Model & scale as conceptual devices in architectural representation

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Keywords: scale model; representation; design process

Abstract This year we celebrate the tenth anniversary of our Computer Aided Manufacturing laboratory (CAMlab, http://www.camlab-bk.nl). From the start we provide laser cutting, CNC-milling and 3D-print facilities for the students and the researchers at the Faculty of Architecture in Delft.
Over the past ten years we have delivered uncountable amounts of fabricated model parts and we have advised several thousands of students. Also, we have participated in many faculty-, museum- and world traveling exhibitions, and we have conducted many courses about model making and prototyping related to architecture and industrial design.
Although we can report and show many successes in scale model making, we also noticed a number of problems, pitfalls and too many examples of rough and unarticulated scale models from students in our own workshop and elsewhere. The downsides of computer directed fabrication techniques were obvious and multiple. First and foremost, we noticed the attitude to see models as an end product. Secondly, as a consequence, there often was the un-articulated outlook, missing the human touch. Thirdly, we noticed the missing sense for scale as a conceptual device. Many models were made as if they were shrunken depictions of reality. This paper describes how we responded to these new problems.

Fig. 1 We explain to our students how to interpret their own sketches

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Lost and rediscovered paradigms

With the introduction of Computer Aided Design, several drawing and modelling concepts from the past were transformed into new and powerful digital metaphors. The 'CAD document' and concepts like drawing in layers, the use of different line types, color and drawing styles became standard features for each CAD application. New concepts, such as groups, components, parametric drawing, rule systems and scripting have totally changed and amplified the toolset for the design process.

Four phenomena have contributed to the obsoleteness of 'scale' in most of the contemporary digital design representations: (1) the introduction of Building Information Models (BIM), (2) the directness in file-to-factory fabrication, (3) the ubiquity of handheld computer devices at the building construction site, and (4) quick zooming in and out on screens. Traditional drawings, distinguished in scales of e.g. 1:500, 1:200, 1:100, 1:20, 1:5, 1:2 and 1:1 are bypassed by digital models that e.g. contain information to instruct the milling machines in a factory and that allow to send the right GPS codes to direct building components to their right place. During the design process, the BIM's can be related to urban contextual models and they can be evaluated and adapted in promptly rendered perspective views. This all is fantastic!

However, at the moment, some really valuable paradigms from the pre-CAD period are temporarily forgotten or at least disregarded. In computational models we miss the notion of scale, the directness of pencil on paper, the tangibility of physical models and the poetic representation of nonentities / doodles / objet trouvé / mistakes etc.

We are not nostalgic. We see the enormous power of new tools and we embrace the opportunities of digital fabrication in model making and in real construction. Our teaching efforts are focused to combine the new digital tools with the rediscovered older paradigms and methods.

Reading sketches

In our courses, we guide the students through the following initial sketch steps:

1. Orientation: initial preferences regarding form, material and proportions are investigated by making little sketches out of scrap materials and little inspiring objects.
2. Interpretation: we teach them not only to produce many versions, but also to interpret the sketches in a focused, open, playful and poetic way. The interpretation gives insight in preferences and cues that often are implicitly available in the sketches.
3. Association: by regarding sketches as language, translations into new ideas can be made.

The combination of these three steps can provide strong direction for next steps and often reveals a guiding theme for the design as a whole.

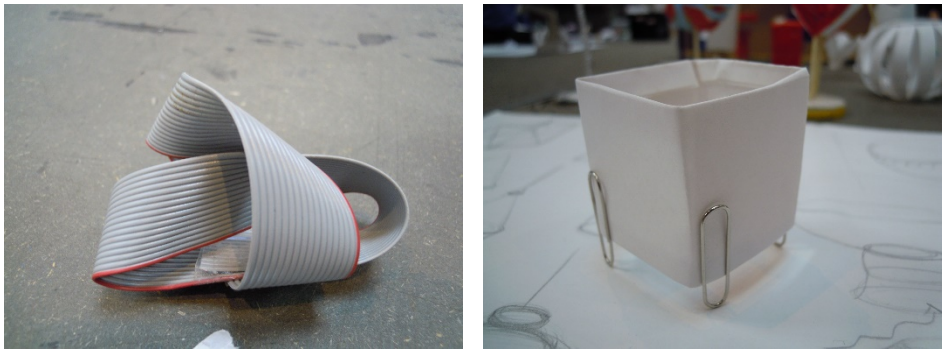

Fig. 2 Two early sketches that already reveal many cues for the guiding theme and even for further detailing steps.

Thematic explorations

After initial ideas are investigated and when the main design concept is clear, there still remain a lot of details that need to be explored. Again, very small scale-models can reveal a huge amount of insights. By making a series of little thematic explorations, the design student can keep track of the different options and produces a physical memory of the main considerations. The sketches also make it easier to discuss the different options with other students and the tutors.

