Tactile Models Carved by Binary Numbers – Connecting Digital and Physical Design Methods

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1 Introduction

Landscape architecture, as with any other design discipline, has always required representation. Before an idea can be realized it must be communicated by words and visualization. Efficient methods of exhibiting, explaining and selling a design are sketch, collage, section, layout plan, digital fly-through, perspective and computer-generated or physical models. "Of all these forms of representation, the model is the only physical, three-dimensional realization of the architect's idea – which, after all, is ultimately intended to be a physical, three-dimensional thing" (MOON, 2005, 11). Even the so-called 3D modeling done on the computer screen is finally represented two-dimensionally.

From a historical perspective there has always been a fascination with scaled-down representations of objects and buildings. Models were used as grave goods in ancient Egypt while in medieval times masons were working with templates and full-scale mock-ups as learning tools. The architectural model, as it is used still today, was invented during the Renaissance (MORRIS, 2006). But do tactile models play a role in design education today? And if so, what are the benefits?

This paper explores parallel teaching strategies that address both digital and analogue design methods in undergraduate design studios. The relationship between the physical model and the computer takes centre stage.

2 Role and Benefits of Physical Models

Nowadays the teaching and learning of digital techniques and their application is considered an essential component of basic design education. While using digital tools and methods is beneficial to students it is also important to include physical, three-dimensional visualization techniques in the early stages of design education. The following advantages are reasons for integrating model-making in undergraduate design studios at the University of Manitoba:

- Model-making fosters creativity. Three-dimensional activities made by real hands help students to overcome mental block and actuate creative thinking.
- Physical models can be used as a tool in the design process. It is "a means of inventing, searching and investigating" (JANKE, 1978, 10). It helps students make design decisions.
- To read a three-dimensional model requires less training than to understand an architectural drawing. "The scale model … persists as a kind of universal represen-

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tation, intelligible to non-architects. CAD drawings and renderings remain, like blueprints, professionally codified." (MORRIS, 2006, 166).

- A three-dimensional model can effectively communicate students' designs.
- Model-making fosters spatial thinking. It is challenging, especially in the case of beginners, to master the relationship between design and spatial impact. Doing drawings digitally and zooming in and out on a computer screen adds to this challenge, as it can actually hinder spatial comprehension. In contrast to this the to-scale model reveals the spatial consequences of a design idea.
- A model helps students to focus on the 'big idea' instead of falling in love with details. "The whole is apprehended in advance of the parts" (MORRIS, 2006, 166).
- The model suggests the design is almost real. It fosters students' pride and engagement.

3 Relationship of Digital and Analogue Design Methods

Nowadays, new technologies such as digitally fabricated models cut by laser or router or those built up by a three-dimensional printer require not only new content but different ways of teaching. "The fact that a three-dimensional model can now be electronically modified, refined, and digitally transformed back into a new physical existence brings a new and exciting dimension to the design previewing skill of the architect" (PORTER & NEALE, 2000, V). In an attempt to foster three-dimensional thinking the authors challenge their students to work with a variety of both digital and analogue design tools. The following teaching methods utilize synergies of two-dimensional, three-dimensional, digital and analogue visualization tools. Employing the mutual interaction of these methods constitutes a timely approach to landscape design teaching in undergraduate programs.

4 Interaction of Hand Drawing and Digital Drawing

Students at the University of Manitoba are introduced to hand and digital drawing through specific workshops as part of their design studios. The digital drawing workshop instructed by one of the authors (Fig. 1) provides an introduction to computer-aided design and computer graphics. The objective of this workshop is to teach students how to draw, illustrate and layout their ideas using digital as well as analogue media. During this first week students get the chance to experiment with the computer as a medium through which to express and present ideas.

Depending on the skills of the students this workshop demonstrates the basic concepts of VectorWorks such as 2D drafting, file organization, basic structure and operation of landscape projects, interaction with photo editing and layout programs, principles of data exchange and data saving, simple 3D modelling to verify the setting and composition, and digital and analogue possibilities of presentation.

