

How to Teach ‘New Tools’ in Landscape Architecture in the Digital Overload

Developing emergent design methodologies

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Abstract. *The central theme of the paper is the introduction of hands-on tools showing the integration of information technology within a postgraduate study program (MAS LA) for landscape architects. What has already become a part of the discourse in the field of architecture – generic design – is now also finding more resonance in the context of large-scale landscape architectural design. If one studies the educational backgrounds of landscape architects, however, they often do not match the same standard as those of architects. A solid background in the area of innovative use of information technology, especially computer-assisted design and CAD/CAM construction is only at a preliminary state at most universities. The critical arguments in the choice of the selected medium and the building up of a continuous digital chain stand here in the forefront. The aim is not to improve the quality of the landscape design based on the variety of the applied tools, but rather through the sensible use of the said. Reflections as well as questions of method and theory stand at the forefront of our efforts.*

Keywords. *Design tool development; computational design research and teaching; new design concepts and strategies; parametric and evolutionary design.*

BACKGROUND

At the Department of Architecture of ETH Zurich, both students and researchers have the newest technical equipment and software at their disposal. Optimal networking with professionals in the area of construction as well as CAD/CAM production allow us to offer courses in the curriculum that allow experimentation with the newest techniques and materials. This excellent infrastructure is supplemented with the advanced resources of the Landscape Visualization and Modeling Lab (LVML) founded by the Chair of Professor Girot in cooperation with the PLUS

Chair, Planning of Landscape and Urban Systems of Professor Grêt-Regamey (IRL). The LVML is equipped with special devices for large-scale data collection, for example a 3D landscape scanner with 2 km range and a drone. To this end, various software and hardware solutions are combined experimentally in order to investigate new boundaries of perception and illustration of the built environment (Figure 1). Professional partnerships to the developers of software and hardware solutions as well as experts in the areas of landscape and urban planning allow for



Figure 1
Generated Data: Combination of point cloud data from airborne and terrestrial laser scanner.

a hands-on examination and implementation in the various research areas. The difficulty in teaching lies not in the lack of equipment, but rather it is seeing this digital overload as a new challenge in a positive sense.

INTRODUCTION

At present, information technologies are an essential component of design and building construction. Contemporary architecture and large-scale landscape architecture as designed by top offices would not be thinkable without them. Without computer-assisted manufacturing and logistics, modern form language and structural solutions would hardly be realizable. Meanwhile, the software and hardware involved has become so sophisticated that the students' generally increased computer skill levels suffice for an architectural program at a technical university. At the present, a heated discussion on the level of education is taking place especially in the field of landscape architecture within Switzerland. In contrary to architecture offices, practicing landscape architecture offices, especially those in Continental Europe, criticize that university graduates are

more and more incapable of understanding and visualizing complex landscape designs. Moreover, the level of expertise in the daily use of digital tools is at a level that is no longer acceptable for an efficiently organized office. In order to close this gap, the MAS LA (Master of Advanced Studies in Landscape Architecture) Program of Professor Christophe Girot was newly conceived in 2009 in terms of content, both methodically as well as didactically. To this end the former design-specific focus was transferred to the learning and use of up-to-date tools.

The MAS LA Set-Up

The course of studies is divided into themed modules, workshops and one concluding synthesis module. The modular structure allows a concentration on individual themes, which can be combined within the framework of an individual project as the concluding thesis module. The main focus of the program is not the acquisition of new software skills but rather the integration of cutting-edge modeling, visualization and presentation technologies as design tools within the field of landscape architecture (Figure 2).

Figure 2
Testing different ways of
presenting large scale
topographical information by
projecting animated informa-
tion to a CNC milled model.



Each module begins with a phase where new techniques are learned. In this phase, individual exercises are connected to current issues in landscape architecture. The students are encouraged to recognize global as well as local economic and sociological demands and integrate them in their designs using and connecting the learned tools. The achievement lies in the diligent selection and connection of the technology with the environment we live in. The critical debate regarding issues of sustainability in conjunction with large-scale design work in urban landscapes plays an essential role next to the technical aspects. In the second part of the module, participants grapple with complex problems, which will be discussed during a concluding presentation. The sequence of modules start with modeling and CNC production followed by visualization, programming, GIS, applied programming and ends with media and photography.

