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Using physical models to generate creative ideas for architecture students

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Abstract

Architectural models serve as a bridge between the idea and its realization. Moreover, it is considered one of the main means by which the architect invents and develops his design. The "Architectural Models" course in many architectural schools introduces the basics of implementing architectural models. Students learn how to think of and build architectural models using different materials. While many of these courses overlook how to think about architectural concepts using physical models. The aim of this research is to state and examine strategies for generating architectural ideas using physical models. This paper discusses various strategies for generating architectural ideas using physical models. Furthermore, it illustrates an experiment conducted in the "Architectural Models" course in the Department of Architecture and Environmental Design at the Arab Academy for Science and Technology, Egypt, which was offered in 2021. The experiment was followed by a small questionnaire. The experiment aims to stimulate the creation of innovative architectural forms using physical models. The role of architectural models goes beyond presenting projects. Therefore, the intended learning outcomes of the "Architectural Models" courses in architecture departments should be developed. Strategies for generating ideas using architectural models were adopted and applied. This is the first paper in which such strategies are examined. The final students' products were very good, and their feedback was very encouraging.

Keywords: Physical Models, Architectural Models, Generating Ideas
2010 MSC: Primary 90C33; Secondary 26B25

Introduction

It is demonstrated that since the beginning of the twenty-first century, the primary functions of the architectural model intertwines with digital modeling for the most part [10]. Nowadays, many architects avoid using physical handmade models though they are widely accepted and prominent tools to create, understand and explain architectural design concepts [9]. This is due to the development of digital technologies that brought new techniques in architectural modeling and the presentation of architectural projects – for example, virtual 3D modeling visualizations or the use of Augmented Reality. However, physical 3D models still play an essential role, especially in architectural education [4].

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Models are one of the oldest mediums used for creating, communicating and representing ideas throughout the ages, whether these ideas are based on dogmatic, intellectual, ideological, or architectural thought [2]. Most of the early models were hidden as funerary objects. Since as early as the predynastic period (pre-3000 BCE), ancient Egyptian pharaohs were accompanied in their tombs by proportionally accurate models of everyday structures [7]. Scale models of buildings, boats, and furniture were hidden to represent properties the dead took into the next world (Fig. 1). In 4600 BC, old Europeans made architectural models of their houses before they built them. Fig. 2 is an actual ancient pottery model showing homes attached like townhouses, with a surrounding barrier found in Romania. On the other hand, architectural models have evolved their role beyond just simulating what reality will be like, as they were used to contribute effectively to the process of architectural design itself. During the Renaissance, creating a physical model was the only way Filippo Brunelleschi could easily guide his craftsmen in the construction of the dome for Florence Cathedral (Fig. 3) [1]. By the late 1800s, architects such as Antonio Gaudi began using models as a means to explore structural ideas using low-tech architectural problem-solving. His experiments let gravity determine the form of a catenary arch which could then be photographed and inverted to gain an understanding of the forces at work (Fig. 4) [11]. In 1936, Frank Lloyd Wright made a mock-up of the Johnson Wax Building column to test its structural loads. It rises about 7m and expands from about 23 cm in diameter at the bottom to a circular slab of 5m in diameter at the top (Fig. 5). It was supposed to carry only 12 tons, however, it did not break until it was loaded with about 60 tons [7]. Despite being a competition winner, Jørn Utzon's design for the Sydney Opera House could originally not be built due to the roof forms being considered structurally unsound. To prove the proposal, Utzon created a simple wooden model to demonstrate the solution to engineering the 'shells' that would form the roof from the surface of a sphere (Fig. 6). This low-tech solution to what appeared a complex structural problem is reminiscent of Gaudí's catenary arch experiments, and the power of even the simplest model to reinforce and even save a design proposal [1].

Figure (1). Model of a granary with scribes, ca. 1981–1975 BCE [7].

Figure (2). Model of a monumental building, Gumelnița culture, Căscioarele, Romania, 4600–3900 BCE. [7].

Figure (3). Filippo Brunelleschi, wood model of Florence dome and side chapels, ca. 1418–1446 [7].

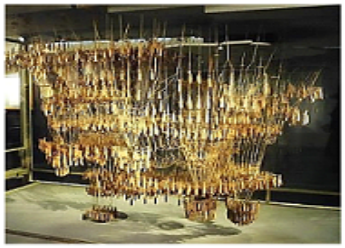

Figure (4). Antonio Gaudi, reproduced a model of "La Sagrada Familia", 1983-1926. Upside-down structural analysis made from strings and weighted bags [11].

Figure (5). Testing the columns for the Johnson Wax Building, Frank Lloyed Wright, 1936 [5]

Figure (6). Wooden concept model showing the geometrical solution for the pre-cast concrete shells, Sydney Opera House, Jørn Utzon, 1957-1973 [1].

