewing the previous work allows students to see their weakness and provide an opportunity to strengthen their skills while re-familiarizing them with the BIM tool.

Following the similar structure of ADPR III, the one third of the semester is allocated for the hands-on exploration of building performance simulation tools which are integral to the BIM process and the tools. The sessions are structured in three parts as (1) the lecture on the elements of the building physics, (2) demonstration of the simulation method, and (3) hands-on practice.

There are a number of reasons to include building performance to the second-year curriculum within the architectural drawing course content. First, the building performance is the responsibility of the architect and the architectural education must raise awareness about the impact of the profession on the built environment, nature and the building occupants. Another reason is the need for the coupling of design processes and the building performance simulation, and the effective use of building performance simulation during the design process. The building performance parameters must be regarded, and the simulation tools must be integrated into the design process from the very beginning of the design process for their potentials to support the architect with well-informed design decisions. At this stage, the students must be well-equipped with such tools and understanding, and this course aims at this integration from the very beginning.

The content of the hands-on analysis sessions includes the basics and parameters of building physics such as the building orientation regarding the sun and wind studies and the exploration of the daylighting and energy analysis an the processes (Fig.2-3). As the key notions of sustainability, the material selection, vernacular and local technologies, embedded energy, carbon footprint, appropriate detailing and cost estimation are also part of the course content. In this regard, students are expected to develop a holistic understanding of sustainable/eco-friendly/conscious building design, process and its informative tools.

The rest of the semester is allocated to the term project. The students are asked to design a small-scale primary school with a site selection and a design scenario. They are expected to conduct research about their site-specific conditions such as weather and the local materials. The detailed building program is given to students during the hands-on analysis period as a BIM practice to generate the model prior to the project assignment. For each week, the students are expected to improve their designs and the BIM model and to share the improvements during the sessions with other students. Sharing improvements with each other is used as a method to sustain the dynamic, interactive and reciprocal learning process. It is aimed to implement the reflective practice to proliferate the exchange of the ideas (Visser, 2010). In this respect, the students could share their suggestions and contribute to other projects.

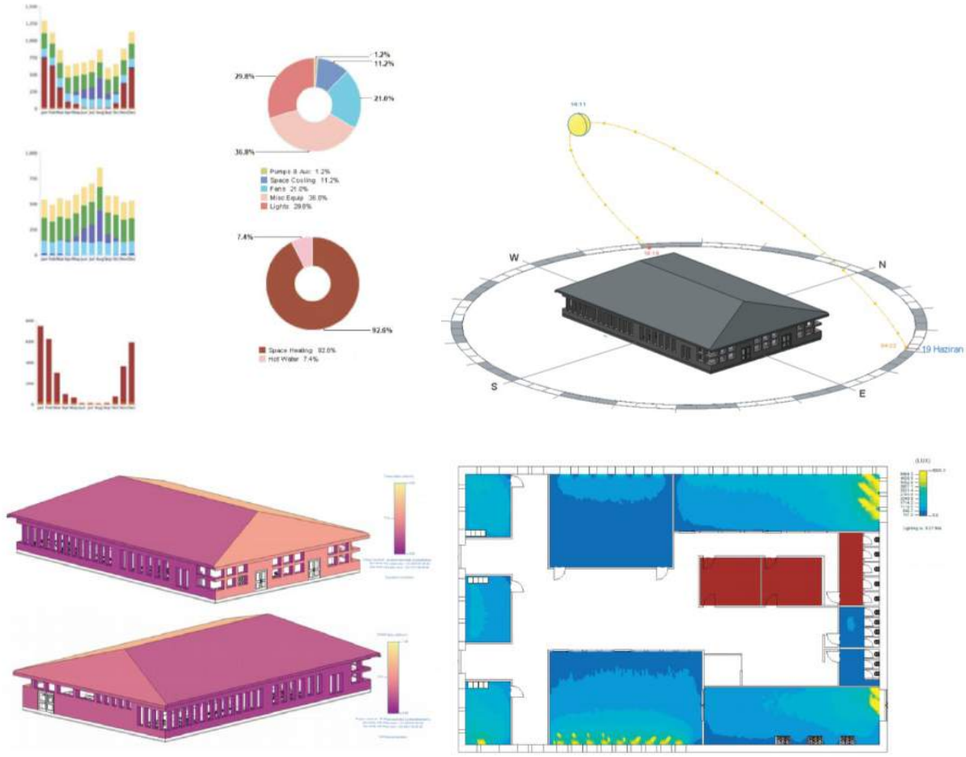


Fig.2: First energy analysis graphics from the generated BIM model a primary school project by Nursima Zengin- ADPR IV

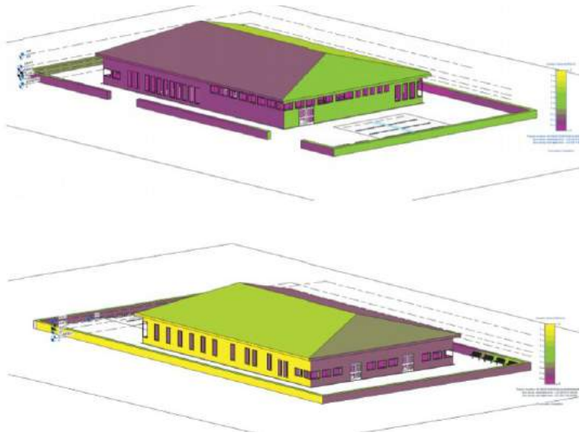


Fig.3: Last energy analysis graphics from the generated BIM model a primary school project by Nursima Zengin- ADPR IV

3 Evaluation of BIM-based Model for Architectural Representation and Representation Techniques Course

The evaluation of the courses is conducted via the questionnaires that are collected from the students to have their feedback and suggestions at the end of each semester. The content of the questionnaire is structured to obtain both the overall and detailed evaluation of the courses. The multiple-selection questions are to acquire quantitative data, while open-ended questions are to have the opinion of the students. From the questionnaires, there are a number of conclusions as follows:

- With the term project of ADPR III, students have an opportunity to explore and to blend, architectural drawing conventions, building information modelling and sustainability principles.
- ADPR IV becomes useful during their 3-month compulsory internship periods. Also, this course contributes to the students' literacy on analysis graphics and terminology in the field of energy and sustainability.
- Weekly assignments of the courses make students master the BIM and simulation tools (Fig 4).
- Both ADPR III and IV contributes to the building technologies and architectural design studio courses (Fig 4).
- With the hands-on practise sessions, the students have an opportunity to explore the simultaneous use of 2D and 3D media of architecture.

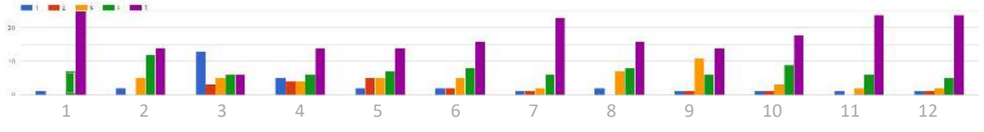


Fig.4: The graphics of the questionnaire for ADPR III-IV

1 to 5: from negative to positive

1: With the structure of the course, I learn the theory of BIM.
2: With the practice sessions of the course, I become able to generate BIM model.
3: I have used BIM tool actively in architectural design studio courses.
4: I have used BIM tool actively in building technology courses.
5: While using the BIM tool, I have explored the construction and design workflows.
6: The courses supported me in my other courses.
7: I have found the content of the course useful.
8: The course materials were adequate for the content.
9: The course hours were adequate.
10: The content of the courses motivated me.
11: The assignments had motivated us to practice BIM regularly.
12: I have found the courses useful in general.

4 Conclusion

This paper presents the BIM-based exploratory learning model as an alternative to conventional architectural drawing courses. It is concluded that the integration of BIM and sustainability principles to the conventional architectural drawing courses could contribute students to develop new skills and raise awareness on environmental issues and the professional design/ construction workflows.

References

Aksamija, A. (2012). *BIM-Based Building Performance Analysis : Evaluation and Simulation of Design Decisions Integration of BIM-Based Performance Analysis with Design*. (Aksamija 2010), 1–12.

Jung, N., Rekola, M., & Häkkinen, T. (2018). Extending Capabilities of BIM to Support Performance Based Design. *Journal of Information Technology in Construction*, *23*(January 2017), 16–52.

Pérez-Lombard, L., Ortiz, J., & Pout, C. (2008). A review on buildings energy consumption information. *Energy and Buildings*, *40*(3), 394–398. https://doi.org/10.1016/j.enbuild.2007.03.007

Visser, W. (2010). Schön : Design as a reflective practice. *Art + Design & Psychology*, 21–25.

Begüm Hamzaoğlu

hamzaoglu@itu.edu.tr

ITU, Istanbul, Turkey

Using Digital Fabrication Tools for Design Generation: An Experiment With 3-Axis CNC-Milling

Abstract: This paper describes an experimental student workshop on generating models using a 3-axis CNC-milling machine which took place in Istanbul Technical University, as an attempt to discuss the integration of digital fabrication tools to the design generation processes in architecture education. A large and growing body of literature in the computational design field has investigated the new design workflow where designers gain control over the parameters of fabrication processes instead of just the results. On the other hand, learning tool-based parameters and using them for generating new models is a different process than what the students are accustomed to in the current curricula. Considering student workshops as an opportunity for exploration, this study investigates the case where graduate students are asked to relate the parameters of CNC-milling toolpaths to the resulting shape transformations to design a geometric pattern. The experiments highlight the variety of possible pattern design generations that were simulated and produced with different milling toolpath strategies.

Keywords: *CNC-milling, Pattern generation, Computational design*

Introduction

Ever since digital fabrication tools such as CNC (Computer Numerical Control) machines started to become more available in fabrication laboratories of architecture schools, they have been used for rapid prototyping or 1:1 scale model building purposes. The usage of these tools is often assumed to be limited to producing precise physical models after the design of the final form is finished by using 2d or 3d digital modeling software. Therefore the responsibility to be familiar with the knowledge of digital fabrication is given to manufacturers or experts and avoided mainly in today’s design education. However, the decisions during fabrication processes have an evident impact on design outcomes since the form is generated

by material transformations based on particular tools and methods. Various researchers from pioneer digital fabrication laboratories developed experimental studies on fabrication-informed design processes (Gramazio et al. 2014; Oxman 2007). These studies suggest that digital fabrication methods can be used as a tool for generating new designs. This new approach invites designers to get familiar with the generative possibilities of the making process, yet, as Celani (2012) points out, design has long been seen as a prescriptive practice that finishes in the form of models and drawings before the construction starts. Therefore, the new process-focused workflow contrasts with today's design routines. This contradiction makes the role of learning digital fabrication tools in today's design education and the question of how to integrate this new methodology to current curricula an increasingly essential and exploratory area.

Over the last decade, various approaches have been proposed to understand the role of digital fabrication tools in design education. Celani (2012) notes that digital fabrication tools can be used for encouraging the development of experimental techniques in design education with a scientific approach. Similarly, Gannon and Brockmeyer (2014) suggest that students can learn from digital fabrication methods on how to respond to functional limits in contrast to virtual models where nearly everything is possible. Boza (2006) associates this responsiveness with real-world construction site conditions. In that sense, digital fabrication tools may also be useful for getting students familiar with integrating material limitations to their designs in various scales. As for the contribution of fabrication technologies to design generation, the possibility of "(un)intended discoveries", as mentioned by Boza (2006) and "the transfer of knowledge from other disciplines such as geometry and programming", as mentioned by Brell-Çokcan and Braumann (2013), were found useful for design students to enhance their design generation skills by means of variety and integrity.

Few researchers have addressed how designers can relate the fabrication parameters to the visual outcomes during the design process. Kieferle et al. (2008) draw our attention to the relation between the tool's movement capabilities and the various resulting geometries in the case of the hot-wire cutting method. Another study by Bidgoli and Cardoso-Llach (2015) proposes the abstraction of wire-cut foam surfaces in the form of Non-Uniform Rational B-Splines to reason about the relation between the geometry and the motion of the robotic arm. Brell-Çokcan and Braumann (2013) controlled the tool's movements using a visual programming tool and thus simulated every single step. They argue that the visual manipulation and simulation of each step allow students to get an intuitive feeling for the complex series of fabrication processes.

The integration of making and design has gained much attention in the field of computational design, not just in the context of digital fabrication but analog crafts as well. The critical issue of this integration is establishing a rule-based approach for formalization and visual reasoning of making processes, as shown by Gürsoy and Özkar (2015). In this context, several studies have proposed formalization methods for different making processes. Harrison et al. (2015) represented a set of folding actions as formal generative rules. Their study highlights the exploration of new forms and spatial relations derived from the properties of the material and the actions. Gürsoy et al. (2015) focused on the sensory aspects of material manipulations in the case of bending cut patterns and formalized the actions and transformations in the form of shape rules. Their method of "designer-centered" formalism focus on the relation between the designer's involvement and its formal outcome. Jowers and Maclahlan (2014) formalized the

actions and transformations in the form of shape rules. Their method of "designer-centered" formalism focus on the relation between the designer's involvement and its formal outcome. Jowers and Maclahlan (2014) formalized the fabrication of multi-material surfaces as shape transformations. Overall, these studies highlight the need for decoding and formalizing making actions in order to track and reason about their generative process visually.

Motivated by the above mentioned generative approaches to integrating making and design, this study presents experimental student works based on generating new designs by manipulating the parameters of the 3-axis CNC-milling process. The experiments were conducted in the form of a one-week workshop as part of the Digital Fabrication and Prototyping in Design course directed by Mine Özkar and Ethem Gürer at Istanbul Technical University Architectural Design Computing Program. CNC-milling method provides an exploratory and intuitive making process since it does not require a final model as input and allows students to simulate the outcomes of various actions rapidly with the help of CAM simulation software. At the start of the workshop, a tutorial on visual implementations of CNC milling methods was introduced. In a previous study (Hamzaoğlu and Özkar 2017) generation of various geometric patterns by using a given set of rules was examined. In this case, students were not given any rules. The students were first asked to create a two-dimensional geometric pattern without restraint and then transform it into a three-dimensional model using CNC-milling simulation software. The purpose was to examine how students respond to visual outcomes of CNC-milling methods during their design generations in an attempt to discuss the integration of digital fabrication tools to design education.

Visual Implementations of CNC-Milling Methods

A typical production process of a CNC-milled model consists of the generation of the toolpath and its execution by the machine. The toolpath is the path that the cutting tool follows in order to shape the material. The machine can process all features of the toolpath (such as orientation, step size, and speed) written in a text file format in CNC programming language (G-Code). Mostly, a toolpath strategy for 3-axis CNC-milling consists of several milling operations in order to carve out a specific form. The milling operations range from rough operations for removing large amounts of material to finishing operations to achieve precision. All operations can be executed in a particular direction, with a particular step size in horizontal and vertical axes. Similar to other manufacturing activities, there are many interrelated factors such as the shape and diameter of the tooltip, material thickness, geometry of the reference shape, and speed. Therefore, as already mentioned by Aitcheson et al. (2005), the CNC-milling is not an automatic process; instead, case-specific instructions should be given to the machine step by step. In other words, there are many ways to cut the same geometry; hence, the generation of the toolpath itself is a creative process. Moreover, as a result of the case-specific nature of the process, explicit knowledge regarding the parameters such as speed and step size is nearly impossible to find in the literature. Expert users claim that the knowledge must be learned by experience.

The formation of a CNC-milled model is a subtractive process. When using CAM software for generating the toolpath, the process can start with a digital two-dimensional or three-dimensional geometry as reference. Two-dimensional reference geometry may consist of lines or curves, whereas three-dimensional geometry may be in the form of a surface or a solid

model. However, the resulting form will be a three-dimensional carved material sheet with a certain thickness.

CAM software provides predefined milling operations for various purposes. The 3-axis operations that were practiced in this study include 2 ½- and 3-axis milling methods. 2 ½ axis milling methods are used for generating toolpaths along reference lines or inside closed geometries in the form of polylines or curves. In all operations, the shape and dimension of the tooltip determine the form of the carved geometry. In our experiments, students were provided with flat-shaped and v-shaped milling tools. After determining which tool to use, other milling parameters can be specified and simulated for exploration. For instance, in 2 ½ axis milling operations, the cut depth is defined by the user. In contrast, in 3-axis milling operations, the cutting tool scans the three-dimensional surface geometry by using specific values for the step size, the number of steps, the coordinates of the starting point. Furthermore, the cut pattern and direction are among the other parameters that shape the carved geometry.

Experiments

The experiments started with the generation of two-dimensional geometric patterns. In the next step, students were asked to create CNC-milling toolpaths to generate final patterns in the form of CNC-milled models. Most of the students preferred to transform the geometric pattern into a three-dimensional surface using 3d modeling tools. For example, one student first extruded the 2d pattern with different height values and used the 3d surface model as the reference geometry of the milling process. The student manipulated the surface by milling the geometry using cutting tools with different parameters such as 5 mm and 2 mm. Figure 1 shows the student's model generation process.

On the other hand, some students chose to use the milling actions to transform the two-dimensional pattern into a three-dimensional surface directly. One example of such a process is shown in Figure 2. In this example, the students experimented with two different 2 ½ axis milling methods to generate the toolpaths. The pocketing method provided walls by milling the interiors of selected shapes. The facing method eliminated the walls by milling both the boundaries and the interiors of selected shapes on the pattern. Various cut depth values were used for different parts of the pattern to generate the final designs.

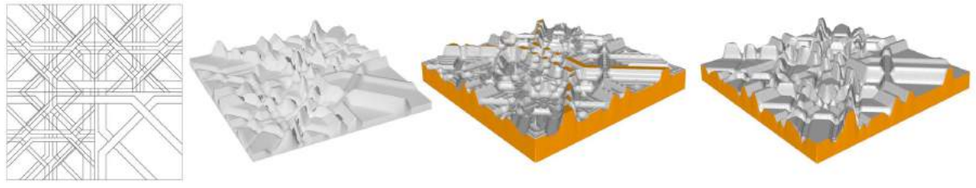


Figure 1:Three stages of the model generation (from left): Generating a 2d pattern, 3d modeling of a surface based on the pattern, generating and simulating milled model variations (Image courtesy: Barış Çağlar)

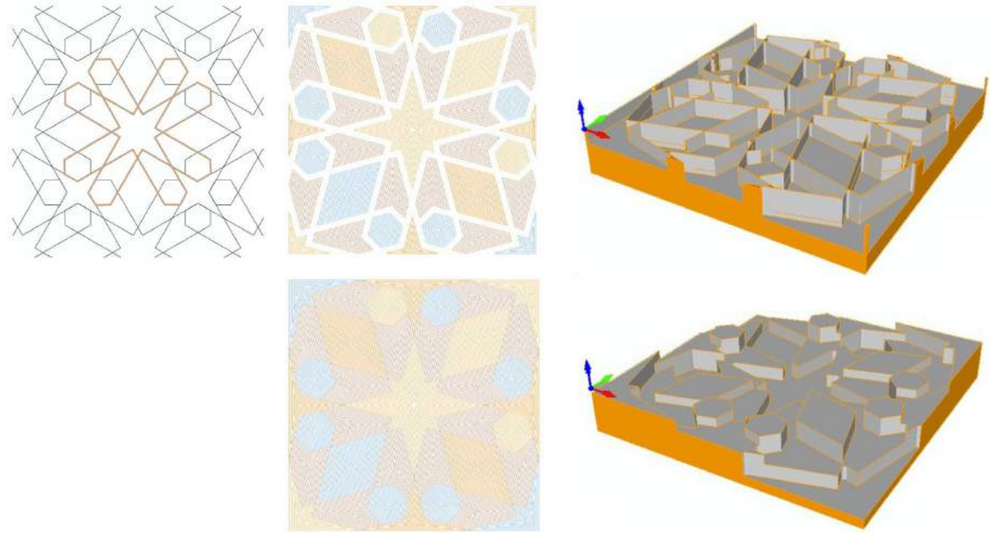


Figure 2: Three stages of the model generation (from left): Generating a 2d pattern, generating 2 ½ axis toolpath variations, simulating milled model variations (Image courtesy: Şeref Atilla Gürbüz)

Simulation of the milling process provides visual outcomes of each toolpath modification in the 3d model format. Students were expected to record each parameter change, the model outcome, and the abstraction of their toolpath manipulations in order to relate the different toolpaths to their outcomes visually. One student generated toolpaths for generating linear patterns in different directions on angled surfaces. The linear patterns were formed by the leftover materials on the carved surface caused by using a larger tool step size than the cutting tool's diameter. The toolpath design idea originated from the hexagon-based pattern that was extruded in different directions. In this case, the student divided the hexagon units into regions and assigned different toolpath parameters for each region. The variations are shown in Figure 3. The first variation was generated by using 0 degrees as the cutting angle in all regions, whereas the second variation includes three different cut angles (0, 60, 120). The third and fourth variations were formed by using a horizontal milling method, which carves out the surface in constant Z-planes in several steps. The difference between the third and fourth variations is the tool diameter and the number of steps generated on the surface. The fifth variation was generated by using the radial milling method, which resulted in lines oriented towards the center of the hexagon.

Another student experimented with the spiral milling method on a three-dimensional surface model. Figure 4 shows the model generation process. The process started with generating a 2d geometric pattern and transforming it into a 3d surface. The student then used the spiral-shaped toolpaths to manipulate the surface. The variations were generated first by using the milling simulation software, and at the end one of the variations was produced using foam as the material. Each row in Figure 5 shows the toolpath, the model outcome, and the orthogonal drawing of a part of the model for three different variations. In the first variation, the toolpath is denser, and the tool diameter is smaller (2 mm), which resulted in leaving narrow shapes on the carved material. In the second and third variations, the distance between the toolpath parts is wider, which leaves larger shapes on the carved material. The difference between the

second and third variations was caused by using small (2 mm) and large (5 mm) cutting tool diameters. The orthogonal drawings highlight the generation of various shapes that emerged with different toolpath decisions.

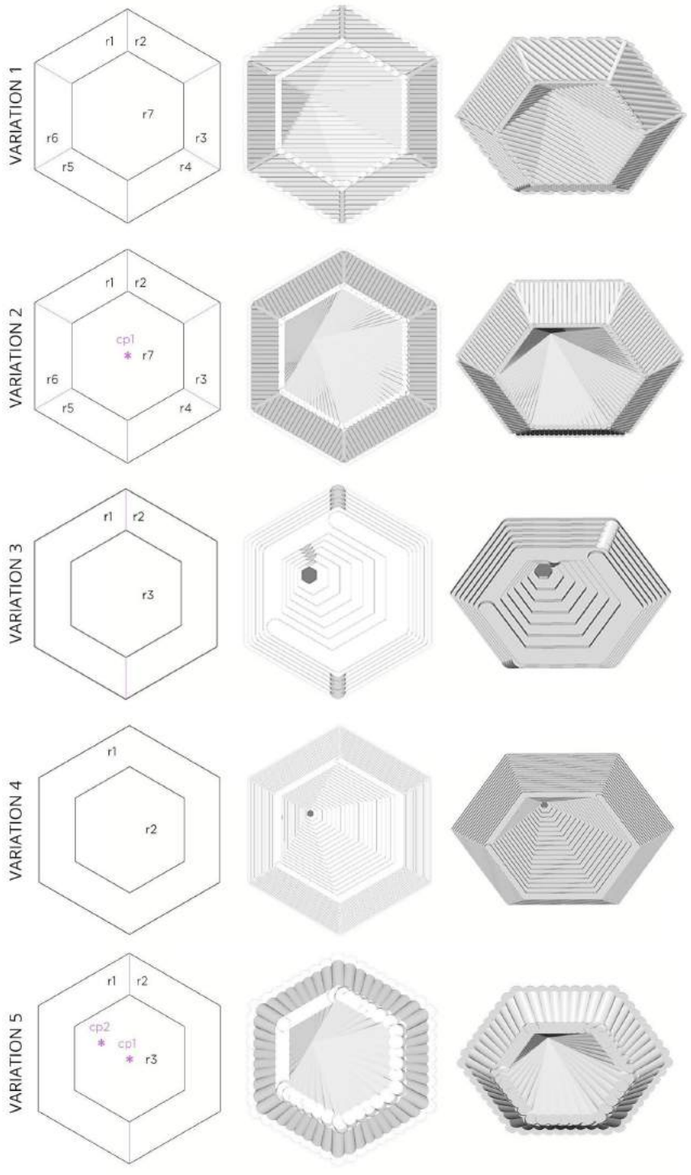


Figure 3: Variations by assigning different toolpath parameters to different regions (from left): regions to assign toolpaths on the hexagonal units, top view and perspective view of the 3d model outcomes (Image courtesy: Rana İmam)

Figure 4: Three stages of the model generation (from left): Generating a 2d pattern, 3d modeling of a surface based on the pattern, CNC-milled material outcome (Image courtesy: Nazlı Bahar Ursavaş)

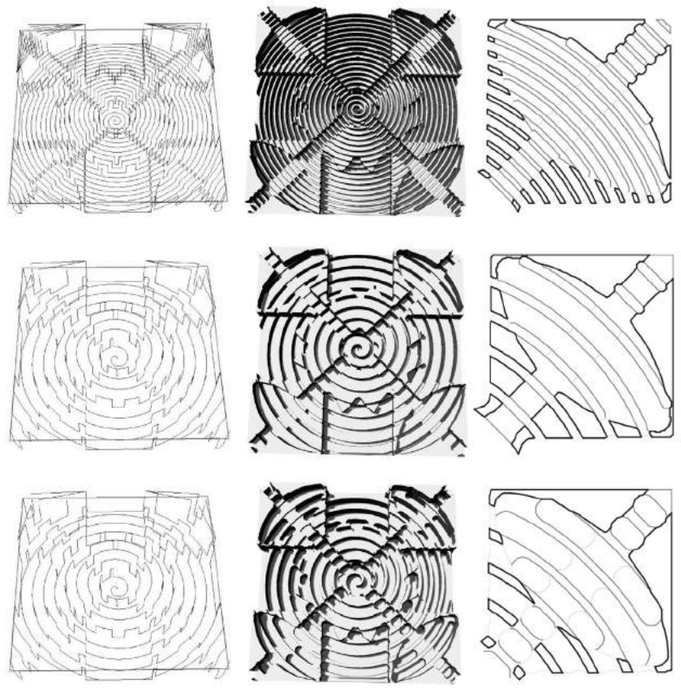


Figure 5: Variations by using different toolpath parameters (from left): toolpaths, top view and of the 3d model outcomes, orthogonal drawing of a part of the milled model (Image courtesy: Nazlı Bahar Ursavaş)

Conclusion and Discussion

The experiments conducted with a 3-axis CNC-milling machine showed that various pattern designs can be generated by manipulating the milling toolpaths. Although the study is limited to a small sample of experiments, the findings suggest that analyzing the visual implementations of milling parameters enhances pattern design generation through diversity and integrity. The outcomes may help in establishing a more integrated approach for using digital fabrication tools in design education. However, future research is necessary to prove this assumption.