Fig. 1: Students attending the workshop “Digital Drawing”

5 Interaction of Hand Models and Digital Drawing

The digital drawing workshop serves as a base to do further experiments connecting analogue to digital design methods. At the University of Manitoba the authors push their students to explore and refine hand models with the help of digital tools.

At the beginning of the design process students are asked to work with their hands in order to reveal design options. They create and constantly revise the hand model in order to test their design idea as it emerges. During this process certain discoveries or decisions may arise that challenge the students’ ability to compose and sculpt spaces but with this dynamic tool both the students and the instructor can be actively involved in the design process together.

Fig. 2: Designing with salt

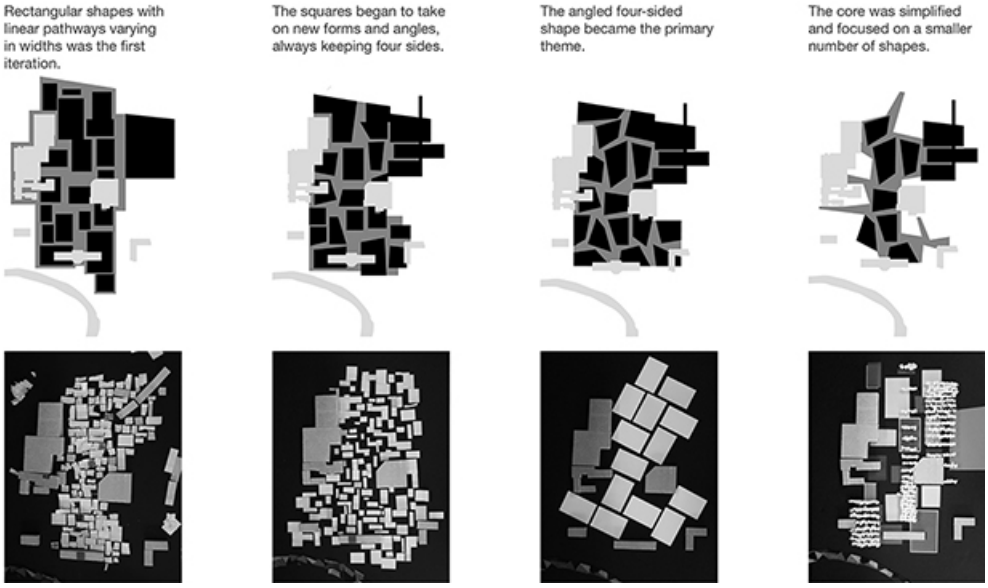

Fig. 3: Design iterations using paper & cardboard versus digital sketch by students Taylor Bishop & Roxane Gratton, 2011