The followings are strategies for generating ideas using architectural Models:

Expressive Model Drawing Strategy: Models executed with the speed of two-dimensional sketching can be effectively used as the prime generator of ideas without the aid of drawings or exact scales. To facilitate this, begin by becoming familiar with the basic program, site requirements, and structural options until they become part of the designer's internal knowledge of the project parameters. Although the model need not be built to scale, it should employ relatively proportioned relationships between its parts, such as floor-to-floor heights (Fig. 7).

Additive/Subtractive Drawing Strategy: One way of approaching three-dimensional forms is in terms of additive and subtractive operations. In additive operations, individual components are joined together to form a

construction (Fig. 8). In subtractive operations, models are initiated with a block of material, and pieces are subtracted to arrive at the design (Fig. 9).

Formal Proportioning Strategy: Another important approach is to use the model as a device for refining proportions and making exacting spatial alignments. This approach requires tighter control and greater attention to crafting the model and focuses on placement and adjustment as its primary concerns (Fig. 10) [6].

Working with Plan and Elevation Drawings Strategy: The sketch model can be used in concert with simple scaled drawings to set a general idea. Once the building begins to appear, the model can be used as a focal point to help visualize additional design decisions (Fig. 11).

Working with Concept Drawings Strategy: In this process, drawings such as collages and paintings can be converted to produce three-dimensional forms, and, conversely, models can be converted to drawings (Fig. 12). This process is usually carried out in the early stages of a project, and the constructions typically require further explanation to move them forward into architectural proposals.

Reuse Strategy: Another way of approaching three-dimensional forms is to treat parts from previous models as found objects (Fig. 13). With modifications and the introduction of new elements, several ideas can be produced in short order. This process is related to recycling elements; however, rather than using existing elements, a vocabulary of new parts is generated.

Found Objects Strategy: Another way of creating architectural concepts is to use found objects which are available around us and group them to form innovative architectural forms (Fig. 14) [6].

Oblique Folding Strategy: Folding as a generative process can be used to discover several ideas (Fig. 15). Depending on the direction taken, the folds can be used to build an enclosure or explore oblique space, producing internal layers and relationships [3].

Exploration of material behavior Strategy: Studies include reactions to planar materials such as cloth and metal deformation, draping, folding, and light studies (Fig. 16) [6].

Conversely, design elements carried out on the model can be used to refine drawings such as elevation studies, which in turn can be used to inform the model.

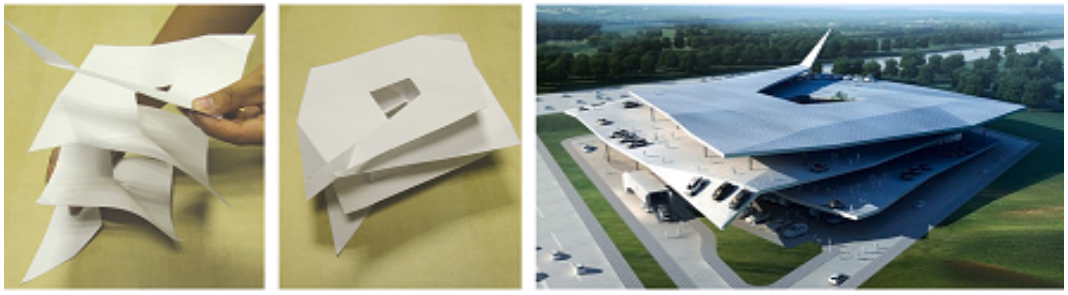

Figure (7). A quickly produced model made from paper shows the initial design idea of the Automobile Museum in Nanjing, China, 2008 [12].

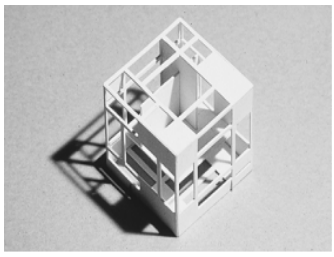

Figure (8). Additive space. [6]

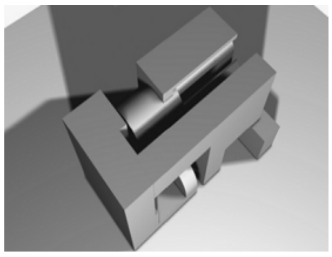

Figure (9). Subtractive space. [6]

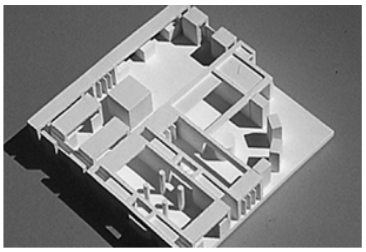

Figure (10). Formal Proportioning Strategy. [6]

