Work Models in the Design Process for House Interior and Exterior: Physical or Virtual?

Tomasz Bradecki¹, Barbara Uherek-Bradecka²
¹ Silesian University of Technology, Faculty of Architecture, Akademicka 7, Gliwice 44-100, Poland
² Katowice School of Technology, Rolna 43, Katowice 40-555, Poland
tomasz.bradecki@polsl.pl, basiauherek@gmail.com

Abstract. The article presents the effects of research on different types of models of single family houses and multifamily houses. Exterior layout and interior functional layout are the main drivers for the final result of a design. Models are an important medium for presentation of architectural designs and play a pivotal role in explaining the first idea to people and potential clients. Although 3D models have unlimited possibilities of representation, some people cannot understand or 'feel' the designed space. The authors try to test how to combine the interior and the exterior in a single synthetic model. Several models of different houses have been presented in the article. All the case studies were developed with physical models, 3D models, and 2D hand sketches. The main focus of the work with the models was to achieve a coherent vision for future feeling of open space in designed houses. The research shows how synthetic models might be helpful in the design process. The research was carried in the URBAN model research group (urbanmodel.org, Gliwice, Poland) that consists of academic researchers and architects. The models reflect architectural experience gathered by the authors during their work on theoretical models, architectural projects and by supervision on site during construction site visits. Conclusions might be helpful for developers, architects, interior designers and architecture students.

1. Introduction
The model making for architecture has a long history and it started approx. 4600 B.C.: at that time first clay figures representing built forms were made. The renaissance brought architectural models closer to a more contemporary form that we know now: models made of wood represented the most significant buildings of that time. Today it is not only the physical model, that helps to explain the concept for architecture but there are also other ways of presentation which are important, such as 3D visualisation and virtual reality models. Today models are much more affordable and easy to make. Therefore, models have become an integral part of the architectural or urban design process.

Today most of the design work in urban planning and architectural projects is done in 2D. Despite the development of digital techniques for architectural imaging, freehand drawing remains a very effective design tool [3]. The main tool used for communication between co-workers in different phases are still 2D blueprints [11]. Traditional techniques such as 2-dimensional drawings, including perspective drawings or plan drawings are easy to use and understand, however they always represent an object once, [2]. Visualization is a medium that technically presents a design to the owner or client and it facilitates the design process for the design team, [5]. As Gil states, computer generated
visualisation proliferates to be a standard way of representing architectural and urban design projects, which are often too defined and too explicit, especially for the early phases of the design process, [6].

Models are an important medium for presentation of architectural designs and play a pivotal role in explaining the first idea to people and potential clients. Models can also be an element of the design process. For instance: architecture studio Coop Himmelb(l)au is famous for its conceptual models that reflect design ideas that do not remind a building at all. Their models rather reflect 'directions' of ideas in spatial form in their early stage. Mills states that Coop Himmelb(l)au has traditionally relied on the generation of sketch models and drawings to initiate the project [4]. These models would not be suitable for presentation of a concept to clients. They help to understand some relations between particular elements in space in the design process. In spite of the fact that at some point the role of physical models decreased, the authors believe that there is a way of using a physical model as an important element in the architectural design process.

2. Working with models in the design process
Design is a subject that does not only require the creation and development of design ideas, but also effective expression of these ideas within computing environments by people, which we see more and more in contemporary architectural practice [10]. The design process in architecture usually begins with a design concept that is either a virtual idea or an idea expressed by a single conceptual sketch or diagram that includes only the minimum of information (see Figure 1). When designing, complex mental processes take place, within which ideas are continuously generated and scrutinized [7]. Sketches are an important component and method of creative work [different products are the result of continues progress in design - the more developed the design, the more sophisticated products that are generated, depending on the design tool used by a designer. For a comparative evaluation of differing designs they must generally be printed out on paper. A physical model, in contrast, can be appraised by everyone, without any effort and without technological support [7].