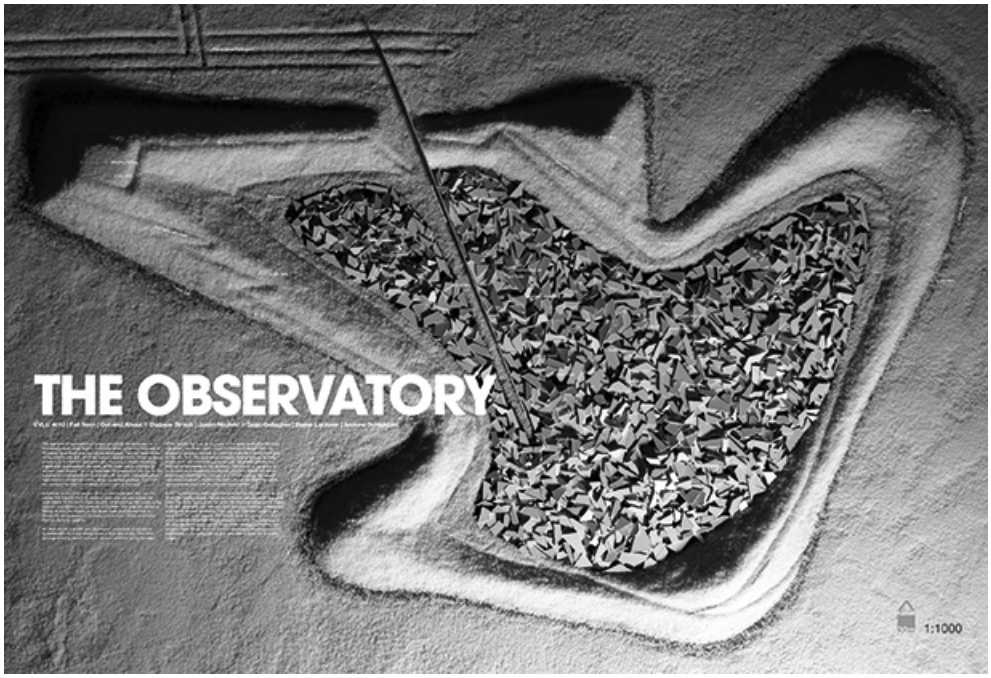

Fig. 4: Refined image of a hand model used as site plan by students Sean Gallagher, Blaise Lachiver, Andrew Schluckbier, 2011

Suitable materials for modelling landscape or urban designs in the early stages include paper, cardboard, fabric, snow, salt (Fig. 2), and clay. Materials should be inexpensive, quick to assemble and supportive to any design changes (MOORE, 1990). In contrast to hand drawing or computer modelling this technique requires a minimum of technical skill. Students benefit from going back and forth between physical model and digital sketch or physical model and hand drawing during the design process. Refining the hand model with the help of a different tool generates new perspectives (Fig. 3). The authors consider this switch between media to be helpful in learning about design and spatial impact.

Hand models can also be used for final two-dimensional representation. With the help of photo editing and digital layout programs students refine pictures of the physical model (Fig. 4) and use them on their design boards instead of the site plan to explain the concept.

6 Interaction of Digital Drawing and Laser Cut Model

Finally, the digital drawing workshop creates the opportunity to explore interactions between the digital drawing and laser cut model. At the University of Manitoba the authors ask their students to provide a digitally fabricated model, cut by laser, for final representation. The main objective is to confirm design decisions and to communicate with an audience who was not part of the underlying design process.

Before laser work for the final model can be done a CAD drawing has to be prepared by students. Specific requirements are to be followed. Similar to acquiring language students have to learn how to communicate with the machine when producing laser-cut models. It is a salutary experience when they learn that neither the computer nor the mechanical cutter machine is automatically designing for them.

Fig. 5: Laser cut samples, Workshop at the Faculty of Architecture, University of Manitoba

Certain procedures have to be followed in order to successfully operate the machine and students need to learn the various skills of cutting, etching, snapping, filling and editing prior to exporting the product to a dwg.file (Fig. 5). They also need to appreciate that decisions must pass through the computer and how any gaps in a project's development will be revealed. Once mastered this knowledge and these skills become essential to the design process.

7 Laser Cut Model and Analogue Exploration

Use of the laser cutter to create models offers up the opportunity of further creative exploration. "Finished models are typically built as monochromatic constructions made from one material… The blank, abstract treatment allows the model to be read in many ways" (MILLS, 2005, 18). The authors ask their students to do further exploration of the unfinished casting through a variety of additional processes such as threading, dusting, burning, candying, and wrapping. These processes are done by hand after laser work has been done and might include additional material that pushes the model beyond a 'monochromatic construction'. In contrast to being blank the students' models become enriched and pictorial in order to represent and punctuate the envisioned character. The plain laser cut pieces serve as a base for additional analogue investigation expressing individual design ideas in a refined way.

