From Reality to Virtuality and Back Again – Teaching Experience within a Postgraduate Study Program in Landscape Architecture

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1 Introduction

The central theme of this paper is to illustrate new didactic concepts for implementing visualization techniques within a one-year postgraduate program (MAS LA). Within the broad categorization of visualization in the thematic of Landscape Architecture, we are principally interested in the envisioning and development of landscape design concepts. Given the breadth of possible visualization techniques and applications, the postgraduate students are encouraged to both learn specific workflows and actively propose alternative methods of working and visualizing space. It is not our goal to train specialists in CAD software but rather give the students an overview of current information technologies relevant to their field. The paper reports on concrete examples of the use of information technologies in teaching and their related potentials as well as challenges.

If one asks leading Swiss landscape architecture offices about the visualization skills of university graduates, the answer may be anywhere from sobering to alarming. Based on the current poor state of the educational system for landscape architects within Switzerland, most graduates are not able to represent large-scale landscape architecture projects in a convincing manner. Since the term landscape architect is not protected in Switzerland and there are no masters-level programs, the need for action is acute. The general focus of the Master of Advanced Studies in Landscape Architecture (MAS LA) of Professor Girot’s Chair of Landscape Architecture at ETH Zurich is the integration of cutting-edge modeling and visualization technologies as design tools within the field of large-scale landscape architecture. The concept presented here is directed towards bringing graduates of planning disciplines as well as people with extensive professional experience up to date in terms of planning and analytical tools.

Fig. 1: Student work: Viewshed analysis using SAGA and ArcGIS (Integration of swiss topo data, terrain analysis – analytical hillshading, manipulation of point cloud data)
2 How to Teach ‘New Design and Visualization Tools’?

At present, information technologies are an essential component of design and construction. Contemporary architecture and landscape architecture as designed by top offices would be unthinkable without them. Without computer-assisted manufacturing and logistics, modern form language and structural solutions would hardly be realizable. The current trend in designing spectacular and complex forms and structures is ongoing. However landscape architects often tend to be skeptical of or helpless in using these technologies. This is why reflections as well as questions of method and theory stand at the forefront of our efforts.

The development of a digital chain poses an essential element to this end. Subsequently, we would like to take a look at the exercises we have conceived to supplement the learning process. The development of new design and visualization tools and their linking with each other stands at the forefront of the MAS LA. We do not limit the term ‘visualization’ to the photorealistic depiction of a design, but rather see it as a highly differentiated playground with application possibilities from the beginning of a design process until the final implementation phase. Elements like using GIS information, visualization tools, and programmed tools should be applied professionally and adjusted according to varying requirements.

2.1 We program

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 (MITCHELL 1990). Within 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 landscape architectural projects that would not be possible using conventional methods (BOHNACKER, GROSS, LAUB & LAZZERONI 2009). This requires the further development of digital tools, which allow for the subsequent design and working with the extracted information.

2.2 Applications within teaching

The communication of such new ways of thinking poses a challenge, especially in a postgraduate program with students with different academic backgrounds and interests. Through simple, manageable exercise sequences, we attempt to give insight into the many possibilities of programming and parametric landscape design (LEINONEN 2010). The resulting skills may then be expanded in their final synthesis project and used in conjunction with a design. The course of studies is intended to be a part-time program over two semesters and is divided into 7 themed modules (Landscape Modeling, Landscape Visualization, Research and Analysis, Landscape Programming, Landscape Scanning, Working with GIS Data, Landscape Video and Photography) and 1 concluding synthesis module. The modules focus on the practice-oriented use of current CAAD/CAAM (computer-aided architectural design/computer-aided architectural manufacturing) technologies in the area of landscape architecture. Each module begins with a phase where new techniques are learned. In this phase, individual exercises are connected to current
issues in landscape architecture. In the second part of the module, participants grapple with complex problems, which will be discussed during a concluding presentation within the framework of a panel discussion with a group of experts.

Three modules of the current MAS LA program will now be described that are exemplary of the program’s technical and didactic implementation:

3 Basis Data for Landscape Architectural Design

In this module the students learn where and how they can glean relevant topographic basic data for the development and visualization of their design. In addition to learning how to integrate 3D data from national land surveying offices in various GIS applications, the main focus is on capturing the topographic characteristics of a landscape space using photography, video and landscape scanners on-site.

The possibility for acquiring up-to-date planning data by using a high-resolution long-range terrestrial scanner gives us the ability to control the digital chain from the outset. As opposed to spatial planning, the use of GIS data in landscape architecture is still somewhat new. A large didactic challenge involves the overcoming of the optical inhibition threshold. Conventional GIS processing programs used by spatial planners have a unique visual language, which many landscape architects find rather unappealing. The indisputable potential of these programs in landscape architecture is tested in a customized module.

