The role of traditional architectural models in the first stages of education

Agnieszka F. Szuta & Antoni Taraszkiewicz

Gdańsk University of Technology
Gdańsk, Poland

ABSTRACT: The oldest architectural models discovered by scientists date from the Middle Ages, while models or 1:1 scale prototypes were used in ancient times. Architectural miniatures quickly evolved into an indispensable tool for designers that enabled them to creatively express their thoughts and ideas. Mock-ups became a way of helping a designer communicate a concept, and their educational value was also recognised. The method of modelling, as with the field of architecture itself, has developed over the centuries. Nowadays, traditional physical models are being replaced by virtual ones. The question arises: can traditional mock-ups be replaced completely by virtual models? The purpose of this article was to examine the present role in education of traditional, physical architectural models. The research was supported by experience gained, involving manual work and spatial games, from Architectural Design 1 in the Faculty of Architecture at Gdańsk University of Technology (FA-GUT). Are virtual models, which undoubtedly have many advantages, a good alternative to the physical ones?

INTRODUCTION

Scale models have nearly always accompanied an architect's work. They function as communication tools that help to illustrate spatial ideas and visualise a designer's concepts. Over the centuries, the role of three-dimensional models has grown, and it was soon noticed that mock-ups as sculptural objects with their own tectonics can not only express ideas, but also stimulate the imagination. They were used by technicians, builders, architects and academic teachers.

In the 21st Century, doubt was cast on the usefulness of traditional cardboard models both for design and education. This is linked to technological progress. Virtual models with their impressive, realistic visualisations, attract people who are not necessarily associated with design or have just started their architectural studies.

In this article, the role of making traditional mock-up models in the first year of architectural study is examined with their impact on further education. The question arises: does technological progress positively affect the education of young architects? This study was held to answer this question. The research was conducted on the basis of literature studies, reflection and *in situ* investigations. A survey was conducted among students who attended the first year of studies in the Faculty of Architecture at Gdańsk University of Technology (FA-GUT), in the academic year 2018/2019 and at present are in their second year (academic year 2019/2020).

HISTORICAL ASPECTS OF MODEL-MAKING

The first models or prototypes appeared in antiquity. These models, at a 1:1 scale, were templates that allowed the production of repetitive architectural elements, for instance column capitals. Until the Middle Ages, architectural models were not used on a large scale. They appeared occasionally, usually wooden, to show an object or estimate the cost of construction. Often, they compensated for poorly developed two-dimensional techniques of representation [1].

In the 14th Century, there was a breakthrough. Renaissance architects did not copy other work (unlike their predecessors), and had no reference as to how the structure designed by them might look. Building mock-ups were introduced to verify that the architects' ideas were feasible and coherent. The most common materials were wood, plaster and clay. In addition to models of individual buildings, entire urban districts and fortifications began to appear.

The models themselves started to become more extensive (e.g. removable roofs were used, which offered the chance to view the usually very carefully and precisely executed details of the interior), and were thus more expensive. Mock-ups no longer complemented drawings, but they gradually became a prime method of communication. In the 18th Century, physical models also became more widespread in the education of technical students and tradesmen [1].

In the 20th Century, mock-ups were used by architects as a basic design tool. Walter Gropius contributed to their dissemination. Architectural miniatures enabled him to test his ideas quickly (e.g. when founding Bauhaus). Since then, mock-ups have become commonplace as a design tool in architecture, and have become an important method of communicating and understanding architecture.

In the 21st Century, the development of computer technology began to influence architecture. Computer-aided design (CAD) software became a new design tool. Within the past 20 years, digital technologies grew in significance in educating future architects. The changes related to the introduction of these digital technologies could be observed in faculties of architecture [2][3]. Visualisations and virtual walk-through tours became an extremely impressive form of communication and for *swapping* ideas, which captured the imagination of both lecturers and students. The possibilities of using innovative technologies in education have been recognised and virtual 3D models have started to replace traditional architectural models - for instance, during the presentation of architectural projects, and while defending diploma theses [4].

