THINKING THE FOURTH DIMENSION

The e4d design series and the education of digital design skills

MARTIN TAMKE
CITA - Centre for IT and Architecture
Royal Academy of Fine Arts, School of Architecture
Copenhagen
martin.tamke@karch.dk

AND

OLAF KOBIELLA
Institute for Theory and Design in Architecture
Technical University of Braunschweig
o.kobiella@tu-braunschweig.de

Abstract. The e4d design series is looking for new aspects of digital technology in the education of Digital Architecture approaches - overcoming the gap between the development of architectural and the necessary digital skills. Digital Design approaches using the full variety of multimedia technology, the parallelism and crossover of analogue and digital techniques, 3d-modelling, rapid-prototyping and visualization tools and finally the presentation in artistic movies or websites are characteristic for the e4d design method. This method was refined during several design projects within the last two years. A problem based design method was developed, that enabled students to learn digital and architectural skills simultaneously in an efficient manner.

The educational concept of the design approach consisted generally of four steps, which are independent from each other in an educational sense, but determined in questions of the ongoing design process. The first step consists of an abstract or subjective research phase for the students which gave all participants an atmospheric and/or conceptual idea of the project. Within the following phase, called „Transformation”, parts of the findings are transferred into spatial or dynamic structures. Later on the detected atmospheric and organizational qualities are used to develop a given building program towards a specific solution. In the last step the different traces are interconnected, when site specific parameters are blended with the found design traces.

The implementations of digital and analogue mock-ups, as well as the evaluation in Virtual Reality environments and the creation of scenic animations were crucial for the projects aim to teach the students a new way of design with the help of digital techniques. The precise use of different kinds of media for the projects visualization, text and
image oriented design approaches, as well as the way the architectural projects could be discussed have been examined.

We like to share our insights concerning a competent monitoring of the digital architectural process, looking for innovative and efficient design strategies and wish to discuss the projects outcomes in architectural as well as pedagogical aspect.

1. Introduction

The capacity of computational design exceeds digital drawing and programming, as soon as its imaginative capabilities are unleashed. A design process taking the unforeseen and dynamic into account – giving our design series the distinct name - design in four dimension (e4d)

In many architectural schools the mediation of architectural design knowledge is separated from the so called technical skills, making it the students decision how and if these two traces are combined in design. This is accompanied by a notion of design departments to neglect the means used, and their enormous influence on the results quality. (Barber, T.and Hanna, R. (1998); Tidafi, Temy and Ivanka Iordanova (2006)).

Taking these experiences into account, several questions evolved: What kind of designs would be borne of the consequent use of digital techniques within the complete architectural design process? How to use digital tools besides a form driving engine (Terzidis, Kostas 2004) or digital substitution of traditional approaches to design (Knight Michael et al. (2006))? What is the shape of an adequate design method supporting different digital tools as imaginative part in an innovative design process?

2. Context and Aim of e4d design series

To gain a full digital design, we introduced the use of digital tools in all essential phases of design:
- analysis and abstraction
- development of concept
- elaboration and visualization

Within the series we aimed at crossbreeding traditional design approaches, which usually lead to a somehow “buildable” design (given brief, site, building program, starting the building design according to urban structure) with the experimental capacities of the digital realm. We furthermore
expected the given brief to state as point of reference, whenever Students encounter the inescapable problems within learning a digital design process. Within the design process we expected them to learn the necessary digital skills. They should develop an individual way, which tools to use at which time to strengthen their design capabilities instead of mimicking a formal design process introduced to them by their teachers. As most CAD packages lack intuitive design tools, we looked for software, with a higher experimental flexibility. 3d animation software seemed to be the right choice for this. The absence of building elements and architectural gadgetry forced the students to improvise and overcome the chains of their former design approaches. The advanced modeling and animation features, the ability to use physical simulation, parametric elements etc. gave a broad variety of tools to start the experiment (Mark, Earl (2006)). We expected the project based learning of digital tools would be very effective, as it would give the students a high degree of motivation (Bridges, Alan H. (1992)).