3.1 Method

In order to document the specific topographic characteristics of a place, the students learn techniques from the area of photogrammetry, among others. A 3D model can be created using image recognition software and a collection of photos or video stills of the project area. The use of a mini-drone (UAV) offers an alternative method for modeling and visualizing territories of several square kilometers (i.e. a floodplain or river delta) in three dimensions.

An additional method for gathering 3D information on a part of the landscape is the use of terrestrial 3D laser scanners. In recent time, this tool from the field of geodesy has shrunk from the size of a small truck to that of a football and is simple enough for students to use quickly and efficiently.

The sampling of the landscape delivered with 125,000 light pulses per second can generate – in combination with photos – a photorealistic point cloud that can, in turn, be combined with less detailed (i.e. aerial) data from national land surveying offices in order to create a complete 3D model of the project area.
Fig. 2: Airborne image-based 3D modeling of a student project site

Fig. 3: Students working with a terrestrial laser scanner (TLS) near Lago Lucendro (Gotthard)
3.2 Challenge

One of the greatest challenges with regard to the use of 3D GIS data is not only the handling of 3D data in general but also the sheer numbers of polygons, points, or pixels involved. If the relevant data is found on an official databank or gathered on-site, these have to be in the right format, in an appropriate resolution, as well as uploaded, managed, combined, filtered, and visualized in coordinate system that is compatible with already existing information. In addition, the integration of data gathered in this manner with modeled project designs puts relatively heavy demands on the spatial imagination of the students for the navigation and their ability to work on the models in the 3D environment. This, on the other hand, is connected to a certain learning curve. An additional hurdle is the repeated import and export as well as transformation of the GIS data in a large variety of other applications and data formats as well as types.

![Fig. 4: Combination of point cloud data from airborne and terrestrial laser scanners, Gotthard tunnel entry Airolo](image)

3.3 Advantage

In the teaching context, students can profit from more favorable conditions in acquiring official data and the use of the still relatively costly laser scanners. However, most of the students of the course will most likely never have access to their own laser scanner with which they can collect the required GIS data on-site. Still one will confront data originating from aerial or terrestrial laser scanners more and more often, and it will become increasingly important for project development in landscape architecture. Thus a proficiency in handling this data will become more and more significant.
Regarding the use of photogrammetric software, this remains – at least in the consumer sector – a quick, low-cost and relatively precise method in order to generate one’s own 3D data of the topography of a specific place. Especially for self-employed recent graduates or those who return after the course as an employee to their office, these new software applications offer a good alternative to the often less-detailed data from official sources.

4 Module Landscape Visualization

4.1 Structure

The module is divided into separate foundation and advanced modules that compliment the intermediate modules. These take place both early in the course as well as in the later stages. The testing of the techniques takes place with application to both discreet assignments, and to the ongoing yearlong Synthesis project.

The initial visualization module takes place early in the course in order to familiarize the students with fundamental software and workflow techniques, as well as establish a strong communication strategy early in the synthesis project, which can also serve them in the later modules (MERTENS 2010).

Various techniques and approaches to landscape visualization are introduced, from traditional analogue techniques to digital techniques borrowed from other disciplines. (BISHOP & LANGE 2005) Practically, this ranges from the novel use of site visit-based photography and sketching, to the generation, modeling and manipulation of colored point clouds.

![Fig. 5: Students combine on-site photography and material textures with their ongoing design modeling development](image)

The main exercise is a site with an established and restricted problem-set, allowing broad experimentation, yet limiting the risk of focusing on design issues alone. Students are encouraged to recognize their own preferred techniques, working preferences, and aesthetic choices, which are supported in the development of new directions and manners of working.
4.2 First module – immersion in landscape visualization

Structure

Within a four-week structure, the students are introduced to various processes, software combinations, and workflows. A single site provides the basis for the individual application of the various techniques, which are then combined intuitively by the students based on their proposals for the site.

The choice of project site stems from its specific landscape themes and clear problem-set. This broad categorization has lead to sites ranging from the reconfiguration of a site through the structured placement of excess tunnel excavation material in a suburban/agricultural context, to the redevelopment of an evolving urban transport node. Key to the choice is easy access for the students, as initial spatial impressions and photographic site data are key to the process and techniques. Additional data beyond simple CAD and GIS sources is deliberately limited and focused, requiring the students to observe, record and generate their own impressions, observations and additional data. This approach emphasizes the visual and sensual aspects of the site, and leads the students to develop their own personal skills of site-analysis and development. During the module, there is a clear emphasis on the process, over the design outcome, in terms of documentation and experimentation. The design results, however, often benefit greatly from this means vs. goals approach.

This focused approach also leads to the use of a limited number of software, namely Rhinoceros and related plug-ins such as VRay, RhinoTerrain, and various custom-made plug-ins. Since the software is not specifically landscape oriented in their application, specific workflows and tools, rather than generalist knowledge is the focus. The content and visual approach of the final project presentation is similarly directed towards landscape design outcomes, rather than requiring a specific content or format. The result combines abstract data, photography, and rendering with plan, section, and perspective in a freeform and often experimental manner.