Figure 1. A diagram showing an initial concept for a house: left perspective sketch, right floor plan diagram; 2014; Tomasz Bradecki

The relationship between the design concept, the technical background and technology that are necessary during the design process and the final product have been presented in Figure 2. There are several products that are being produced during the design process. These products are the effects of the design process and are used to communicate with the client.
Concept

| product                                    | Technical background necessary to prepare the product |
|--------------------------------------------|------------------------------------------------------|
| single view sketch or diagram              | idea                                                  |
| physical model                             | Physical model                                       |
| Visualisation or animation                 | 3D virtual model                                     |
| Real time experience of a design via virtual reality | Virtual reality model                                |
| peripherale.g. VR helmet                   |                                                      |

Figure 2. A diagram showing the products of the design process; Tomasz Bradecki

Sketching is usually used at an early, design conceptual phase. Sketches are usually hand-made and are the most effective way to present the basic idea. Sketches are easy to make if applied for exterior views. Usually sketches are not a good way of presentation of the interior, since interior views need to show materials, textures and require a high level of detail. Sketches are quick and time-effective. They can be easily corrected with tracing paper and other techniques (erase, copy, change or fill with new body).

Physical models are spatial representations of architectural ideas. Physical models are very often finished pieces of fine art. Such models present the final design product in a scale. Sometimes physical models present one of the stages of the design process, for instance: just a form of a building and its location, but no details, such as windows, doors or finish surface materials. The most important issue about physical models is the fact that models are not easily changed in a simple and effective way. The more detailed and complicated a model is, the more 'finished' it appears and people who analyse it get the impression of a finished design product, that cannot be changed anymore.

Visualization is the product of work with a 3D virtual model. A single image of design mostly shows one view in a designated environment. Very often the environment is a site with all the existing buildings in the neighbourhood.

Virtualization is seen by many as essential to the practice of architecture, [1]. A virtual reality model is a 3D model prepared to be presented via virtual reality peripheral such as VR google or VR helmet or 3D VR cave and other. The advantage of such technology is that the recipient can get an experience of being nearby or having a walk around a designed object or being inside the object (very effective with interiors). For many years’ virtual reality technology was depending on expensive peripherals, such as VR helmets and special software. Today smartphones with google technologies (for instance SAMSUNG gear, Oculus rift google) or google for videogames (for instance SONY VR) made virtual reality much more affordable.

All the four products of the design process with their advantages and disadvantages are presented in Table 1. There can be no straight comparison between them since a lot depends on the recipient and the designer. However, there are limitations for each phase and each tool used for presentation during the design process.

3. Models for houses in the design process

Sketches, physical models, 3D models and virtual reality models can be used and applied in designing house interior and exterior. All products are very important for the house’s future users who are the designer’s clients. Very often all the design process tools are used to present a design properly. Since most houses are relatively small and not complicated, it is common to design them in high standard. Figure 3 shows the design for the same house in different design phases. Slight differences can be noticed when comparing physical models, the sketch and visualization. These are the products of the
three design stages according to Mojtaba [9]: ‘analysis, synthesis and evaluation’ (citation after G. Broadbent).

Table 1. Advantages (+) and disadvantages (-) of different forms of presentation for the interior and the exterior of a designed house from the designer’s perspective

|                | sketch                                      | physical model                                      | Visualisation                                      | Virtual reality model                                                                 |
|----------------|---------------------------------------------|----------------------------------------------------|---------------------------------------------------|---------------------------------------------------------------------------------------|
| **Exterior**   | + requires minimum effort to present an idea + the level of details depends on the designer + changes can be made easily | + easy to see from all points of view + level of detail depends on the scale and the designer | + can be similar to a real image if prepared properly - changes cannot be made easily | + the model can be easily accessed from every side                                      |
| **Interior**   | - requires high level of detail + changes can be made easily | - large scale and large size - hard to see the real, man-eye level perspective view | - one view does not reflect the feeling of being inside | + the feeling of being inside - requires high level of detail in the entire model  |

Figure 3. Three products of the design process for a single family house: physical model, hand-made sketch and visualisation

Although 3D models have unlimited possibilities of representation, some people cannot understand or 'feel' the designed space. For house design, the most expected and questioned space is the living room and open space. The role of a living room in a contemporary house seems to be very obvious: it is the space that is used in everyday life for meetings, relaxation and sometimes for occasional consumption [12]. Very often open space can be perceived as the most important both for exterior and interior design reasons. Therefore, the authors tried to test how to combine the interior and the exterior in a single model. Such an approach is more and more common since most of the visualisation programs are capable of showing both at the same time. However, it is not that easy to make at an early stage of the design process, since many elements are self-dependent, for example the size and form of the windows has an impact on the interior and the exterior.