The students' most frequent feedback showed that exploring tool movements and translating them into visual design ideas is unusual for them. One of the critical aspects of the experiments was that they were done by graduate architecture students, which means that the subjects have already been accustomed to prescribing end forms rather than experimenting and generating

forms with making parameters. For that matter, most of the students during this workshop, and also in previous workshops, tend to design a 3d model before they start experimenting with the milling process. Further experiments with novice design students will be critical in the next steps of this research to discuss in what stage of design education digital fabrication tools need to be integrated.

The students' other feedback was that it is hard for them to anticipate the formal outcomes of the milling process. As Knight and Stiny (2015) already concluded, the challenge of integrating design and making is that formal outcomes of each action depend on various and interrelated parameters such as tools, materials, and actions. Therefore, design generation based on making parameters is a case-specific process based on discoveries and feedback loops by nature. In this case, records of the visual outcomes and associated milling parameters enabled students to start with decoding the relations between the tool movements and their formal implementations. Moreover, experiments show that the formal relations differ from case to case. For example, the variations shown in Figure 3 were related to the direction angles of the linear patterns. In contrast, the variations shown in Figure 4 were related to the shapes of the leftover materials. Future steps should include investigations on the formalization of material transformations in milling and their potentials in design generation processes.

Acknowledgments

I would like to thank the graduate students of the workshop Barış Çağlar, Nazlı Bahar Ursavaş, Rana İmam, and Şeref Atilla Gürbüz for providing material from their projects.

References

Aitcheson, R., Friedman, J., & Seebohm, T. (2005). 3-Axis CNC Milling in Architectural Design. International Journal of Architectural Computing, 3(2), 161–180.

Bidgoli, A. & Cardoso-Llach, D. (2015). Towards A Motion Grammar For Robotic Stereotomy.In CAADRIA 2015 Conference Proceedings, 723 -732.

Boza, Luis Eduardo (2006). (Un) Intended Discoveries Crafting the Design Process. In Synthetic Landscapes, pp. 150–157. Proceedings of the 25th Annual Conference of the Association for Computer-Aided Design in Architecture.

Brell-Çokcan S., Braumann J. (2013) Industrial Robots for Design Education: Robots as Open Interfaces beyond Fabrication. In: Zhang J., Sun C. (eds) Global Design and Local Materialization. CAAD Futures 2013. Communications in Computer and Information Science, vol 369. Springer, Berlin, Heidelberg.

Celani, G. (2012). Digital Fabrication Laboratories: Pedagogy and Impacts on Architectural Education, Nexus Network Journal, 14(3), pp. 469-482.

Kieferle, J. B., Katz, N. & Thaleck, K. (2008). From Shape to Fabrication. In Architecture in Computro: 26th eCAADe Conference Proceedings, Antwerpen, Belgium, 537-544.

Gannon, M. and Brockmeyer, E. (2014). Teaching CAD/CAM Workflows to Nascent Designers. In Proceedings of the 19th International Conference on Computer-Aided Architectural Design in Asia (CAADRIA). Kyoto, JP. pp. 801–810.

Gramazio, F., Kohler, M. and Langenberg, S. (2014) Fabricate: Negotiating Design & Making, gta Verlag, Zurich.

Gürsoy, B., Jowers, I., & Özkar, M. (2015). Formal Descriptions of Material Manipulations. In Computer-Aided Architectural Design Futures. The Next City-New Technologies and the Future of the Built Environment (pp. 439-457). Springer Berlin Heidelberg.

Gürsoy, B. ve Özkar, M. (2015). Visualizing Making: Shapes, Materials and Actions. In Knight,T. and Vardouli, T. (Eds.), Design Studies 41(A), 29-50.

Hamzaoğlu, B., Özkar, M. (2017). Hesaplamalı Örüntü Tasarımında Yapım Kuralları: CNC Frezeleme ile Bir Deneme. MSTAS 2017 İmkansız Mekanlar, Olanaksızın Olanağı [11.Mimarlıkta Sayısal Tasarım Ulusal Sempozyumu], Orta Doğu Teknik Üniversitesi, Ankara, 10-21.

Harrison, L. Earl C., Eckert, C. (2015). Exploratory making: Shape, structure and motion. Knight, T. Ve Vardouli, T. (Ed.), Design Studies 41(A), 51-78.

Knight, T., Stiny, G. (2015). Making Grammars: from Computing with Shapes to Computing with Things. In Knight, T. & Vardouli, T. (Eds.), Design Studies, 41(A), 8-28.

Jowers, I. & MacLahlan, L. (2014). Formalising Flexible Multi-material Surfaces as Weighted Shapes. SA'14 SIGGRAPH Asia 2014 Creative Shape Modeling and Design,Shenzhen.

Oxman, N. (2007). Digital Craft: Fabrication Based Design in the Age of Digital Production. In Workshop Proceedings for Ubicomp 2007:International Conference on Ubiquitous Computing. September; Innsbruck, Austria, 534-538.

Schodek, D., Bechthold, M., Griggs J. K., Kao, K., & Steinberg, M. (2005). Digital design and manufacturing: CAD/CAM applications in architecture and design New York: Wiley – Academy Press.

Süheyla Müge Halıcı
halicis@itu.edu.tr

6

ITU, İstanbul, Turkey

A Proposal for Implementing AR Models into Architectural Design Education/Curriculum

Abstract: In architectural design education, students have always been encouraged to have some practice on both physical and digital tools. Augmented reality (AR), as one of the recent promising technologies in the field of architecture, facilitates its users to engage with the digital realm within the real environment as a kind of merged realm. This display technology can provide a sense of depth, offer seamless interaction while designers are still not detached from the physical world. This merged realm, the united of physical and digital, brings different potentials for architectural education. In both architecture and education studies, AR has been reported as exciting, and engagement technology, which could be leveraged in architectural design education.

The goal of this paper is to present initial attempts of implementing AR models in architectural design education. Three intensive half-day workshops in a row were conducted. Through examining each workshop process, outputs, and behaviors of participants, this paper aims to discuss the impact of the AR model in architectural design education, which indicates using the AR technology have been providing architecture students with a new tool to present and inspect their design.

Keywords: *Augmented Reality, Design Modelling with/in AR*

Introduction

One of the most promising emergent technologies that currently exist is augmented reality (AR), which allows interactive experience with overlay 3D computer graphics onto the real world. According to Milgram and Kishino, AR is placed on the virtual continuum, spanning

from the real environment at one side to the virtual environment at the other side (Milgram & Kishino, 1994). Recently, AR became more affordable, user-friendly and popular with recent technological developments in mobile devices, such as handhelds or wearable glasses.

In the age of the fourth industrial revolution, AR has become popular in the architecture engineering and construction (AEC) industry. In AEC industry, AR offers designers and engineers to put, and analyze their design ideas in the physical environment, and owners to gain an immersive and interactive experience (Figure 1), and property sellers to communicate with customers efficiently (Rahimian et al., 2014). Because of easy access to project information on the construction site, AR supports decision-makers, even better than PC-based and traditional visualization techniques (Meza et. al., 2015; Hansen & Kjem, 2018). Designers have benefits of 3D assembly and manufacture instructions via the AR environment on-site (Fazel & Izadi, 2018). In addition, AR technology also supports effective visualization which provides an understanding of complex performance simulations with improved visual perception for designers (Ergün et al., 2019). AR technology has been using in many different stages of the design process, as indicated above. There are also significant attempts on the implementation of AR technology in the early stage of the design process.

Sketchand+ is a preliminary prototype to make an initial attempt to use AR in the early architectural design stages (Seichter, 2003). Seichter showed that collaborative tangible interaction with models in AR provides design investigation environment. Dünser and his colleagues' findings indicated that AR can be used to develop useful tools for spatial ability training (Dünser et al., 2006). In 2007, Seichter presented 'Augmented Reality Urban Design Studio' as another early attempt to bring collaborative design environment within Augmented Reality (Seichter, 2007). Moreover, recent research has documented how a designer's behavior can be affected by this representation method (Gül, 2017; Gül et al., 2018). The use of an AR-based interface in the design process provides a positive contribution to the design in terms of interaction with the physical and digital environment.

Figure 1: Photo of Apple Headquarter model with object-based recognition AR application (Credit: Halici)

AR Models in Architectural Design Education

In the field of architecture, one of the most important roles of models is to externalize initial design ideas and facilitate the evaluation of the design. Models lead architects a reflective dialogue with concrete materials, spatial figures, proportions, dispositions, and shapes (Yaneva, 2005). Models offer communication between architects and other related parties as well. Model making process facilitate the inspection of the complex visual relationships (Porter and Neale 2000). In architecture education, one of the main goals of using models is to develop the ability to read space, scale and spatial relations of design through those 3D design representations. Thus, researchers and pedagogues are eager to focus on this new visualization tool, as a learning tool at the same time, for improving the current teaching models in the field of architecture.

> *"unique ability to create immersive hybrid learning environments that combine digital and physical objects, thereby facilitating the development of processing skills such as critical thinking, problem-solving, and communicating through interdependent collaborative exercises."* (Dunleavy et al., 2009)

While AR technology combines the real and the virtual reality, it also enables participants to interact with digital information embedded within the physical environment (Dunleavy & Dede; 2013). As a learning tool, AR enables students to see the world around them in different views, and engage within the same context without disconnected (Klopfer & Sheldon, 2010). Moreover, using AR technology in drafting or computer-aided design keeps the students engaged with, and excited in the learning process (Villano, 2008). In various recent research studies, AR technology highlighted as low-budget and exciting representation method in both the education and architecture fields (Pombo and Marques, 2017; Fleck et al., 2015; Camba et al., 2014). Bach and his colleagues (2018) stated that visualization environments that match human perceptual and interaction capabilities better to the tasks at hand improving the understanding of 3D visualizations. Visualization is the key in the design development, as a part of geometrical thinking and modeling, it is crucial in solving problems related to 3D space. In that sense, AR technology has the potential to enable also architecture students more engaged to experience their 3D digital models in a real environment in different scales, and even interact with them. When designers develop their 3D digital models through an AR environment their sense of scale and space was significantly more realistic than those who developed their spatial perceptions through a flat-screen or the physical model. In 2013, according to the study of Redondo et al., architecture students gained a more complex understanding of the relationships of their design; they have been satisfied and motivated by these new methodologies. Thus, AR has suitability as a new tool to be used in learning processes (Redondo et al., 2013). In 2015, Özenen & Şener also presented a study that revealed AR technology has many potentials to be used in architectural education (Özenen & Şener, 2015).

Despite all these attempts, only a few studies were conducted on the implementation of AR model in a design studio curriculum, in the early design stages. This study aimed to understand AR as a visualization environment in the design development, and assess AR as a learning tool in the early phase of design for architecture students. In order to understand the potential of AR model in architecture education, three workshops were conducted. In this study, the observations and findings of these workshops are presented and discussed.

Workshop Series of Augmented Cube

In 2017, a group of researchers in Istanbul Technical University, who are interested in AR technology, established a research group, Augmented Cube[1]. This group has conducted several workshops in order to introduce AR technology to design students in different universities. In this study, three half-day workshops of Augmented Cube (AC 1.1, AC 1.2 & AC 2.2) were presented. All participants of these workshops were architecture students, having no prior experience in AR. In those workshops, the participants were introduced about AR, basic-level game engine program Unity and lastly the AR plug-in Vuforia for Unity to build AR applications for mobile devices. At the end of the workshops, the participants had an opportunity to visualize their proposals on their mobile devices. The study compares those three workshops. Each workshop had different programs and participant groups, as shown in Table 1.

	Participants	Physical Object	Task	Design	Modeling Software	Marker	Interaction	Product
AC 1.1	8 master arch. students	cube	generative design	3D space design	free	image-based	grasp, rotate object	
AC 1.2	16 second year arch. students	cube	rule-based design	3D space design	free	image-based	grasp, rotate object	
AC 2.2	12 second year arch. students	architectural model	conceptual design	3D conceptual model	Unity	model-based	grasp, rotate object, rotate around the object, pointing	

Table 1: Focus groups of three workshops.

In general, the system architecture of AR consists of mainly tracking and registration systems. According to those systems, there are several methods to reach the AR environment. One of the most common, affordable, and easy-used tracking and registration technique is the image-based marker method. Using an image as a marker helps the devices' camera to read the physical world and registering the virtual content on related reference coordinate and orientation. Another technique is using a physical object, as a model-based marker. Both AR techniques are affordable, and need less equipment than other AR techniques. Thus, in the first and the second workshops, the image-based; and in the third workshop, the model-based marker technique was introduced (Table 1).

In this paper, the insight of the impact of the employment of the AR technology in design education through these three workshops is presented. The paper concludes with some highlights based on the observation of these workshops about the integration of AR as an emerging learning tool into the architectural design education.

Workshop 1 (AC 1.1)

In the first workshop (AC 1.1), participants were 8 master's degree architecture students. In the introduction part, participants learned the procedure of building a marker-based AR application to generate an AR model, and manipulate the AR model through a graphical user interface. In the second part of the workshop, the design task was introduced as the 'designing an AR cube' that could run on mobile devices (smartphones and tablets). Studio instructors gave participants a physical cube, and assigned each face of this cube to either one student or two students as the group. Then, participants were asked to design a space with generative design approaches, but they also needed to consider the design proposals of the adjacent faces of the cube during the design process. In this workshop, participants were free to choose their own 3D modeling programs. Then, they exported their initial proposals to Unity and continued to develop their AR models there.

Workshop 2 (AC 1.2)

In the second workshop (AC 1.2), participants were 16 second-year architecture students, who were asked to develop their own image-based AR model, again. The same structure of the previous workshop (AC 1.1) was implemented. But in the second part of this workshop, participants were encouraged to do a small exercise from second-year design studio syllabus with this emergent technology, AR. By providing detailed information about design expectation, participants were asked to generate their own rules to design the task. Similarly, participants were free to choose their own 3D modeling program. During this workshop, the participants were encouraged to discuss design proposals by hands-on methods such as sketching or physical model making, too.

Workshop 3 (AC 2.2)

In the third workshop (AC 2.2), participants were 12 second-year architecture students. The program of this workshop focused on experiments of the AR technology and shifted with model-based AR. In the introduction part, participants learned the procedure of building a model-based AR application to generate the AR model. Participants were divided into three groups and used pre-modeled objects. They overlaid virtual 3D models on those analog models. Participants were asked to study on a conceptual design for their analog models by using simple geometric shapes. In this workshop, participants were only allowed to use Unity as a modeling tool.

Observation and Findings

In each workshop, the participants engaged with the AR models easily. Participants were surprised by the outcomes of the workshops, too. Bringing a digital representation into the physical world, and similar feeling of grasping the proposal in a short time period is completely an unusual experience for the participants which means the AR environment provides new motivation to the users. Thus, the AR environment makes designers more engaged with their design proposal process. Different student profiles didn't affect the behaviors of participants or the workshop process. The inspection of the AR model from a different point of view in the physical environment gave participants the opportunity to explore 3D space better. They could understand the relations between digital and physical models more.

Participants enjoyed holding and rotating the physical cube while looking at the virtual designed space. There were two sizes of the same cube in AC 1.1 and AC 1.2. Participants looked, grasped and experienced their digital design with both sizes (Figure 2). In this way, they had a chance to explore the scale differences and variations through AR technology. Design proposals of those two workshops were quite interesting because some participants challenged and got out of the box. They pushed the limits of the AR environment and proposed intriguing design ideas which exceeded the cube's boundary. Within the limited time and experience,

1 Augmentedcube.com

participants explored the potential of the AR, space idea, and relationships with neighborhood.

In the third workshop (AC 2.2), participants got a chance to work with different kind of 3D visual information with analog models. (Figure 3). Then, they developed their scene with digital conceptual models. Instead of grasping the model and turning it, they leaned on the model and walk around it. Participants gestured by pointing on the model when they highlighted similarities with the key elements on virtual mass. This refers that participants tend to act for visual inspection of the design proposal and communicate through an AR environment.

On the other hand, there were some disadvantages in dealing with new technologies in a short time period. Participants had struggles and limits on learning new tools while working in groups. But, most of them got the knowledge and sense of the AR environment and its features mainly. In addition, using model-based AR model (AC 2.2) causes sometimes error because of tracking issues in Vuforia. To prevent this technological deficiency, participants had to use solid analog models.

Figure 2: Interactions of participants through different device's cameras – AC 1.1 & AC 1.2

Figure 3: Model-based marker study – AC 2.2

Concluding Remarks

In half-day intensive workshops, without prior training, participants were introduced to the basic concepts of AR. They had the opportunity to apply this knowledge to develop their initial design ideas as an AR model, and experience it in an AR environment for the first time. The AR environment challenged participants to think differently about their design ideas. Constraints of the physical world and analog models became limitless in terms of boundaries on design ideas. AR enables visualization of invisible concepts, events, and abstract concepts in the

AR in architecture education enables establishing a unique combination of collaboration and communication of an interactive design process can be transparent and immediate.

In architecture education, AR foremost increases interest and enhances enjoyment, which raises the level of engagement. Thus, AR enhances learning motivation. AR is a convenient way to take a digital model to a real environment for experiencing it to understand spatial relations and quality of space. Because of enhancing spatial ability, the AR model will become more pervasive as a learning tool in architecture education.

In conclusion, this study could be considered as an early attempt and development of the integration of emergent representation of the AR technology for the future architecture curricula. Besides observing the potential of the AR in terms of enhancing the perceptual and representative feature of visualization, the implementation of the AR to curricula should also be examined and evaluated with more comprehensive studies.

Acknowledgment

I would like to thank, studio instructors, Prof. Dr. Leman Figen Gül, Assoc. Prof. Dr. Güzden Varinlioğlu, Can Uzun and Muzaffer Karslı. The first workshop (AC 1.1) was funded by the Scientific and Technological Research Council of Turkey (TUBITAK), PN: 115K515.

References

Bach, B., Sicat, R., Beyer, J., Cordeil, M., & Pfister, H. (2018). The Hologram in My Hand: How Effective is Interactive Exploration of 3D Visualizations in Immersive Tangible Augmented Reality?. *IEEE transactions on visualization and computer graphics*, *24*(1), 457-467.

Camba, J., Contero, M., & Salvador-Herranz, G. (2014, October). Desktop vs.mobile: A comparative study of augmented reality systems for engineering visualizations in education. In *Frontiers in Education Conference* (FIE), 2014 IEEE (pp. 1-8). IEEE.

Dunleavy, M., & Dede, C. (2013). Augmented Reality Teaching and Learning. Handbook of Research on Educational Communications and Technology, 735–745.

Dunleavy, M., Dede, C., & Mitchell, R. (2009). Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. *Journal of Science Education and Technology, 18*(1), 7-22.

Dünser, A., Steinbügl, K., Kaufmann, H., & Glück, J. (2006, July). Virtual and augmented reality as spatial ability training tools. In *Proceedings of the 7th ACM SIGCHI New Zealand chapter's international conference on Computer-human interaction: design-centered HCI* (pp. 125-132). ACM.

Ergün, O., Akın, Ş., Dino, İ. G., & Surer, E. (2019). Architectural Design in Virtual Reality and Mixed Reality Environments: A Comparative Analysis*. In IEEE VR 2019, the 26th IEEE Conference on Virtual Reality and 3D User Interfaces.*

Fazel, A., & Izadi, A. (2018). An interactive augmented reality tool for constructing free-form modular surfaces. *Automation in Construction, 85*, 135-145.

Fleck, S., Hachet, M., & Bastien, J. M. (2015). Marker-based augmented reality. *Proceedings of the 14th International Conference on Interaction Design and Children - IDC 15.* DOI:10.1145/2771839.277184.

Gül, L. F. (2018). Studying gesture-based interaction on a mobile augmented reality application for co-design activity. *Journal on Multimodal User Interfaces, 12*(2), 109-124.

Gül, L. F., Uzun, C., & Halıcı, S. M. (2017, July). Studying Co-design. In *International Conference on Computer-Aided Architectural Design Futures* (pp. 212-230). Springer, Singapore.

Hansen, L. H. & Kjems E. (2019). Augmented Reality for Infrastructure Information: Challenges with information flow and interactions in outdoor environments especially on construction sites. In *37th eCAADe Conference Proceedings. Porto, Portugal,* Volume 2 (pp. 473-482).

Klopfer, E., & Sheldon, J. (2010). Augmenting your own reality: Student authoring of science-based augmented reality games. New Directions for Youth Development, 128 (Winter), 85–94.

Koçer Özgün, F. N. & Alaçam S. (2019). An Augmented Reality-Based Interface Proposal For Early Design Stages. MSTAS, 137-152.

Meza, S, Turk, Z and Dolenc, M 2015, 'Measuring the potential of augmented reality in civil engineering', Advances in Engineering Software, 90, pp. 1-10.

Milgram, P., & Kishino, F. (1994). *A TAXONOMY OF MIXED REALITY VISUAL DISPLAYS.* Paper presented at the IEICE Transactions on Information Systems.

Özenen, G., & Şener, S. (2015). Evaluating the impact of augmented reality of augmented reality systems for model-making in architectural education and design studios. *Sakarya University Journal of Science, 19*(2), 197-201.

Pombo, L., & Marques, M. M. (2017). Marker-based augmented reality application for mobile learning in an urban park: Steps to make it real under the EduPARK project. *2017 International Symposium on Computers in Education (SIIE)*. DOI:10.1109/siie.2017.8259669

Porter, T., & Neale, J. (2000). *Architectural supermodels: physical design simulation*. Architectural Press.

Rahimian, F. P., Ibrahim, R., Wang, J., Wang, X., Shou, W., & Xu, B. (2014). Integrating BIM and augmented reality for interactive architectural visualization. *Construction Innovation.*

Redondo, E., Fonseca, D., Sánchez, A., & Navarro, I. (2013). New strategies using handheld augmented reality and mobile learning-teaching methodologies, in architecture and building engineering degrees. *Procedia Computer Science, 25*, 52-61.

Seichter, H. (2003). Sketchand+ A collaborative augmented reality sketching application. Proceedings of the Conference on Computer-Aided Architectural Design Research in Asia (CAADRIA 2003), in A. Choutgrajank, E. Charoensilp, K. Keatruangkamala and W. Nakapan (eds), 18-20 October, Bangkok, Thailand, 209-219.

Seichter H (2007) Augmented Reality and Tangible Interfaces, in A Dong, A Vande Moere & JS Gero (eds) Collaborative Urban Design, CAADFutures'07, Springer Dordrecht, 3–16

Villano, M. (2008). When worlds collide: An augmented reality check. *THE Journal, 35*(2), 33-34

Yaneva, A. (2005). Scaling up and down: Extraction trials in architectural design. *Social Studies of Science*, *35*(6), 867-894.

Zissis Kotionis
kotionis@gmail.com

7

UTH, Thessaly, Greece

Model and the Object in Assemblage

The Anthropocene criticism leads to the conception of design and making not as an introduction of new forms in new territories but rather as an assemblage of already existing material. This material is included into our secondhand world of things.

An approach to object-making includes the object in all scales and in different practices such as design, sculpture, installations, building design. These practices are all one: object making. Object-making is conceived as model-making in all scales. All objects are models of themselves. Then in a way object-making is model-making. The notions of prototype and paradigm are questioned in parallel.

Object-making is not considered as a process to bring out things anew. It rather considers making as a process of assemblage of already existing material, techno natural particles and reused objects. Then the question is for the subject: Who assembles? We are confronting architectural design as if it could configure a DIY construction process.

Tactics of modeling and assemblage are briefly discussed in a combination of samples from private and educational work.

Spartaco Paris *spartaco.paris@uniroma1.it*
Roberto Bianchi *roberto.bianchi@uniroma1.it*
Afshin Nazarieh *afshin.nazarieh@uniroma1.it*

UNIROMA1, Rome, Italy

Back to the Human Scale: Some Comments The Physical Model as a Tool for Training Culture of Design, From Object to Space

An "Integral" Search Tool

There is a hidden phenomenon in the field of training processes of the designer role, which is characterizing the transformation of education's demand in the whole culture of design. From one side we are facing the growth of quantitative and qualitative relevance of design schools and the trend of reduction of schools of architecture; from the other side the transformations of the jobs market are requiring not only specialized competences and knowledge but also capabilities to manage flexibility among these; it seems more adaptive to the current dynamic world a new "integral" designer in the process of creating and implementing artifacts, while the training context requires time to transform from a specialist approach to knowledge holistic approach. (Raiteri, 2014)

The presented text is an attempt to rethink the educational path of designers, around the modalities in defining morphological choices of design during a processual development, besides the building activity, "form the material's transformation to an organization, able to make the new modifications in the state of things" (Gregotti, 2018). The tendency is to make the designer more conscious and open to the transversal visions, able to face critically the current reality, fulfilled of uncertainty, and at the same time to question the current sector-specific system of knowledge: this is a new challenge to open the dialogue between fundamentals of design discipline and a specific historical, geographical, technical and symbolic condition of our current time, considering the market needs (Ortega, 2017).