We challenge the students to go beyond the boundaries of conventional domains and test the tools in analysis, design, and visualization. The programs and different CAAD/CAAM techniques, which the students have become acquainted with in the different modules, complement each other and

should be applied and recombined to explore new design methodologies in their final project (Hagan, 2008). The concluding module of the postgraduate program acts as a test case for the questions or agenda, which have been defined throughout the teaching year.

Parametrism – the Solution for All Problems in Architecture?

Ever since the 11th Architecture Biennale in Venice 2008, is Patrick Schumacher's postulated concept "Parametricism as Style - Parametricist Manifesto" all the rage. For many students, complexity equals quality. The use of parametric tools, i.e. Grasshopper is often seen as the solution to conceptual problems. Our desire is to show students solutions and approaches how they can choose the right tools for the design problem at hand in order to test their ideas efficiently and unconventionally, realize them, as well as also later generate suitable formats for the construction process. Here the learning of specific software does not stand in the forefront but rather the learning of a new way of thinking that understands the tools as integrative design tools (Mitchell, 1990). The sequential structure of the MAS LA pro-

gram allows the students to deepen their individual interests and test the newly learned work processes on their applicability to professional practice. In terms of content, classical, traditional themes like modeling, visualization, GIS, data acquisition are complemented and leading to a new perspective by working with experimental themes like perception through film photography and programming (Greenberg, 2007; Reas and Fry, 2010). The goal is to create an overview that shows spatially relevant aspects in landscape structures enabling the students to communicate their future projects within real practice in a professional way. Together with architects, urban planners and city authorities, graduates will be able to illustrate and communicate their design ideas professionally.

DEVELOPMENT OF SPECIALISED TOOLS

What are the tools that adequately serve current landscape architectural trends and how can they be conveyed? The past years have shown us that programming within architecture has become as commonplace as CAD drafting (Wanner, 2010). Within landscape architecture, urban planning but also building construction, for example, parametric designs are often the only solution to dealing with complex form language. To this end we would like to use the computer to realize projects that would not be possible using conventional methods. This requires the further development of digital tools, which allow for the subsequent design and working with the extracted information (Kolarevic, 2003). Programming has the advantage of solving complex tasks, accompanied by the risk of sacrificing the intuitive abilities of a designer. Our goal within the MAS LA program is to reduce the technical hurdles and apprehension towards programming in order to first reach an understanding of its necessity within landscape architecture. (Bohnacker et al. 2009). To reach this goal we have developed specific tools, like the "Sandbox Tool" for the special need of landscape architecture.

How to Influence Topographical Data within a Dynamic Planning Process?

An application influences to a great extent the work processes and therefore the design process. If, for example, at any point the designer is aware of statistics like areas and details regarding the execution of a building, he or she will be able to orient themselves to these numbers and take them into account during the development of a design. If these numbers can only be gained through tedious procedures, they will only be collected at a few points in time and will therefore have a limited influence on the design. Even more so than numbers, visualizations of data can give the designer a feedback as long as these are created dynamically and without much effort. If these presentations contain data on which the design should orient itself, a loop is created ideally from the designer's actions and the presentation of their ramifications.

If the presentation of data influences the designs, in that they are permanently in front of the designer's eyes, the designer must determine how these illustrations look like. The students have to learn how to program in order to maintain a dynamic planning process and in order to control his design.

A further development of digital tools is required, which allows the interaction between design and data. This has to come from the designers themselves, because they have to determine to which presentations they choose to react during the design process.