Students build the final model with due care and great attention to craftsmanship (Fig. 6). Usually they become very proud of their final laser-cut model as it emerges in three-dimensions. The model suggests that the design is close to reality, a reality that is not apparent in the two-dimensional plan.

Since the laser-cut model is a small-scale copy of the envisioned project discussions about attention to material are inevitable and important. The model brings back memories of childhood and associations with train models or other detailed assembling toys. The challenge is to appreciate the potential of the design model to represent the whole in advance of details.

Fig. 6: Students working on their final model

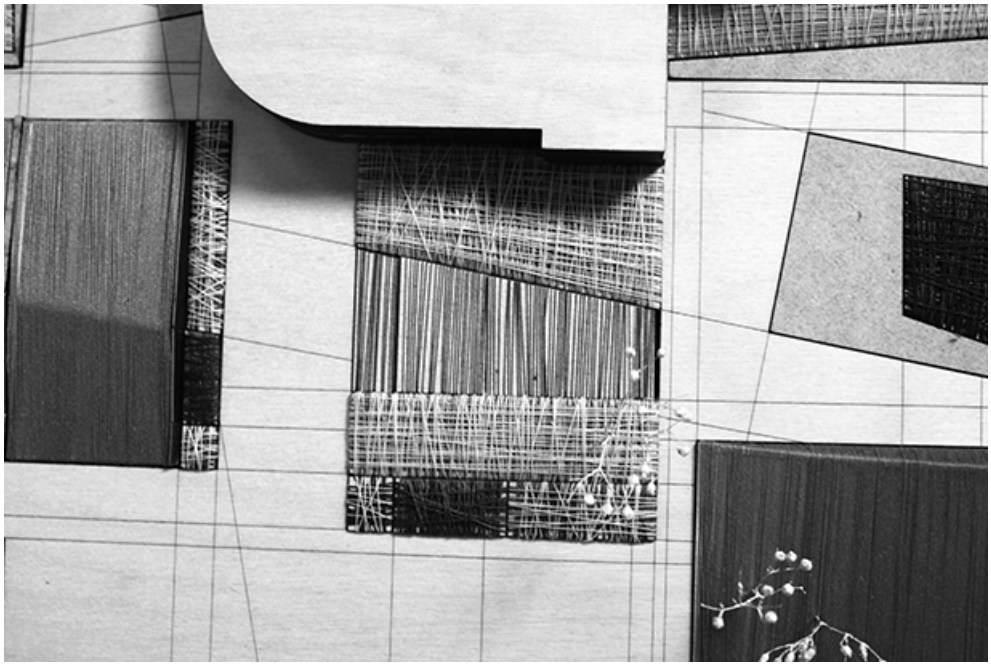

Fig. 7: Threading by students Taylor Bishop & Roxane Gratton, 2011

Fig. 8: Candying by students Andrea Linney & Lee Ann Bobrowski, 2011

In this spirit the authors ask their students not to do literal simulation in order to avoid distraction. Once students understand that the 'big idea' and its representation is the main focus there are no bounds to creativity. Thus students zero in on how to represent topography, buildings, water, and plants in a representational rather than literal way (Fig. 7 and 8).

8 Conclusion and Outlook

Students benefit from working with models both as part of their design process and as part of their final presentation. Model making takes time and money but more importantly, for someone who is starting a design career, it fosters spatial thinking. With increasing demands for students with expertise in both digital drawing and spatial thinking, it seems essential to promote a parallel education that fosters not only CAD skills and physical hands-on experiences of representation but an understanding of how to glean most use from both of them. The key to success in undergraduate design courses is for students to become capable of understanding spaces and their dimensions.

Some might think the binary revolution of images would have rendered the physical model obsolete. It seems to be the very reverse. New technologies expand the possibilities of designing with scale models. The "tactile model is enjoying a comeback" (MORRIS, 2006, 8) – and with the benefits of digital technology it is more useful than ever before.

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