In the context of academic training, it is therefore necessary at the present time to ask what educational tools could be able to form a design culture, linked to the inseparable relationship between idea, form and matter, that is an expression of the concreteness of the "doing" required by the job market. What educational tools would provide transversal and holistic approach?

The model is, therefore, to be understood as a practical opportunity for investigating concrete, realistic and pragmatic experimentation, didactically effective in the context of the architecture

and design schools, aimed at developing the student's ability to think and cultivate a sense of responsibility of just acting. The model can, therefore, be considered in the design process "an open and non-linear operational tool, where the formal configuration is the result of partial" experiments "and repeated calibrations, hypotheses, and assumptions, rather than the certainty of a result" (Bearth, 2012).

In this sense, the model can, therefore, constitute a 'way of proceeding' which, starts from a totalizing predefined idea, allows the designer to rapidly obtain a multiple constellation of meanings and conjugations that can be declined from case to case in alternative scenarios and interpretations. The model is particularly useful for achieving the solution considered most suitable for the reference context.

In recent decades in which, through design and three-dimensional parametric modeling, computers are able to create digital models that allow the object to be controlled in all its aspects, the model, created through manual practice, still represents for the designer today, and in particular for the architecture student, an operational tool able to simultaneously investigate the geometric relationships in the space of the real dimensional object in relation to man and natural light. A tool that allows the designer to accurately express the relationship between conceptual content, form, and materiality of the artifact.

In the field of operational and teaching practices, we can consider the model a tool capable of supporting a critical thought as the basis of the project, where aspects such as manual ability, the ability to experiment and to see things and also the static aspect are concentrated more (De Lucchi, 2014).

The model is a didactic design tool belong to the well-established 'generalist' architect (Botta, 2013). It still represents a tool capable of constructing the design thought that, with simplicity and in a synthetic and incisive way, obliges the student to work adroitly with primary elements of expressing, on the scale of the architectural and industrial artefact, the emotional, imaginative, visionary and at the same time concrete nature of living. Through a process of codification, the model allows reflecting critically on contemporary issues starting from the few fundamental and recurrent elements in the real experiences of architecture, exhibit design and industrial design such as atmosphere and context, use and functionality, proportional measurement, relationships and space, and construction.

The Model: From Conception Control to Production Simulation

We can therefore argue that in the field of training of the new 'integral' designer, the model represents an operative tool for research, experimentation, and verification of design choices, valid in the field of architecture and design, which transversally crosses the different scales of in-depth analysis, from the conception to the verification during the executive prototyping phase.

With reference to the concept, the use of the small-sized model is an operational tool for expressing an idea precisely through a form. The small-scale model, stripped of any

unnecessary additions, allows us to summarize the idea that we intend to elaborate on the project with maximum precision. "The small scale of the model and the idea of creating it with dimensions that can be contained in the palm of the hand oblige us to reflect seriously on the design project: a kind of reflection characterized by research, which sometimes, for those who are not architects, It's difficult to understand" (Baeza, 2013).

With reference to the executive phase and the definition of details, in the context of the forms of teaching, implemented in design schools and requested by the productive market, the model is now confronted with the new technological tools of digital three-dimensional prototyping. Through the use of equipment for thermal and laser cutting, numerical control machinery, scanners and three-dimensional printers, it is now possible to obtain models of great precision, particularly effective in the design of industrial products and in the choice of the most appropriate and most suitable manufacturing technology. suitable, such as to make the production of the object on the market commercially sustainable.

In the didactic laboratories where the design is taught, independent of the scales of the experimentation object, the model turns out to be stainless and, we would say, an indispensable tool.

Let's try to explain the reasons for this consideration, in a relationship with the production of models and simulations. Digital type is always faster and more sophisticated. We believe, on the basis of a series of considerations by masters of the artifacts projects, from architecture to design, the instrument is the one that brings man closer, "objectively" to the product of the forecasting design activity.

In this sense, we can identify two prevailing aspects that insert the model in the formative process of the new 'integral' designer, which specifically concern: the model as a tool able to represent the real physicality and dimensional proportionality in relation to man and natural light and the model as a verification and in-depth tool relegated to the constructive dimension of the designed artifact.

The first aspect, linked to the physical relationship that the model establishes with man and with the natural context of reference, makes it possible to analyze and verify both the volume and the space, forcing the designer, at various scales and consistencies, to search in the most identifiable creative process, formal configurations of 'piece' in 'piece' and changeable from case to case (Mateo, 2013).

In architecture the model, in the different scales, allows occupying the absorbed space through volumes, to be convex or flat. At the scale of design products, the model - to be honest - is directly related to the human body. These two conditions are subject to progressive digital technological developments in which the augmented reality promises approaches to the simulation of "virtual reality", such as a variety of generative design platforms in the engineering design market.

In the teaching activity of the Technological and environmental design laboratories of the Public and exhibition design Ateliers the teaching is carried out, the creation of models at various scales that represents a critical tool for making students verified from the very beginning. with

their own hands, the shapes, placements, proportions, and details of the design strategies and constructive solutions are adopted. It is therefore a creative process where the model becomes a tool for experimentation and design investigation aimed at studying the relationship between form and space, between matter and light and between comfort and ergonomics. (Melluso 2015)

The second aspect concerns the productive/constructive condition, which the realization process of the model imposes on the physical matter which it is constituted. This process, formidable from the educational point of view, is functional to the verification of the “feasibility” and we would say with Josef Albers of the economy of the form of the products, therefore of their sustainability, to be understood with the widest meaning. We do not presume to affirm that this last aspect is ‘denied’ by digital modeling (see the diagnostic modeling tools and on energy efficiency), but in the domain of geometry that the digital modeling tools solicited, leads to an ex verification post form efficiency.

As part of the teaching and training activities carried out within the Product Design Master’s courses, the model is considered a “pragmatic” tool that is particularly functional to the production of the industrial artifact. As teachers of product design laboratories, the model takes on a central role in the entire creative process aimed at developing concrete ideas. In addition to represent a more precise and more intuitive operating tool for understanding the functionality of an idea, the model represents the most appropriate tool to process all the details, even constructive details of an object, in relation to its function and the place where it will be placed, but also consistent with manufacturing processes (Tomas Kral, 2014).

Towards a New Post-Digital Season

The teaching activity aims to develop in an integrated way, different disciplines belonging to the entire design project definition process, offering a synthesis capacity in learning and knowledge.

It is intended to propose a processual approach which at the same time becomes the basis of the design and critical element of its development. It begins and is acquired in the course of academic training and it continues, consolidates and matures in the profession and in the relationship with the productive field, in response to the real conditions of the present in the architecture and in the design. Is it possible to join a design approach more conscious about the technological choices, at the same time where they become an operative tool to manage the decisions and influences the choices about what to think and what to do (Grassi,1990) ?
Is there a hidden wire which connects the different scales of artifacts designed along the educational path? And which is the role of technologies in relationship with the production processes? The hypothesis developed to give technologies a cultural role, able “to contribute and understand the articulated and heterogeneous frame of contemporary needs, considering the knowledge of a technological culture to sustain a deeper and more coherent design ability. (Nardi, 2003).

The design learning is therefore addressed through a methodological process that, considering the different themes and scales of application, takes some starting recurring elements: restrictions, constraints, and level of the economy.

These factors are considered factors that are relevant to determine the ability to make choices and are nowadays strongly influenced by the role of the technologies and the need to acquire to control them instead of being dominated by them (Paris, 2017).

Also in the field of product design, the model plays a fundamental role in controlling the shape of the project. What changes, compared to architecture, is the scale that the model simulates, which relates the product directly to the human body and which allows to simulate the real material of the product. from a technological point of view, there has been incessant progress in rapid prototyping. This proposed tool has an impact on the production methods of companies.

We can now describe the model as a complex research and design experimentation tool obtained through the use of technologies, mainly traditional cutting / subtraction processes of addition matter for rapid prototyping, where the techniques interface between the physical and digital environment, aimed at searching for the meaning of ‘doing’ at different scales of intervention and in different conceptual, dimensional in a constructive environments. A hybrid device therefore made by hand and with digital instruments that, used both as a small-scale model and as a full-scale prototype, is configured within a production process belonging to industrial design, in which the modeling coincides in the last phase with prototyping and realization.

With the new technologies, we can, therefore, argue that the model continues to have, as in the tradition of the past, a pivotal role also in the context of what we could call a real “new post-digital season”, with significant repercussions not only in terms of academic training and the definition of a method of transversal design research and generative and cognitive strategy of the design project, but also above all on the creative and operational process linked to the conception and production of the artefact. (1)

note:
(1)

The use of the model as a educational tool for a integrated approach to design has been investigated by the authors through laboratorial experiences in teaching activities in the design and architectural technology courses held at some Architecture schools in Italy and Europe. The results presented provide a summary of the state of progress and are related to activities performed by Spartaco Paris and Roberto Bianchi during their courses. In particular: Building design studio (by Spartaco Paris), Product design (Spartaco Paris) and Public and exhibit design workshops (by Roberto Bianchi) held at the Sapienza University of Rome; Building Design systems and Design materials and technologies held at the Eduardo University Vittoria ‘of Ascoli Piceno (by Roberto Bianchi); international seminars and design workshops at ECNU - Shanghai (2016 by Spartaco Paris), RWTH - Aachen (2018 by Roberto Bianchi) and l’École de design Nantes Atlantique (2019 by Spartaco Paris).

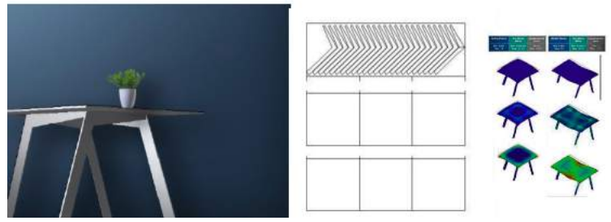
The text shows a perspective around educational training processes belonging to the field of design and have the peculiarity to escape from a typically quantitative method of assessment. How to teach design with an integrated and collaborative method? The contribution should focus on some specific studio activities developed by the authors, in a range of different educational and thematic contexts, different scales, different schedules in architecture and

design (undergraduate and master programs).

The article has been written and edited through different contributions: Spartaco Paris is the supervisor and main author of the paragraph ‘An “integral” search tool’; Roberto Bianchi is the main author of the paragraph ‘The model: from conception control to production simulation’; Spartaco Paris and Roberto Bianchi are authors of the paragraph ‘Towards a new post-digital season’; Afshin Nazarieh has reviewed the editing and collected the illustrative materials.

Model prototype. Research experiment. Elab – Shanghai, 2017 (Spartaco Paris, Roberto Bianchi)

Technolgical design Lab, Msc Arch, Sapienza 2016 (Spartaco Paris)



Technolgical design Lab, Msc Arch, Sapienza 2015 (Roberto Bianchi)

Technolgical design Lab, Msc Arch, Sapienza 2017 (Spartaco Paris)

Product design studio., Msc Product design, Sapienza 2018 (Spartaco Paris)

Giovanni Pascoli secondary school,Turin, Italy. Competition Project, 2017 (Spartaco Paris, Roberto Bianchi)

References

Amariei M. (a cura di), (2012), Atelier Bearth, Microcosmi, Mendrisio Academy Press, Mendrisio

Campo Baeza A., (2013), Un'idea nel palmo di una mano, Domus 972, settembre, pp.10-11

Botta M., (2013), Necessità dell'architetto generalista, in L'architetto generalista, Frank C., Peretti B., (a cura di) Silvana Editoriale, Milano, pp.7-10

De Lucchi M., (2014), Il pensiero come base del progetto, Domus 979, ottobre, pp.6-9

Grassi G., (1990), Un parere sulla scuola e sulle condizioni del nostro lavoro, Domus 714, marzo, pp.21-32 Campo Baeza A., (2013), Un'idea nel palmo di una mano, Domus 972, settembre, pp.10-11

Botta M., (2013), Necessità dell'architetto generalista, in L'architetto generalista, Frank C., Peretti B., (a cura di) Silvana Editoriale, Milano, pp.7-10

De Lucchi M., (2014), Il pensiero come base del progetto, Domus 979, ottobre, pp.6-9

Grassi G., (1990), Un parere sulla scuola e sulle condizioni del nostro lavoro, Domus 714, marzo, pp.21-32

Gregotti V., (2018), I racconti del progetto, Skira

Kral T., (2014), Un approccio pragmatico, Domus 982, luglio-agosto, pp.10-13

Mateo J. L., (2013), Insegnare a progettare, Domus 973, ottobre, pp.4-7

Melluso V., (2015), Metamorfosi, Domus 997, dicembre, pp.6-9

Nardi G., (2003), Tecnica e cultura: considerazioni sparse, in Bertoldini, M., Zanelli, A. (a cura di), Tecnica, progetto e scienze umane, Libreria CLUP, Milano

Ortega L., (2017), The total designer. Authorship in the Architecture of the Postdigital Age, Actar

Paris S., (2017), The transformation of technological culture in design, through new tectonics and digital technologies. International teaching and research scenarios. Techne 13, Firenze University Press, Firenze

Croset P.A., Peghin G., Snozzi L., (2016), Dialogo sull'insegnamento dell'architettura, LetteraVentidue, Siracusa

Raiteri R., (2014), Progettare progettisti. Un paradigma della formazione contemporanea, Quodlibet, Macerata

George Mitroulias
gmitroulias@gmail.com

9

UTH, Thessaly, Greece

The Post-Digital Doll-House

Architectural models are traditionally used to understand the form of a building, its scale, access, position within the site and relation to the surrounding context. Detail is minimal, allowing the abstract form to express the basic characteristics of the project. Today such models can be easily produced by fabrication technology, whether it is a 3D-printer or a laser-cutter. Since their proliferation in architecture schools, these machines have changed the way students and architects think about and produce models. While in the beginning the new technology presented itself as an exciting opportunity for formal and tectonic experimentation -and to an extent it still is- many students and architects simply use the machines as a fast and easy way to produce models that could otherwise be constructed by hand. The final model is usually made of a single material, and its assemblage -if it is made from multiple pieces- bares a minimum relation to the tectonic understanding of the building it represents. Most importantly, this type of model has an air of finality: it comes at the very end of the design process, and it doesn't lend itself to adjustments or changes.

If one wants to liberate architecture, both as professional practice and academic education, from this mundane version of model-making, one needs to challenge the notion of what a model can be or what it can be used for. A particularly fruitful reference in this regard is that of the Victorian doll house: a large-scale representation of an interior, with a full set of furniture, objects and action-figures. Its most notable feature can be called a "participatory aesthetic", which derives from the following features:

- It invites the individual to touch and play.
- It allows for a deeper understanding of social context and the possibility for narratives to be envisioned: who is the user and how do they live inside a space?
- It allows us to look from the inside out, rather than to look just at an exterior form.
- It goes beyond the abstract form to capture materiality and atmosphere.

The Victorian doll house brings to mind the term “synomorfia”, borrowed from the pedagogic sciences, in speaking of how a space, its contents (furniture, objects, finishes) and the daily activities inside it correspond to and enhance each other. Similarly, one can imagine architecture models that go beyond abstraction to incorporate a variety of ephemeral elements, such as furniture, objects and people, that can help communicate specific lifestyles and social interactions. These are not to be understood as the only ones possible but are a means to better understand the relationship between the physical characteristics of a space and what can happen inside it.

The scale of such a model is very important (for example, 1/20 or larger), whether it is just a room or a building fragment, and it allows for as much information as possible about materials and finishes. The process of making such a model is similar to inhabiting the space: moving furniture around, choosing colours and textures and taking the place of the user by looking inside the model at eye-level. Such models are also an excellent way to approach the non-architect by inviting people to physically explore, touch or even move elements, so that they can fully understand the implications of a projected space.

1

2

Fig. 1, 2: AREA, Athens Charting, “Made in Athens” exhibition, Greek Pavilion Venice Biennale 2012 Hand-drawn paper model with blue ink

3

4

5

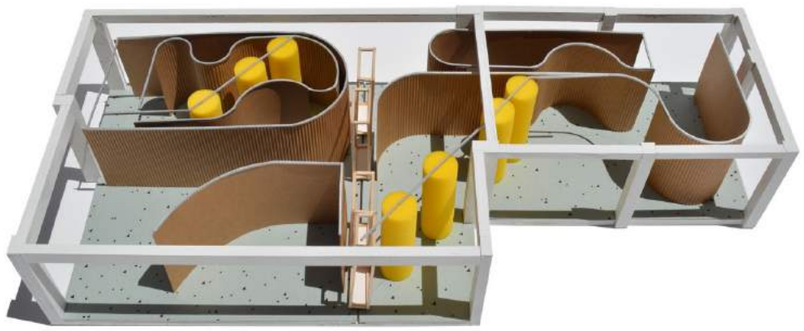
Fig. 3, 4, 5: AREA, Aigaleon 639, Participatory Workshop in Aigaleon Athens 2014. Polystyrene Model with alternate pieces

6

7

8

Fig. 6, 7, 8: Doll-house models. Student work, "City of Rooms", University of Thessaly 2017



9

10

11

Fig. 9, 10, 11: Doll-house models . Student work, "Learning Environments", University of Thessaly 2016

Selda Bancı
sbanci@etu.edu.tr

The Making of Concrete Walls

This paper focuses on a summer school that was held in TOBB University of Economics and Technology, Ankara during the summer of 2019 and it tries to analyze how the making of full-size models (i.e. concrete walls) could be a tool in the learning environment in architecture. The first part of the paper explores a ground for discussion considering the making of life-size models and the summer school as an alternative program. The second part concentrates on the summer school as a case, its theme, the outputs, and the concrete walls together with the versatility of the roles they take as an architectural model. Consequently, this paper aims to present what this summer school has pedagogically brought to architectural design education- from one-to-one production to hands-on experiences, and to reveal hidden themes, and invisible discussions covered by the case.

*

Architectural physical models have been taking on different roles for many years in architecture owing to their wide variety of uses: Architectural model as a teaching, learning, presentation, design or communication tool, a research medium, or a place for experiments, thinking and sharing ideas.[1] Architects' need for design representation, time, resources, and facilities in general define and determine these roles. Architectural model, where design ideas are materialized, almost always situates between abstract and real, presents variability and diversity in its physical appearance and materiality and finds its expression in different scales. As some researchers have already suggested, there appear two broad categories if one tries to classify architectural physical models in terms of their use: presentation models and working models. The first category approaches the model as a "completed" artifact. Here, the architectural model is a representation tool, or an end-product to be presented, for instance, to a client or competition jury. It is one of the after products of the design visualization or materialization

1 For a detailed summary of "important invisible functions" of architectural models through history, see Morrison &Ostwaltz, 2006.

process in architecture. In the second category, an architectural model is a design tool or an environment in which architects test their design ideas. It accompanies architectural work in progress. Nevertheless, there also appears a third category: the life-size model or replica. It can undoubtedly be in somewhere controversial, perhaps peculiar within the lengthy journey of the architectural model, its significance and function in architecture notwithstanding.

It is indicated that some building "pieces" were modeled in full-scale in Greek and Roman periods to guide the workers at the site (Morrison & Ostwaltz, 2006). On the other hand, it is common that one-to-one implementations (mock-ups) are used as an experimental model for structural design optimization. As one of the well-known instances from the history of architecture is Frank Lloyd Wright's "test column" in Johnson Wax building. Another well-known example again from the history of architecture should be the *Weissenhofsiedlung* whose project Mies van der Rohe oversaw. That is a model residential settlement built in 1927 as a part of an exhibition *Die Wohnung*. Here, the life-size "models" promoted a "new way of living and housing" through architecture. The German Building Exhibition, directed by Mies van der Rohe, organized in Berlin in 1931 also includes twenty-three life-size "displays of housing in a context" (Miller, 2001). For example, in the housing sector nowadays, there are other forms of use such as sample apartments. Hence, considering these examples, the boundary between the model and reality is getting blurred. Whether made for experimental purposes, checking stability, or spreading architectural ideas, full-size models also offer great pedagogic insights into architectural learning environments. Creating design mock-ups gives students a hands-on experience and provides them an opportunity to feel the actual size and material(ity) of the space or structure, and to experience the entire process from design idea to implementation.

In architectural education in Turkey, there has been a tradition of the making of full-scale mockups and/or the construction of life-size models/buildings. For instance, architecture students have constructed small-scale buildings in rural areas at irregular intervals since 1958 in the summer practice program of the Middle East Technical University, Faculty of Architecture (Önür, Özkar, Alkan & Gür, 2006). After the digital turn, approaches that value hands-on works in architecture and tacit knowledge hidden in the making and the practice of a craft are increasing. For example, "design-build studio" has taken its place as part of the curriculum of MEF University Faculty of Arts, Design and Architecture, where the students design and build "projects" such as boathouse, play spaces, bridges, etc. in their summer internship (İnceoğlu & Sezgin, 2018; Aydemir, Sezgin & İnceoğlu, 2019). This summer practice like the practice of the Middle East Technical University is considered being a social responsibility project conducted by MEF University. Both universities cooperate with local authorities and/or schools open to experimentation, and the summer practice programs are supported by professionals, master builders, and sponsors.

Besides these initiatives, which are part of formal architectural education, there are also informal attempts that approach the making of full-size models in a pedagogically creative way. As an alternative setting that has also pedagogic, educational, and social dimensions, Betonart Architecture Summer School, conducted by Turkish Cement Manufacturers' Association (TCMA), offers a broad range of experiences that should be added to the above practices for the field of architecture in Turkey. The summer school together with the *Betonart* magazine, first published in 2004, aims at raising awareness of creative uses for concrete and promoting knowledge accumulation in the country. Each year hosted by an institution or a university in different regions of Turkey, Betonart summer school has organized annually since 2002. Each summer school program, with its very intensive schedule organized around a theme, involves architecture students all over Turkey accompanied by studio moderators. Additionally, the cement plant or other institutions in the region provide support for the school. In this sense, Betonart summer school is an important endeavor to emphasize the architectural use of concrete, interdisciplinary relations in the field (such as between industry, university, and other institutions), and to offer a unique experience for architecture students in Turkey.

We held the 18th Betonart summer school between July 27th and August 5th, 2019 at TOBB University of Economics and Technology (TOBB ETÜ) in Ankara. The summer school brought 30 architecture students, coming from 21 different schools and 13 different cities of the country, in 6 studios to meet the material, technique, and practice through concrete. The theme of the Summer School 2019 is "standardization" and Ankara Baştaş Cement and Konya Cement Factory supported the school. It is an appropriate meeting for Betonart 2019 Architecture Summer School to be hosted by TOBB ETÜ Department of Architecture. TOBB ETÜ is one of the leading schools of architecture in Turkey with its fresh approaches to architectural design education, which brings business world – university cooperation to life. Founded in 2007 in the Faculty of Architecture and Design, TOBB ETÜ Department of Architecture blends art and science with technology in its program. In the first year of the curriculum, especially in Basic Design Studio and Building Technologies courses, the large part of the course practices is based on one-to-one scale productions and hands-on exercises. In other words, the making of a life-size mock-up or a full-size model has an important place in the educational model of TOBB ETÜ. These pedagogical approaches introduce the first-grade architecture students to the notion of scale and raise awareness of the design concepts such as form, geometry, rhythm, structure, and material behavior.

Figure 1 Students at work during the summer school 2019 at TOBB ETÜ.

Betonart 2019 coincided with the 100th anniversary of the Bauhaus school.[2] In this context, the summer school aims to design and foster a process that claims to speak about the future by remembering Bauhaus and getting inspiration from the past. Hence, as an alternative education model, the summer school leads to the question of "standardization" in architecture through designing, building, and making of a concrete wall as one of the building components.[3] The Bauhaus school was founded in 1919 in Weimar, Germany by architect Walter Gropius to propose a new model of education against rapid industrialization, technological developments, and change that affect nearly every facet of life throughout the past century. The school argues that art could be experienced by the masses through the alliance of arts under the wings of a "new architecture," and believes that new relations would be established between industry, art and, crafts through architecture. Besides the emphasis on industry, the technique in design and production, and the concept of rationality and standardization took its place among the principles of the school. As such, the Bauhaus school approaches architecture as a research topic through the industrial age's conceptions such as standardization, repetitive/mass production, and mass consumption. Similarly, in the information age, in the school's 100th anniversary year, we can talk about designs, structures, and architectures which are adaptable, series but not the same which include variety and complexity, and we can discuss new methods, new materials, and new experiences in architecture. Therefore, Betonart Summer School 2019 has considered standardization in architecture, space, and many structures through the making of a piece of wall – that is to say, an ordinary building fragment which was defined by the curator as follows: The wall provides structure, the wall is a separator, the wall protects, the wall hides, the wall defines and divides the space, the wall organizes movement, the wall is built and constructed, it is cast through formwork, the wall is repaired, one can sit on the wall, and lean against the wall, the wall has layers, voids, cracks; it has a surface and texture, the wall changes according to the climate, time, and place, the wall can be transformed, the wall has a language, and shadow, there are two-dimensional walls, low walls, permanent/temporary walls, fluid, permeable, solid, static walls and non-walls… (Bancı, 2019) Therefore, Betonart summer school presents experiments on what the wall is, what it does, how it is designed and built.

