Architectural Parametric Designing

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This paper describes a unique coupling of an architectural urban design studio with an in-depth digital media course in order to explore new ways of architectural expression, form finding and communication. It reports on the variables, goals and outcomes of this design studio as well as its integration of digital parametric design that allowed the participants to create innovative urban design language, based on parametric descriptions. The paper portrays the educational approach; the way parametric computer design tools have been introduced, as well as the process and outcomes of the studio. It discusses implications on design education as well as understanding and communicating of complex design tasks that are responsive to a variety of parameters.

Keywords: *Urban design studio; parametric modelling; design exploration.*

Introduction

Architectural Design Studios are the essential learning experience for architectural students. Its tradition and proceedings are well established. The studio is informed and supplemented by courses and seminars, which can feed into the learning outcomes of the studio. The studio goes beyond pure skill training and requires reflection and creation of knowledge. Yet there is a gap between the training of skills and the application of knowledge within the studio context.

This is true in relationship of digital media courses, where on one hand the underlying concepts of architectural design using digital communication tools are presented, on the other hand software-skills and learning of technical issues have to be trained (Kvan, 2004). The integration of a digital media course into a design studio often fails, because the basic acquisition of skills prevents a deep exploration of design and theoretical aspects. Only long after participant

have learned and gained sufficiency they are able to employ digital media tools within a studio context. Yet by then the studio may not consider these skills any longer. A dilemma of semester-based teaching is that students have the highest level of skills and experience at the end of a term, when they leave into their break and are not able to apply their knowledge. At the beginning of the next term however, the gained knowledge and skills are either inactive or not employed because the learning focus of the next semester shifts to other aims.

This paper reports on an urban design studio that tried to address these issues by integrating the skill training within the design studio learning experience. Participants were able to utilise digital media skills from a very early point of the studio and expand from there on their understanding and communication of design issues. The studio builds upon design studios that allowed participants to explore design methods and tools beyond their original definition and perceived limits (Schnabel et al., 2004).

Studio outline

A form or architecture in general can be expressed and specified in a variety of ways. Commonly, geometric properties are described using drawings. Thus, a building or a stair can be explained, depicted and constructed. Alternatively, observed behaviours that are described as it can be found in performance specifications. It is also possible to describe properties as relationships between entities. In a spreadsheet, the value of a cell is specified as the result of a calculation of other cell entries.

These calculations or descriptions do not have to be explicit. Responsive materials change their properties in reaction to the conditions around them. A thermostat will sense air temperature and control the flow of electric current and hence temperature of supply air. Using such techniques, artists have created reactive sculptures and architects have made sentient spaces, spaces that react to the occupant or other factors. Lights turn on if lux levels fall below a threshold; ventilation starts and stops according to need; walls move as users change location.

Using parametric design tools, links to a variety of data can be established and serve as the base to generate geometric form. When designing urban space, it is usual to collect some data of the type of urban qualities desired. These are then for example translated into master plans, themselves specific spatial descriptions. Performance requirements for urban places can be written, linking the description of the urban space to experiential, financial, environmental or other factors (Picon, 1997)

As base of the exploration, the studio took at a distinctive new-town neighbourhood within the Hong Kong urban context. This district is in need of redevelopment of the earlier urban planning that did not anticipate changes that arose over the years of habitation.

Studio Set-up

The studio was one of the required design studios of the *Master of Architecture Programme* at *The Uni-*

versity of Hong Kong. Twenty-four students elected to join this urban design studio that was supervised by two design teachers and one architectural consultant in digital media. Studio-meetings ran on twice per week during September to December 2005. It was structured into four components that related to and built upon each other. The aim was to integrate a variety of skills acquired during the studio into the final design work.

Creation of Parameters

The first component included collection and understanding of data that arrived from the site. This module went beyond the traditional 'site-analysis' and required students to relate data and their own interests in the site to either each other or alternatively, to two key issues that represented their findings. These parameters informed about the site, and allowed a description of the site based on dependencies and interconnected relationships of site relevant information. This component concluded after two weeks with presentations of data, parameters and individual interpretation of the site.

