CNC Morphological Modelling in Landscape Architecture

Alexandre Kapellos[1], Martina Voser, Philippe Coignet, If Ebnöther[2]
[1]Institute for Landscape Architecture, Urban and Landscape Network (NSL), Department of Architecture, Swiss Federal School of Technology, Zurich, Switzerland
[2]Digital Workshop, Department of Architecture, Swiss Federal School of Technology, Zurich, Switzerland
www.landschaft.ethz.ch, kapellos@nsl.ethz.ch

The landscape design studio proposes to research synergies between teaching landscape architecture and using computer numerically controlled (CNC) machines as prototyping tools for students.
The focus of the course is not to be proficient in CAAD-CAM technologies but to familiarize architecture students with landscape design and the problematic of large-scale topographical interventions and use these tools as verification instruments. Many prototyping tools are available to the students at the school and are easily accessible: a 3-axis mill, laser cutter, flatbed cutter and a 3D printer. Of all the CNC machines, the 3-axis mill allows for the best translation between idea and model in landscape modeling. Of interest to us is the continuous and more fluid exchange between paper/idea and a physical three-dimensional output, the ability to be able to re-shape continuously the model.
The result is a series of models or evolutions, documenting the project idea as it has evolved from the initial concept to the final project.

Keywords: *Abstract Types of Spatial Representation; CAAD-CAM technology; Digital prototyping; Landscape / Morphology*

Course description and Context

The landscape design studio is a regular course open to master students in architecture at the Federal Institute of Technology in Zurich. A maximum of 16 to 18 students are accepted, working in groups of 2. The scope of the course is not to form landscape architects but rather to make them aware of specific questions related to intervening on territorial scales and working with topography.

Presented here is an approach implemented during the summer semester of 2005 and renewed since.

Water has been central to our research for the past 3 design studios, whether with the Rhine river in Chur (Waterscapes studio), the Rhone delta on the Léman lake (Watershores studio) or the Lütschine river in Interlaken (Wasserwege studio). In the broader context of global warming, urban expansion and evolving contexts, our interest lies in providing answers to problems on these sites beyond the obvious engineering or technical solutions, offering more viable and coherent answers that take into account the many aspects that are inherent to

Fig. 1
Topographical concept model

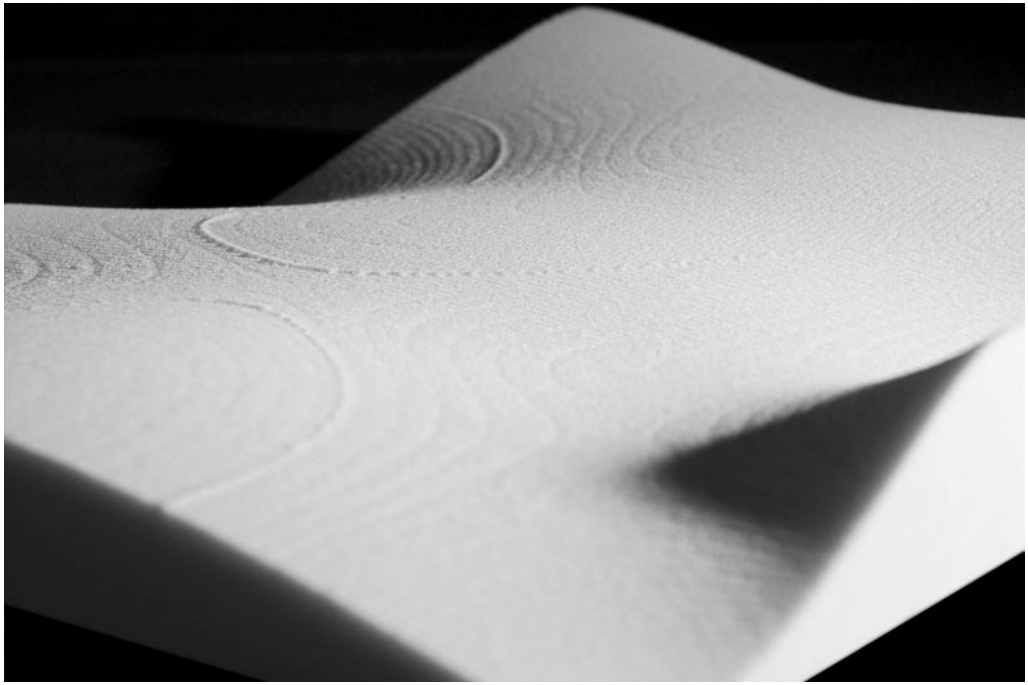

Figure 2
Site – the Rhone delta (Watershores studio) on the Léman Lake and former military airport in Interlaken (Wasserwege studio).

such large scale interventions. Solutions do not lie in engineering alone.