2 The Bauhaus School became the most influential art and design school in the world; however, it was active only for 14 years before shutting down by the National Socialist regime. So, various events around the world and in Turkey celebrate 100 years of the Bauhaus. Known and unknown aspects of Bauhaus are under investigation. Some of the anniversary programs focus on the concepts of simplification, repetition, and standardization to which the Bauhaus school attached importance since its early years. For example, the Bauhaus Dessau Foundation chose the concept of "standard" for 2018 as the annual theme and put it on their agenda for both the *Bauhaus Magazine* and their exhibitions organized. The Bauhaus Archive in Berlin, on the other hand, discusses the relationship between production, mass production, originals and reproductions through the exhibition titled "Bauhaus: production- reproduction."

3 Walter Gropius (1965) expresses his thoughts about "standardization" and "standard" in one of the most important books on modern architecture, *The New Architecture and The Bauhaus* as following: "Our age has initiated a rationalization of industry based on the kind of working partnership between manual and mechanical production we call standardization which is already having direct repercussions on buildings. There can be no doubt that systematic application of standardization to housing would affect enormous economies-so enormous, indeed, that it is impossible to estimate their extent at present. Standardization is not an impediment to the development of civilization, but, on the contrary, one of its immediate prerequisites. A standard may be defined as that simplified practical exemplar of anything in general use which embodies a fusion of the best of its anterior forms – a fusion preceded by the elimination of the personal content of their designers and all otherwise ungeneric or non-essential features (pp.33-34)."

Figure 2: Concrete walls produced in the studios of Betonart Summer School 2019

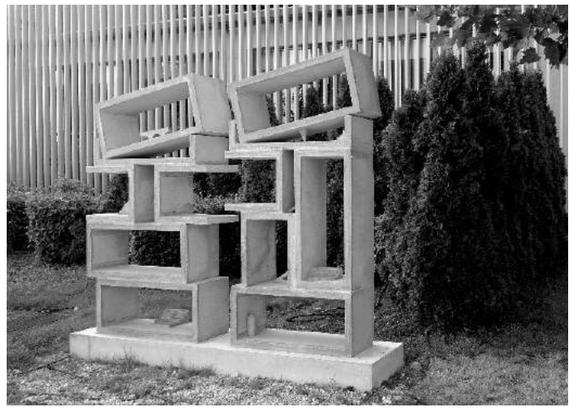


Figure 3: STUDIO I "Mimarlığın Bellek Nesneleri" Moderator(s) Refa Emrali Asistant(s) İrem Tümay, Zeynep Öztürk Students Kübra Gülhan, Betül Öz, Zeynep Göktoprak, Helin Gülay Yüksel, Elif Lehlebici

Figure 4: STUDIO II "Hadrian's Regard" Moderator(s) Jorge Mealha Asistant(s) Beyza Ayaz Students Nursima Zengin, Nijat Mahamaliyev, Emre Taş, Neda Haşemi, Barış Kavraroğlu

Figure 5: STUDIO III "refleX" Moderator(s) Alper Aksoy, Serkan Karaaslan, Yunus Özmerdivenli Asistant(s) Emre Cansever Students Sena Tokmak, Hüseyin Melih Baktır, Ece Onulay, Melih Yavuz, Merve Civcik, Elif Turna

Six studios comprising moderators, assistants, and students produced six concrete walls in the semi-public open space of the TOBB ETÜ campus at the Betonart summer school in 2019.[4] All groups dealt differently with the theme and the making of a concrete wall. These variations remind us of the diversity of roles being undertaken by a full-size model in architecture education. For **Studio I**, the concrete wall is a representation tool in which the concept of "memory" was discussed. The work entitled "Memory Objects of Architecture" is an attempt to question how the images in the collective memory of architecture are materialized in individual memory. The re-construction of memory through the making of a wall is the main idea of the project. **Studio II** examines the possible links between an ancient wall (i.e. the wall of Hadrian's Villa) and contemporary society and techniques. In this sense, the second team proposes a wall to be a device for several activities. So, the making of a life-size mock-up is a design tool for them. **Studio III** tries to respond to the Bauhaus school's concept of standardization with the modules the team designed and produced. The studio believes that the concept of standard should be sustainable. Hence, they wanted to create a concrete wall which can respond to the conditions and needs of the context. In this sense, for Studio III the concrete wall is the representation of their design idea. **Studio IV**, preferred to stay out of the mold, tries to explore their paths in the making of the concrete wall by experimenting about what the concrete wall is. The fourth team is interested in how each parameter involved in the design and production process changes the final production. So, the concrete wall is a research medium for this studio. **Studio V** aims to design a concrete "mansion" which will shelter living creatures in the long run. The team discussed transforming the concrete elements, reaching their end of life economically and technologically, into flexible and sustainable resources for urban ecosystems and living diversity. Here, the concrete wall becomes a metaphoric sign of building a future and the presentation of design philosophy because it is an experiment in solving an actual problem of our time. **Studio VI** focuses on the relation of architecture to the alternative production systems offered by today's digital technologies. In this sense, the sixth team pursued a distinct way in the making of the concrete wall with the aid of CNC technology instead of making use of conventional design methods and traditional formwork techniques. So, the concrete wall for

4 **Academic Advisor:** Nur Çağlar **Curator:** Selda Bancı; **Coordination:** Gizem Buzacı, Ömer Özgenç, Şeyma Nur Çalışkan, Fidan Özenç

Studio VI is a research field in which today's making of a concrete wall is explored. As a result, while exemplifying a variety of roles they play in the learning environment in architecture, these models have become an explorative, cognitive, representative, and descriptive tools in each wall in the Betonart summer school 2019.

Figure 6: STUDIO IV "Kalıp Dışı" Moderator(s) Ramazan Avcı, Ozan Gürsoy Asistant(s) Büşra Bal Students Gökalp Yiğit Denktaş, Alp Fahri Ardıç, Furkan Alişinoğlu, İlayda Akak, Esra Ergün

Figure 7: STUDIO V "Konak" Moderator(s) Aktan Acar Asistant(s) Aysu Haşimoğlu Students Alá Haj Taleb, Melih Karataş, Aysu Fatma Kuştaş, Bingül Çakacı, Sercan Deniz

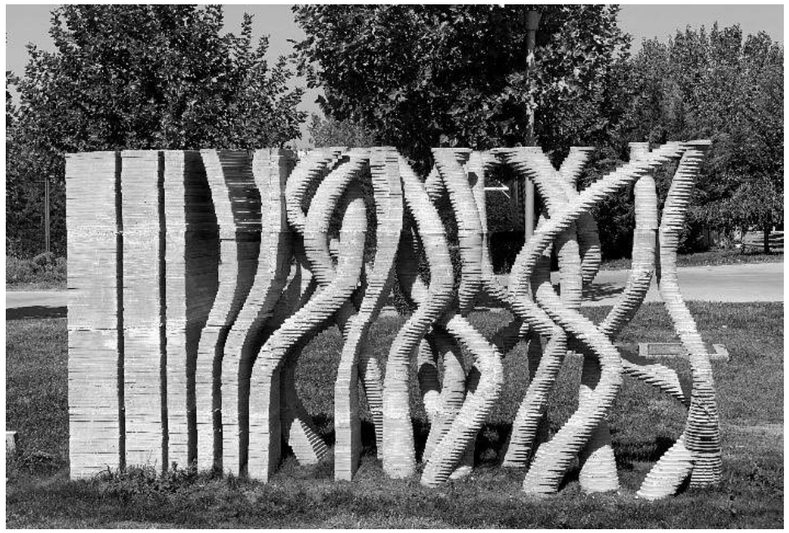


Figure 8: STUDIO VI "In-between" Moderator(s) Murat Sönmez, Aslı Özbek, Nihat Eyce Assistant(s) Mert Doğaray, Kevser Özkul Students Tülay Haspolat, Gizem Alıçay, Çağrı Sarıkoyuncu, Kerime Hatun Uğurlu, Rıza Durmuş

Betonart Summer School 2019 limits its scope to particular building material through implementing an ordinary building fragment to pave the way for creative, innovative, traceable, and comparable processes. As Adrian Forty (2006) argues; concrete is "not a material, it is a *process*: concrete is made from sand and gravel and cement – but sand and gravel and cement do not make concrete; it is the ingredient of human labor that produces concrete" (pp.35-36). Concrete becomes a product, to put in another way, being embodied in the "walls" of the summer school – only with the help of human labor, design, and time. Therefore, these six concrete walls follow diverse paths in developing design ideas in the given parameters. They have appeared by ten days together with their different aesthetics, richness, and variety.[5] The summer school was intended to provide students with the ground to gain skills in hands-on experiments with the material. Concrete walls are both the products of material-based design and that of hands-on work. Emphasizing hands in the teaching process of architectural design reminds a definition of architecture by Juhani Pallasmaa (2009): "Architecture is also a product of the knowing hand. The hand grasps the physicality and materiality of thought and turns it into a concrete image" (p.16). The concrete walls address the relationship of the body to space and materiality. On the other hand, architecture students witnessed the whole stages of a building process from concept to implementation. While participating in teamwork, the students established open communication between the groups and people on campus through exchanging comments, ideas, and hand tools, etc., and they also socialized with their colleagues and friends. It can be argued that the summer school to be an attempt in blurring the boundaries between the studio and the site, design and implementation, architecture theory and architecture practice, reality and representation, and virtual and the physical. By making concrete walls, the school complements the idea of integrity with theory and practice both in architecture education and practice. Theory not only explains the practice but also guides the practice. Hence, each wall attempted to reveal a design idea: Therefore, concrete walls are architectural models in their own way, so every wall is a mockup of itself. To be sure, they are also architectural structures. As Jane Jacobs points out: "The model is no longer the imitation of a building but becomes itself a building" (Jacobs, 1958). Along with their primary purposes, architectural models are formed as "semi-independent objects of art, or at least of aesthetic appreciation" (Pallasmaa, 2009, p.59). So, further and deeper study should be carried out to analyze the creation of buildings and "the making of architecture" in the case of the Betonart architecture Summer School 2019.

5 Forty argues; not that concrete has only one aesthetic, but that it has much aesthetics (Forty, 2006).

References

Aydemir, Ayşe Zeynep, Ahmet Sezgin and Arda İnceoğlu (2019) A Design Build Experience: Kilyos Boathouse, *The Hidden School EAAE Annual Conference August 28-31, 2019*, Faculty of Architecture University of Zagreb.

Bancı, Selda (2019) *Standartlaştırma* (Standardization) [Betonart Architecture Summer School 2019, announcement text].

Forty, Adrian (2006) A Material Without a History, *Liquid Stone: New Architecture in Concrete, eds.* G. Martin Moeller Jr and Jean-Louis Cohen, Princeton Architetcural Press, pp. 34-45.

Gropius, Walter (1965) *The New Architecture and the Bauhaus, trans.* P. Morton Shand, USA: The MIT Press, Cambridge and Massachusetts.

Inceoğlu, Arda and Ahmet Sezgin (2018) Design Build Studio (DBS), *MEF FADA Faculty of Arts, Design and Architecture, eds.* Burcu Serdar Köknar and Eda Yeyman, İstanbul: MEF University, pp.10-66.

Jacobs, Jane (1958) The Miniature boom, *Architectural Forum*, May 1958, pp.106-111, 196.

Miller, Wallis (2001) Mies and Exhibitions, *Mies in Berlin, eds.* Terence Riley and Barry Bergdoll, New York, The Museum of Modern Art, pp.338-349.

Morrison, Tessa and Michael J. Ostwaltz (2006) Shifting Dimensions: The Architectural Model in History, *Homo Faber: Modeling in Architecture Exhibition, ed.* Brenda Marshall, Homo Faber: Modeling Architecture Exhibition Catalogue, pp.142-157.

Önür, Selahattin, Mine Özkar, Alper Alkan and F. Berin Gür (2006) [Interview] ODTÜ Mimarlık Bölümü Yaz Uygulamaları (1958-2006): Kurumsallaşmış Sosyal İçerikli Bir Program, *Mimarlık*, November-December, 332, pp.55-59.

Pallasmaa, Juhani (2009) *The Thinking Hand: Existential and Embodied Wisdom in Architecture*, Italy, John Wiley and Sons Ltd.

Acknowledgements

A special thanks to all instutions and participants of the summer school for their hard work.

Fabiano Micocci

fabianomicocci@gmail.com

Model-Making as Tool for Urban Design

Abstract: The paper illustrates the use of large-scale urban models inside the environment urban design studios. The relevance of using these kind of models is referred essentially to three aspects: the first is related to the use of a collective model of the city as s round-table to trigger discussion, confrontation and sharing ideas among students and teachers; the second identifies in the large physical model the very nature of a map, that is the representation of a portion of the Earth with a clear design intention; the third introduces the possibility of merging digital data and virtual modelling into the process of the making of a physical artefact. These three issues will be illustrated describing a workshop that was conducted at the Department of Architecture at the University of Thessaly during which students were asked to deal with physical and digital tools, to creatively work on a map mixing different media and to collectively produce a new map of the city of Volos.

Keywords*: Maps, Large-scale models, Collage, Collective work, Design studio*

The Critical Agency of Model-Making

Model-making for urban design is a fundamental tool to represent the city as it looks today, analyzing and indicating morphologies, dimensions and scales of urban contexts, but it is also an effective way to show the city as it will look in the future. Indeed, representing how the city will change in time means to describe the very nature of urban environments because they are constantly evolving entities (Farrelly, 2011). The use of large-scale urban models is a diffused and consolidated practice into academic environments as educational tools to understand contexts and to test students' architectural proposals. The use of large-scale models is also widely implemented by professionals and administrations to illustrate and promote future

projects and to share visions in community forums. A famous example of this kind that merges the historical context with future projects is the outstanding model of Central London, produced by Pipers Model Making and exposed at The City Center, that presents to the public the history of the built environment of the British Capital City together with new buildings at the stage of the planning permission.

The paper will investigate three issues that are considered relevant when large-scale models are used for academic and teaching purposes. The first part presents the physical model as a round-table to support and to assist students and teachers during the entire design process with the scope to facilitate the debate and the comparison between points of view. Thinking at a model like a round-table emphasizes its collective agency: during the initial phase of the model-making, students work together to build a collective physical-model of the context with the help of digital tools; afterwards, and throughout the whole design phase, the collective model helps students to test their work and to facilitate comparison with the proposals by other students; finally, during the final presentation, projects are presented inside the urban context with the scope to bring to the fore urban matters related to the architectural proposals. Therefore, the role of such a model is not limited to be a supporting tool for design activities, but it makes easy the discussion among classmates and teachers.

The second part illustrates a theoretical position that considers large-scale models as maps. A map is a representation of a portion of the World that stands on a flat surface. Its scope is not to represent reality but to conceive new models to interpret and design the World (Farinelli, 2003). Large-scale physical models share with maps these very same properties and, instead of being purely representation tools, they can be seen as an attempt to redraw the urban environment.

The third part will stress the importance of using physical models, that are purely analogical means, into the academic environment of an urban design studio as a counterpart to the diffusion of the digitalization of data and the digital modelling. Notwithstanding, physical models should not be seen as an alternative to digital technology, but they should be thought as a way to convey digital information into physical support. From this point of view, the integration of digital and analogical tools can be considered a valuable strategy to select and manage data, to visualize information and to stimulate the imagination.

Based on these premises, this paper will close presenting a workshop that was conducted during an urban design studio at the Department of Architecture at the University of Thessaly. This workshop aimed to design a collective map of Volos interweaving digital mapping applications to physical model-making to invite students to shift between different means of representation understanding the potentiality of each, to create a collective artifact to be used as a round-table for discussion and to conceive a new map of the city of Volos as a critical and speculative agency (Corner, 1999). The scope of the workshop was to use model-making to raise the awareness among the students in relation to the interlaced and conflicting aspects of a city and to the idea that the city is a collective artifact produced by many actors.

Model-Making is a Collective Process

Large-scale models are fundamental tools for academic urban design courses because they

may establish a concrete reference point inside the physical environment of the class. There are many techniques to construct physical models that may convey different kind of information, like, for example, the use of various materials to highlight morphologies and infrastructures, to distinguish working models from presentation models and to bring to the fore architectural proposal against the city background. Models can also be distinguished according to the level of details showed, like the morphology of the roofs and the design of the elevations. Moreover, models can be also tri-dimensional, flat or abstract, according to the scope of their application.

Fig. 1, Final models presented at different scales (1:2000, 1:500, 1:200), University of Thessaly, Fall Semester 2016-2017 (students: Fenia Palapela and Markos Pavloudakis).

Fig. 2, Large-scale urban model of a study area in Rome (scale 1:2000), University of Thessaly, Fall Semester 2019-2020 (class model).

In particular, the possibility of conceiving distinct but complementary models at different scales, and made using a variety of techniques, is stressed here. Having more than one model of the context is a strategy that helps to bring to the fore different contextual aspects and, at the same time, to test architectural proposals at the territorial, urban and architectural scale at the same time (fig. 1). For example, topographical models with natural features may add a spatial dimension to a specific geographic setting (fig. 2). Differently, flat models with buildings cut-out on white paper allows to highlight street networks, land occupation, urban fabrics and the natural topography (fig. 3).

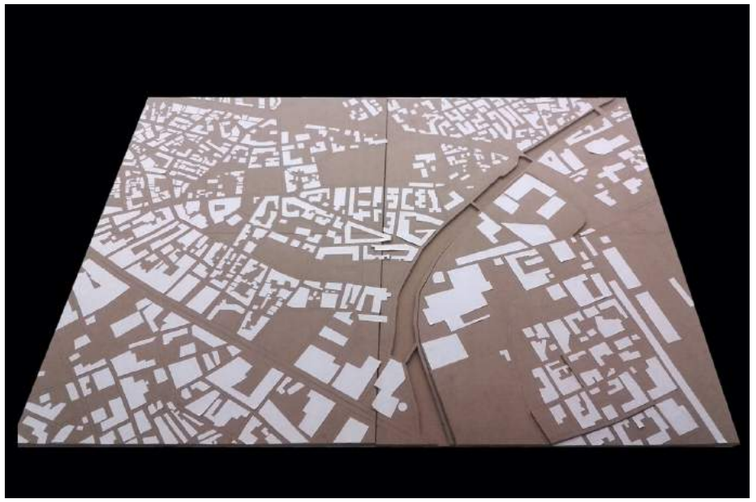


Fig. 3, Flat model of a study area in Volos (scale 1:1000), University of Thessaly, Fall Semester 2017-2018 (class model).

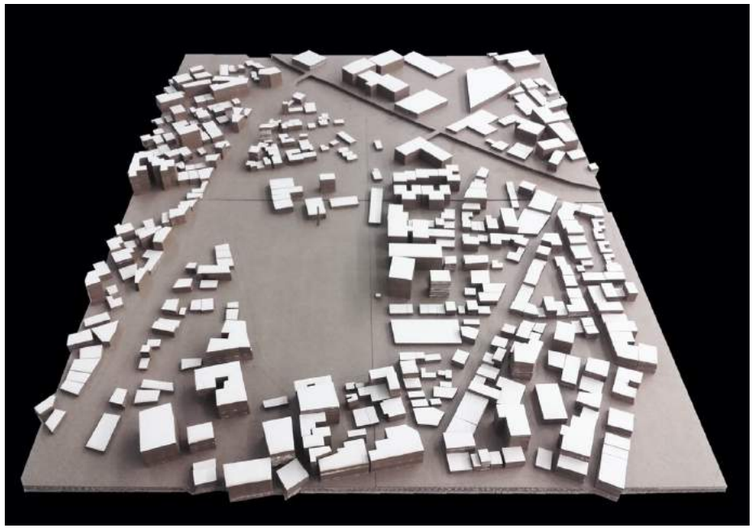


Fig. 5, Massing model of a study area in Volos (scale 1:500), University of Thessaly, Fall Semester 2017-2018 (class model).

These models are used as a tool to redraw the city by hands, for example drawing over the model with tracing paper or using the technique of collage to create quick urban diagrams (fig. 4). In any case, the models that are most commonly used are massing models. Besides representing a reading of urban typologies and masses, massing models also narrate the depth of the urban space, the tri-dimensional void that can be better comprehended and visualized as a sequence of three-dimensional spaces (fig. 5). Having at least two large-scale models at different scales, and that are presented in class one close to the other, helps students to shift between information contained in each artefact (fig. 6). This methodology aims to substitute the digital zooming, activated by the simple movement of the finger that scrolls the mouse's wheel that quickly crosses scales, with the human eye that focuses on the synchronic existence of different scales at the same time.

Fig. 4, Student working on a class model (scale 1:1000), University of Thessaly, Fall Semester 2017-2018.

Making large-scale models in class should be seen also like a collective enterprise. During my design courses, collective large-scale models at different scales were made by the participation of all the students together, and then placed at the centre of the class where they were kept during the whole semester. At the beginning, students were collaborating, coordinating, and discussing between themselves about how to physically construct the model developing a sort of participatory process. Each team of students worked on a different portion of the area of interest so that a constant confrontation with the work of their neighbours was required to be sure that different sectors of the city could join together without big mistakes. The result of this collective effort was physically displayed in class establishing a sort of bias between the participants and the constructed artefact. Afterwards, students were able to test their proposal by plugging their models inside the large ones with the possibility of understanding the impact at the scale of the city. The class-models thus worked as a sort of round-table that facilitated the gathering of students to discuss, to compare and to share thoughts. The implementation of this process has two very clear targets: the first is to push students to discuss among themselves, to criticize and to learn one from the other; the second is to have a physical artefact that reclaims attention to invite students to constantly reframe their point of view into the city context. Finally, the individual contribution to build collective models introduces students to the collective dimension of the city.

Physical Models are Maps

A second important aspect of working on large-scale models is the fact that buildings stand on a plane that works as a base. This plane is usually a thick and solid volume that looks as a portion of the Earth's surface. Working on a delimitated and flat surface insinuates that behind its construction there exists a process of abstraction - an interpretation of the physical and spherical shape of the Earth - that is the very characteristic of traditional maps. The Italian geographer Franco Farinelli points out that a map is not a depiction of the reality as it is looks to the human eye, but a way to propose an idea that should not be mistaken for the real (Farinelli, 2003). Maps, indeed, are nothing else than an abstract representation of the World on a paper that coincides with the incredible effort to design the World.

At this point, it is important to make a distinction between traditional and digital mapping applications. While it has been noticed that the firsts are an abstraction of the World, the latter, like Google Earth, depict the World as a sphere with an incredible amount of data and details taken form satellite and aerial views with the aim to reveal every single point of the Earth as it really looks in a sort of photographic realism (Brotton, 2012). The same distinction exists between physical models and virtual three-dimensional models. Indeed, while physical models are abstractions, virtual models depict the reality with a presumed accuracy. This excessive accuracy is nothing else than the reflection of a single point of view - the one of the model-maker - and it entails the risk to mistake subjectivity with objectivity (Ross, 2006). Another difference exists between the dichotomies of the traditional map/physical model and of the digital map/virtual model: the first still indicates a scale that establishes a direct proportion with the things that really exists, while the immateriality of the second completely nullifies the scale (Farinelli, 2009). Therefore, according to Farinelli's statement about the nature of a map, the process of model-making can be compared with the attempt of building the World using a cartographic map.

Between Digital and Analogical

During the fall semester 2017 an induction workshop that merged model-making and digital mapping was proposed as an introduction to the Urban Design Studio at the Department of Architecture of the University of Thessaly. The workshop was intended as a tool to help students to reach a confidence with urban issues, to focus on the impact of architectural projects inside an urban context and to trigger the imagination towards future urban scenarios.

The aim of this workshop was to blend analogical and digital tools to force the potentialities of each. Students were asked to confront their ability of extracting data from Google Earth, to use these data to build the tools for the exercise, and finally to deal with some rough and initial urban design proposals to face the challenges and the problems of the city of Volos. The exercises was not intended to offer abstract and universal tools to design cities, like new ordered spatial organizations, but it was an attempt to challenge the city that already exists. In other words, urban design was not considered with its internal rules, but as an agency able to criticize existing cities. With these premises, the workshop allowed students to familiarize with the city as a complex combination of events and forms. More specifically, the aims of the workshop were the followings: introducing students to the scale and dimensions of an urban project; using precedents as analytical tool; prompting the use of online mapping applications; understanding the city as a complex process of transformational relations and inventions. The methodology applied was structured into four phases: the analysis of the context using Google Earth to extract measures; the construction of a catalogue of precedents thought a data analysis using Google Earth; the creation of a combination of precedents inside the selected area of the city by combining, repeating, altering and adding, at the same scale, data to discover new urban models; the use of the technique of the collage to produce images that are quickly comprehensible in order to suggest an alternative vision for the future.

Fig. 7, Cover of the catalogue of the exhibition 'Roma Interrotta'

The background of this exercise was lying in the ‘Roma Interrotta’ exhibition that was conducted in 1978 in Rome (fig. 7). Under the direction of the architect Pietro Sartogo, the famous map of Rome that Gianbattista Nolli, that was drawn in 1748, was divided into twelve sectors where each invited architect could draw new possible urban transformations of the city challenging the history of the city (fig. 8). This framework was the base for the exercise: the aerial map of Volos was divided into nine sectors and each sector was given to the students as their individual study area. An aerial photography was extracted from Google Earth, divided accordingly assigned delimitations, and mounted on boards. Each panel was thus representing both a fragment of the wider city and the area of the individual exercise.