The thematic explorations are mainly concerned with composition / organization of several parts of the design. It can be e.g. about:

- Program interpretation and relation to the site and context;
- Rhythms / directions / plasticity of the building volumes;
- Organization of mass / space and function;
- Proportions;
- Structure;
- Use of color and different materials.

Although these investigations can be noted and compared in very small models, in many cases larger, much more detailed, models and investigations are necessary in order to gain the insights to underpin the larger decisions. Therefore it is necessary to switch between different scales and media in order to get grip on the many issues that are relevant.

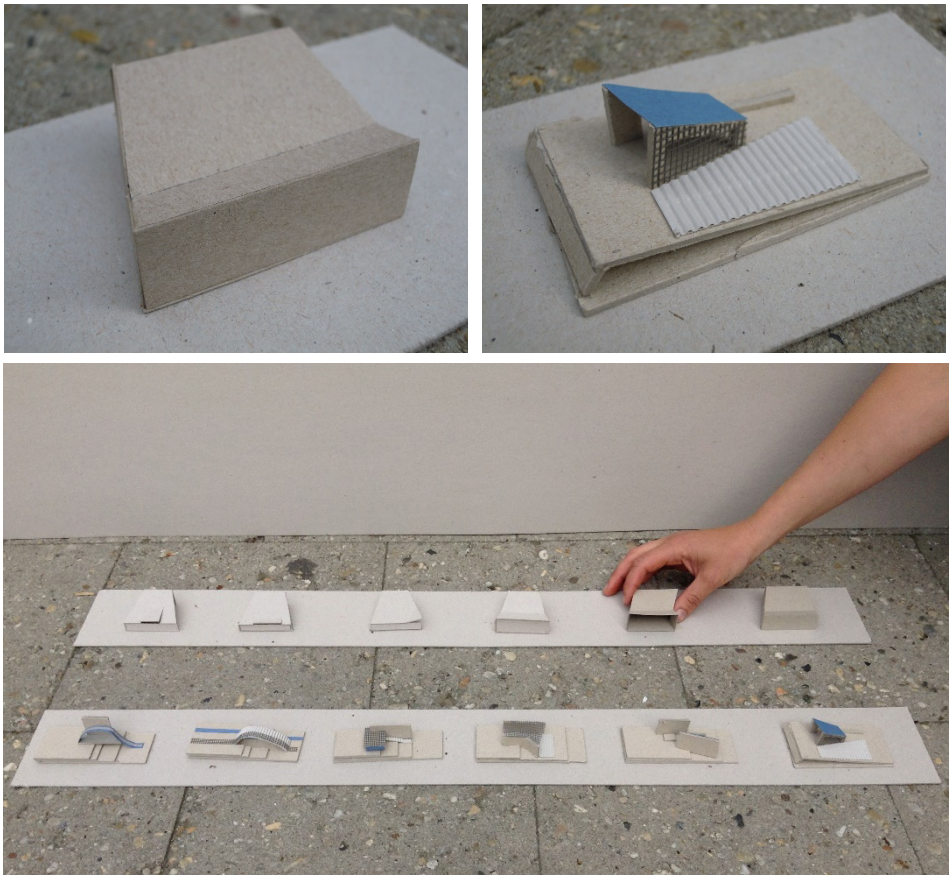

Fig. 3 Two rows of thematic explorations: roof-shape and composition regarding height differences of the site

Levels of detail / levels of abstraction

To an architect, one well-placed dot of a pencil can indicate anything, from a screw to a city. In order to manage all aspects of a design, it is essential to switch between different levels of detail and different levels of abstraction. The model (with its characteristics such as size, material, framing, status, etc.) and the chosen scale of a model are important conceptual devices in architectural representation. Similar to a map, a model can (and probably should) have a legend that makes clear to the users of the model what is communicated. In most cases the meaning of the model remains implicit and we rely on people's 'model-literacy'.