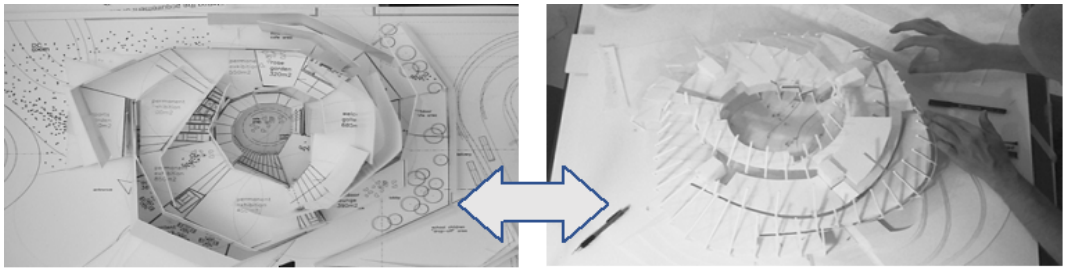

Figure (11). Working with Plan and Elevation Drawings Strategy (Mills, 2011).

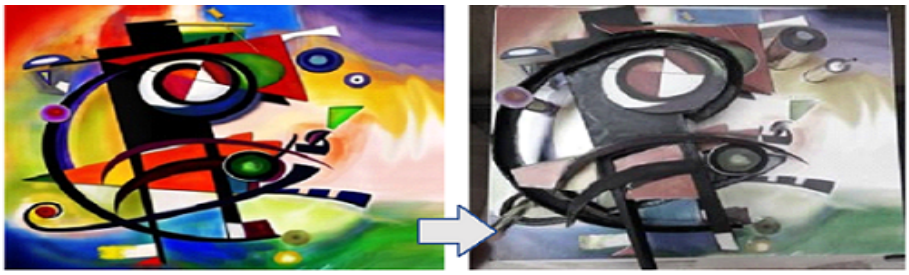

Figure (12). A model implemented by Arab Academy students under the supervision of researchers

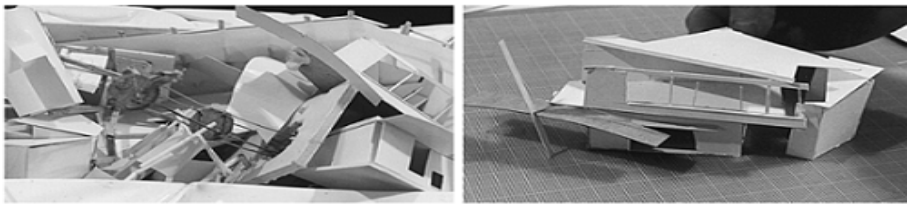

Figure (13). Reuse Strategy (Mills, 2011).

Figure (14). Found objects Strategy

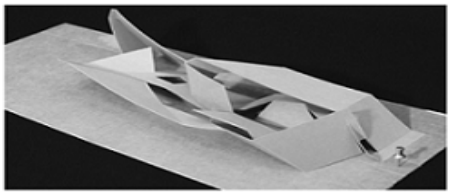

Figure (15). Oblique Folding Strategy (Mills, 2011).

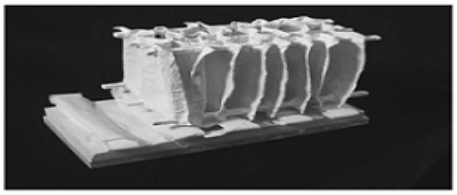

Figure (16). Exploration of material behavior Strategy: Plaster material study (Mills, 2011).

1 Materials And Methods

18 students in the Architectural Models course, level 4, at the Arab Academy for Science, Technology and Maritime Transport participated in this experiment. They were trained first on the skills of implementing models, then the different strategies for generating architectural ideas were explained. The students made a set of exercises to apply different strategies to generate architectural ideas. Students were asked to choose three strategies to implement a pergola in a public garden. The required scale was 1/50.

On the other hand, those students were administered a small questionnaire to assess their opinions regarding the use of various strategies to generate ideas using physical models. The questionnaire consisted of three statements and an open-ended question:

- Has your point of view changed that physical models have an essential role in generating architectural ideas

rather than merely presenting them?

- Will the course change your method of generating architectural ideas in the future?
- What is the best strategy from your point of view for generating architectural ideas?

2 Results And Discussion

Students' work was evaluated, and then a questionnaire was created to evaluate the experiment from the student's point of view. The final grades were as follows: 2 students got (A+), 3 students got (A), 6 students got (A-), 3 students got (B+), 2 students got (B), 1 student got (B-) and 1 student got (C+) (Fig. 17). Figures 18-20 illustrate various categories of students' products.