3. Structure of e4d design process

The e4d series should first of all set free a spirit for innovative designs – including new proceedings, understandings and ways of presentation. Thus the design start should not be primary digital but an innovative search for answers to new architectural problems. As the opportunities in the digital realm are widespread and develop fast, we introduce a Meta level in our method, giving a consistent structure to handle different digital tools. Thus we would be furthermore able to give the students and structure to cope with the experimental approach. The invented series consists of 4 steps. Formal and conceptual ideas are continuously developed within the process; nevertheless every step can be seen as task of its own. The single tasks are not necessarily depending on each other. Thus they provide a mental fallback solution for students, who could not cope with the previous step, as the next level might be more appropriate for them and give them a chance to reenter productive work.

STEP 1: BRIEF, RESEARCH, ASSOCIATIVE REFERENCES

This phase aimed to give all students an atmospheric and/or conceptual idea for their project. The phase started with a briefing, not demanding a digital solution.

Table 1. Illustration of Step1- Instant Homes Design Project – Winter term 04-05- Structural Game The access towards the design is done by examining structures according to personal knowledge and motivation. 10 individual chosen spatial structures are analyzed and individually interpreted. Projects by Nana Apel, Florian Holik, Michael Boelling, Stefan Neudecker
STEP 2: TRANSFORMATION, IDEA TO FORM

Due to digital techniques ideas (e.g. images, dynamic fields, structure of any scale) are directly transformed into form, evaluated afterwards. Instead of running through the traditional order of design (urban context as start, box-like figure as proposal), the students create a problem-specific and detailed 3d-object.

Table 2. Illustration of Step2- Instant Homes Design Project – Winter term 04-05-
Transformation The findings are transformed into a three dimensional structure with a high emphasis on spatial questions. Projects by Nana Apel, Florian Holik, Michael Boelling, Stefan Neudecker

STEP 3: FORM TO FUNCTION

The invented atmospheres and structures are used to refine the given building program. In a reversal of usual design approaches this bottom up process provides the chance to test the solutions ability to scale and adapt to other formations.

Table 3. Illustration of Step3- Instant Homes Design Project – Winter term 04-05- Programm + X The detected atmospheric and organisational qualities are used to develop a given building program towards a specific solution. Projects by Nana Apel, Florian Holik, Michael Boelling, Stefan Neudecker
STEP 4: SITE IMPLEMENTATION

The different traces are interconnected. Site specific parameters are blended with the found design traces and concepts.

Table 4. Illustration of Step4- Instant Homes Design Project – The developed structures are redesigned to match a specific site. Projects by Nana Apel, Florian Holik, Michael Boelling, Stefan Neudecker

![Illustration of Step4- Instant Homes Design Project](image1)

We focused in each design project on a distinct topic, to test the methods ability to cope with different tools. In the beginning we dealt with the software’s experimental possibilities, combining innovative features, animation and rendering styles. Later, specific tasks, as Virtual Reality and its making, light simulation and the transfer of light into VR, Dynamic Systems, 3d video capturing and Augmented Reality were examined.

The projects, mainly attended by 4th year students, took place within a strict schedule of 13 weeks time. The digital knowledge was mainly taught by concentrated tutorials (3-4 x 2 days) giving an overview of the techniques. Further imagination arose from lectures at the beginning. Students tutors gave supplementary help.

4. Examples of e4d design tasks

Four different design tasks were created as an experiment in digital techniques and teaching – constantly improved by insights made during the process.

SUMMER TERM 2004 | NCCA KALININGRAD/RU

Task and process of this project ingrained the most in traditional design studios. Our brief asked for an extension to an existing Art Center, situated in an old fortress’ tower. A dialog between the massive old structure and the new building had to be designed. Abstract atmospheric images were demanded first, from which the students derived structure and concept. A focus was set on the use of software specific tools (dynamics, metaballs, layering of surfaces). The last 2-3 weeks were used to refine the concepts in form of movies.

Table 5. NCCA Kalingrad RU – design project of Peter Roch using particle systems for form generation
WINTER TERM 04/05 | INSTANT HOMES

„Instant homes“ was an attempt to develop new networked living structures and communicative atmospheres free of boundaries given by site or function, which were introduced later on. This studio had a strong emphasis on interaction, movement and the creation of atmosphere in design. VR, digital design reviews and the use of light simulation were used intensively. (Tamke, Martin 2005) At first the functional aspects of living were abstracted to pure structure - serving as blueprint for the later elaboration. The final presentations were done as interactive multimedia files, taking reference to the seminars overall topic.