Here we mention scale of a model separate from other characteristics, because scale plays a key role in the topical focus and the related abstraction and level of detail. Again, switching in scale gives control over the complex design process. Through scale, the dots can be thematically connected… from screw to city…

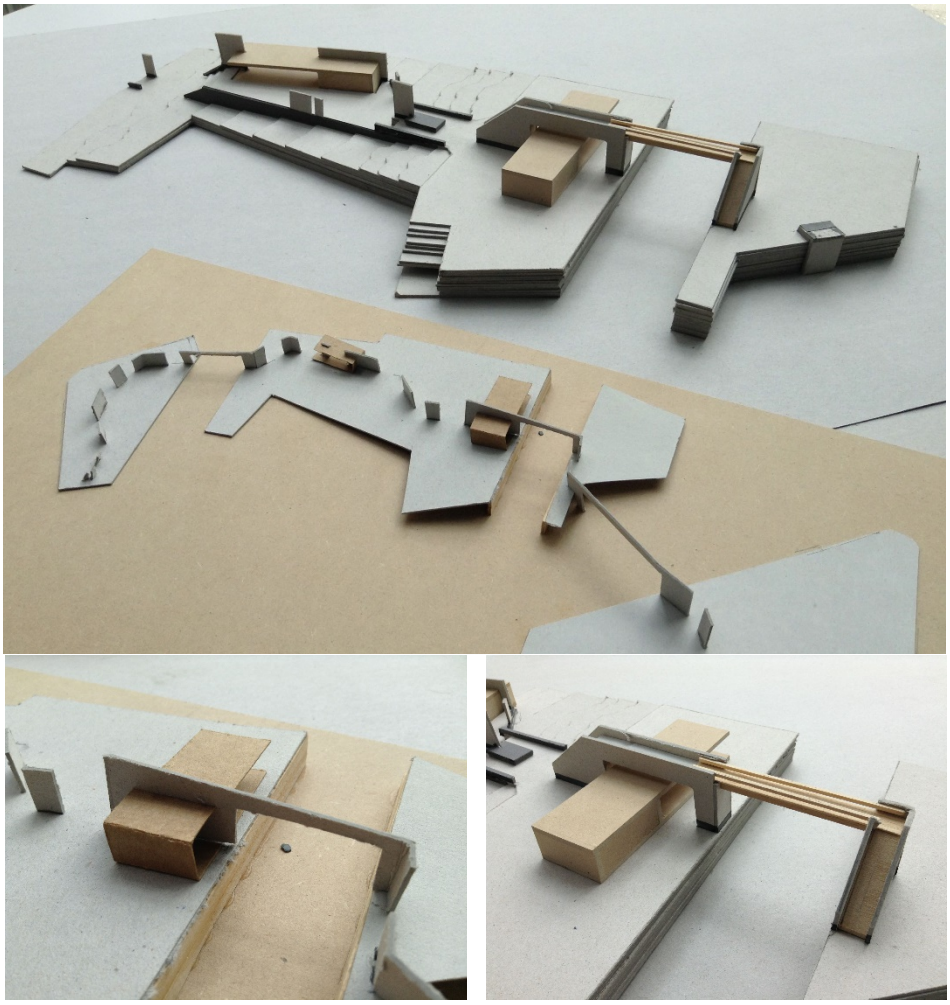

Fig. 4 A wall and a path become, in more detail, a path on a wall, and partially a bridge and stairs

Combining insights from different levels of detail

Architectural design is focused on establishing qualities in our full scale 'real world'. To develop these qualities we use media such as scale models and computer models. Those representations have their own reality: the reality of cardboard, glue and paint or bit's and bytes, code and coordinates. Those models also need to be detailed and those details inform the designer only partially about full-scale 'reality details'.

The two models in Fig. 5 are about the same building and seem to show an inconsistency: one roof is black, while in the bigger scale it is transparent with a beam structure underneath. Both representations tell part of the story. At one distance the glass volume can be seen as bright and transparent, at a further distance (and probably in bright daylight) the volume can be seen as dark and solid. The many models and design documents together provide understanding, insight and product descriptions for the conceived real building.

Fig. 5 Studies for the entrance of a building in two scale models

Quick precision and multiple media

Further on in the design process scale models can be made in accordance to digital models. Each type of model can inform and enrich the other type of model. We even encourage our students to express their design ideas alternately in digital and physical form, and not just in CAD and scale models, but also in digital and physical images, collages and (time lapse) animations.

Laser cutters can easily make surface textures and precise shape cuts of facades. Other building components, such as stairs, columns and beams can sometimes be made of very simple pieces of cardboard, but in some cases the non-standard geometry can be better created with a 3D-printer.

Sometimes there is too large a contrast between machine fabricated model parts and rougher manmade scale model parts. The model in Fig. 6 is a pleasant exception in which hand and machine made parts go well together. It is a further elaboration from the explorations in Fig. 3.

Fig. 6 Hand made parts, combined with laser cut scale puppets and facades. Top right: some 3D printed columns

Working with computer models

When students come to pick up their new 3D prints, we often hear their excited reactions. In many cases they are surprised by the size and complexity of the print and sometimes they are confronted with unexpected collisions. If it was possible they would make many more intermediate prints, but unfortunately they often come at the final moment or the intermediate print becomes too expensive, so they choose to rely on renderings and make only final models.