Learning of Parameters

The second component focused on the understanding of parametric design concepts and the acquisition of skills of a design application that allows parametric and rule based three-dimensional design. Participants were trained intensively during studio-time in the use of *Digital Project*™ (2004). This highly complex software-application allows users to not only create three-dimensional models but also establish rules and create dependencies of its entities. It allows visualising and modelling of highly complex forms that may offspring from non-traditional design-data, such as noise-data or pedestrian flow. Participants used their own parametric and rule based design analyses of the first component and subsequently studied the use and operation of this software, the creation of rules, parametric and generative design. After three weeks of interactive studio training, the students reached an advanced level of

skills that enabled them using *Digital Project* as tool within their development of their own design.

Designing with Parameters

The third component concentrated on the design creation, reflection and communication of urban design proposals, which was scheduled for seven weeks. Using the data of the first component and the skills of the second the students now started to establish and visualise their design in three-dimensional forms that created spatial expressions of their findings and explorations.

The studio was in particular interested in describing the built form by creating dependencies and parameters that define the urban spaces and landscape. Normally spaces between buildings result passively from describing the buildings around them. With the use of digital media it is easy to design geometric generators that create external spaces and then define the building forms that result

in the subtraction of the built from with the urban space (Karakiewicz, 2004).

Merging of Parameters

The concluding component brought together the various aspects and results of the earlier three modules. Within two weeks, the students merged their individual designs and parametric dependencies of urban strategies, components and rules into one large cluster file. This synthesis created layers of descriptions and dependencies that are highly complex and interrelating. Yet both, the content as well as the tool, allowed a seamlessly communication to a larger audience using the method of parametric design descriptions.

Results

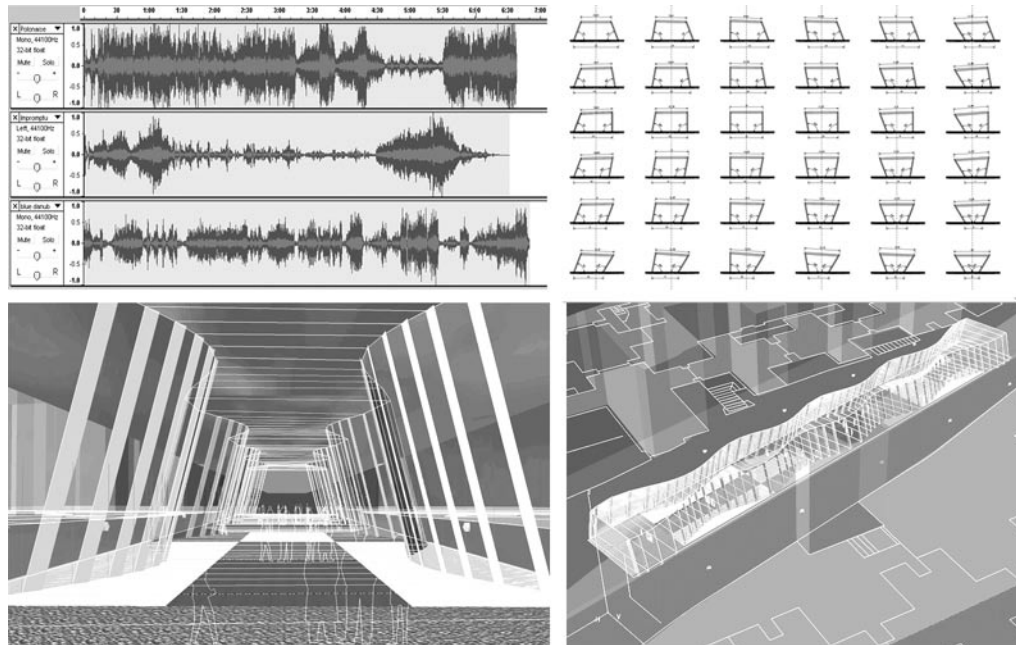The students acquired the highest amount of skills using a complex software tool already within the

Figure 1
Jeff Cheng: The Sound Link

first halve of the semester time. This enabled them to employ the tool as an amplifier to generate their design. Subsequently the students were not limited to the knowledge or level of skills in order to be able to express their design.