Approach

Working with CNC technology offers an interesting analogy. Milling is a subtractive process where material is taken away. This is similar to the way landscape is modified and sculpted: earth is also subtracted (or displaced). The mill proceeds from a rough to a fine surface in much the same way a bulldozer proceeds: digging, terracing, leveling, scraping.

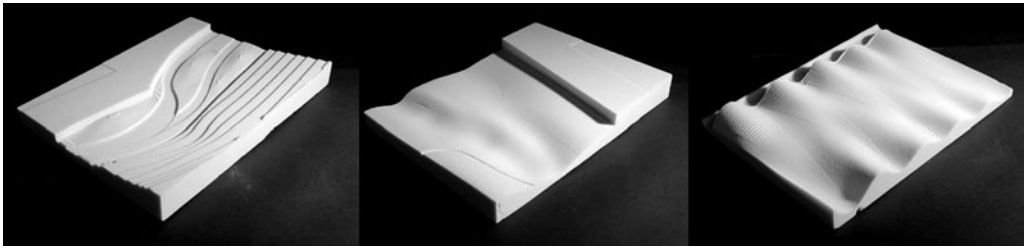

Figure 3
Wasserwege Studio – Topographical models in foam

Technology

Throughout the semester the students are asked to produce a number of milled models. For technical reasons related to the machines used in the process, *NURBS* modelling software has to be used (as opposed to *polygonal* modelling). Despite being proficient in CAAD software, students usually have limited, if no prior knowledge in NURBS modelling. A one-day intensive CAAD-CAM workshop is organised as an introduction, where they are taught the basics of Alias Maya™ and Surfware Surfcam™ and of the Precix 3-axis CNC mill. The workshop should give the students sufficient information to get them rapidly modelling.

Maya™ is readily available at the ETH and installed on most of the campus computers. Its very intuitive interface makes it an ideal choice for landscape projects; surfaces can easily be generated, deformed, pushed and pulled in much the same way a clay or sand model is manipulated.

Surfcam™ is used to generate the milling paths for the mill and to create textures on geometries sculpted in Maya. Surfcam generates a file (in G-Code) understandable by the mill.

Concept development

A site visit gets the students acquainted with the site; data is collected in the form of photos, videos, sections and sketches. Rapidly the students are asked to elaborate an initial topographical concept developed in Maya and milled on a block of foam 40 x50 x 7.5cm. This model is scale-less and abstract, its intention being to show the student's intention, lines of forces, limits and so on. Throughout the semester this prototype will evolve and change, in a constant move between different scales and adaptations in the project, to becoming more detailed and precise.

In parallel to this digital approach, a more ana-

Figure 4
Plaster sections (left) & Precix™ 3-axis CNC mill (right)

logue one is developed alongside: students build a sand model, usually at a precise scale, of the whole site. Alterations of the project onto this are more direct than on milled models; but these sand "mock-ups" have no memory, each project step is lost with each modification, while re-milling a foam model is a matter of minutes.

The initial idea takes shape in the form of a model accompanied by sketches and collages. It is of interest to note here that the milled model is often closer to the students' initial topographical idea than the drawings themselves. Formal concepts such as *oscillating, folding, compression* are easier to represent three-dimensionally than graphically.

Students are also pushed to experiment with different materials and modes of expression, working with plaster, wood and in section instead of plan (Figure 4).

In a second phase, students develop their idea in a much smaller scale, defining determining elements: circulations, edges and surfaces, materialisation, vegetation, soil types, etc.

Final models

For the presentation at the end of the semester, students are asked to show their conceptual models developed throughout the project and a final model (alongside the usual documents: situation plans, sections, time-span schemes, etc).