ROLE OF MODEL-MAKING

Mock-ups are sculptural objects with tectonics that facilitate the expression of ideas and stimulate the imagination. Traditional architectural mock-ups enable direct interaction with the 3D model, which significantly assists communication in a clear and comprehensible way. Moreover, in the early stages of education, model-making develops students' ability to hone their aesthetic values, as well as to use basic tools of architectural composition. Nevertheless, in an era of virtual technologies and the popularisation of CAD and building information modelling (BIM) software, traditional mock-ups in the university classroom are being replaced by computer models. It is worth considering that using virtual models may contribute to traditional modelling being abandoned and lost. Although both physical and virtual models are referred to as *3D models* they differ significantly, as Aktaş writes:

> *Handling the material connects the designer with the actual world and augments the visual perception. Although digital models enable three-dimensional working space, they are literally bound in two-dimensional flat computer screens. The digital modelling media provide only indirect relation with the modelled object via a mouse or touchscreen. On the other hand, actual tangibility provides more control over the form. Thus, physical models are manipulated easier and enable instant decision-making* [5].

Kuhn shows that combining traditional approaches to design with the use of digital technologies improves architectural practice among both professionals and students [6]. However permitting, at an early stage of education, the completion of project work by means of computer software alone should not normally be allowed. Premature substitution of traditional modelling for virtual could confine the students' imagination to the level allowed by the software. Although advanced digital technologies provide a wide selection of materials for building models their impact does not match the physical, tangible properties of the traditional mock-ups.

> *Even though most of them are made with very basic materials such as cardboard, acetate, and styrofoam, material properties have an essential role in the conceptual model-making process. For example, if in the pE3 the designer had chosen a different material (modeling clay instead of metal mesh), the result would have been completely different. However, digital processes are not affected by the material properties. As it is observed from both protocol studies and the author's own experiences, intrinsic properties such as elasticity, hardness and smoothness affect the design process while working with physical models. Besides, extrinsic properties such as transparency, colour and texture have an effect on the conceptual model-making process* [5].

Although achieving proficiency in using computer software often becomes a top priority for students, it does not necessarily bring the desired results, and sometimes even limits them. Aktaş demonstrated this by means of a simple exercise: it is possible to bend part of a mesh held in one hand, while simultaneously keeping another part still in the other hand. In a computer model, achieving such an effect would be difficult because a parametric model would have to be created to control the force over the surface. Therefore, a simple physical action requires advanced knowledge when it comes to using computer software.

Gaining fluency in using advanced software takes a long time, which may result in students becoming over-attached to computer models, which they spent hours to create. This is completely different in the case of traditional models, which are built as tentative mock-ups, and the elements of which can be easily stripped down and moved, thus enhancing the design process and stimulating the creativity of the designers. Accordingly, it is important to start each design project by using traditional models, as well as curbing the use of virtual 3D models during the initial years of study and conceptual work in general.

> *It is necessary that students are led by imagination and spatial perception before they start entering their projects into computers* [7].

> *The digitisation of architects' workshops should not completely replace traditional design methods, such as handcraft modelling or drawing, which are still essential for the proper development of early-stage design*

models. There is also a risk of over-automatisation that could lead to a drop in creativity and critical thinking. The work of an architect has been, and always will be, interdisciplinary, therefore studying should involve as many design aspects as possible [8].

Despite the above, it has been observed that computer models featuring good graphics present a great temptation for students, and so they are a frequently chosen as alternatives to traditional mock-ups [9]. It also has been noticed that traditional mock-ups are perceived by students as unattractive; similarly, learning how to draw, model and other subjects related to different areas of art seen by students as gratuitous, add-on subjects [7]. Is it possible to create a sufficiently attractive plan so that students will not turn to modern techniques?