Taking these problematics into account, the final project of the MAS LA Program shows one example of implementing this thinking within the process. The task focused on the excavation material of a highway tunnel, which had to be 'concealed' within the context of a landscape design. When designing in the conventional sense, our students could not make any concrete statements on the actual cubic meters involved. Only with the integration of an own script they were able to comment at any time on the already built amount of material and thereby

Figure 3
Depthmaps for Terrain(1),
Cones(2) and Top View on the
Result(3) by student: Christine
Baumgartner.



maintained absolute control over the impact of design changes.

The Processing script of MAS LA student Christine Baumgartner allows one to manipulate the height of the cones and the terrain lying underneath independently from one another (Bader-Natal, 2010). The heights were saved in two separate depth maps that represent the relative heights through gradations of gray. The height of the cones is always taken relative to the terrain (Figure 3). The sum of the cone volumes can be calculated at any time and in conclusion adapted so that it corresponds with the volume of the excavation material. The simple data modeling of the heights in the form of gray-scale images allows for simple data saving and var-

ied processing possibilities. The user can fall back on the entire toolset of image manipulation software in order to influence the height information. Here comes in the Processing script itself tools like brushes for localized work as well as global ones, such as the blur filter. The application allows a view over the area with an orbit camera. Any current condition can be saved with the pressing of a button as an image and the model as a DXF to be used later on for generating a visualization (Figure 4).

Theoretical Programming

Going one step further, we introduced in spring 2013 the first time an intensive 3-day workshop for the MAS LA students called "Theoretical Program-

Figure 4
Using the generated data to
automate the visualization
process (student: Christine
Baumgartner).





Figure 5
MAS LA students using
CRC-cards to communicate
their set-up of the project.

ming". The overall objective of this workshop was the critical reflection of the implementation possibilities of programming, within the real practice as an landscape architect. Out of our experience these projects often fail due to misunderstanding and wrong expectations from both sides.

After the students find an initial foothold in programming with the module "Programming Landscape" this knowledge was deepened in the subsequent module "Applied Programming" where first applications were searched for within known CAD workflows. The results of the past few years, however, have shown us that the students have no problem with creating their own programs only they often do not have the fundamental understanding for their necessity and potential within professional practice.

In order to make a convincing appearance in a professional context, it is necessary to be able to speak the language of the other profession. To this end, we supplement our teaching team with a computer specialist who spans a continuative theoretical background. Programming paradigms of greater scope, for example object-oriented, automata-based and genetic programming will also be presented (Hight, 2008). The students become acquainted with concepts such as spring systems, shape grammar, Lindenmayer systems and agent systems.

At the same time, we take advantage of this short but intensive time together in order to reflect

on the module with the students.

The set-up of the workshop was a combination of lectures and role play in the loneliness of a mountain hut in the swiss alps. Within groups of 4, the students were asked to communicate a complex design problematic to a programming consultant. The students have been learning different techniques and methods how to bridge and communicate a design to an IT company (Figure 5).

The result of this experimental workshop was surprisingly positive. The students understood through this playful attempt the problematics and could define potential application fields of programmed solutions in their design. The feed-back of the students pointed out the importance of such reflections and training for the real practice. With the 3 days they learned different techniques, like the usage of "UML", "CRC-cards", "class diagrams", "story board"... to prepare all the desires of the landscape architects, in order to have the IT company programming the software.

The Sandbox Tool

Another aspect that we are investigating at the moment is the simplification of workflows through the unconventional linking of existing software and hardware. What happens when traditional manual techniques are combined with state-of-the-art CAAD/CAAM technologies that are adapted to the workflow? Are the students accepting this simple

Figure 6

In order to understand the complex transformation processes of water landscapes, the student will each be using modelling-sand, realtime scanning stations, and a specially made software to give feedback.



tools as part of their design workflow?

Within the framework of a case study, an existing topography is created in a milled negative model. The students could use this as the formwork, in order to create the same point of departure at any time. The knowledge of this possibilities frees the students to work in a very experimental way. All manual techniques are allowed in the modeling of the designs. If the designer wants to capture a state of the model the student makes two photos from different viewpoints, which are then transferred through photogrammetry into a computer network model where they can be digitally stored and analyzed (Figure 6).