Table 6. Instant Homes – Design Project of Monka Losos, 3d structure to create sponge-like communication spaces

SUMMER TERM 2005 | CHERNIKOV MUSEUM

This design demanded radical ideas for a museum for the Russian architect, well known for his expressive drawings. Focusing on one single work of Chernikov, the students started individual approaches. After formulating a manifest, the following transformation mimickeries the traditional way of adopting a 2d sketch into a 3d drawing, but underlined the graphic qualities of Chernikovs drawings. Movements within the building were stressed in the later steps. Movies presented the graphic and dynamic qualities of the designs.

Figure 1/2. Chernikov Museum – Design Projects of Julian Busch and Eva Dietrich, Exploration of the dynamic qualities of the Museum – Stills from the animations
Table 7/8. Chernikov Museum – Design Projects of Julian Busch and Eva Dietrich, Exploration of the dynamic qualities of the Museum – Image sequences from the animations

The shift from mainly synthetic to mixed reality design processes was stressed in the last of the e4d series. The aim to emphasize the sites specificity and to take the granularity of reality into account was done with the use of digital Video for analysis and development of an idea. 3D tracking
tools helped to overlay digital and video footage with the virtual space. The movie centric approach dealt further on with the crossbreeding of the designs in physical and virtual realm and was closed by the making of architectural movies – consisting of synthetic as well as video material.

Table 9/10. Campus Symbiont – Design Project of Lars Wintjen and Stefanie Wallis, stills from Video to Form and Augmented Reality

5. Discussion of teaching process

According to Questionnaires done, the students appreciated the general approach and the skills learned very much. Some would have liked less abstract approaches and support by using analogue tools. Most students asked for more lessons in techniques and more personal tutorials. The combined teaching of design and digital skills was appreciated. Stating that they continue the use of the new skills intensively, especially in the specification of concept, in elaboration and presentation, students claimed a lack of time. Especially the series time consuming theoretical background (abstraction, transformation) has been always a matter of discussion, mainly by students with more interest in using known design principles. Still, most students experienced the intense project as a worthwhile learning situation and a highlight in their curriculum.

The modular system of the series (design tutorials, technical workshops by experts and guidance by previous e4d students at the end of the program) is flexible to adjust to new circumstances and future digital tools. The integration of external professionals in the teaching, allows to experiment with different digital media from year to year.

The division of the project into 4 different steps proved to give the students a reliable structure to orient and a fallback level, if they did not cope with the abstract level of the fist steps or with the projects experimental approach in general. Thus especially weaker students had the chance to take up parameters as site or program to start over with their project in a later phase. Although the direction of the steps in some of the projects proved to be quite heterogeneous, the students’ motivation and curiosity was refreshed as soon as they entered a new phase.
6. Discussion of design results

The resulting design projects are of great diversity in terms of concepts. Although all students were confronted with the same architectural problem and course structure, individual approaches can be classified:

1. students starting with a strong abstract idea as the solution to the architectural problem
2. students starting with a strong interest in a specific digital tool
3. students starting with a strong interest in exploring new sculptural forms
4. students starting with their repertoire of analogue techniques

The subjective abstraction of the architectural problem not only frees the student from traditional expectations, but enables him to find an experimental proposition. The order of the classification above is also a ranking of the resulting design quality. This assumption was proved to be true by the work handed in, but students who constituted their abstract idea at a later stage in the process also developed significantly good results.

Table 11. NCCA Kaliningrad RU - Design Project of Henning Rose, the task specific digital analysis of the existing building developed a twin-like extension to the tower

The work of Henning Rose is exemplary for the results. We asked for a collage representing the (subjective) essence of the existing building. Fascinated by the piranesian like circulation within the tower different movements have been imagined. A 3d model of the tower and its site was executed, to examine the context which could not be visited. To evaluate the internal space of the tower and to simulate the imagined movements, several particle systems were tested, giving a feedback of the internal areas dynamic qualities (step1).