As mentioned before, a problem of many computer models is the lack of tangibility, but an even larger problem comes from a characteristic that in most cases can be regarded as a quality: the possibility to work very precise. While most computer models become valuable because of their logic and unambiguity, in many steps of a creative process it is good to have openness to other interpretations and surprises. Some students can totally loose their global view of the design because they zoom in and focus on details that need no attention at the early stages of the design process. Only very skilled students are able to include variety, surprise and levels of scale into their digital models.

Another pitfall is working and extending a parametrically scripted model without keeping track of the steps and decisions that are made. This will lead to processes that become totally un-communicable to oneself or the tutor.

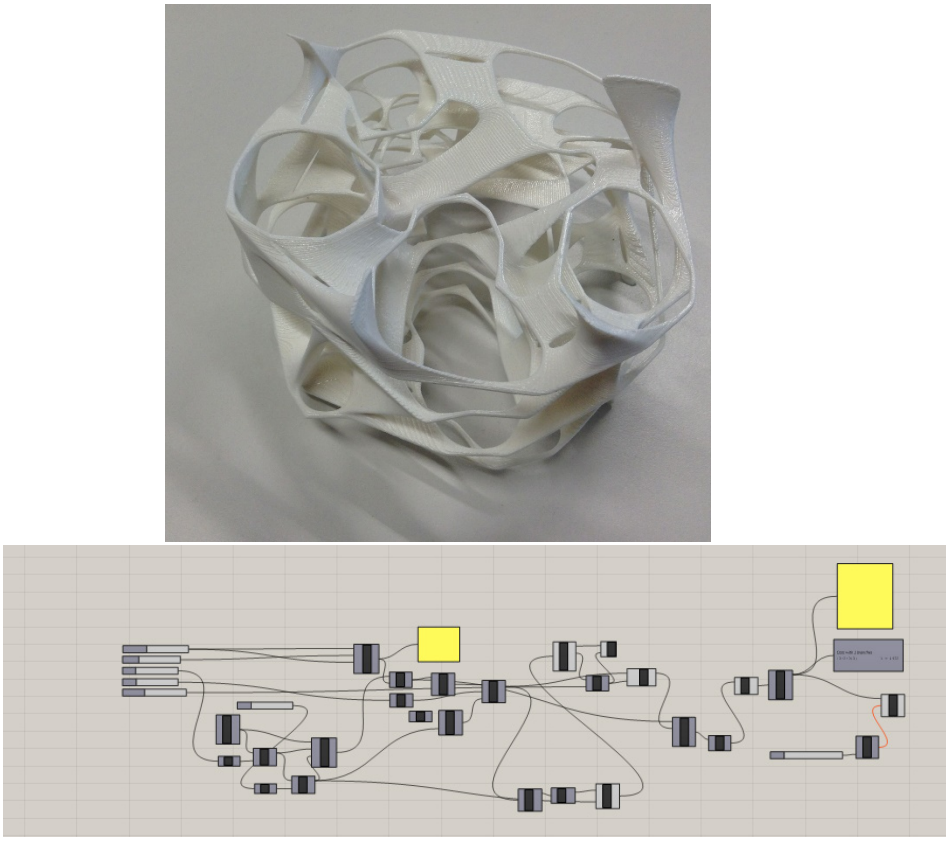

Fig. 7 Top: 3D printed building structure. Bottom: Rhino/Grasshopper scheme

Choices and Focus

In the previous paragraphs we have expressed a preference to use several types and scales of models in order to investigate, develop and present the qualities of a design. In some cases, however, there is only chance to use one single model. Especially in exhibitions and competitions one image or one model should tell it all. In those cases the right choices of scale, size, level of detail, level of abstraction and materials become utmost important. The model needs to tell a story and should be instantly clear.

Recently we had the commission to prepare six scale models for a museum exhibition in Leuven, Belgium. We had to present how a number of designs were placed in their context. We decided to be quite radical in reducing the context to elevated contours of buildings, only indicating variety in shape and subtle color differences. We emphasized the designs by using a heightened level of detail (regarding the small 1:500 scale). We used laser-cutters to make the parts for the context, and we used our plaster 3D-printer for the buildings. The two levels of detail and deliberately different surface finish (silk matte for the context, pearl / metallic for the small buildings) made the final models well readable for the museum visitors.

Fig. 8 Exhibition 'Architectuur in Context', 13-03-2013, Museum M, Leuven, Belgium

Conclusions

Model and Scale are the instruments with which architects can envision their design ideas.

We have described some aspects of scale models, which we consider key tools to explore, refine, develop, communicate and present design in spatial, tangible, surprising ways. These aspects are qualities that still cannot be fulfilled by purely working with computer models. Digital and physical models need to be developed side by side and ideally could mutually enrich each other.