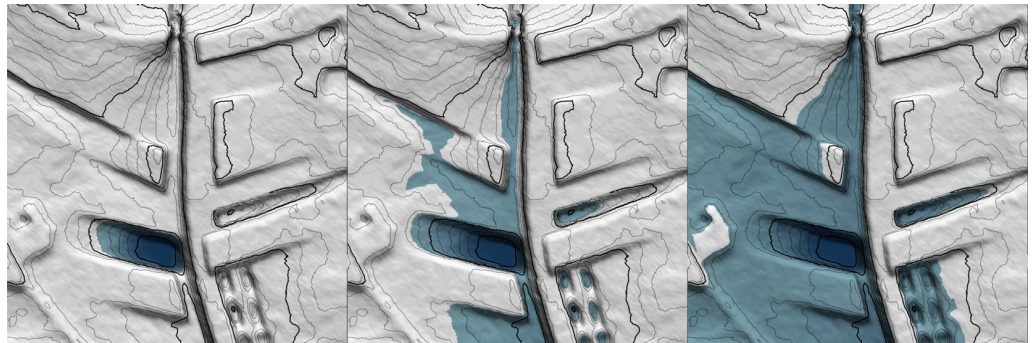
We developed our own software that allows one to generate two-dimensional analyses and visualizations directly. Different analytical methods have been programmed to supply the students analysing their design proposals:

We supply the designer with an elevation map, including a separation of the gradients above and beneath the water table. Additional features include a visualization of the slopes and normalized lighting conditions for all the models (Figure 7).

As a result, the students never work on a computer 3D model but rather focus their work directly on design statements in plan. The 'analog' sand model thereby maintains its significance and be-

Figure 7

*LandscapeAnalysis_flooding:
3 Waterlevels composed with
Contour Curves from different
Layers of the Analysis Tool.
Elective Course Students 2012.*



comes an interface for analysis and visualization through the associated digital workflow.

According to our observations, the students are very creative when working on the sand model. The milled negative form allows them to return to the original state at any time and they can save any variation of the design with only two photographs. A real physical model cannot offer these qualities. On the other hand, the physical model has clear advantages over a digital one: one is able to work with one's own hands and with any kind of tool imaginable. When one removes material, one is aware of the volume in his or her hands. One inevitably gains a feeling for how much earth is being moved. In addition, a group of students can work on the model simultaneously and be able to discuss from any point of view.

CRITICAL THINKING

While most universities are extremely well-equipped, the students often lack reflection as to the application potential of these digital tools. This often leads to an uninhibited combination of all available tools. The use of generative components like Catia, Rhino, Grasshopper, etc. was only available for experts until around 10 years ago. In the meantime, each student has access to these programs and is able to use the software to a certain degree without any official schooling (Mertens, 2010). The designs become more complex and are often no longer controllable from a certain stage, and the quality suffers under the unfiltered use of the tools. Therefore a rethinking needs to take place within design methodology so that not the learning of specific software stands in the forefront but rather the learning of new ways of thinking that exploit the potential of these tools in integrative design (Leinonen, 2010).

On the other hand, we see the great challenge in the sensible linking of these tools. The concept "Emergent Design Methodologies" spans a top current field, which has the goal of using information technology to support design as well as an analysis, design, and production tool. We see the beginning

of the design process already with the gathering of necessary actual data. Through the use of long-range terrestrial scanners, one is able to gather data in the form of point-clouds that can be successively used in combination with aerial photography taken by a drone to create specific and up-to-date contexts for design analysis and the planning process. This first step of the design is especially important for the general understanding and individual advancement of the various design tools. In order to gain this general understanding, students must be given a broad overview of current techniques and research fields in information technology. Through simple and short exercises the manipulation and use of different software modules are to be tested. More in-depth courses and workshops offer the possibility to elaborate the rudimentary knowledge based on the working out of current problems and through the building of full-scale models, in order to be able to test them until the very end in the form of a semester design.

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