Next step?

The landscape architecture workshop is now in its 3rd semester. A few comments can be made: CNC machines provide an excellent method of rapid prototyping, verification and visualization not easily or rapidly attainable with traditional processes. But we must also keep in mind that the scope of the course

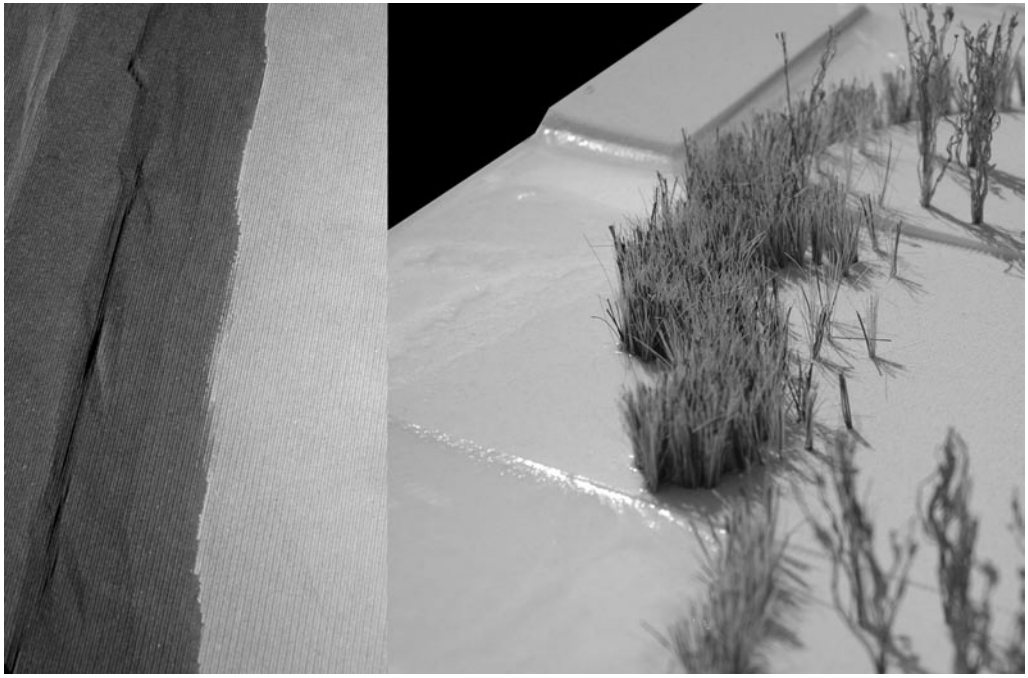

Figure 5
Watershores Studio final models – Project "React 4D" (left) & Project "Still Water" (right)

is not to teach modeling but to open up the students to the subtleties of landscape design. Modeling and CNC fabrication in our context must remain a tool, a means to augment the students' capacities in expressing their ideas.

So far, in the context of our work, the students have used digital modeling as a verification and prototyping tool. But as the software proficiency of the student increases and along with the different possibilities available in CAAD software packages, numerous possibilities become available to us.

One area of interest is "programmed landscapes". Scripted languages such as MEL in Maya™ open up a number of interesting possibilities that have yet to be explored: parametric, computed topographies.

This brings us to the question of GIS (geographic information system) data. Teaching in a country where this data is readily available, how can this be integrated into the topographical process? *Can* it? If yes, *how*?

From a broader standpoint, in our research we are interested in the integration of readily available data in the design process: from data collecting to landscape visualization. How can this process be rendered more fluid in the same way that it has become for traditional CAAD packages?

Having access to highly specialized hardware such as 3D scanners, readily accessible in other departments at the ETH, is also of interest to us. How can this equipment be integrated into our teaching? So far we have been *outputting* models, what about *inputting* models and modifying them, integrating them in a broader creative process? How interesting could it be to scan our sand models *back* into modeling software, thus changing the starting point of the process?

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References

Imperiale, A.: 2000, New Flatness – Surface Tension in Digital Architecture, Birkhäuser, Basel Boston Berlin

Cache B.: 1995, Earth Moves – The Furnishing of Territories, The MIT Press Cambridge Massachusetts