ARCHITECTURAL PROJECT 1

The aim of the Architectural Project 1 completed at the FA-GUT during the academic year 2018/19 and led by A. Gębczyńska-Janowicz and A.F. Szuta, was to enable students to achieve a balance between artistic and constructional issues. Another aim was to strengthen the students' aesthetics and the use of basic tools of architectural composition. An important element of the programme was to stimulate the students' imagination and conduct the tasks in such a way as to not limit the participants to a computer-based approach. As a result, students should be well prepared for the challenges they will face in education in future years.

The classes were inaugurated by an exercise that consisted of illustrating abstract concepts, such as *harmony*, *happiness*, *chaos* and *lightness* via a spatial form (Figure 1). The students were forced to think more abstractly and beyond the familiar. During the first meeting they worked on the concept on trial models. Students were obliged to submit their final mock-ups. Such an introduction was a fundamental and necessary element in the completion of the rest of the programme.

The goal was not only to develop the imagination, but also to sensitise students to the importance of aesthetic values, purity and details of the final mock-ups. The complexity of subsequent tasks increased and the themes moved from the abstract to real problems; for instance: seat design, a bus shed, a footbridge and a viewpoint (Figure 2). To help students to understand their architectural work, each task included a short lecture and literature review.

Figure 1: *Happiness* (Photo by the Authors).

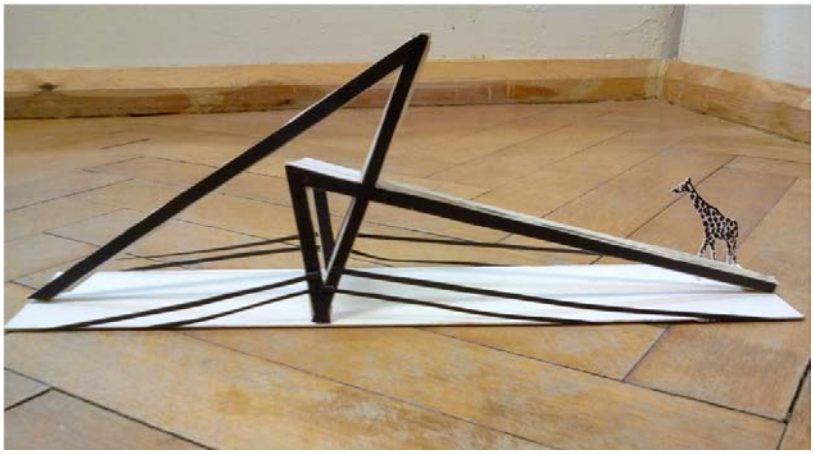

Figure 2: A footbridge (Photo by the Authors).

Figure 3: The students struggled to build the towers (Photo by the Authors).

The last task planned in the schedule was to design a viewpoint as before, beginning with work on a traditional trial model. To make the students aware of the laws governing construction, a *building a paper tower* competition was carried out during the classes. The task was to build the highest possible tower from A4 sheets of paper and books. The only condition was that the base of the structure should be made from paper on which upper floors, made from books and paper, could be placed (Figure 3). The students struggled to build the towers. Contrary to first impressions, the task was not easy. By a process of trial and error, the students came to understand basic principles of construction (for instance, they noticed the existence of a centre of gravity).

QUESTIONNAIRE

To verify if the proposed programme was interesting and helpful for the further stages of education, a survey was conducted among 14 students who participated in the classes. The questions referred to the students' perception of the role of mock-ups in the design process and whether they see any advantages in traditional model-making. The final open question was intended to reveal the students' attitude towards the usage of manual techniques and their replacement by digital technologies.

Question	Yes	No
1. Did you willingly participate in Architectural Project 1 classes in 2017/18, where you were requested to present your ideas on traditional architectural models?		
2. Did the way of conducting classes encourage you to present new ideas on rough mock-ups?		
3. Did the preparation of the trial mock-up help you in the design process?		
4. Do you agree that the presentation of the concept by means of mock-ups is more comprehensible than presentation based on a digital visualisation?		
5. Did you use the techniques based on work with scale models which you familiarised yourself with during the first year of studies? Why?		
6. Do you think that conducting classes on the same subject, albeit with a complete replacement of the manual techniques with digital technologies (3D models, films simulating the fall of the tower, etc) would be equally attractive? Why?		