A modifier (meta-balls) on the particle system transformed the inherent qualities of the spaces into form. A sculpture was created, inheriting essential characteristics of the existing building (step2), which was then adjusted and detailed according to the required functions. Material properties and illumination qualities were introduced to match the characteristics of an art center as well as to create a dialog with the old building (step3). The new
object, virtually breaded within the old structure, was finally placed as a twin adjacent to the existing Tower (step4).

As intended, the abstract idea became the starting point of a digital analysis. The 4 step e4d structure, constantly triggered the students imagination and encouraged the use of experimental techniques on different levels of the process. In dialog with the given task a specific set of tools was chosen and a concept emerged unimaginable without digital means.

Figure 3. *NCCA Kaliningrad RU - Design Project of Henning Rose, section of the Kronprinz Tower and the new Art Center extension*

7. Conclusion and future prospects

The focus on specific digital presentation formats, especially VR and film, distinguishes the projects from other design projects represented in drawings and models. Although this is no expression for quality, the simple difference creates a wide public reception of the work. Today, this advantage should not be underestimated, although this argument will surely vanish, when digital techniques are used more commonly by the architectural community. The e4d series explores the inherent qualities of digital production and representation of design. The 4-step e4d structure provokes experimental design concepts, as well as the tutorials give broad insights to digital techniques. As these parts are taught parallel, the students are encouraged to superimpose technique and concept, leading them to a highly subjective design, inseparably connected to both.

Figure 4. *NCCA Kaliningrad RU - Design Project of Natalja Kopycko, elevation of the Kronprinz Tower and the new Art Center parasite*
The claim to teach digital techniques by means of architectural design and vice versa seems to be fulfilled. In order to achieve a balance between both sides, compromises had to be made:

The time necessary to learn and carry out experiments within software, alien to most students, reduces the amount of detailing and functional and constructional parameters are often of lower development. The experimental approach chosen, stressed the formal and conceptual quality of the design. Our aim was the discovery of new spatial and conceptual relationships. Some of the work led to new tectonic qualities, which might be worked out to new construction methods. Other participants simply ignored questions of buildability and focused on different fields. These fields were highly determined by the proposals given and the digital techniques introduced to the students. Especially the projects dealing with experimental, formal structures in the beginning led to new tectonic inventions.

In general the building qualities related to concept, form and movement are generally deeply detailed – a different focus arose within the projects. New building forms and design concepts are stressed, the four dimensional presentations emphasize the buildings atmospheric and dynamic qualities.

During the design series a direct link between the student’s ability to handle the software and its will to use it in an experimental way could be drawn. Students, who attended similar courses or used 3d software before, performed usually better. Thus, the use of digital techniques should be emphasized throughout the student’s curriculum, enabling him of critical mastering between different packages and methods.

Students, who come with a learned set of fixed analogue tools, have to transform this knowledge to the e4d structure – a problem for weaker students. Consequently the concentration on only one digital tool and a less individual approach was discussed by the staff regularly, as the self-positioning of the students in the “experimental” designs would take less time and provide specialization. This master class-like system was never established. The student’s responsibility for his decisions, his self-conscious
positioning in terms of design strategy is not only important to develop a personal agenda, but seems to create extraordinary and unforeseen results in design. While some of the projects results may be seen as situated within the realm of blob- or bionic architecture, the method introduced does not aim at formal qualities, but towards a discussion of design methods in the digital realm, which don’t have necessarily to follow well established rules of site, program and tectonics.

The experimental use of tools from a different discipline (here mainly animation software, as Greg Lynn did in the 90’s) will continue to produce new, innovative results. Still, the interdisciplinary approach needs to incorporate new modules and other packages. Time consuming mediations as scripting are difficult to integrate into the existing time schedule.

In order to foster the theoretical background in digital techniques, we are currently introducing a preliminary research seminar with practical exercises, enabling the students to experiment with digital media. The same students, charged with detailed digital knowledge, will work on the next e4d project in spring 2007.

Acknowledgements

We would like to thank Tom Schülke from lichtecht.de, Sven Havemann, Prof. Dieter Fellner from the Institute for Computer Graphics and especially all students who put massive efforts into their projects.

References