The authors’ main focus in their work with the models was to achieve a coherent vision for future feeling of open space in designed houses. The idea of a synthetic work model seems to be obvious and is well recognised. However, the authors were searching for a model that might be modified during the work with clients. There are several main issues that the authors decided are important in synthetic work models. Firstly, a model should be easy to modify during discussions with the client. It should be ready to be cut, changed in a reasonable time (5 minutes at the maximum). Secondly, a work model
should have unified colour and material. The aim was not to suggest too much (finish materials and colours) and leave time for future decisions during design process. Also, work models should be affordable - their cost should not exceed high values since that would be the client’s cost and it would not allow experimenting on several models. This led the authors to hand-made models cut in white foam boards. The models for houses turned out to be quick and convincing for the clients.

The idea of presenting the interior and the exterior at the same time led to tests on disposable models that can be easily disassembled. If a model had removable roof or entire storey, the interior house layout could be seen. Such models can be treated as 3-dimensional plans and can be a good addition to work with people with no architectural or spatial feel. An example of such a model and a test interior design visual have been presented in Figure 4. Initially, models were prepared in the scale of 1.100 or 1.75. However, since some models were very small (for instance 10x12 cm in the plan) and the dimensions of living room were even smaller in models, the authors to decide to use the scale of 1.50.

![Figure 4](Image)

*Figure 4* An example of a design synthetic work model and test interior model visualisation. The House with Terraces, 2015

The authors also tried to enhance the idea of multi-family housing estates. Initially, massing models showing the structure of an estate (see example in Figure 5) turned out to be effective at an early design stage, but later on structure work models and visualisation were essential. The advantage of a structure model is orientation to the clients. The case study of a physical model for a housing estate in Borek in Chełm (see Figure 6) showed that the physical structure of flats and rooms showed in the physical model of the estate was helpful in understanding the location of each flat and daylight analysis. The disadvantage of that model was large scale: it takes a lot of space.

![Figure 5](Image)

*Figure 5* An example of a multi-family housing design in Pszczyna: massing model, work model showing the structure and visualisation
4. Conclusions

Application of the synthetic work models for houses has been developed by Tomasz Bradecki and Barbara Uherek-Bradecka since 2011 during their work on several projects. The most important ones are illustrated in Figure 7. The work on models was and still is being improved and many experiments have been done to get different results. Nearly 30 models have been prepared that represented various house designs: starting from small houses of approx. 120 sqm of total area up to a 550 msq. house, which was 1-meter-long (in the model). Test on the model for the housing estate in Chełm, Borek showed that some models can reach 2 meters or more and allow for easy live presentation (what is where), but they also cause problems with finding a proper space for presentation and difficulties with transport.
The models were presented to the clients, structural engineers and other participants of the design process at different design stages. On some occasions they were presented at a nearly design stage of the very first concept. This was an occasion to test whether the clients understand the main concept and what their house structure would be. As for the test on the interior layout, some partition walls were not fixed with glue and so they were easy to move or take away. On some occasions the initial model led to dramatic changes in the concept of the house. During work on one of the case studies, models were being cut and changed 'live' during meetings with clients to convince them that some of the solutions could be easily changed. On some occasions several types of roof for the same model were prepared to test the pitched roof inclination. The models of humans, a car and basic furniture, such as the coach and dining room table, turned out to be very helpful to understand the scale of the model.

Sometimes the model was the final product of the design process just to confirm that the rendering reflected the form. The authors also noticed that the plot size, if prepared in a model, was very helpful in understanding the distance between the house and the plot border. Many models have limitations: some details cannot be presented easily unless proper scale is used and the level of detail is sufficient. The main conclusion of the research is that models of houses are helpful, especially to work on both the interior and the exterior. Conclusions might be helpful for architects, developers, interior designers and architecture students.

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