The results of the survey are presented in Figure 4.

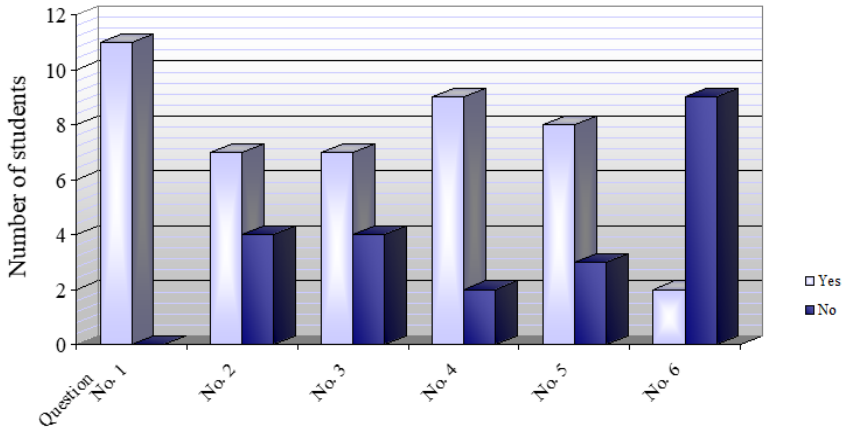

Figure 4: Distribution of survey responses, Q1 to Q6, administered to students.

RESULTS AND DISCUSSION

According to the survey, although all students willingly participated in the classes, 40% claimed they did not feel encouraged to use traditional model-making. Nevertheless, the majority believe that preparing a mock-up helps in the design process and 82% believe that the presentation of concepts by means of traditional models is more understandable than by its virtual version. In response to the open question, students point out that traditional model-making greatly assists the development of a design and facilitates an understanding of what is being designed, while also quickly presenting the idea in a very comprehensible way.

> *It helps to present the concept and dispels doubts about the project. Mock-ups help you to see an object from any perspective, not just the one included in the visualisations (A positive response to question no. 5, author's translation).*

Students also note it is essential to learn about different design methods, as well as which digital techniques are best for the final presentation of the project. The answers to question no. 5 show that the students notice and appreciate the role

of making traditional mock-ups. This is also shown by the fact that 73% of the respondents continued to use the traditional model-making technique (which they learnt in their first year of studies) during the following academic years. What is more, 82% of the respondents say that classes based solely on digital technologies would not be as attractive. Below are some answers to question no. 6:

- *Paper models helped us to grasp the scale and understand how something works (A positive response, author's translation).*
- *The use of digital technologies is more enjoyable than traditional model-making. Making mock-ups requires patience and a lot of time is wasted, e.g. while you are waiting for the glue to dry (A negative response, author's translation).*
- *For first-year students, traditional model-making is indispensable in order to* feel *how structures should be built. A traditional model allows you to imagine which kind of construction should be used. With a mock-up, it is easier to imagine what you would like to achieve (A positive response, author's translation).*
- *Now everything is done digitally and the amount of content makes remembering difficult. I have no idea what happens on the slides shown for most subjects, but I remember my experiences with physical models much better (A positive response, author's translation).*

Findings from the survey conducted show that students discern and appreciate the role of building traditional mock-ups. This is evidenced by the fact that even when they gain skills which allow them to operate computer software, they still continue to use a technique based on traditional models, which was learnt during the first year of studies. Moreover, the vast majority of students questioned noted that manual techniques enable a better understanding of the problem and that experiences with physical models are easiest to remember compared with digital technologies, which also caused a feeling of being overwhelmed.