4.3 Second module – generative algorithm workflows in landscape visualization

The second visualization module begins with a workshop in which the various possibilities of generative modeling and visualization are explored. The Grasshopper plug-ins and related additional extensions lend Rhinoceros a visually simple method of approaching flexible and extensible visualization workflows (HiGHT 2008). Various data inputs from Rhinoceros can be combined with external inputs such as GIS data, image sources, environment data, and connected to other software for added functionality.

The project applications shift from brief example problems to the ongoing Synthesis project, allowing the students to directly integrate their findings and developments into their thesis project. This generative mode of working also allows the integration of much of the production from the intervening teaching modules, where programming, photography, point cloud, GIS and abstract analog sources may be combined into discrete landscape design workflows.
Fig. 6: An example of the large-scale implementation of design parameters, generating volume, surface grading information, and areas

Fig. 7: Project experimentation with point cloud data, combining existing and proposed landscapes in one interactive model

4.4 Challenges within the teaching process

Over the years of course development, the key challenges for the teaching program have greatly re-shaped the method of teaching. Of particular importance are the short timeframes allocated to each module, requiring a well structured and specialized approach. The other aspect that has most likely influenced the course structure the most is the varied background of the students, whether in discipline, methodical approach, culture, or education (HAGAN 2008). This particular challenge has been the impetus to directly focus on the development of design workflows, based on each individual. The key benefit for the
students is the ability to further specialize their own interests within the broad field of Landscape Architecture.

5 Module Programming

5.1 Structure

Through the use of customized programmed tools we see a further possibility for supporting design and planning processes in an innovative way. For this, we experiment with the use of Processing as a programming language (REAS & FRY 2010, WANNER 2010). In this manner, the students were introduced to the principles of parametric design. Through several exercises, which build on each other in content and a lecture series with guest speakers, the possibilities of ‘programmed design’ are learned and discussed. The goal of the module is for students to be able to recognize and define starting points for programming in a design.

Processing is our preferred language of choice due to its simplicity, the excellent documentation available, as well as the ambition of its academic user community. Processing is an open-source language developed by Ben Fry at MIT’s Media Lab (GREENBERG 2007). It has the advantage of offering a very simple development environment. In addition, its procedural introduction makes it easy to learn, and we have observed that the learning curve is very good.

Fig. 8: Student project: Generation and control of a design project by a customized program and verification through 3D output

5.2 Method

The didactic approach poses the greatest challenge in the teaching of a programming language. Landscape architects are visually influenced people, who for the most part feel helpless and at odds towards the mathematic and prosaic structure of a program. This first hurdle is quickly overcome in comparison to other programming languages with the learning of Processing. Already after the first three lectures, students are capable to create scripts with variables and loops and test their scripts in a visual output window. The five-week module concentrates essentially on the learning of the basic principles of modular programming based on a series of exercises built on each other. The relatively short
timeframe yields significantly better results in comparison with semester courses, since a beginner at programming can reach his or her goals more quickly in a concentrated period of time as opposed to divided up and distributed over an entire semester. Through the use of sketchpad, the students can exchange scripts and deepen their individual interests. Since we focus on applied programming, we teach the efficient use of existing tutorials including scripts from the Internet. Through each exercise, the script becomes more complex in content and the output adjusted to the individual’s demands. The versatile output possibilities of Processing allow the programmed result to be shown, i.e. as a printout, or real or lasered 3D model (BURMEISTER 2006). These different visualization possibilities provide a new level of communication as a design-supportive medium. In addition to the programming, the main second element becomes the critical theoretical debate of possible applications within the framework of professional practice. When does it make sense to integrate a programmer into the planning team, and how do these specialists communicate with each other? These and other questions must be considered in order to understand as well as realize the potential of parametric design.

Fig. 9: Student project: Application of programmed tool to simulate the growth of green pockets

5.3 Next Steps

A next step would be to network with other universities that teach and research in similar topics and areas. The example of the open-source programming language Processing and its active user group is a model for future teaching. In this way, the difficult path of implementing existing knowledge and skills in built landscape architecture can be accelerated and qualitatively improved. Of course not every landscape architect needs to be a programmer. However, we tend to believe that programming constitutes an important role within landscape architecture and therefore a basic understanding must be conveyed within the course of studies. In so doing we place great emphasis on using programming languages that are simple to learn and also offer interfaces for further applications.

6 Summary

Within the framework of a concluding thesis project, students are encouraged to combine the tools and test new forms of working method. 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 are to
be applied and recombined to explore new design methodologies in the final project (Kolarevic 2003). The concluding module acts as a test case for the questions or agenda defined throughout the teaching year.

During the MAS LA a number of discussion/presentation deadlines serve to test one’s individual focus or agenda and make them more precise. At each deadline the students are asked to prepare a meaningful presentation that is complemented by new examples of use. During the final working phase they are supervised during one-on-one weekly meetings. The scope of the final project is defined during interim presentations.

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