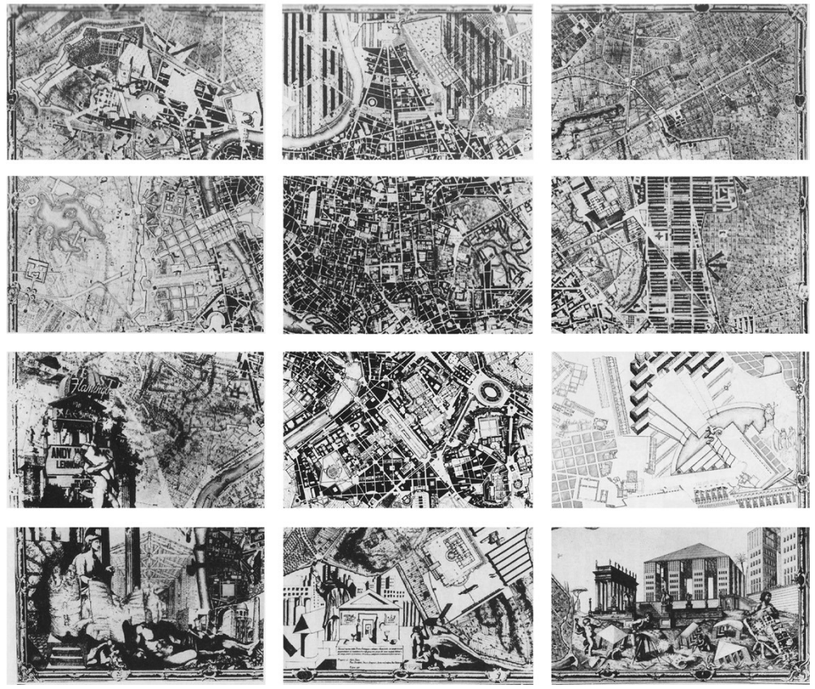


Fig. 8, The final map of the exhibition ‘Roma Interrotta’.

Some dysfunctional buildings from the city of Beirut (abandoned buildings, urban ruins, luxury apartments building that work like gated communities, public buildings that represent dysfunctions in the management of the public infrastructure and welfare and many others) were then selected to build an archive of precedents to be used in the exercise. Students drew axonometric drawings and built physical models of the buildings using data collected from digital maps (dimensions and architectural features of the building). The exercise of re-drawing was aiming to bring to the fore the discrepancy that may exist between architectural forms and their effective functions (fig. 9).

Each student chose some of these buildings and then played on his sector re-arranging the existing urban setting. Physical models, aerial photography and various other images collected from the web were used at the same time. In this way, each student mixed the creativity of the analogical collage and the physicality of the masses with the absoluteness and neatness of satellite maps. The insertion of dysfunctional buildings inside the city context of Volos had the scope to bring to the fore social contrasts, morphological differences, urban dysfunctionality and other important urban issues (fig.10).

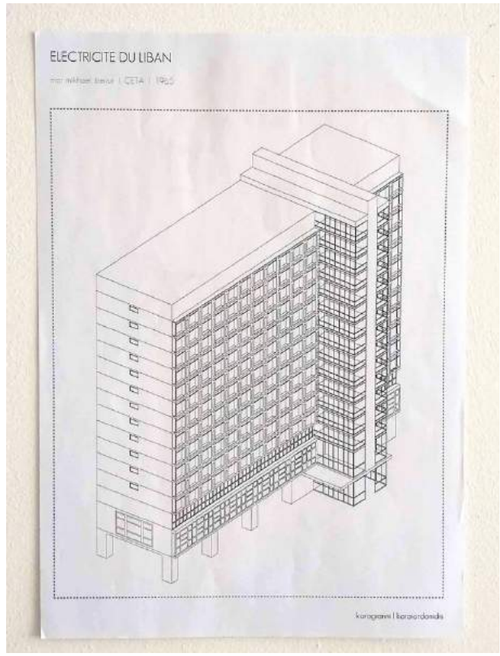


Fig. 9, Volos Interrupted Workshop, Axonometric drawing of a precedent.

Fig. 10, 11, 12, Volos Interrupted Workshop (scale 1:2000), University of Thessaly, Spring Semester 2017-2018 (class model).

At the final step of the workshop, the nine sectors were joined together on a wall to build an unprecedented map of the city (fig. 11). The final map embedded, at the one hand, the individual works of the students in a specific area, and, at the other hand, the effort to redesign the city collectively (fig. 12). The map was showing the idea that the city is assembled in parts, an idea that recalls the notion of urban assemblage proposed by Ignacio Farías. Farías, indeed, introduces the idea of multiplicity to explore the horizontal relations that exists between networks to run away from the idea of the city as a whole (Farías, 2011). Depicting a dystopian future, the final map worked as a round-table for discussion, where every student was presenting his proposals with an immediate impact on the works proposed by the others.

Conclusions

To conclude, model-making can be considered more than just a representational tool. As for the example of the workshop previously presented, physical models, with the support of digital tools, facilitate to unveil the hidden structures that lies between the visible in a combination of human facts, objects, and processes. Model-making should thus be seen like an epistemological inquiry that has the scope to produce questions instead of drawing immediate conclusions from the visible.

References

AA.VV. (2015). *Roma Interrotta.* 12 Interventions on the Nolli's Plan of Rome. Monza: Johan & Levi Editore.
Brotton, J. (2012). *History of the World in Twelve Maps*. London: Penguin Books.
Corner, J. (1999). The Agency of Mapping: Speculation, Critique and Invention. In D. Cosgrove (ed.). *Mappings* (pp. 231-252). London: Reaktion Books.
Farías, I. (2011). The Politics of Urban Assemblage. *City*, *15:3-4*, 365-374.
Farinelli, F. (2003). *Geografia. Un'introduzione ai modelli del mondo*. Turin: Einaudi.
Farinelli, F. (2009). *La crisi della ragione geografica*. Turin: Einaudi.
Farrelly, L. (2011). *Drawing for Urban Design*. London: Laurence King.
Ross, R. (2006). Perils of Precisions. In J. Abrams and P. Hall (eds.). *Else/where: Mapping New Cartographies of Networks and Territorie*

Nuno Mateus
nunomateus@fa.ulisboa.pt

Building the Void – A Process of Model Reversal

This exercise has been the framework for the 4th year design studio in the Architecture Department of Universidade Autónoma de Lisboa during the last 7 years. This program is run together by arch Pedro Reis and myself and has been applied in class with students of the first year of the master degree, the second stage of an integrated master degree in architecture, according to Bologna guidelines.
Within the guidelines of the school academic plan for the 4th year, this exercise articulates different curricula units to widen and deepen cultural design grounds, such as History, Urbanism and Architectural Technologies, etc. After the first 3 years of graduation in Architectural Studies, where students are exposed to different tools and acquire competences in a wide range of subjects that are the source and substance of basic architectural culture, it is the role of the master degree to train complex operative processes of interaction between those different fields, replicating in the design class interdisciplinary routines that are common in any professional practice.
The aim here is to study a new city every year, selected among the most relevant paradigms of a specific European urbanistic and architectural culture.
This program has been so far applied to the following cities: Barcelona, Amsterdam, Berlin, London, Stockholm, Athens, and Prague. In the present year we are working in Rome.
The exercise begins with the research of basic historic and contemporary cartography and iconography to enhance our preliminary knowledge of the city and to lay down foundations and begin to build references for an adequate design intervention.

1. Analysis

The overall design process consists of several sequential and inter-related steps spreading over the full semester, and begins with the analytical unfolding of the territory, to be studied

through the work on 10 conceptual layers of readings, at different scales and scopes. These layers, to be consubstantiated in rather large physical models are planned to be executed over a period of roughly 4 weeks, drying time and exhibit assemblage included.
Teams are organized with 2 or 3 students each, to promote collaborative work, generate a context of discussion and increase production pace.
The proposed topics to be studied, which have slightly been adjusted from city to city, according to its specific nature, context or history, which may vary, are most often the following:

1. Geographic Territory – or the search for the reasons why the city is established where it is.
2. Topography – understanding of the nature of the city natural ground
3. Nuclear urban core – a reading of the original city footprint
4. Historic walls – revealing sometimes hidden structures that were decisive constraints to urban morphology and generated visible shifts in building typologies
5. Urban Sprawl – understanding main arteries and commuting fluxes and observe the daily process of extension and compression of the city, center and periphery
6. Contemporary urban structure – observing the city as it is
7. Urban morphology 1 – a survey of a distinctive and coherent urban pattern
8. Urban morphology 2 – an alternative clear urban pattern – evaluate contrasts on city morphologies
9. Architectural typology 1 – A reading of a symptomatic building type
10. Architectural typology 2 – A an alternative specific building type

These models, are to be defined on a single size of 80x80cm and built in reinforced concrete. The familiarity of the use of this material, so banal in the professional field of construction industry, is intended here as an important and structuring acquisition in the school environment which will produce knowledge that somehow will bridge into professional practice. The domain of pragmatic physical issues like sand & concrete proportions, mixing mortar, sealing moldings, greasing for easy unmolding, structural reinforcements, vibrating, drying, unmolding and cleaning are key to the success of the models. Small and fast sample test models are recommended to be done prior to the full model, to test and adjust technologies to each task and scale. Some moldings are more properly executed with the resource of a cnc cutter, others may be more effective with laser or even cut directly by hand. Most of them end up being a combination of different tools. These trial models are also important to test and feel in our hands the basic properties of concrete, such as weight, viscosity, chemical interaction with the molding, drying time and solidification or capacity to accept later cleaning or eventual repair.

The method implies a previous classical research on cartography, iconography, focused on the topic to be studied, etc, followed by intermediate steps of digital or/and hand drawing translation to generate adequate information for the tools to be used on the making of the moldings in question. Working scales may vary from city to city but they often range from a 1/50000 of territory models to 1/200 of architectural typologies.
With this framework of analytical readings and constructions, the city at stake is to a certain level decoded and became somewhat familiar, ready to accept an informed design reaction to a local problem.

At the end of this analytical stage, students prepare and install an exhibition of the sequence of the different models.

1. Program

The choice of place and size of intervention is intended to be adequate for a 1000-2000m2 building above ground. It is also chosen to be consistent with a plausible housing program, i.e., we do not intend to open ground for exceptional buildings, on the contrary it is meant to be a current community housing building.

2. Site

The second step of the program consists on the selection of individual project sites for a later intervention.
These sites are spread around the city core, generally distributed roughly in a circle path that can be walked through in a full day in town. It is intended that the particularities of each site choice, as an overall group strategy, outlines what we may consider at this point a representative survey of typical land-plot conditions and building typologies, that conveys the particularities of the city settings.
Earliest steps of this process are based in the manipulation of graphic tools, such as digital files of the city, photographic aerial mappings of google earth and walking through street view. One develops, at first, a certain degree of perception and familiarity based on tools of remote experience of the city and contexts, to be confronted later in an actual physical visit to the city.

Each context model is to be built on a 1/200 scale, the first scale adequate do develop architectural thoughts in the long process of project decisions. Site models are casted in black pigmented concrete, on a 40x40 cm base. Context buildings and public space to be included in the model should convey the most relevant near context topographic/building type/public space information that will inform the design process. The site for the building within this base model, is left voided and excavated around 3cm (6m in reality), to allow enough flexibility to accommodate underground construction, ramps or stair access, or courtyard and garden interventions.

3. Volumetric Proposal

The void left in this black site model will be ultimately filled with a white concrete model of the student project. This contrast, is intended to outline the presence of different project interventions. There is an affinity with the material and an opposition with the color, testing different possibilities of this material for conveying conceptual intentions as well as becoming familiar with its expressive potential when extrapolated to other combinations.
Early stages of the project are triggered by fast sketch models that address the first stages of tentative decisions, such as volume heights and proportions, continuities, re-definitions or ruptures with the context, public and private space, etc. These are often models done in light solid materials easy to cut, like polystyrene. This stage of the design tends to be a process generated through addition, a composition of positive volumes as we see them. Conceptually it is a formal oriented process, i.e. decisions are taken according to the arrangement of building parts as solids.

At this point, roughly one month from the beginning of the semester, when the earliest preliminary instinctive models have been done and we have a first sketchy response from students to each building site, we travel together to the city. There we walk along all the building sites, experience the city building types, construction culture, current use of materials and details. We discuss together our perception of every plot, confront our local physical experience with earlier remote assumptions, and discuss the adequacy of the earlier steps. Sometimes strategies are confirmed, other times they are abandoned as something else is revealed more adequate. At the end of the day, we visit a local architectural school and attend a special class, prepared by a resident professor, on the subject of the city history.

Those earlier models are later revised after the trip and soon evolve into models built from assemblages of sheets, such as carboards, pvc or wood, which introduce completely different issues in the design process. These later models, built from flat surfaces, are appropriate to address intermediate steps such as floors, stairs, structure, opacities or openings, which will slowly introduce in the procedure questions of internal space. The fact that, with the use of these materials, every piece is individually cut and assembled in place, expands time incorporated which allow us to question physically and conceptually every single part of the building. These sequences of study models are alternately replaced in the void left in the context model, to test, compare and incorporate new project intentions. On the other hand, while sitting outside the context model, if properly organized, these study trials may document paths of investigation, shifts in project decisions and sometimes allow to recover lost tracks of adequacy. As a whole, they document a design cognitive path.
At the end of the process, final models will be materialized in white concrete, enhancing through contrast the primary urban reading of the architectural proposal.
Due to its relatively small architectural scale, details are filtered to express what is strictly fundamental, working at the end of this stage as devices for a hierarchical filtering synthesis.
Procedures of casting in concrete reverse conceptual work once again. In order to be casted, voids are now built as solids and we have the opportunity to experience visually and physically the structural importance of space conception in building design. This process of concrete casting brings to presence and into the equation, the inseparable space-form relationship, bringing into conscious the nature, potential and limitations of every study methodology.

4. Architectural Proposal

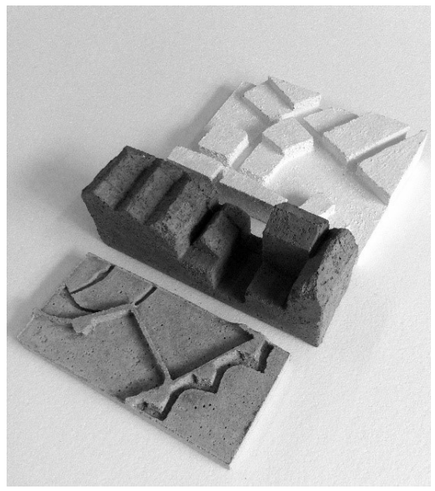
This process of design through models is here systematically crossed by drawings, of different kinds, from the beginning until the end of the project. Drawings select and trigger early decisions, they measure, test and adjust with enhanced accuracy intermediate steps of the project and they detail or define and fix final stages of design. This systematic crossing between drawings and models clarifies our perception of the potential role of each design tool in the process. Switching from one to the other, displaces the observer (and the architect) from the object. And when we see from a different point of view, we see differently, or different things. The project opens then new grounds for further developments and evolutions.
Any scale change has also the same kind of impact in the design development process. A simple change of scale is very often an important tool to boost conceptual thinking in the design process. Every architectural scale frames a certain universe of considerations to address, revealed through the proportional relationship, and consequently perception, between the size of drawings in the architect table and the actual size of buildings in reality. It helps the

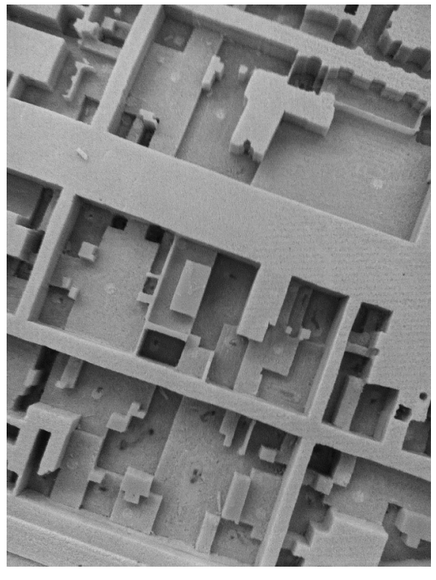
development of a conceptual understanding if this process is considered step by step, not as a smooth seamless sequence. We always experience, retrospectively, that when we change the scale of a drawing, we transform ourselves (in size)in relation with the architectural object and therefore we see differently, we see from a different perspective.
The scroll wheel of our current computer mouse, suggests that building representation scale is not a fixed level of interaction and understanding with the project, that may change at every scale change, but instead it suggests that it has become a continuous and unstable field in permanent transition. As a consequence of that, design process becomes a linear smooth process, without gaps, cuts or transitions. This is certainly a new fertile ground for architectural design investigation, although not in the context of this essay.

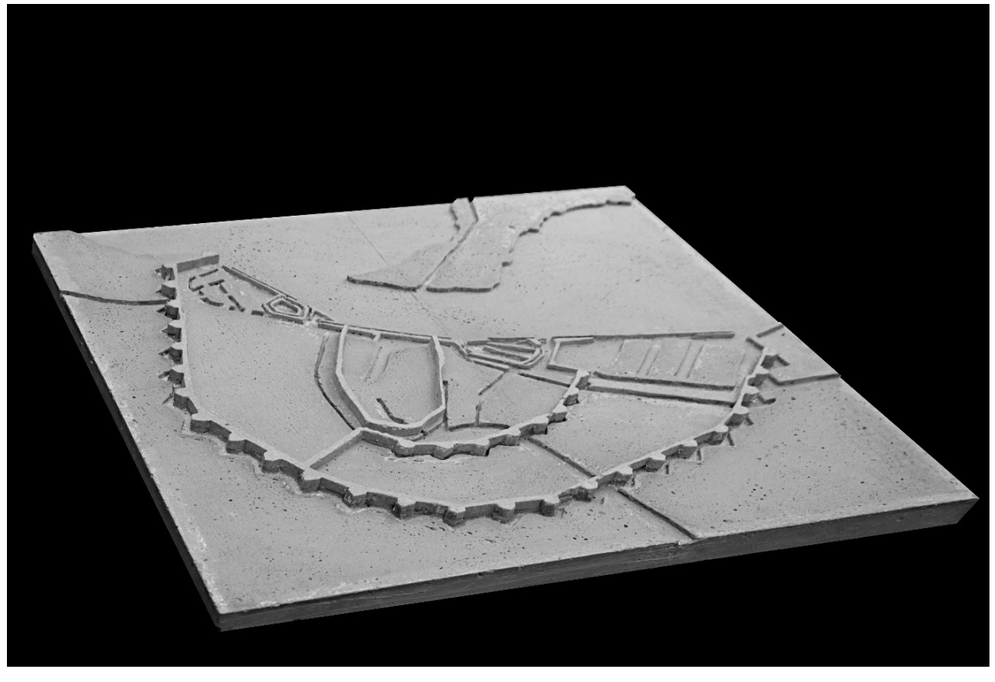
At this point of the project, we introduce at this point the request for a model at a 1/100 scale, probably the most common scale used by architects to document architectural projects. The immediate correspondence 1cm = 1m is without question in the origin of this choice. This model is once again to be built in (grey) concrete. Its increased size and detail requested, outpoints the need to incorporate a new realm of decisions and move apart from the level of definition of the previous white model at 1/500 and to avoid a simple enlarged version without further developments. This new model, aiming to be pushing further definitions, is deliberately conceived as a free-standing object (contextual evolutions will be checked in the site model). It is focused on its intrinsic architectural issues, as new grounds to experiments and developments emerge. At this point and scale, volumetric definitions are no longer enough. This scale requests decisions in crucial topics such as structure, walls, roof, openings, textures, etc, embodying another degree of rigor previously tested in drawings. Once again, and to a larger extend due to its greater size, and exposed by the reversed process of building the negative of the final casted object, the making of the molding reveals the full potential of space conceptual thinking in design process.

5. Space Section

The last model requested is at 1/50 scale. Students should develop and cast a partial fragment of the building that should address the main intentions for internal space design within the building. The selection of this fragment should communicate as clearly as possible the specific space qualities of the design and the inseparable relationship inside vs. outside. At this point of the process we are no longer discussing issues of form, but we are rather conceiving a receptacle that talks about one´s haptic experience of interior space. Certain pragmatic architectural aspects that this scale clearly introduces, such as steps in stairs or windows as voids in the building shell, should now be represented, and they affect the construction of the molding close enough as they will affect the construction of the building.
This model is to be built, once again, in white concrete and will join the earlier group of a scaled sequence of casted tectonic artifacts.
As a whole, we leave behind a considerable trail of evidences of different sizes and scopes. A process made of trials, errors and critical corrections that slowly evolve in size and subject.
We have experienced design as a cognitive evolutive understanding of an architectural problem, from simple to complex and overlapped decisions. Its operative energy comes here from the need to continuously address new questions of physical construction in a context of a frequent conceptual reversal of the relationship between space and form implied by the process. And, to a great extent, this is what happens in the reality implied by the work of architects.







Nesli Naz Aksu *neslinazaksu@gmail.com*
Burçin Yılmaz *burcinsonmezyilmaz@gmail.com*

TOBB ETU, Ankara,

Reconstructing the Site: Studio Spaces as the Architectural Model

Abstract: Architectural models, either physical or digital have always been significant for architectural design education, therefore further research and various experiments have to be done to better understand their role. The research, conducted under the scope of architectural design studios in TOBB ETU, tries to use the studio space as a foundation for *architectural model* in order to question urban conditions. The threshold between architecture and landscape architecture is important for the studio to understand the blurred boundaries in the city. Architecture as an object cannot be considered detached from its surroundings. In accordance with this understanding while trying to evaluate the urban conditions, the studio tries to reconstruct these cases in the studio space. Starting from the decision on site boundaries to the final presentation each step becomes a piece of the *architectural model*.
Within the scope of this studio, it is aimed to investigate and explore new ways and media of perceiving and reflecting the site with all its layers and simultaneously proposing new urban strategies. While doing that, instead of suggesting only a building with a predetermined program, this studio tries to speculate on the site by using drawings, digital and physical models, photographs, collages, the space and their composition. Throughout the semester the studio space is transformed by the students and becomes a model of the site which allows to reconstruct the site with new strategies where the designer becomes a part of it and plays a crucial role. The process itself and the final representation provide a basis for reconsidering the meaning of the *architectural models.*

Keywords: *Architectural Model, Studio space, Architectural representation*

THE STUDIO

Le problème n'est pas d'inventer l'espace, encore moins de le ré-inventer (trop de gens bien intentionnés sont là aujourd'hui pour penser notre environnement…) mais de l'interroger, ou, plus simplement encore, de le lire; car ce que nous appelons quotidienneté n'est pas evidence, mais opacité: une forme de cécité, une manière d'anesthésie.

Georges Perec, 1974

Georges Perec states the importance of *reading the space* instead of inventing or re-inventing it. Giving importance to his idea, the studio carried out for five semesters including fall, spring and summer 2018 and fall, spring 2020, tries to read and speculate on a selected part of the city. These speculations embrace the questions of what architectural models are, how they are related to the site and how it may contribute to a design studio. While speculating on the site, regardless of the distinction between the artifact and nature the city is seen as a whole, and the foundation of the studio is constructed upon that. How two things come together and how they are constructed is a crucial point that the studio concentrates on.

Fig. 1: selected part of the city

ARCHITECTURAL MODEL

Architecture stems from a sapient working together of writing, drawing, and construction lines. The critical study of genetic architectural representations by examination of the sedimentation of architectural materiality inscribed in weathered boards, papers and models develops the ability of architects to become architecturally conscious. Architectural lines are material, spatial, cultural and temporal occurrences of refined multi-sensorial and emotional understandings of architecture.

Leon Battista Alberti, 1485

The architectural models are approached by the studio to investigate and explore new tools and media not only to represent the site/architecture but also design by using it. The initial point of constructing the model is perceiving and reflecting the site with all its layers. Speculations on the site are done by using drawings, digital and physical models, photographs, collages, the studio space and their composition. This approach was tried by combining different representation methods to redraw the site and design by it where examples on understanding and intervening the site can be given as; manipulating the photographs from the site, togetherness of a model and a drawing and their representations in the studio space (fig.2) as well as a three dimensional book that includes some scenes from the proposal on the site.

Within the discussions on architectural models, the studio suggests that they are neither the final representation nor the design tool by itself, but they are the composition of all the architectural tools that was mentioned before. In accordance with this understanding while trying to evaluate the site, the studio tries to reconstruct these cases by using the studio space (fig.2) as a foundation for the *architectural models.* Throughout the semester in various scales the studio collects, combines and works with different tools and in the final, with all the outcomes the studio space is transformed and installed by the students like a performance space which leads the observers, students, jury members to become a part of it that helps to reconstruct the site in the studio space with their interpretations.

Fig. 2: studio space

PROJECT | SITE

The Manhattan Transcripts differ from most architectural drawings insofar as they are neither real projects nor mere fantasies. They propose to transcribe an architectural interpretation of reality. To this aim, they use a particular structure indicated by photographs that either direct or 'witness' events (some would say 'functions', others would call them 'programs'). At the same time, plans, sections, and diagrams outline spaces and indicate the movements of the different protagonists – those people intruding into the architectural 'stage set'.

Bernard Tschumi, 1994

The studio selects a site and starts with questioning that given part of the city. The main concern considers the parcel rules and boundaries as its main purpose since it is the base of how things come together in the city. To do that the city is considered as a model to be reconstructed. There are a series of buildings and open spaces formed according to these parceling and its rules and they are disconnected with the geographies that they are in. The main idea is to think all these divided pieces as a whole. In order to construct the model these rules and boundaries must be reconsidered and to understand the site and its layers properly these rules should be ignored first. So, with no pre-consumption the site is divided randomly as a research area (fig.1). These randomly divided site pieces are shared by the students in groups. Each group starts their research by their personal experiences, perceptions, observations and anything inspired by the environment. This new way of division transforms the area of study to a model that has both blurred and strict boundaries which cause overlaps. Trying to find a way of representing these cooperation and overlaps makes a collage model consisting of different tools (fig.3). Going back and forth to this model creates a performative design process.

Trying to reconstruct this collage, every group has a sequence of using different tools but in the end, each becomes a part of the whole. This notion brings new challenges that require a knowledge of materials and a study on how firstly each tool can inspire another as well as how projects can come together. As it was mentioned at the beginning, this is an ongoing research on using the tools of architectural design together and trying to transform/use the studio space while doing that.