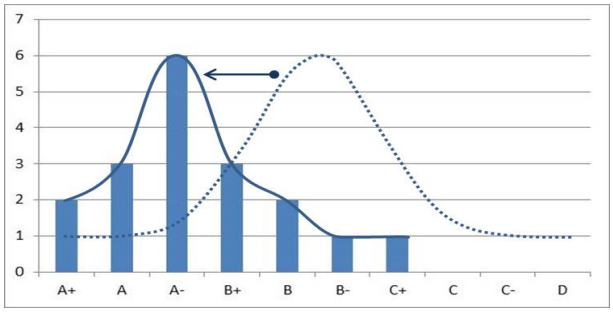

Figure (17). The bell chart of the students' results shows high consistency with a left skew (toward higher grades), indicating the students' diligence and great interaction with the course.

With regard to the questionnaire, the vast majority of respondents (73.3%) strongly agree that their point of view changed that physical models have an essential role in generating architectural ideas rather than merely presenting them while (26.7%) agree that their point of view changed. (40%) of the students strongly agree that the course will change their method of generating architectural ideas in the future while (60%) agree that it will change their method. The percentage of students who preferred additive and subtractive drawing strategy (46.7%) was larger than those who preferred folding strategy (20%) and other strategies (33.3%). The open-end question was about suggestions to improve the course. The students suggested working with different materials, not just cardboard. They prefer increasing the number of assignments to include a variety of more complex projects and sites.

Intended learning outcomes (ILOs) of "Architectural Models" course in The Department of Islamic Architecture, UQU:

In the Department of Islamic Architecture, Umm Al-Qura University, KSA, the ILOs of the "Architectural Models" course in the previous plan (37) were as follows: (a) Demonstrate an understanding of processes and methods of design; (b) Demonstrate an understanding of architectural shapes and forms, and ways of presentation; (c) Demonstrate mental-physical coordination in producing architectural models and (d) Execute physical models efficiently.

As a result of the previous experiment and questionnaire, the ILOs have been modified as follows: (a) Demonstrate an understanding of a wide range of specialized knowledge related to architecture; (b) Create innovative concepts and forms for the built environment and (c) Execute physical models efficiently.

3 Conclusion

Physical models are used side by side with digital virtual models in the design practice of architecture, art, design, engineering, and many other creative professions. The role of architectural models goes beyond presenting projects. Through several strategies, students and architects can create innovative architectural forms and generate creative ideas. Therefore, it is necessary to update the intended learning outcomes of the architectural model courses to keep pace with this trend because of its great benefit to the student of architecture.

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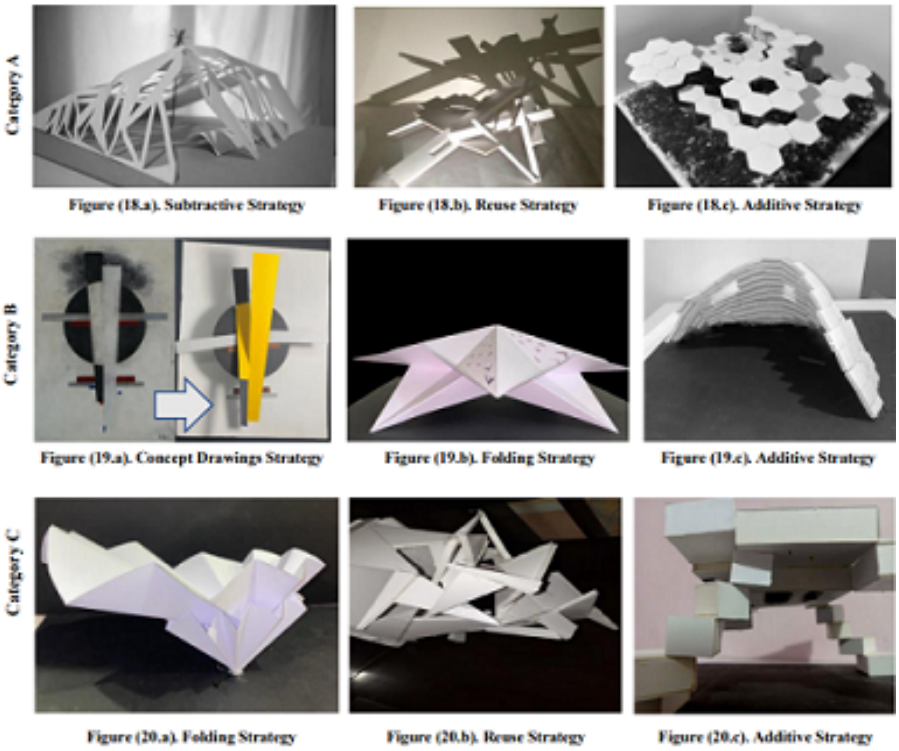

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