Therefore, the teaching method based on traditional mock-ups could play a crucial role in education. It is worth paying attention to the fact that students indicated many times that traditional models are better than virtual models in terms of understanding, as well as allowing a quick grasp of the scale of a designed structure. Responders also noted that traditional mock-ups allow a quick, comprehensible presentation of their concepts. The use of traditional model-making from the concept stage and in subsequent phases of the project might also make the teacher's comments more understandable during discussion about the form and elements of the designed structures. This is especially so for students who find it difficult to think in abstract terms.

APPLICATIONS AND SUMMARY

Mock-ups were the first tool that could present designers' ideas in three dimensions. In recent years, through the evolution of science and technology, a replacement of traditional cardboard models by virtual 3D models has occurred. Although it is clear that technological progress facilitates design, moderation and balance should be observed in the use of digital tools during the initial education of young architects. All tasks at the early stage of education should be chosen in a way that allows students to strengthen their ability to reflect aesthetics when applying the basic tools of architectural composition.

The desire to create spectacular visualisations is a great temptation for young architects who want to attract attention to a project. However, insufficient computer skills in the first year of study mean spending many hours on building a virtual model which, in turn, could lead students to become overly attached to their digital models. Consequently, students may demonstrate indifference towards the teacher's comments, as well as reluctance to rethink design solutions or to improve a structure. This situation might differ significantly in the case of work based on mock-ups, which allow students to present an idea quickly even if it is very complicated. Dunn emphasises the essence of the use of traditional models:

> *…tool used by a student provides a method of communication, and when used as a tool by the tutor enables him/her to assess a student's ability and learning, communicating both what and how well they have learnt* [10].

The programme of Architectural Design 1 at the FA-GUT during the academic year 2018/19 was based on working with traditional model-making. During several initial classes, the students were requested to present abstract concepts by means of mock-ups. The tasks bordered on artwork, and each subsequent exercise involved more technical/construction aspects.

An important part of the programme was a competition, which consisted in building the highest possible tower from books and sheets of paper. Students could discover the basic principles of construction by direct participation in what might be impossible to achieve through digital technologies. The tasks carried out were intended to stimulate the students' imagination and familiarise them with the basic tools of composition, as well as the work of architects, and were expected to help students find a good balance between technique and art.

To verify the objectives of the programme, a survey was conducted. After analysing the answers, it turns out that the students who used mock-ups for the first year of study, despite their proficiency in the operation of computer software, continued to use them at the concept stage. The ability to analyse forms as a result of creative gluing activities becomes an attractive tool for students and should not be restricted. The findings of the research conducted at the GUT dovetail with the conclusions of other studies that have shown that models, which can be physically manipulated, are particularly helpful in understanding the early phases of a project [10]. It is worth mentioning that traditional models allow direct interaction with materials and tectonics, whereas digital models remain two-dimensional - they are viewed on a flat screen.

According to the above, it may be concluded that the aim of class programmes conducted during the first year of architectural studies should be to carry out tasks that help the students to stimulate their imagination, as well as to understand the limitless possibilities of shaping space. As demonstrated, such effects are achievable, but should not be restricted by skills in using computer software. Therefore, one of the most important and basic elements of architectural education, despite significant technological progress, should be work based on traditional model-making. Undoubtedly, the advantages of building traditional architectural models are the quick and unlimited possibilities of formation, even in the hands of untrained students in the first year.

Exercises based on working with mock-ups allow students to control and use basic architectural composition tools. Traditional, physical models, thanks to the unlimited shaping capabilities of them, are a support for the presentation of ideas, as well as an aid for teaching a sense of aesthetics and facilitating teacher-student communication. Therefore, it is important to make a prudent and gradual introduction to digital modelling in Architectural Project 1 classes conducted during the first year of study. This can prevent a student from becoming overly attached to a design made by means of digital tools.

When using digital tools, students may focus on how to divert attention from any underdeveloped parts of their project; for example, by changing camera settings or impressive graphical solutions. It is worth noting the greatest works of architecture ever achieved were based on traditional architectural models; none of the leading architects ever considered how to set the camera direction to hide any flaws in their work, but rather how to model cardboard to fix those flaws.

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