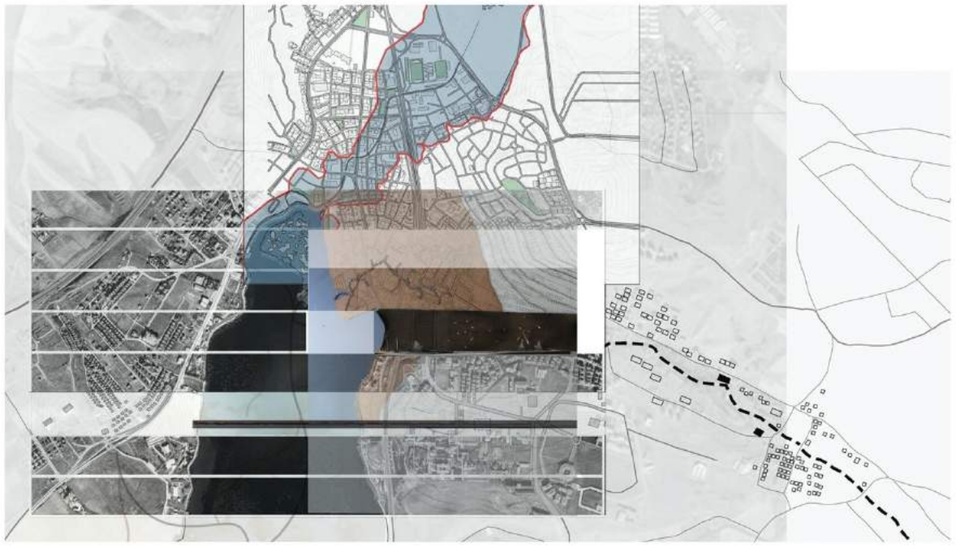


Fig. 3: collage model of the site (summer, 2019)

EXAMPLES

These 3 examples express the aim of the studio in terms of architectural models and how they are used, installed in the studio space. The first example (fig.4) is from the studio space where the drawings are embedded in a video and construct a composition with the hard copy drawings and a scaled model of the proposal. The video and the drawings itself are

also a collage of photos, physical models and digital models. While designing, changing scales became an important design tool which later organized the model. Second example (fig.5) shows how the students are thinking of the model as the extension of the drawing and trying to construct them together. Another example (fig.6) is giving the process of modeling the idea with different materials, taking its photo and trying to construct the project between digital and physical models by going back and forth.

To sum up, the students use all the tools, compose and recompose them to conceive and open up a discourse/discussion on the site. Thus, starting from the decision on site boundaries to the final presentation each step becomes a piece of the *architectural model*.

Fig. 4: link by ali rıza özkaya, damla özden, (summer, 2019)

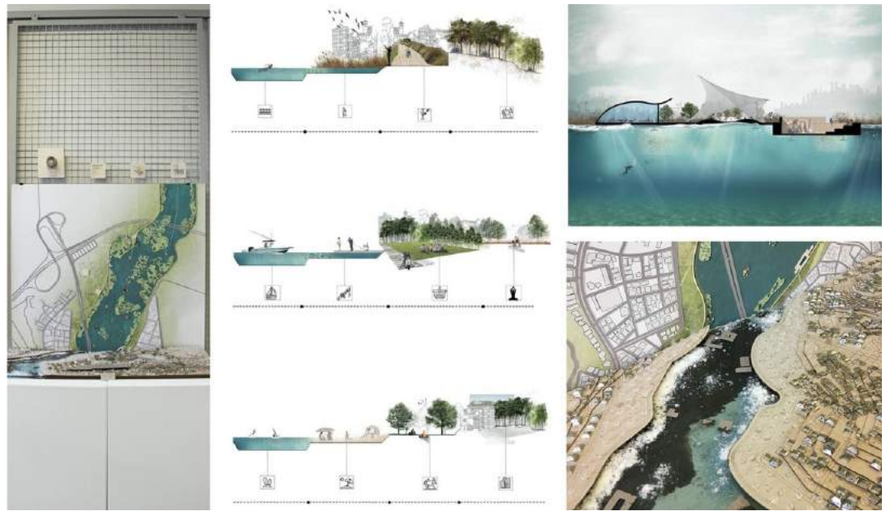


Fig. 5: dynamic city by hira şevval demirci,

References

Frascari, M. (2007). Models and drawings - the invisible nature of architecture. In M. Frascari, J. Hale, & B. Starkey (Eds.), *From Models to Drawings* (pp. 1-7). New York: Routledge.
Perec, G. (1974). *Espèces d'espaces.* Paris: Galilée.
Tschumi, B. (1994). *The Manhattan Transcripts.* New York: Academy Editions.

Sérgio Proença
sergioproenca@edu.ulisboa.pt

Interpretation and Exploration The Role of Models in Second Year Architectural Education at the ULISBOA, Lisbon School of Architecture

1. River Theatre, a Theatre for the Tagus River

The presentation focus on the pedagogical role of models in the work developed by the students tutored by Sérgio Barreiros Proença along the second semester of the second year of the Architecture degree design studio, taught at the Lisbon School of Architecture of the University of Lisbon in the school year 2018/2019.
"*River Theatre, a theatre for the Tagus river*" was the semester theme proposed by the coordinator of the year, Jorge Cruz Pinto, and aimed at the creation of a wooden floating theatre for the Ginjal Pier.
The functional program for the floating theatre was elementary: a versatile main room with capacity for 100 to 150 spectators; lobby; ticket booth; wardrobe; bar; toilets; technical area with dressing rooms, storage room and the reggie/control room.
The Ginjal Pier, in the south bank of the Tagus river, is an area characterized by its privileged position facing the city of Lisbon, although nowadays in a state of physical decadence and ruin, it remains an alternative leisure promenade for contemplating the river and the city.
The assumption was that the introduction of this very simple theatre, and the reinvention of the piers in its relationship with the margin, would allow to stem from the qualities inherent to the site for the design of the theatre in continuity with the pier structure and allow its fruition.

2. Second Year Framing

The first year design studios are dedicated to an introduction to Architecture materialized in project explorations mainly made with styrofoam models that underline the values of light, form and space. In a certain way, we could say that it explores the creation of architectural spaces from the excavation of voids in thick, dense surfaces. A stereotomic

architecture,[1] even because students don´t have at that moment the construction physics knowledge to do in another way.
Complimentary, the second semester of the second year design studio classes are mainly focused in tectonic architecture,[2] using both drawing and models as essential tools for the development of the projects. This approach is possible given the acquired knowledge in constructions curricular units and the protoarchitectural project developed in the beginning of the first semester design studio of the same year titled “Childhood box”, in which students build a full scale model using wood structural elements.

3. The Second Semester of the Second Year

Alberto Campo Baeza considers that *“the ideas that give origin to architecture (…) is a synthesis of concrete factors that concur in the complex architectural fact: Context; Function; Composition and Construction.”*[3]
The design studio is a curricular unit mainly focused on exploring architectural composition as a creative formal synthesis of an idea to answer a concrete question. Furthermore, in architecture, typological innovations and creativity are catalysed when unusual intersections are made, for example when a stabilized functional program intersects a new context or a new construction system.
Therefore, the foundation of the methodology of the semester is based on the **interpretation** of a context – the Ginjal Pier – a functional program – the theatre – and a construction system – the wood frame – as three fixed pillars that concur for the creative formal synthesis, allowing students to explore composition variations of an idea based on them. The **exploration** of a formal answer to the design question is based on the synthesis of context, function and construction, defining the project – the River Theatre, a wooden floating theatre – with progressive composition precision.

1 “We understand by stereotomic architecture the one in which gravity transmits itself continuously, a continuous structural system where constructive continuity is complete. It is the massive architecture, mineral, heavy. The one that rests on the earth as if born from it. It is the architecture that searches for the light, that punctures its walls in order for light to come in. It is the architecture of the podium, of the base. The one of the stylobate. It is, in synthesis, the architecture of the cave.” Campo Baeza, A. (2000) “CAJAS, CAJITAS, CAJONES: Sobre lo estereotómico y lo tectónico” in La idea construída, Madrid: Libreria Tecnica CP 67 / Universidad de Palermo / ASPPAN. p. 61.

2 “We understand by tectonic architecture the one in which gravity transmits itself discontinuously, in a structural system with nodes where construction is syncopated. It is the osseous architecture, woody, light. The one that rests in the earth as if rising on tiptoes. It is the architecture that defends itself from light, that must shade its voids in order to control the light that floods itself. It is the architecture of the shell. Of the abacus. It is, in synthesis, the architecture of the hut.” Campo Baeza, A. (2000) “CAJAS, CAJITAS, CAJONES: Sobre lo estereotómico y lo tectónico” in La idea construída, Libreria Tecnica CP 67 / Universidad de Palermo / ASPPAN: Madrid. p. 61.

3 “The IDEAS that give origin to Architecture are complex concepts. COMPLEXITY in Architecture is natural to the IDEA. IDEA is a synthesis of concrete factors that concur in the complex architectural fact: CONTEXT; FUNCTION, COMPOSITION and CONSTRUCCION.
CONTEXT is related to the Place, to Geography, to History. To where, the UBI.
FUNCTION that generates Architecture with its what for.
COMPOSITION that orders the space with its geometrical how. With the Dimension and the Proportion. With the SCALE.
CONSTRUCTION that turns into reality the Space with its physical how. With the Structure, the Materials, the Tecnology. Directing the GRAVITY. With the MATER.
The IDEA, the why, will be as precise as the most accurately answers these where, what for and how.”
Campo Baeza, A. (2000) “ESENCIALIDAD. MÁS COM MENOS. Manifiesto” in La idea construida, Madrid: Librería Técnica CP 67 / Universidad de Palermo / ASPPAN. p. 35.

3.1 Interpretation

The first exercise of the semester consists on an approach to three themes: context – the margin of the Tagus river, more precisely the Ginjal Pier – a functional program – the theatre, understood as an architectural typology that defines a spatial relation between actor and spectator – and a construction system – the wood frame, selected as material technology for the construction of the project.
This tripartite approach, developed simultaneously, in groups of 4 to 5 students, has the goal to introduce and make students familiar with the three essential themes [margin; theatre; wood] for the sequent individual composition and synthesis of the River Theatre.

margin
Regarding the margin, the morphological interpretation of the Ginjal Pier [fig. 1] and its composition elements stems from an approach to the Cacilhas margin, in the south bank of the Tagus river, from the city of Lisbon, materialized in the elaboration of an individual serial vision in ten hand drawings and one 1:500 model. The ten drawings that compose the serial vision along the selected path from Lisbon to the Ginjal Pier should express an individual impression of the place and its elements, from the views and framings, approaching five binomials: alignments / focal points; positive / negative; interior / exterior; limits / transitions; mater / texture.
Complimentary to the serial visions, an interpretative mono-material model was made in 1,5mm wood cardboard on a 1:500 scale representing the pier promenade – from its urban layout and the scenography of the façade – and the topography of the site including the river, built by assembling individual sections [fig. 2].
This interpretative model gave order to the fragmented serial visions and allowed to isolate specific layers of the reality through a “*de-layering*”[4] and recomposition process, enabling students to focus on essential composition elements of the context: the geographical support, both topography and the river; the limiting buildings; and the piers that configured the relation between land and water.

Fig. 01_Cais do Ginjal pier

4 “a process which allows us to “see” certain formal configurations that are not perceivable in reality and, therefore, affects the way in which we see the city” Gandelsonas, M. (1991) The Urban Text, Chicago: MIT Press. p. 26.

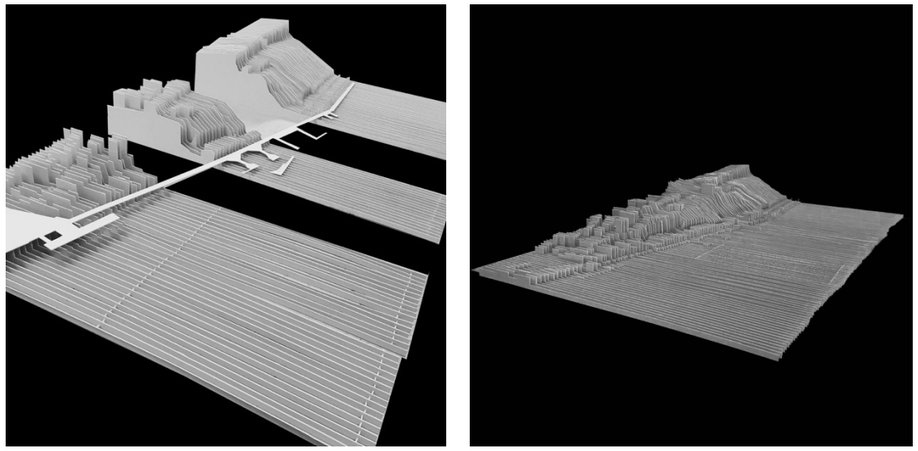


Fig. 02 and 02a_Interpretative model of Cais do Ginjal area

theatre

Regarding the theatre typology, each group chose a different a case study from a previously given list of cases. The interpretation of the case study was elaborated giving attention to specific binomials: container/content; stage/audience; served spaces/server spaces. Analytical decomposition drawings based on plans and sections were made regarding each binomial at the 1:200 scale for all cases enabling the comparison between cases as different as the Agrippa Odeon (Athens, 16-13 b.C.), the Oficina Uzyna Uzona Theatre (São Paulo, 1991-1993) or the Thalia Theatre (Lisboa, 1843/2008). Regarding specific elements to be addressed in each pair of binomials: container / content focus on the relation between volume of the building and the volume of the "acting box"; stage/audience focus on the relation between surface of the stage and the surface of the audience; served spaces/server spaces focus on the relation between the atrium, audience, stage vs. the ticket booth, wardrobe, bar, toilets, technical areas, dressing rooms.

wood

Regarding the wood frame construction system, tectonics interpretation addressed one of three types of cases from a list of preselected cases that contained: three-dimensional wood structures; wall sections; or a set of assemblages. Each of the cases should be dealt using wood models at specific scales: three-dimensional structures at 1:50; wall sections at 1:20 or 1:10; and assemblages at 1:5, 1:2 or 1:1. The students of this class dealt with cases such as the frame of the Makoko floating school, the Final Wooden House, a wall of the Swiss Sound Box pavilion and different types of assemblages [fig. 3].

The aim of these models was to familiarize students with an ancestral construction system that nevertheless remains current and continually is revisited and reinvented in architecture. Furthermore, while building the interpretative models that highlight the different qualities that were found on each case, students were earning an empirical sensibility regarding not only the tectonic qualities and abilities of wood but also its materiality, given the fact that models were made of balsa or pine wood.

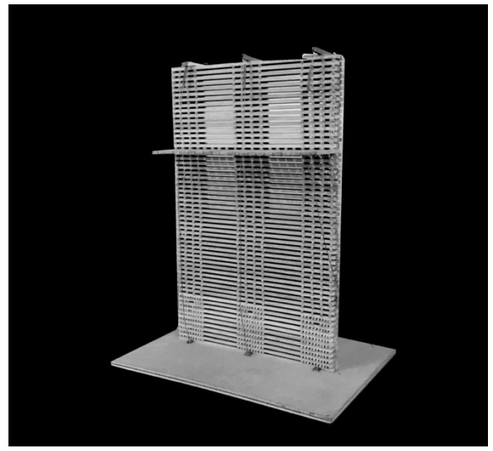


Fig. 03_Interpretative model of a section of the wall building structure of Peter Zumthor's Swiss Soundbox Pavillion

3.2 Exploration

The second exercise of the semester consists on the development of the project for the River Theatre. The approach to the overall project exercise was subdivided in autonomous sequent steps, each one an elementary exercise that allowed students to focus on specific questions regarding the project, alternating the scale of the work back and forth and stemming from the previously done interpretation exercises for the design exploration. Thus, five exercise phases were considered: 1. urban scenography/arriving and entering; 2. skeleton, *tamponatura*, metric; 3. structure, order, organization; 4. acting box; 5. materiality and constructivity. Along these steps, both drawings and models concurred for the development and precise definition of the ideas that were tested.

urban scenography: arrival and reception.

The aim of this phase was to design an idea of arrival to the theatre, in sequence with the pier promenade as far as the contact with the river. Methodologically, students considered the previous interpretation of the **margin**, working on a 1:500, 1,5mm wood cardboard model, based on the transformation of the urban layout layer of the interpretation model, considering the permanence of the other elements, defining a new configuration for the public space sequence that would receive the floating theatre [fig. 4].

Students were asked that the model expressed a justified choice of a specific location within the pier and a strategy for the occupation of the site relating to the river, the pier and the near and far landscape. In this phase it was also possible to already consider different possibilities for the physical structuring of the theatre: singular or multiple elements; totally floating or partially floating; mobile or fixed.

This abstract model enabled students to focus on the shape of the spaces of arrival and reception before entering the theatre, i.e. the configuration of the public spaces of representation of the theatre.

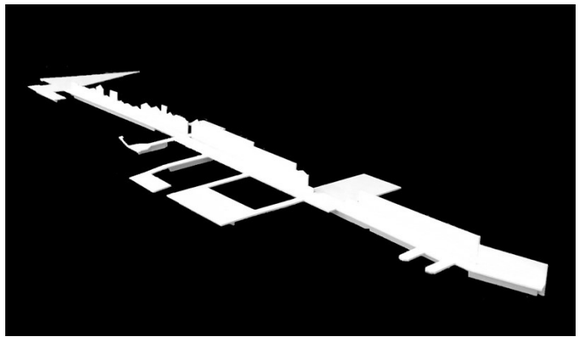


Fig. 04_Urban scenography: arrival and reception spaces model.

skeleton, *tamponatura*, metric

Following the definition of the relation with the context, students were asked to jump to a different scale and theme of the project, related to the constructive system definition named "*skeleton, tamponatura, metric*".

These three concepts were directly connected to three elements:

. *skeleton* was developed resorting to a model, built in balsa wood on a 1:20 or 1:10 scale, and consisted in the exploration of a three-dimensional structural module, exploring the spacing and assemblage between structural wood elements leading to the definition of the structure geometrical base;

. *tamponatura* is the Italian word for infill and its exploration was made resorting to the previous skeleton model, testing different textures and opacities/densities by subdividing and infilling the spaces between structural elements, leading to the definition of composition principles for the partition of modules. Based on this skeleton + tamponatura model, 1:20 rigorous plan, section and elevation drawings were made.

. *metric* consisted on the exploration of a multiplication and reciprocal adaptation of the skeleton + *tamponatura* module and the occupation footprint idealized in the previous phase of the work. The metric matrix was materialized in a 1:200 drawn diagram defining a composition regulatory metric both for the constructive system and the spatial composition.

fig. 05_Skeleton, tamponatura, metric model

structure, order, organization

The phase *structure, order, organization* consisted in a drawn exploration in a 1:200 scale that stems from the previously defined metric matrix for the organization of the spaces and the distribution of the functional program, both in plan and in section.

The aim was that each student defined an initial conceptual principle for the composition of the theatre spaces based on a critical position regarding the previous interpretation that had been done of the theatre case studies in the first exercise. To guide the ordering of the spaces, students were advised to conceive an idealized path to structure the theatre spaces, in continuity with the public space structure of the pier.

acting box

The *acting box* phase consisted in perfecting and precising the previous phase, in a 1:100 scale, resorting both to drawings and models. Insistence was made for the conception of the spatial partition of the theatre to be coordinated with the structural metric. This operation led to reciprocal adaptations of spaces and structures, because *"Structure is not only a question of transmitting loads to the ground, it is essentially the establishment of an order in space."*[5]

The use of light balsa wood models to explore the precise dimensions of metrics, partitions and composition elements, physically testing and comparing design options within the guiding idea, enabled students to earn a conscient autonomy regarding their own choices in the creative process. The precise model building and rigorous drawing in a 1:100 scale allowed to explore and clarify the continuity relations between the pier, the theatre and the river, as well as the inside / outside proposed relations, exploring in-between spaces potential.

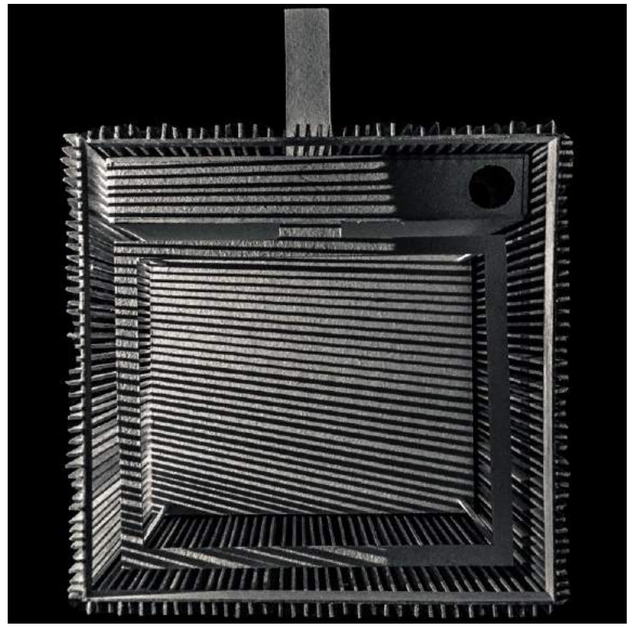


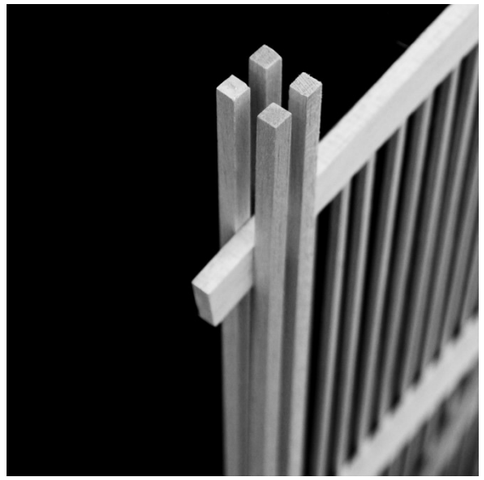
fig. 06_Acting box model.

5 Campo Baeza, A. (2013) [2011] "De elefantes e pássaros" in Principia Architectonica, Casal de Cambra: Caleidoscópio. p. 67.

materiality and constructivity

The *materiality and constructivity* phase consisted in the detail definition explored in 1:20 models of a vertical limit a section that, when stabilized, was drawn in plan, section and elevation in a 1:50 scale.

The aim of the balsa or pine wood 1:20 models was to explore not only the assemblage of elements but also the atmospheric qualities of the space associated with the material and constructive qualities that were defined on each project.



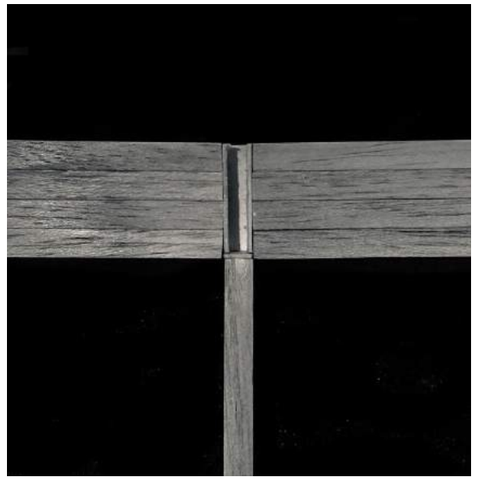


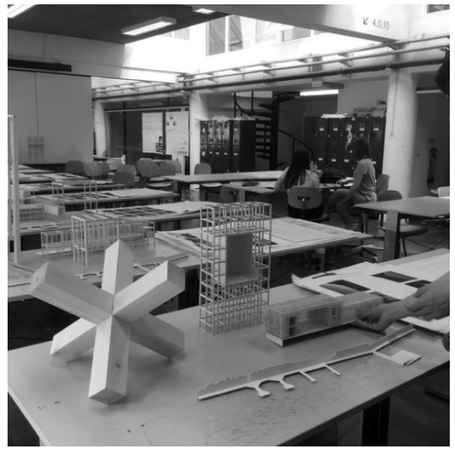
Fig. 07a and 07b_Materiality and constructivity models

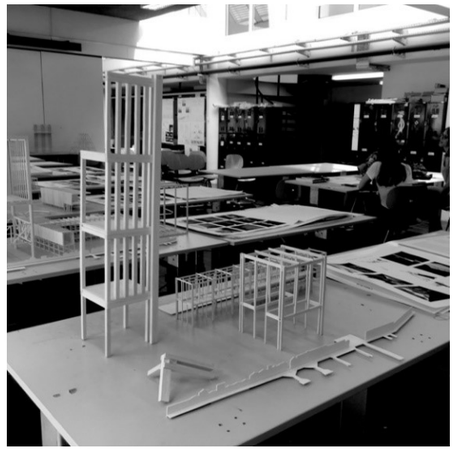
4. Usefulness of models in architectural interpretation and exploration

In the course of the semester, students followed the advice present in the second book of *De Re Aedificatoria*, building models that enable to place in evidence *"the framing in the context, the area delimitation, the area, the number and the disposition of parts, the configuration of walls, the solidity of the covering and, finally, the ordination and conformation of all the elements discussed in the previous book."*[6]

In the development of the project, models had an instrumental role alongside drawing, enabling the improvement of these two architectural tools – drawings and models – while exercising them in two distinct aspects of the project: the **interpretation** of context, functional program and construction system; and in the **exploration** of composition design leading to a final formal synthesis and its detailing. The sequence of the exercises and phases allowed for students to progressively earn autonomy and define more precisely the project while adopting as an essential part of the design process a critic transference of qualities from the interpretation of context and case studies of theatres and wood structures.

