Rapid Prototyping Techniques in Landscape Model Making

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Invited Paper

Abstract

This study focuses on providing a reference of a practical implementation of Rapid Prototyping Techniques to generate a tangible 3D topographical representation of an existing landscape. It pretends to serve as an example to understand, compare, distinguish and execute a series of steps to develop similar exercises. Furthermore, it will expose the strengths and weaknesses found during the work with two of the most accessible machines throughout manufacturing centers, such as CNC router and Laser Cutter Machines, to be able to assess some of the relevant aspect as production time scale, costs, materials, required training and generally all the possible issues or findings that can come up in the process.

This hands-on experience follows the standard procedure of some of the Prototyping Laboratories available to students and practitioners at well-known European educational institutions, such as the RAPLAB at the ETH in Zurich and the Digital Manufacturing Center at The Barlett School of Architecture of UCL (University College of London).

1 Introduction

Models, as an essential tool of designers, have traditionally served to represent the actual and to explore what could be possible in the future. More than a merely representation, models suggest diverse spatial and structural solutions, as suggested by different authors such as Karen Moon, in her book “Modeling Messages: The Architect and the Model” Hence, the potential of exploring and developing models according to today’s requirements and challenges, become an asset to understand and support design ideas. Especially when the landscape industry is everyday getting an increasing contribution from different fields of knowledge, such as engineering, urbanism, geology, cartography, architecture, etc, which are nowadays commonly communicated through a digital CAD language.

We are facing a time where material is enriched by information. Material and data are now interwoven to open up the gate for digital fabrication, especially when we deal with high speed of production that requires us to be more efficient. For diverse industries this has represented the need to adapt faster and more competitive design, manufacturing and communicative tools. Current sophisticated computer modeling techniques facilitate us to convert virtual information into analog products.

Buhmann, E., Ervin, S. M. & Pietsch, M. (Eds.) (2013): Peer Review Proceedings of Digital Landscape Architecture 2013 at Anhalt University of Applied Sciences. © Herbert Wichmann Verlag, VDE VERLAG GMBH, Berlin/Offenbach. ISBN 978-3-87907-527-0. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (http://creativecommons.org/licenses/by/3.0/).
Despite the increasing availability and access of these technologies over the last decades, the use of them still concentrated in Product Design, Architecture, Industrial Engineering and Manufacturing industries.

2 Role of Analog Scaled Models in Creative Process

The author Albert C. Smith, writer of “Architectural model as machine” says that a model is a machine for imagining, for developing the free association needed to develop new ideas. Based on this, one can recognize the transforming role of models from images into processes. Models are no longer considered static artefacts with a representational purpose. Smith explains in his book why models are important into the design process, by going through some historical examples of architectural models and their significance. He starts from the magic of the Egyptian scaled models that were thought to control nature and have some influence in the afterlife. Passing by the roman view of Vitruvius who understood and represented military camps, dams etc through small models of them. Or the Alberti’s models during the renaissance that serve the builders when it came to the execution of the buildings, furthermore as the famous architect Spiro Kostof said “these models will enable us to weigh up repeatedly and examine, with the advice of experts, the work as a whole and individual dimensions of all the parts, and before continuing any further, to estimate the likely trouble and expenses”.

Through similar historical journeys it is possible to appreciate how models were used as mechanisms of thinking about design and becoming communicative devices, being less ambiguous than drawings.

Models present themselves as containers of dynamic processes rather than static images that nowadays have been revolutionized thanks to the influence of different disciplines taking part in a digital era with a very important role in design and fabrication.
3 Project Description

This practical exercise explores the implementation of two Prototyping techniques in the generation of a topographical relief model of an existing landscape. This specific experimentation is meant to support the site analysis carried out by Vogt Landscape Architects, where the intention was originally to detect potential view points on the open landscape located in Somerset (UK) called “The Hadspen House“. The framework will be defined according to the expectations and model-making requirements of the real clients of the project.

Due to the lack of previous reference of similar large-scale models at Vogt Landscape Architects, it justifies the need of testing at least two different technical approaches to obtain diverse results suitable to be adapted to the final model.

This hands-on experience pretends to generate a topographical representation of the same landscape location, based on the standard procedure of two of the most accessible machines throughout manufacturing centers, such as CNC milling machine and laser cutting machine. Thereby, it is possible to document and describe the subsequent achievements and failures of both processes, in order to obtain random results used as measurable tool to compare, analyze and evaluate the contribution of the selected techniques in this specific model making challenge.

In those terms, the goals are:

1. To exemplify, describe and compare a digital fabrication process in Landscape Architecture, by using at least two different technological approaches.
2. To implement and assess the process of milling and laser cutting when generating a topographical relief model.
3. To collect relevant aspects to support the election of a desirable technique to produce a full size model according to the model expectations.