The students produced a variety of individual design proposals as well as one large design-cluster. They created rules and parameters that allowed generative design to emerge. These highly complex representations however, cannot be communicated using traditional urban planning methods or tools.

For example, a student designed a noise-protection wall that reacts to of the generated sound with design specific space patterns (Figure 1), while another related the field of vision at any given point at the site to the porosity of the surrounding buildings (Figure 2). Other results include the relationship of pedestrian-flow and attraction to urban spaces with responsive structures

(Figure 3), as well as the influence of (sun-) light and the need of comfortable outdoor space facilities that relate to human activities within a 24 hours time cycle (Figure 4), to name a few samples.

In the four components of the studio, the students presented an in-depth cluster of multifaceted urban design proposals for the given site in Hong Kong. The students demonstrated a high level of thinking processes that ended in compound design generations. Each student contributed on at the same time to both, micro and macro scale, in order to create an urban design scheme.

Conclusion

The studio presented here addressed (computational) concepts of architectural urban design creation influencing the recent development of architectural
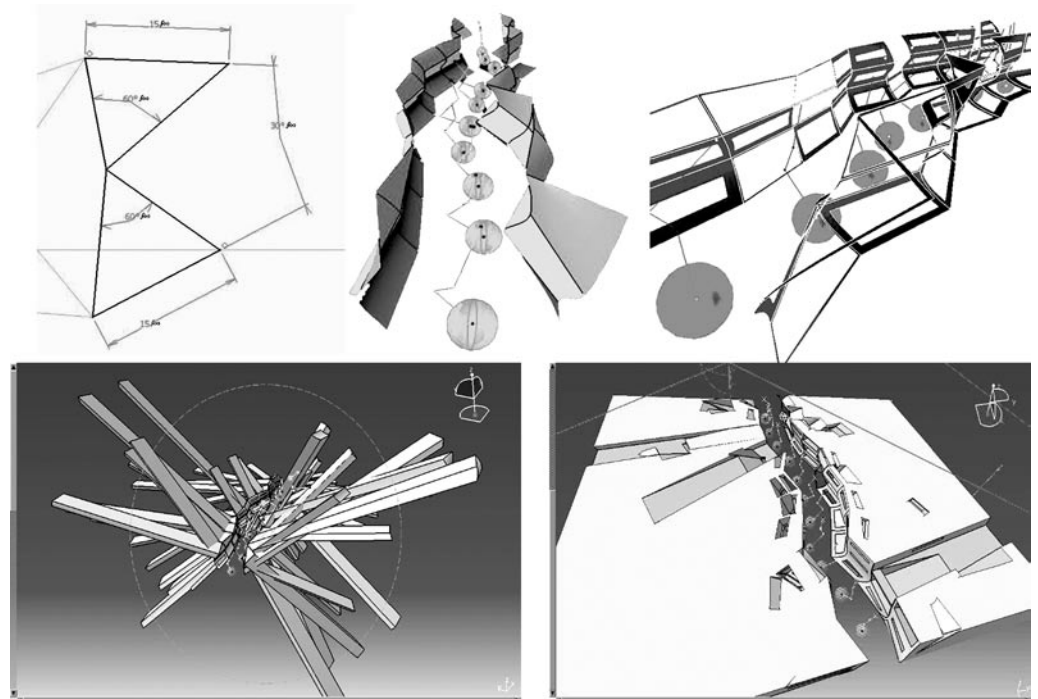