6 Alberti, L. B., traduzido por Mário Kruger e Arnaldo do Espírito Santo (2011) [1485] Da Arte Edificatória, Lisboa: Fundação Calouste Gulbenkian, Serviço de Educação e Bolsas. pp.188-189.





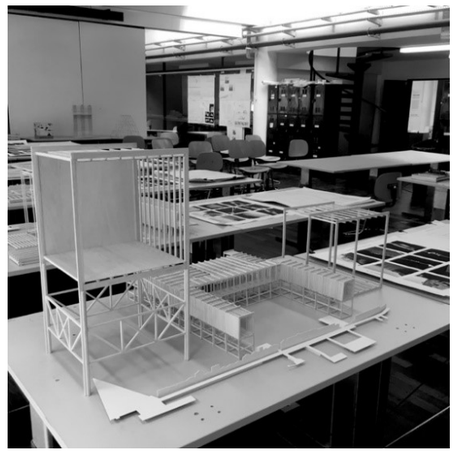


Fig. 08a to 08d_Set of final presentation models.

References

ALBERTI, L. B., traduzido por Mário Kruger e Arnaldo do Espírito Santo (2011) [1485] *Da Arte Edificatória*, Lisboa: Fundação Calouste Gulbenkian, Serviço de Educação e Bolsas.
CAMPO BAEZA, A. (2000) *La idea construída*, Madrid: Libreria Tecnica CP 67 / Universidad de Palermo / ASPPAN:.
CAMPO BAEZA, A. (2013) [2011] *Principia Architectonica*, Casal de Cambra: Caleidoscópio.
CRUZ PINTO, J. (coord.) et alli (2019) *Teatro do Rio. Um teatro para o rio Tejo*, syllabus of Laboratório de Projecto I course of the Master in Architecture at the Lisbon School of Architecture of the University of Lisbon, Lisbon.
GANDELSONAS, M. (1991) *The Urban Text*, Chicago: MIT Press.
SMITH, A. (2004) *Architectural Model as Machine*, London: Routledge.

Acknowledgements

The images presented are part of the work developed by the 2nd year 2018/2019 design studio class students tutored by Sérgio Barreiros Proença which we acknowledge: Ana Almeida, André Pedro, António Graça, Beatriz Luís, Bruna Marçal, Bruno Esteves, Carolina Pereira, Cassandra Machado, Diogo Rodrigues, Élcio Djata, Fábio Remoaldo, Fernanda Costa, João Abrantes, João Palma, Larissa Miranda, Lucas Silva, Mafalda Lopes, Maria Gameiro, Mariana Reis, Paulo Barros, Pedro Robalo, Pedro Leitão, Pedro Lopes, Pedro Santos, Rita César, Tiago Silva, Tomás Abelha, Tomás Rodrigues.

Sjef van Hoof *j.j.p.m.v.hoof@tue.nl*

The Dialogic Relationship Between Making and Experiencing Architecture

Subject: Design projects that use the model workplace at the Eindhoven University of Technology as a working and living environment

Aim:
The aim of the project is to explore the relationship between “experiencing” and “making”/the materiality of architecture. Students are encouraged to explore materials without any prior knowledge or bias, to make for the sake of making with no final product in mind - similar to the way children might play with building blocks or clay. We will then analyze the product that will result from this, defining the characteristics and placing it in a wider architectural context.

Method:
We will start with observing and experiencing an activity, such as reading, and will establish which factors can influence the experience, such as light, fresh air, background noise etc. The shape and the materiality of the place where the activity is happening is also important to consider, as well as the mood of the observant. Every student will experience the space in their own unique way.
The students will then develop their findings by means of creating several artefacts. Each artefact will be themed around an aspect of the space that is deemed to be important, such as the sound, material, colour etc.
The students will be working in small groups. One student will be responsible for creating the artefact, while the other will observe and define the process and the product. The creator naturally has underlying thoughts and intentions when developing the artefact, and this will influence their experience of the product. The observer, however, will see the final product for what it is. We will not be discussing the intentions of the student, only the final product itself.
Moreover, the size and proportions of the artefact are also important in order to maximize the effects of experiencing and making the object. By making the object as large as possible,

preferably larger than a human, the proportions of the student can affect the result. Particular characteristics such as the flexibility and strength of the material might also have an impact, and combining different materials might lead to different insights. When creating objects of larger proportions, the resilience of the material will become a deciding factor for making the artefact and the final result.
Finally, another way to experiment is to change the context of the artefact. Your perception of an artefact in the outside air will be different than on the worktop.
The task of the lecturer is to hold back and explore the link with architecture. They will be focusing on the artefacts as the final result of a creation process. Like a painting can be read as a portrait or a landscape, it can also be perceived in terms of how the paint is applied and how this affects the nature of the painting.

Examples:

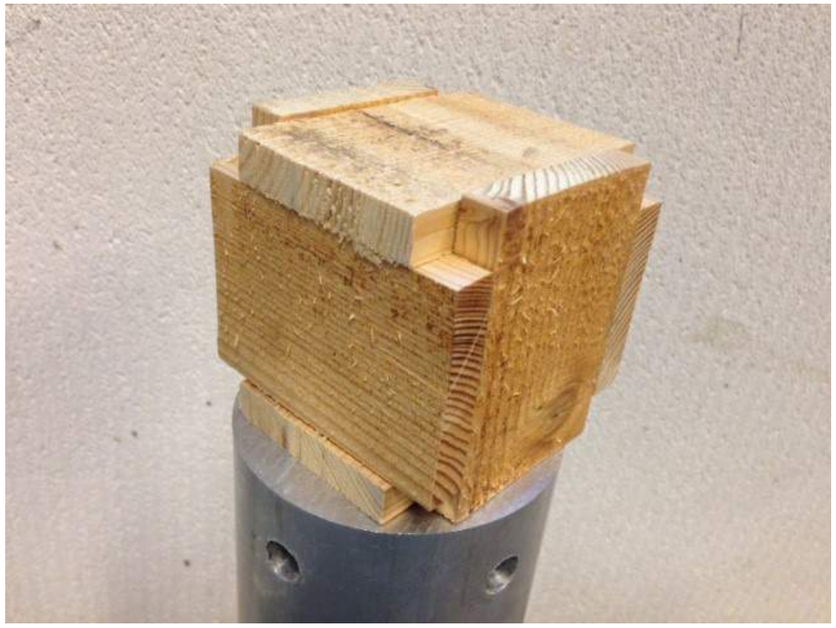


Figure 1

Six wooden boards form a closed block, but also surround an invisible space. You cannot see the space, but you know it's there. This demonstrates that perceiving and defining objects goes further than what you can perceive - this is not only true for the expert but for everybody. Architects create buildings like urban artefacts. These will be perceived by everybody (ordinary people), and not just by fellow architects. This means universal meanings are important.

Figure 2

A strip of foil around a plank of wood form a container and if you turn around it will define an invisible space. The individual materials are flat and weak, but when combined together they're strong and resilient. Also, the space is tangible. By wrapping the plastic around the board, it can resist the gravity. Perceiving and defining simple artefacts like this are useful when creating architectonic spaces.

Figure 3

The large artefact made of cardboard and insulation material brought in a new challenge, combining the two materials to create a certain expression. The result aims to communicate flexibility as the small icosahedron-sphere sets bend through the weight distribution. Likewise, a dialogue between hollowness and solidness is noticeable in the final artefact, overall creating a complex repetitive arrangement with a clear regular grid resulted in an extraordinary majestic in its form figure.
(extract from the report of the course ‘Architectural expression’ at TU/e)

Reflection:
This exercise focuses on how architecture comes about. By working with artefacts instead of architecture itself, the act of creation is used as a design principle. Students will learn this way that the creation process is of crucial importance to the appearance and expression of architecture.

Note: “This design approach is derived from Herzog & de Meuron’s 2002 exhibition *Archaeology of the Mind,* accompanied by the the book *Natural History.”*

Iris Lykourioti *lykourioti@arch.uth.gr*
Evelyn Gavrilou *evelynga@otenet.gr*

UTH, Thessaly, Greece

C ST M S
Costumes; Customs; Design Festivities

We are going to present the making of clothes as an experimental tool at both undergraduate and post graduate level that helps students to make sense of the performative and transformative character of architecture as a social process of production and inhabitation.
The design and making of an object that will dress the body was introduced as an intermediary exercise within a more conventional compositional practice that started with the study of various references such as existing edifices, urban realities, techniques of construction, and narratives on space and ended with the creation of a small building.
We noticed that students tended to

a) study existing spaces and edifices by ‘seeing’ and reproducing rather simplistic aspects of them while at the same time they are accustomed to reproduce such simplistic versions of interpretation as ‘new’ architectural types, due to their immersion (passive and active) into the commodities of architectural mass culture generated, nowadays, exclusively by the real estate business.

b) detach edifices from their contexts: their geographical and cultural environments, the social processes in their making, their functions, how distinct social groups (including the authorities) appropriate them or how they reject or criticize them, how gender issues are involved in design, how they are daily transformed by the complexity of human customs,

c) while they were familiar with making scale models of buildings they did not have experience in making prototypes, meaning full scale objects that can be tested through human performance,

d) were not rationally aware of the fact that any design effort that includes

references to concepts that come from various fields of culture, science, observation and study is actually a process of cross-modal translation into design and architecture. To do it well or rather to do it in a profound way we need tools that make us, designers, apprehend it.

e) develop a creativity stress (bottleneck effect) when the above set of ideas and references seemed not to deliver compositional results at the desired speed (creative speed being a question in itself) and the desired profundity (abductive cognitive step).

We introduced the question ‘what if the case study you have selected was a T-shirt; or a costume?’ that allowed us to respond to

a) by focusing on the performative elements of space: the act of constructing, movement, the reciprocity of encounters, visit vs inhabitation, vision, sensory perception, spatial centralities and spatial peripheries etc,

b) by using the etymological origins of words as habit (attire) or the proximity between the words costume/custom and introducing examples in culture and history (attire making as a woman’s labor and man’s signature, carnival, scallops, ‘smart’ building skins) where materials, economy, practices and the making of objects are explained as social relationships.

c) by mixing various techniques and processes of trial and error rehearsals,

d) by making replete the common and distinct features across concepts and a variety of their possible new material expressions: a brick-shelve translated into a sleeve and then into a flexible building structure, understanding subterranean architecture by testing bread models as the earth under heat and humidity changes, translating social contradictions around the partial demolition of the modern ‘Fix factory’ in Athens by Takis Zenetos into an action of cutting and stitching, making and unmaking of a garment,

e) by diverting the design problem towards a different cognitive-design path by making design choices and finalize the form of an object (solving the bottleneck creative problem with the experience of an abductive solution) and getting pleasure and confidence from participating in the completion of the making of the design object in reference. Finally getting social feedback and setting up a creative intermission where each individual body participates (making and rehearsing) and all bodies together meet in a set of festive actions: dressing others, dressed for others and a collective ‘catwalk’ performance before going back to (renewed) the use of building types and architectural notations.

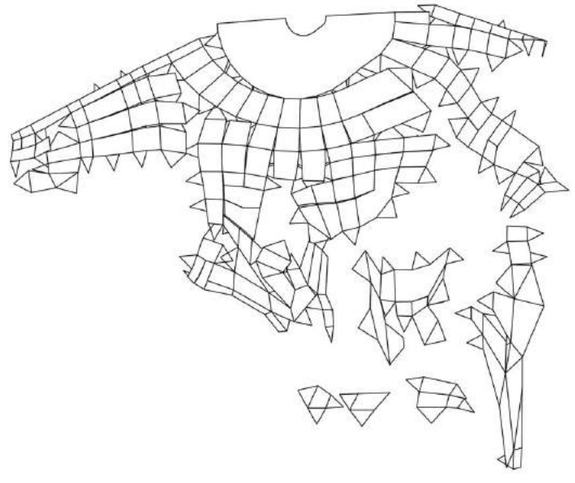


Fig.1 and 2: left: ‘The feeder’ apron for feeding bird;, right: pattern for the ‘secret life’ mask from the post graduate course ‘Kineshperes/ Commonspheres’.

Irene G. Curulli
g.i.curulli@tue.nl

17

TU/e, Eindhoven, The Netherlands

Sensing Through Model Making An Alternative Approach To Understanding Industrial Heritage

Sensing is the quality of perceiving, conceiving and understanding an existing environment. From this perspective making sense is based on the engagement of a dialogue with the context. Design is the direct result of it (Vassilis, 2011:9)

When transforming dismissed industrial sites, where existing buildings are often of heritage value, the notion of sensitivity and creativity play a key role in both interpretation and intervention. This paper discusses the role of physical architectural models as educational tools in 'sensing' the specificity of the context of intervention and in 'fitting' the design intervention in that specific context.

Nowadays, 3D models, renderings, 3D printers and many other digital forms of visual representations are commonplace among students and in architectural offices. There is no doubt that these digital products express the rapid technological progress of production methods as well as the acquisition of new skills in computer technologies. However, the sophisticated level of representation of such models and the realism of the visualizations or 'series of isolated retinal pictures' (Pallasma, 2015: 12) do not allow the experience of the architectural work. According to Juhany Pallasma, such experience lies in the fully integrated material, embodied and spiritual essence of the work. In his seminal book 'The Eyes of the Skin', Pallasma argues on the current role of the computer in the design process. He states that '*computer imaging tends to flatten our magnificent, multi-sensory, simultaneous and synchronic capacities of imagination by turning the design process into a passive visual manipulation, a retinal journey. The computer creates a distance between the maker and the object, whereas drawing by hand as well as model-making put the designer into a haptic contact with the object or space. In our imagination, the object is simultaneously held in the hand and inside the head, and the imagined and projected physical image is modelled by our bodies. We are inside and outside of the object at the same time.*' (Pallasma, 2015: 12-13)

Therefore, the increasing virtual imagery and technology of the contemporary world has an impact on the way we sense reality and the way we design for the 'real world'.
To these terms, the making of physical models is extremely valuable as educational tool: it represents the first step to understand what reality is and it helps bridging physical world with personal experience of places and spaces in all their tactile and sensory complexity.
This is the research method adopted with master students in architecture and landscape architecture, during design studio and research-oriented courses supervised at TU/e, Department of the Built Environment at Eindhoven University of Technology (NL) and UO, Department of Landscape Architecture at University of Oregon (OR, USA).

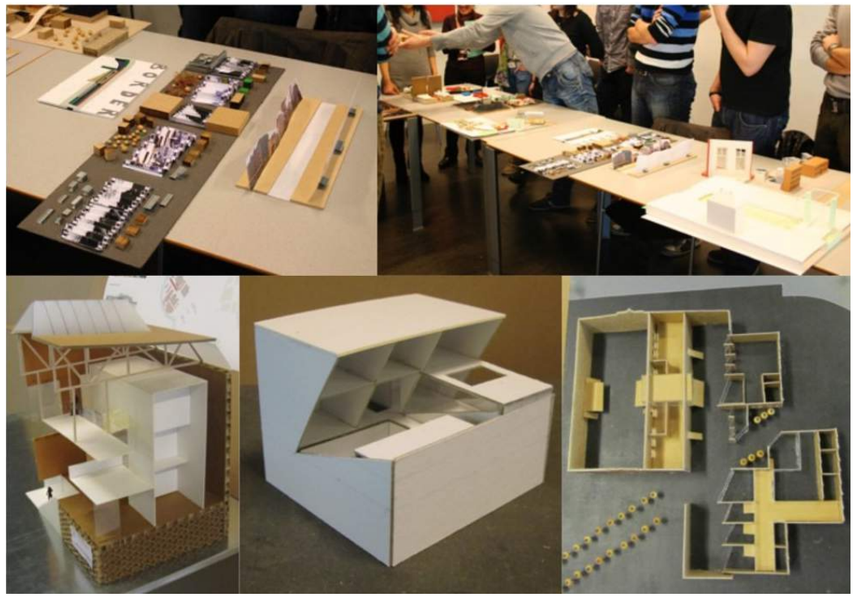
Case 1. *Transforming the dismissed canal zone of Breda (NL).* Design studio at TU/e

The master design studio intended to increase the students' sensitivity in revealing the characteristics and values of industrial buildings/areas as well as the environmental awareness about their role as a source of local identity. The course was the fourth one in a series of design studios focusing on former canal zones in Brabant, the southern region of the Netherlands, well-known for its industrial past in textile production and transportation of raw industrial materials.
The teaching method that I adopted in the courses showed that the students had acquired a new 'mentality' on this topic. The making of representational and abstract models led students to more attentive design explorations and to a selective 'demolition' process arising from an objective and motivated assessment of the reality.
Each course was organised in four interrelated phases: *research work, sensing, making sense and testing.* The second phase is of our interest.

Sensing Havenkwartier
Students visited the canal area, first. They had only a map to orient on the site and each student took personal notes/sketches. Afterwards, students were required to express their impression of the site through one physical model.
The models did not relate to any scale of design, or to a specific material: students could define these characteristics according to their personal impressions.
The objective of this assignment was to sense the potentials of the canal zone and recognize the multiple layers of the site through the reading of the perceived aspects that each individual experience. Furthermore, students learned to synthesize these sensorial perceptions into useful elements to be put forward in the process of design.

Evaluation
Students learned to observe the site, experience it, instead of simply looking at it. They were used to assessing values in the built-up environment only through historical archive material, analysis of its geometric features, typological and morphological characteristics and other conventional parameters. Students detected and valued those personal elements of the canal area, starting to define key aspects of discussion within their own team.
Sensing the site by visiting and making models, made a shift in point of view for the students. The choice of materials to making the model, its dimensional scale and type (abstract or representational) was essential to this scope. The models helped students to distinguish and filter the senses perceived during the site visit and to identify operational design tools.
Therefore, the result of this inquiry was of great surprise to them: there was a wide range of models, topics and unexpected subtle readings of the context that were displayed at the

class presentation. During it, open-ended questions arose as well as open-ended answers. Students were able to address different problems and criticism towards the meaning and the essence of the industrial heritage of the canal zone. Models initiated an intense and rich discussion, with wise observations that encouraged students' creativity and grounded their design choices. During the first meeting, all students organised together the varied models into different categories and selected and assigned to each group a specific theme for further investigation. Later on, students used the models to test each other architectural proposals, with the aim to highlight qualities, threats and 'conflicts' of the industrial buildings they were transforming.



Models 1: Sensing the site and detecting industrial buildings values. View of various 'expression models' and design proposals

Case 2. *Converted University Campus buildings*. Course 'Built-up Heritage over Time' at TU/e

The aim of the course is to enable students to review retrospectively the heritage impact assessments of built development projects so that students can recognize the distinguished role of heritage in society and can define what role transformation design and urbanization should play in global sustainability targets. For 8 weeks, students work in small groups and research into a series of transformation designs according to a 3-step process: (1) design, (2) pre-design, and (3) impact assessment. The first two weeks, students analyse and build a 3D model of the transformation design (as built), distinguishing old (remains) and new architecture (additions). During the second two weeks, students focus on the original building (before transformation). The building is analysed, and 3D modelled while distinguishing those elements that were kept (remnants) and removed (subtractions). Last two weeks, students interview key stakeholders/users and analyse their answers, distinguishing the positive and negative impacts of such transformation designs.
The first two phases are of our interest. They help students to understand the parallels occurring between design and valuation processes of built-up heritage.

According to Randall Mason (Mason, 2005: 5) the value assessment suggest a threefold challenge: *'identifying all the values of the heritage in question; describing them; and integrating and ranking the different, sometimes conflicting values, so that they can inform the resolution of different, often conflicting stakeholder interests.'* The work process of the students explores these challenges, while making them aware that design processes are affected by the subjectivity of the designer, the assignment s/he receives, etc.

Sensing CREA building, UVA Campus Amsterdam

In order to understand the design of transformation (2012) of the former polishing diamond factory (1848) into a cultural student centre (CREA) of the University of Amsterdam, students carried out a research archive and visited the building. Furthermore, they made a sequence of drawings (compiled as timeline) to show the building's evolution, namely a palimpsest of layers/interventions made over time. These 'chrono-mapping' (Clarke et al., 2019:7) helped to define the 'facts' of the buildings, without any value judgement. Therefore, students understood where and how adaptations occurred, replacement, retrofitting and volume changes.

These materials were the basis for making the physical model. Different colour codes showed the actions and effects of the design of transformation.

The structure of the analytical approach aimed to:

- Discover and visualize heritage components
- Relate (intangible) heritage values to heritage components
- Prioritize heritage values that guided designer's decisions-making
- Reflect on the limitations and success of the transformation project

Evaluation

The physical model was a revelatory tool to the students. By evaluating the remnants and showing the sequences of additions and subtractions occurred over time, the model contradicted the findings of the previous investigation, which was based on the analytical 2D drawings. In fact, students concluded that the transformation was mainly visible only in internal changes of the volume and structure, while changes were kept to the minimum on the outside/façade. Overall, transformation was considered very limited, with low impact on the heritage values of the building.

On the contrary and by making the model, students understood the deeper impact of the renovation design. The initial consideration of 'minimal' impact (influenced by the retention of the main façades) turned into a new understanding and acknowledgement of the 'profound' impact that the addition of a new large volume (behind this façade) dictated on the entire perception and identity of the building. The model clearly unveiled the difference between design and pre-design and showed how and where occurred the loss of continuity with the history of the building. Through the physical model, students understood the inconsistencies in the architect's design attitude and intentions of the project; they discovered the way the replacement of existing buildings with new masses (added functions) affected the integrity of the historical building, thus turning it into a 'containing envelope'.

Finally, the model made the students aware of the dimensional scale of the new functions, opening up a discussion on the appropriateness of the chosen programs.

Models 2: Sensemaking of retrospective impact assessment. De-construction, use of colours to identify additions, subtractions and remains, help revealing design processes, their impacts and arouse students' criticism

Case 3. *Open to Construction. Designing for a new landscape-industry to come* (Portland, OR). Design Studio at University of Oregon

This landscape design studio aimed to design a hybrid place-ground changing over time, which combined landscape evolution and flexibility of a wholesale distribution centre. The challenge at hand was to design with the understanding that the facility would move away in 20-30 years. The site was located along the Columbia River, close to an IKEA shop. It was not an industrial site yet. A valuable habitat characterized this location, but it was under threat of development. Three interrelated phases were developed during the course, starting with a 3-day workshop.

Sensing Parkrose-Ikea site

During the 3-day workshop, students were given the opportunity to quickly express site impressions and to tackle specific themes related to the future programmatic and environmental changes of the site. The charrette consisted of a sequence of activities of about 2 hours each, specifically:

a. experiential recording of the site that complements more conventional readings;
b. based on selected observations of the elements/qualities experienced on the site, students were given a paper 'box/site' within which they were asked to create a model for the site;
c. students were asked to form interdisciplinary teams to develop a conceptual intervention to accommodate the open-endedness of the landscape and distribution centre.

Model making was the key tool to recognize and express students' site perceptions. Each student carried out an individual sensorial perception walk (starting with a list of given words)

and collected (physical or digital) material from the site. These materials were the components for a personal and first ‘impression model’ of the site of design. The same assignment was repeated by using the selected word resulting from the first model and expressed through a given paper-box. Both models were used as basis to initiate conceptual interventions for the area. The site was interpreted as a ‘puzzles’ of land parcels and box-industry ideas.

Models 3: Making sense of site' sensorial perceptions. Conceptual models help to identify, prioritize and generate personal design tools

Evaluation

The various phases of the charrette revealed hidden characteristics and conflicts occurring within the site; moreover, they enabled students’ exploration of design as an evolving and time adaptive process. From the analysis of the first and second model, student understood three important aspects: firstly, to sense the specific friction areas within the given site; secondly, to make sense of their perceptions by sorting out the key components generating the frictions; thirdly, to understand their values and priorities in order to safeguard the unique features; fourthly, to build a wider and personal set of design tools as basis for their design ideas to be tested against the perceived and physical constraints.

The making of various conceptual models was highly valuable to students’ learning: models promoted actions and processes that helped the development of their cognitive abilities towards a problem-solving attitude. Initially, models helped revealing unexpected peculiarities of the context; later on, they complemented and strengthened the design process of iteration and adaptiveness that characterised the development of individual proposals.

Conclusion

In retrospect, we can conclude that the use of models as tools for sensing and embedding built-up heritage was well received by the students. The method added quality to the design proposals, enriching the design process and nourished their exploration and creativity. In

particular, de-constructing and making perception models nurtured critical analysis, collaborative research and provoked debate among the students.

By making physical models, students acquired a personal awareness of existing site features and heritage values and learnt how to enhance their uniqueness. Students learnt that there are not standard solutions, but only appropriated ones, which relate to the specificity of the context.

And finally, the sensing method made students realize that understanding, interpreting and intervening are unified moments, which belong to the same process of cognition and are in dialogue with the site.

Sensing a specific context and *making sense* of an architectural intervention into it is a working method that goes beyond personal empathy and individual analytical skills. ‘Sensitivity’ is the key element in both interpreting the historic context and in intervening in it. According to the Vienna memorandum (2005:4) a culturally and sensitive approach to the historic urban landscape ‘(…) should avoid all forms of pseudo-historical design’ and ‘(…) demand for high-quality design and execution, sensitive to the cultural context (…)’. Therefore, ‘sensitivity’ binds analysis to creative design.

Sensing through physical model making, as explained in this paper, is a successful method to achieve this link.

Acknowledgements:

I would like to express my gratitude to all students participating in the courses described in this paper for their sensitive models.