Fig. 2a: Contour lines
Fig. 2b: Both, the CNC router and laser cutter machine do require a Digital Terrain Model (DTM) to start any work. In this case, it has been generated by using AutoCAD Land Desktop to produce a triangular surface based on contour lines.

Fig. 3: AutoCad Workflow to generate DTM (Digital Terrain Model)
Fig. 4: Both, the CNC router and laser cutter machine do require a Digital Terrain Model (DTM) to start any work. In this case, it has been generated by using AutoCAD Land Desktop to produce a triangular surface based on contour lines.


## 4 Model Assessment

### CNC ROUTER MACHINE

<table>
<thead>
<tr>
<th>Technique</th>
<th>FORMING: Subtractive process, 3D remover, Mechanical operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine constraints</td>
<td><img src="image" alt="Model sample 500x500mm" /> &gt; <img src="image" alt="Expected full size model 4000 x 3000 mm" /> Max. cutting area 2400 x 1500 mm</td>
</tr>
</tbody>
</table>

**Average Time**
- Model sample = 1-1.5 hours
- Full size model = 24 hours

**Material**
- Foam

**Weight**
- 50 Kg / m³

**Cost**
- 20 CHF per hour
- 400-500 CHF = 24 hours

**Training**
- Digital files preparation is more time consuming
- General interface with the router is more complicated due to its mechanical nature
- Requires more maintenance and set up time

**Job quality**
- Range of smooth or rough finishes according to specific needs
- Limited size and finish of small details related to bits diameter
- 2D and 3D engraving and cutting jobs
- Depending on the type of job assigned, one must stop and exchange the bits
- Due to its large working area, few loose component are produced
- Height limitations vary according to specific project, tool selection and path design
- Direct contact with material may cause distortion or reboiling

### LASER CUTTER MACHINE

<table>
<thead>
<tr>
<th>CONTOURING: Solids form by 2D profiles. Laser operation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Model sample 500x500mm" /> &gt; <img src="image" alt="Expected full size model 4000 x 3000 mm" /> Max. cutting area 840 x 594 mm</td>
</tr>
</tbody>
</table>

**Model sample**
- 1 hour (cutting job)
- 3-4 hrs (assembly)

**Full size model**
- 14 hrs (cutting job)
- 6-8 hrs (assembly)

**Cardboard**
- MDF

<table>
<thead>
<tr>
<th>Weight</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7 Kg / m³</td>
<td>14,2 CHF (£10)</td>
</tr>
<tr>
<td>700-750 Kg / m³</td>
<td>199 CHF (£140)</td>
</tr>
</tbody>
</table>

- Less sophisticated training required
- Few simple operation steps and material set up
- Simple system that demands less maintenance

- Precise definition of cuts, fine edge finish
- High definition cuts (90° angles, narrow slot width)
- Only 2D engraving and cutting jobs
- One continuous process, no need to interrupt in order to remove additional tool
- Requires a strict and methodical collection of cut pieces
- Height limitations of a model vary in relation to the material thickness
- No direct contact with material that can cause distortion
5 Conclusions

After comparing the results of the two model samples produced with different technologies and re-viewing the initial model making expectation, the following conclusion arise:

- Based on the desirable scale of 1.1000 of the designated landscape, both technologies (CNC router and Laser Cutter machine) are equally capable of producing an accurate topographical representation of the site, where only the range of finishes may vary. Nevertheless, for this specific case, the large scale of the model suggests that the more suitable tool is the CNC router due to its higher volume of production.

- In order to produce a model easy to transport and handle, the main aspect is the type of material to be used. Its consideration was obviously the low weight and available dimensions. Therefore, between the materials suitable for both machines, there were three selected: Styrofoam, Cardboard and MDF. From all of them the Styrofoam is highly recommended in terms of the large size of the model, which in combination with the extended working area of the CNC router could produce a full size model with a minimum amount of individual component.

- Regarding the different pieces that can potentially compose the model, is it true that a CNC router and a Laser Cutter can perform a very efficient production. What could make a big difference is the process of assembly, in which case, the first technology would be more convenient.

- The last relevant aspect relates to the expected period of time for completion. In this respect, both machines can meet the time frame expectations. The only aspect that should be taken into consideration is the available time slots allowed per person for each session in the corresponding Manufacturing Center.

In general, it is worth emphasizing that despite using very sophisticated machines with a very high level of accuracy, there is also a level of uncertainty; from the moment one manipulates the digital data until the final settings and material reactions in the output process. Rapid prototyping technique is a tool that is taking its place in landscape model making and also proffering solutions to issues of landscape development in the world as a whole.

References


Fricker, P., Girot, C., Melsom, J. & Wemer, P. (ETH Switzerland), *3D Landscape Modeling and Planning Methods: From Reality to Virtuality and Back Again.* Teaching Experience within a Postgraduate Study Program in Landscape Architecture.


MIT OpenCourseWare (Massachusetts Institute of Technology), http://ocw.mit.edu.


Moussavi, F., *The Function of Form.*


http://www.topos.de/