Figure 2.
Angus Ngai and Kevin Lok:
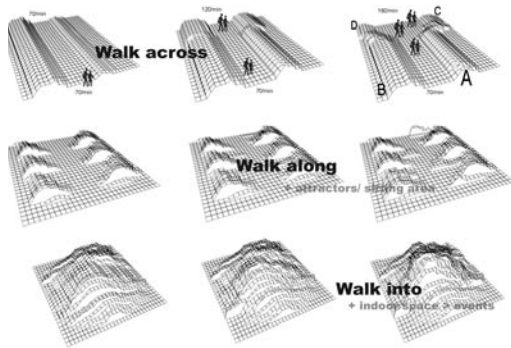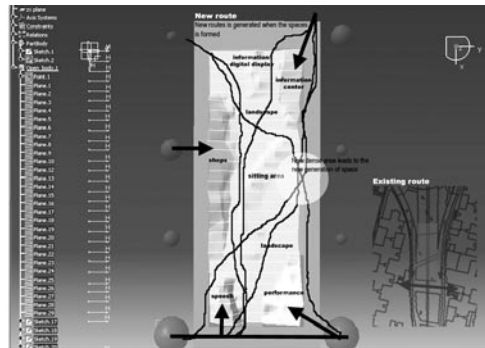*Porous Street Scape.*
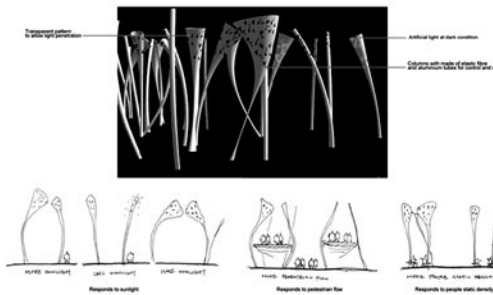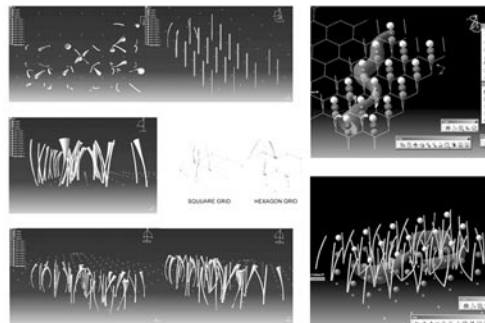
production. This partly experimental, partly realistic studio explored innovative methods of architectural expression, form finding and communication and developed unconventional solutions. It coupled the studio-learning environment with an in-depth digital media assignment in order to close the gap between the training of skills and the application of knowledge and to explore new ways of integration of compound design issues. The use of digital parametric design tools allowed the participants to create an innovative urban design language, based on rules and generative descriptions.

For this reason, the training of skills that related to the studio was embedded into the studio. The students acquired their skills of software and parametric design methods already within the first halve of the studio. This amplified their design experience and learning outcomes. The students connected their knowledge with their ambition to express their design proposals.

The synthesis of all individual projects removed the students from an individual ownership of their design but allowed them to reflect on their own as well their colleagues' design as a whole cluster of contributions (Kvan, 2000). This relates to earlier research of design studios that were based on the same principle where media were applied outside their normal pre-described purpose, and innovative design methods are deployed by interplaying the digital media and design explorations (Schnabel et al., 2004).

With the employment of parametric software that allowed to experience spatially the dependencies and rules of the various individual contributions as well as the overall common proposals the design can be communicated using tangible interfaces or

digitally controlled devices. The generated design data can be linked in a variety of ways to extract or generate new geometric forms and understandings. These descriptions can then be used directly in the manufacture of objects by means of e.g. digitally controlled devices (Seichter and Schnabel, 2005).

Each of the components was an essential part of the overall of design creation. It addresses and expresses certain aspects of the process. This enabled a holistic discussion about design, form, function and development, which is significant not only within the architectural education, but also in all other dialogues involving spatial representations.

Acknowledgements

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