References

Clarke, N. Kuipers, M. Stroux, S. (2019) Embedding built heritage values in architectural design education. *International Journal of Technology and Design Education*, Springer

Curulli, I. (2012) *Industrial Heritage: awareness and sustainable design in architectural education. The former industrial canal zones of B5, The Netherlands*. In proceedings of Heritage 2012, 3rd International Conference on Heritage and Sustainable Development, Porto 19-22/6

Mason, R. (2005). Assessing values in conservation planning: Methodological issues and choices. In M. De la Torre (Ed.), *Heritage values in site management: Four case studies*. Los Angeles: Getty Conservation Institute; pp. 5–30 Available at: https://www.getty.edu/conservation/publications_resources/pdf_publications/pdf/assessing.pdf ; retrieved on September 2, 2019

Pallasma, J. (2005) *The Eyes of* the Skin. Architecture and the Senses., Wiley & Sons, Chichester, p. 12

UNESCO (2005). Vienna Memorandum on “World Heritage and Contemporary Architecture Managing the Historic Urban Landscape and Decision 29 COM 5D”. Available at : http://whc.unesco.org/archive/2005/whc05-15ga-inf7e.pdf

Vassilis, G. (2011). From sensing the context to making sense of architectural interventions: a working theory. In Babalis, D. (ed. by), (2011) *Chronocity. Sensing Interventions in historic environment*. Florence: Alinea; pp.7-10

Manuel Couceiro da Costa

mcoucy@arquetipo.com.pt

Lessons from the Models

1. This essay deals with possible kinds of outputs one, not only students, can get from models, in an architectural context, analysing it’s potential along the continuous learning process, including knowledge upgrade, creativity development, representational capacity, surprising impact modes and, so, widening the action field and valuing that potential.
The approach is from a set of viewpoints, including the academic one and, in this case, going beyond the strict interest of the architectural design studio classroom, considering architectural education and research as a whole.

2. Construction toys, such as “Lego”, probably the most popular worldwide, not exclusively, are nevertheless essential for children development, considering both facets, intellectual and manual ability, offering a huge field for creativity and deeply related with architecture features. We can also say that, in the long term, they can play a strong role in the decision about the field of interest and even profession of those children.
Notions and capacities of model construction / reproduction, scale, colour organization, creative rule breaking, structural viability and many others are permanently tested along playing (Fig.1)

3. During this playing and in our specified architectural context, a facet rarely evoked must be stressed, namely the interaction between the 3D pieces and models and the graphic representation of the toy and it’s assemblage procedure.
In fact the graphic reading introduces children to drawing projection systems, also inducing some kind of “strategy” / planning for the achievement of their goal – the model construction (Fig.2).
On the other hand, there are cases, more rare and probably concerning those with tendencies for design, that create their drawings beforehand and then improve models construction.
The graphic presentation of the models and pieces, in boxes and instruction booklets, are usually, more than a useful document, good advertising and artistic presentations.

4. But the potential of the “construction toys” is so great that the “toy” became much more than that, being able of extraordinary complexity and sophistication, requiring expertise, fascinating children and grown up, producing fantastic objects, such as the “cow-boy” and the painting, shown in the slide (Fig.3).
This complexity and sophistication is also demonstrate through the huge panoply of thematic sets of models, from architecture to space, from machines to animals, from races to wars, from 0-99 years of age …

5. In what respects architecture, this kind of “toys” is seldom use to represent famous buildings, such is the case of “Champalimaud Foundation”, in Lisbon, design by Charles Correa, a building whose aim is to host international high research and health care, mostly related to cancer and to the eyes.
The morphology of the building, with curved lines and surfaces, contrasts with the morphology of the toy pieces, what requires for the model execution expertise and imagination, but the final result, exposed in the real building, as the capacity to attract everybody attention, with a mix of admiration and child memories (Fig.4).
Strangely this kind of “toy” is not very much used in architectural courses.

6. A completely different kind of model, where creativity and manual ability are not the core of it’s use intention, the goal being the teaching of descriptive geometry and/or mathematics or, in other words, a more abstract intellectual development and improvement of visual thinking – the goal and the science are perennial, the kind of model is not actual, but it can work (Fig.5).
(models by courtesy of ISEP)

7. Also created on the purpose of the teaching of descriptive geometry, professional and highly sophisticated models where created, including parametric features, through simple but scientific developed movements.
Again science remains perennial, the models are quite interesting and work, but not actual (Fig.6).
Parametric is a feature that is actually dealt with appropriate software, so somehow tending to turn models obsolete, but the thing is that experts on the matter, are returning to models of a new generation, like the colourful one that allows highly complex polyhedra transformation – through the upgrading efficiency in the joints of deployable structures (Fig.7).
(models by courtesy of ISEP and APROGED)

8. The abstract geometric models are an inspiration for another kind of models which, besides geometric features, considers material, use, structure and sometimes movement – we are now in the field of stereotomy.
The scale of the models and the kind of material, dictates the level of detail, being those more of the representative kind than conceptual.
(models by courtesy of ISEP)

9 & 10. Considering stone as a building material, through the ages it’s stereotomy evolved immensely and a lot of studies and books where produced – the teaching of this science in architecture and engineering courses were mandatory by the end of the XIX century and during most of the XX and, corresponding to this appeared a kind of models, somehow working as puzzles (Fig.8).

Through them, one might understand the all, the parts, their interaction, the correspondent geometric structure and joints.
(models by courtesy of FBAUL)

11. Opposing the predominance of graphic tools, conceptual and for representation, architectural studio seldom require lots of models which may variate in many aspects according to the correspondent goal: conceptual ones are usually easy and quick to built, rough and with few details.
Their correspondence with graphic pieces is not exhaustive and sometimes even flexible – somehow they correspond to sketch drawings (Fig.9).

12. Another level of the use of models, sometimes tending to exaggerate in detriment of graphic tools as usually this visual impact is greater, brings students to volumetric expression of what should be a developed design and, in these cases, it work as an upgrade, but opposite can suggest inconsequent volumetries, with no details, technically incorrect – from my point of view the interaction model / drawings must be deeper and stressed.

13. Academic models are also common to understand and deeper visualize topography, namely when it’s a rough one and layers, with limits according to level lines, are superimposed (Fig.10).
It seems, at first, a moment of positive reinforcement of interaction between 3D and it’s 2D graphic expression, but many times a nice model doesn’t correspond to a good knowledge of the student concerning slope grades and it’s adequate use on the viability of the solution and of the corresponding technical approach.
A much deeper study of the geometric principles of topography and/or physical geography is usual needed, including it’s graphic representation and modelling principles.

14. Also urban design benefits from the use of models and, in this case, with powerful and easy expression of the city fabric and with minor possibility of expressing technical defaults, as most times building are monolithic volumes.
Urban proposals must obviously consider a variety of conceptual inputs and interdisciplinary approaches and, the good or bad solutions, appear more clearly through models.
That is what seems clear in the examples we present, that represent interventions in the city of Lisbon, in real context (Fig.11).

15. Another kind of the use of models, looking for more added values, such as pushing the reflection on the contrast built / space, stressing the coordination 3D/2D, putting in evidence and solving technical difficulties of the use of concrete or obliging the physical contact of hands and “dirty” material, as been presented by FAUL teachers during former events of Materiart.
In class, after a conceptual explanation of the goal and process, students started their design, which should be presented through a concrete model and a drawing panel, experiencing through the process the dynamics (concentrated in time) of the conceptual process.

16. About the model itself, important moments were such as the making of the concrete that, in practice, obliged to look for some alternative/available materials, the consideration of material proportions and making methodology, feeling the material, formwork building and the formwork infill – a deep technical experience.

Added to the moulding experience, also the undoing of the formwork were moments of vivid experiences with the awareness of new technical difficulties, some of them showing that the model morphology should have been different (Fig.12).

17. The process ended with an exhibition of models and panels, putting in evidence the good and the not so good technical approaches of the concrete moulding, including the acknowledgment of the reasons / causes of the defaults and consequently upgrading students technical capacity. Also evident was the correlation model / panel which tried to portray the dynamic of the creative process, stressing the respective figure – the space (Fig.13).

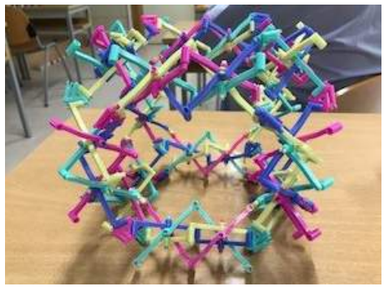
18. Models can also convey other messages and concepts, like historical information and the sense of scale, as shown in this slide, which presents traditional / monumental buildings of Portugal, organized as a thematic park for children, named Portugal dos Pequenitos, in the city of Coimbra.

19. Another surprising model and corresponded output is here presented.
Contrasting with a traditional global model, done by specialists, the colourful model represents the city of Lisbon, using eatable materials (fruit, vegetables, cakes, …) organized by the communities leaving in each part of the city, including minorities.
For those that know Lisbon, Terreiro do Paço, the main square of the city, close to the river Tejo is perfectly noticeable.
The quarters, not only were visually identifiables as they taste different – in fact the “material” correspond to the gastronomic culture of each community and when the show ended, people tasted of city, eating the model during a nice sharing moment.
A model with cultural and social output (Fig.14).

20. Greeting from Lisbon.

Acknowledgments

APROGED – Associação dos Professores de Geometria e Desenho
FBAUL – Faculdade de Belas-Artes da Universidade de Lisboa
ISEP – Instituto Superior de Engenharia do Porto
Portugal dos Pequenitos, Coimbra



Contributors

GÜNSU MERIN ABBAS, a full-time lecturer at TOBB ETU, Dep. of Architecture, holds a B.Arch. from Izmir University of Economics (2011) and M.Arch. from METU (2014), where she conducts her Ph.D. studies. In line with her studies, she has also taken part in office practice focusing on hospital and institutional building projects, as well as a number of international freelance projects focusing on computational façade design. Her research interests are design computing, performative architectural design, tooling, and emergent technologies. Günsu teaches 2nd year drawing and representation courses by employing BIM and performative design tools and aims at implementing BIM and performative design understanding to the existing curricula, as well as elective courses on computational design.

SIBEL ACAR is Assistant Professor of Department of Architecture, TOBB University of Economics and Technology, Ankara, Turkey. Holding a BS in civil engineering from Middle East Technical University, Ankara, she received her MA and PhD in Architectural History from the same university. She teaches undergraduate architectural history survey courses on 19th and 20th century architecture and Mediaeval and Early modern architecture in Turkey. She also conducts elective courses on architectural photography, structural systems and materials, and a graduate course on visuality studies in architecture. Broadly speaking, her interests are historiography, nineteenth and twentieth century architecture, and visuality studies.

SELDA BANCI is a faculty member, PhD at TOBB University of Economics and Technology, Department of Architecture, and currently a member of the board of directors of Architects' Association 1927. She holds an architecture degree from Gazi University and a doctorate in the history of architecture from Middle East Technical University. She is the author of *Matbu Mimarlıklar: Türkiye'de 1950'lerden 1980'lere Mimar Oto-Monografileri* (Printed Architectures: Architects' Auto-Monographs in Turkey, 1950s-1980s) by METU Press and co-editor of *Ernst A. Egli: Türkiye'ye Katkılar - Yerel Yorumlar, Eğitimde Program, Pratiğin Muhasebesi* (Ernst A. Egli: Contributions to Turkey - Local Comments, Program in Education, Reviewing Practice) by Chamber of Architects of Turkey. Her research specialization is 20th century architecture in Turkey, architecture books, architecture and media, and architectural historiography.

IRENE CURULLI is an Assistant Professor in Architectural Design at Eindhoven University of Technology (NL) where she teaches seminar courses, graduation studios and supervises Ph.D. students. Her primary focus in research and teaching is the revitalization of post-industrial landscapes, particularly water-related ones. She holds a PhD and two master degrees in Architecture and Landscape Architecture, respectively.
She is currently researching on industrial heritage reuse with relation to water and the climate change. She was awarded the 'Lawrence Halprin Fellowship' by the Cornell University (USA) and was a Visiting Scholar at the University of Oregon (USA). She has lectured on her research topic throughout Europe and the USA and was jury member at Harvard University and at the University of Pennsylvania. She is author of the following books: *Ghost Industries* (2018), *The Making and Remaking of Dismissed Industrial Sites (2014) and Industrial Canal Waterfronts in The Netherlands* (2012)

BURAK DELIKANLI is a young researcher and architect working on computational design studies. He focuses on the relationship between architecture, kinesis, and technology, as well as his research areas are robotic and cybernetic architecture. He attended many workshops as participants, instructors, and tutors, and also volunteered in many student collectives. He continues his M.Sc. study at Istanbul Technical University, Graduate School of Science Engineering and Technology, Department of Informatics, Architectural Design Computing Graduate Program.

LEMAN FIGEN GÜL is a Professor of Architecture in the Department of Architecture and Architectural Design Computing Program at Istanbul Technical University since 2014. She completed her PhD in Architecture at the Key Centre of Design Computing and Cognition at the University of Sydney in 2007. She was awarded several research projects 1001 and 1002 grands funded by TÜBİTAK and BAP and International Research Projects funded by ITU in 2013-2019 and Erasmus+ KA203 project in 2017. She was awarded the University of Newcastle Early Career Researcher Grant, the New Staff Grant, two travel grants, and she worked in a WorkCover Assist Applied Research Project funded by WorkCover Authority of New South Wales, Australia. In 2005 she participated in a research project that was funded by the prestigious Cooperative Research Centre for Construction Innovation in Australia. She was visiting scholar of Macquarie University, Australia in 2018. She has extended her research interest to various interdisciplinary areas of design and technology. Her research interests includes parametric design and fabrication technologies, game and serious games, the use of virtual-world technology in the construction industry, virtual environments, augmented reality, artificial intelligence as design assistance, navigation, human design behaviour, collaborative design and cognitive design studies.

SÜHEYLA MÜGE HALICI is a researcher and architect. She continues her Ph.D. study at Istanbul Technical University, Graduate School of Science Engineering and Technology, Department of Informatics, Architectural Design Computing Graduate Programme where she received her M.Sc. degree. She studied architecture at Yaşar University in Izmir. She has been involved in various project teams that were awarded for architectural design competitions and hackathons. Her research interests focus on augmented reality, internet of things and space architecture.

BEGUM HAMZAOGLU is a Ph.D. Candidate at the Architectural Design Computing Graduate Program at Istanbul Technical University. She holds a master's degree in Architectural Design Computing from ITU Institute of Informatics. For her M.Sc. thesis, she investigated a computational making method for carved stone patterns from medieval Anatolia. Her research interests include robotic tectonics, digital humanities, shape studies, visual computing, and craft theory. As a teaching assistant at ITU Faculty of Architecture, she has been involved in graduate and undergraduate level design studios and computational design courses since 2017. She has also run numerous workshops on computational making. Her current research focuses on bridging the knowledge across architectural heritage and fabrication technologies.

FABIANO MICOCCI graduated from the Faculty of Architecture of the University of Roma Tre in 2002 where he also specialized in 'History of the Design Process' (2003). He obtained his PhD degree in Architecture and Urban Design from the University of Florence (2010). He is Adjunct Assistant Professor at the Department of Architecture at the University of Thessaly, in

Greece, and previously he taught at the University of Florence, Lebanese American University and Portsmouth University/Metropolitan College of Athens. He also participated as Visiting Professor and Tutor in many international workshop and summer schools. He is co-founder of the architecture office NEAR architecture (www.neararchitecture.com), a practice focused on design and research based in Athens and Rome.

GIORGOS MITROULIAS is founding member of AREA (Architecture Research Athens), an experimental design practice, together with architects Styliani Daouti, and Michaeljohn Raftopoulos. The team's approach actively engages with the public and often develops through participatory practices, exploring the relationship between culture, form and context. AREA's theoretical and built work ranges across multiple scales, from furniture to urban design, and has been published and exhibited in Greece and abroad. Their work has received numerous prizes in competitions for public and private projects. Giorgos Mitroulias is an associate professor at the University of Thessaly Department of Architecture in the city of Volos.

NESLI NAZ AKSU graduated from Istanbul Technical University Faculty of Architecture with a dual degree on Architecture and Landscape Architecture. After her graduation she moved to New York and worked at Eisenman Architects. During that period, she got accepted to Columbia University and got her Master of Science degree from Advanced Architectural Design Program in 2016 and continued at the same university as a teaching assistant for design studios and workshops. Currently she is conducting her PhD studies in Middle East Technical University and participating design studios as a part time instructor at TOBB ETU. At the same time, she is a partner of azaksu architects where she continues her practice and holds various prizes from national and international architectural design competitions.

SÉRGIO BARREIROS PROENÇA graduated in Architecture Urban and Territorial Planning (2001) at the Universidade de Lisboa, Faculdade de Arquitectura, where he completed the Master in Modern and Contemporary Architectural Culture (2007) with the dissertation "Colonial Urban Planning in the Eastern Provinces. Continuity and Change in the elaboration of Urban Plans in the State of Índia, Macao and Timor, 1934 - 1974." and the PhD in Urbanism (2014) with the thesis "The Diversity of the Street in the city of Lisbon. Morphology and Morphogenesis." funded by a Foundation for Science and Technology PhD grant (SFRH/BD/44847/2008).
Assistant Professor at the Universidade de Lisboa, Faculdade de Arquitectura, where he teaches since 2000. Founding member of formaurbis LAB, a research team on Urban Morphology. Has been invited to lecture in other national and foreign institutions. Participates in seminars and regularly publishes articles on the topic of urban morphology and morphogenesis.

BURÇIN YILMAZ graduated from the Faculty of Engineering and Architecture in Gazi University in 2010. During her bachelor, she took part in several workshops and carried out internships in various design offices in Ankara. After her Bachelor, as a profession, she worked at design offices for two years and established her own company in 2012. She acquired her master's degree at TOBB University of Economics and Technology in 2017 under the supervision of Nur Çağlar. Thereafter, she taught as an adjunct staff in the design studio courses at TOBB ETU. Currently, she is developing her doctoral research in the department of the Built Environment at Eindhoven University of Technology.

SPARTACO PARIS (Prof. Arch. PhD), Architect, received his MSc Degree at University of Rome "La Sapienza" in 1999. PhD in Environmental Energy Technologies for Development he is currently Faculty member as Associate Professor in Architectural Technology at Faculty of Architecture of the Sapienza University of Rome. He currently teaches Product Design in the Master of Science Diploma in Product Design and in the Master Diploma in Architecture, as chair of Building design. He develops his research around the topics of technology, sustainability in the broad area of design, between architecture and industrial design.

ROBERTO BIANCHI (Adjunct Prof. Arch. PhD Roberto Bianchi) Architect, has received his PhD in Technological Culture and Environmental Design at the «G. d'Annunzio» University of Chieti-Pescara. Since 2002 he has carried out research activities, and he is an adjunct professor at the Faculty of Architecture of the Sapienza University of Rome and since 2016 at the University School of Architecture and Design «Eduardo Vittoria» (SAAD) of the University of Camerino in Ascoli Piceno. He is a founding member of the bianchivenetoarchitetti studio.

AFSHIN NAZARIEH Industrial Designer received his MSc Degree at University of Rome "La Sapienza" in 2018 in Product Design. PhD student in the field of product design at the University of Rome "La Sapienza" from 2019.

MANUEL COUCEIRO DA COSTA Manuel Couceiro da Costa (b. 1952), architect (1977, Lisbon Fine Arts School - ESBAL), PhD in Architecture / Visual Communication (1993, Faculty of Architecture of the University of Lisbon – FAUL), associate professor at FAUL, started his architectural practise as a student in 1971, in collaboration with several renowned portuguese ateliers and created his own, namely Arquétipo Atelier, since 1981 (reference buildings: Headquarters of the State Housing Management Institute (IGHAPE) / Almada, Employment Centre / Estremoz, Dispatch Centre + Headquarters of the National Gas Company (Trangás / REN) / Loures, Cork and Cork Oak Observatory / Coruche, Municipal Library / Vagos, …), all in Portugal. Since 1978 started his academic and research careers in ESBAL/FAUL and in parallel at Lusíada University / Lisbon (1986-2001), pointing out having been Dean of FAUL (2010-2012). The pedagogical and scientific components of the academic activity have their core in architecture and in drawing and geometry applied to architecture, design and urbanism, also addressing research projects such as "Extended Perspective System (EPS)", "i-Cork / Cork, Architecture, Design and Innovation" or "Architectural Design as Research", having presented lectures in several conferences and universities (Argentina, Australia, Austria, Brazil, Czech Republic, France, Greece, Italy, North Cyprus, Portugal and Spain). Actually is an European Association for Architectural Education (EAAE) Council Member, President of the General Assembly of the Portuguese Association of Drawing and Geometry Professors (APROGED), a representative of FAUL at the Building Portuguese Technological Platform (PTPC), investigator at the Research Centre for Architecture, Urbanism and Design (CIAUD) / FAUL and chairman of the EAAE/ARCC International Conference – Lisbon 2016.

NUNO MATEUS Castelo Branco, Portugal, 1961 PhD in Theory and Practice in Architecture, Lisbon School of Architecture, UL, 2013; Master of Science in Architecture and Building Design, Columbia University, New York, 1989; Graduated in Architecture at Architecture School, Lisbon Technical University, 1984; Has worked among others with Peter Eisenman in New York from 1987 until 1991 and with Daniel Libeskind in Berlin in 1991; Director of Architecture Department, Universidade Autónoma de Lisboa, 2004 - 2007; Currently professor

at Lisbon Shool of Architecture / UL and Universidade Autónoma de Lisboa. He has been teaching in several different architectural schools in Portugal and abroad; Lecturer in different countries about ARX´s work and juri member in several national and international architectural competitions and professional prizes; In 1991, together with José Paulo Mateus, he founded ARX Portugal Arquitectos. The office work is wide spread in nature and scale from private to public commissions in Portugal and abroad. Some of its major projects have been built and a few are currently under construction. ARX´s work has obtained several prizes, selections, nominations and honorable mentions such as the International Architecture Awards The Chicago Athenaeum, USA, International Association of the Art Critics, Prize in Architecture, Mies Van der Rohe Prize, Premis FAD, Secil, among others. ARX projects have been widely published in articles and references in specialized newspapers and magazines around the world. A few monographic books have also been published such as: Dez Obras, ARX Portugal Arquitectos, Casa Editrice Libria, Italy, 2020, ARX Portugal 1991-2015, Verbo, 2015, Brick is Red, Author Edition, 2013, Ílhavo Maritime Museum, Caleidoscópio, 2004, Realidade-Real, CCB,1993, and A Second Nature, Editorial Blau, 1993.

IRIS LYKOURIOTI (b.1970, Athens) is an architect (NTUA 1996, 2001) and Assistant Professor at the Department of Architecture, University of Thessaly, Greece. She has participated in more than 100 architectural/ design projects. Her theoretical, academic and built work has been awarded, presented in various exhibitions, invited lectures, workshops, conferences and journals (Greek and international), while she has co-edited two books on the contemporary perception of Le Corbusier's work in Greece. She has been a member of the collective of the Greek Architects Association that curated the Greek participation in the 15th Venice Architecture Biennale (#ThisIsACo-Op, 2016). She is co-founder of *A Whale's architects*, an office based in Athens and Brussels doing research, objects and edifices. Their work focuses on the social and cultural practices behind the making and the habitual use of objects and space and on the standpoint that design is a manufacturing process that transforms raw materials and creates employment. In 2014 A Whale's architects has been selected by Blueprint Magazine among the eight most innovative architectural practices in Greece.

EVELYN GAVRILOU (b. 1976, Athens). is an architect (NTUA 2001, 2002) and Assistant Professor at the Department of Architecture, University of Thessaly, Greece. She is working as an architect since 2001 in Greece and has participated and received prizes and distinctions in several national and international architectural competitions. She has also participated in international conferences. Her research focuses on interdisciplinary approaches of design and more specifically on the tracking and formulation of specific design intentions through diagrammatical and representational strategies. Her architectural work has been published in international group exhibitions and publications.

ZISSIS KOTIONIS (PhD) is an architect, writer and artist. He is a Professor in the Department of Architecture, University of Thessaly, Greece. He has published twelve books and monographs on architectural theory, urban culture and narrative poetry. His architectural and art projects have been internationally published, awarded and exhibited in Universities, Galleries and Museums. His work includes built and performative architecture, design and art projects, performances, installations and public art practices. In 2010 he has co curated and deigned the Greek National Pavilion in the 12th Biennale of Architecture, Venice (The Ark). Kotionis' research work in architecture, urban studies and artistic practices include topics on

Greek/Mediterranean landscape, phenomenology, existential topologies, cultural activism, bodily and social artistic practices, public policies, eco-poetics, social housing, sustainable design. His work as researcher and author include many articles in Greek newspapers ("Kathimerini" 1994-2000, "Avgi", 2015-2020) and magazines ("Greek Architects") publications in collective books and International Journals ("Thresholds", MIT). He often participates in international workshops, artistic and architectural events. Zissis Kotionis is involved in artistic performances, installations and in public art practices. He was founding member of the group Urban Void that introduced performative architecture in urban environments, in the late nineties, in Greece.

Nur Çağlar is currently teaching architectural design and design concepts and approaches in urban landscapes at the Department of Architecture at TOBB University of Economics and Technology. She is a graduate of Ankara State Academy of Engineering and Architecture. She has got her MSc (1986) and Ph.D. (1992) degrees from the Landscape Architecture Department at Ankara University. Before TOBB ETU, she taught Architectural Design and Design Concepts in Architectural and Urban Landscapes at Gazi University, Department of Architecture between 1992 and 2011. Besides her academic career fields, she has focused on architecture and architectural design education. She carries out studies that take care to develop the studios as a research environment on design practice. She brings together the thinking and making of architecture in learning environments. She emphasizes cross-curricular learning, co-curricular, and extracurricular experiences in the studio. She has considerable experience in creating these activities and intertwining them with curricular structures. To make her communication strong and continuous in this field, she takes various roles in national and international level non-governmental organizations working on architectural education. She has several prizes and mentions in architectural design competitions. Author and editor of several publications on architectural design and education.