

Towards Improved Architecture Education

A Research Framework

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Abstract. *In this paper we report on a PhD research project that has just started. The main question of the research deals with improvement of architectural education, and we are concerned in particular on the influence of CAD. First we outline the basic assumptions and major considerations of the research, following we describe the research methodology, and show the principal direction of the work. Some work has already been done, and the paper ends with a few tentative “educated guesses” what the possible outcomes of the work may be.*

Keywords. *Education; Pedagogy; Collaborative Design; Sketching.*

INTRODUCTION

In this paper we report on a PhD research project that has just started. The main motivation of the research is to identify ways how to improve architecture education. In particular our concern is to study the potential of CAD in this respect. CAD has undoubtedly changed (and is still changing) both practice and education. Students are experimenting with parametric design, generative design, use programs like SketchUp for ideation, collaborate using Internet and exchange models by means of BIM. We also see some constants however. The design studio remains the main pedagogical strategy to teach students design, and most of the time software is taught in separate classes on the level of skills (press this button to achieve 'x'). Nevertheless, design studios with fully integrated CAD/CAM have been established world-wide.

Improvement of architectural education is a very wide area, and it faces a number of research methodological difficulties. General skills of designers and design students have been studied early

(see for example Cross 1990 and Lawson 1990). Work on learning styles and design performance has been investigated by Demirbas and Demirkan (2003) and Kvan and Yunyan (2005). Angulo (2006) compared the learning outcome of students using E-learning tutorials. Kvan and Song (2005) investigated at the meta-level of learning loops the performance of students in particular in collaborative teams. Matějovská and Achten (2008) aim to identify working strategies of students working with CAD.

Research on improvement of education is quite ambitious and not without research methodological problems. One issue for example is what counts as an improvement: is it the speed of learning a particular skill, the efficiency by which a certain task is performed, the ability to explain some concept, or something other? In a design context, will an improved educational strategy lead to better design by the students, or should we look at the proportion teacher-student contact hours, or the number of design variations generation, the depth of an analysis,

or the quality of a presentation? Even when it is possible to establish some metric along which to measure improvement, there will be issues of interpretation what the results actually mean.

The preliminary focus in our research is twofold: to look at the ideation and concept generation phase of the design process and to look at the way students communicate and share their ideas between themselves and with their teachers. Furthermore our interest lies in the tools by which students generate and communicate ideas - i.e. the sketch, model, and so on. Our intuition is that there is a lot to be gained in these areas. To get ourselves oriented in this area, we set out a number of 'probes':

- Literature review on the role of sketching in the ideation and concept generation phase.
- Study the ideation and concept generation process of students in a design studio.
- Post on online inquiry for students about their use of sketching and modelling in design.

Additionally, we were fortunate enough to obtain a grant for collaboration between our faculty and ETH Zürich. During that period we will be working at the ValueLab and undertake a number of experiments of collaborative design between ETH and CVUT.

PROBE 1: Literature Review

Several articles related to sketching were reviewed, to anchor the presumption, that it is not possible to bypass it in the architectural praxis and thus education. In the next 6 paragraphs we will try to summarize the main points of the sketching process, which impede using regular CAD programs at the front edge of designing. All writers, whose thoughts we describe distinguish between creative sketching and sketching in communication. For the first mentioned they use the term "visual thinking."

Nature of drawing ability

The ability to draw precedes the ability to speak. It is not so, that a child would draw exactly what it wants to draw. It enjoys creating marks on paper and let's

itself be inspired by what it sees. When it creates something that it likes, the child starts repeating that line or dot on the paper within a system. It is learning to draw. In the age of approximately three years the child starts to draw exact objects, but if it reminds of something totally different in the middle of the process, the child finishes something else. For example the child starts to draw a fish, but if it reminds him/her of a leaf, it finally ends up as a leaf. Later the child starts speaking, which it is practicing every day, and most likely the amount of drawing lessons. Therefore to be able to use sketching as a visual thinking tool it needs to be practiced and developed the same as other skills, in our focus the usage of a CAD tool.

Psychological background - brain borders

We accept the well known statement that a human brain has a limited ability to save chunks of information and that it ends with the number 7±2. The so called Short Term Memory STM, which is fast enough to help us operate information (like Ram) has this limited potential and therefore we need to make notes when solving a complex problem. Designers usually make visual notes: sketch, draft, text, dimension, and calculate Ullmann (1990). They extend their memory via some external medium which more or less creates a restriction to the transformation of the vision in mind to the representation (picture) in reality. Therefore the more facile the medium works, the more data would be recorded Ullmann (1990). If there are any process obstructions in the visual thinking activity, the information recording is too slow to work positively.

Interactivity

As mentioned above, sketching is not only a one way record of inner view, it is an interactive process of seeing – drawing – seeing (Goldschmidt, 1994). This cycle resembles more a brain activity like creativity than straightforward perception. Designers surely need a lot of inspiration, which can be achieved by external inspiration boards, but the best inspiration for further creativity is their own sketch. It is like playing the game of association, where your partner

guesses the associated word to one you say. Creative sketching is like playing the intuitive association game in pictures with yourself. In addition, one reads off the sketch more information than was invested in its making Goldschmidt (1994).

Personal visual language

Designers use very informal way of making notes, they evolve through the years of sketching their own shortcuts (Goldschmidt, 1994) and level of abstraction (Ulmann, 1990), which is useful only for them and it is not transferable to anybody else or it is not generalizable so that CAD systems would be able to substitute it. The advantage of sketching in architectural design process is the speed, which is very important in facilitating the transformations (Tovey, 2002), and easiness of the activity. Even though design sketches are different to drawing from the object, designers must sketch quite intensively to be good at it. We do not need to learn the basics, though we think designers need to practice their drawing expression skills. Another thing which we may notice is the development of a personal visual language or style which distinguishes one designer from another.

Mistakes and incompletion

We spoke about the interactivity above and together that we know that what the designers see in their head is not the same what they than see on “paper”, we can assume there might be some vision-reality transformation defects. If the designers are expected to find new forms and solutions to the problems that in most cases overwhelm them, it is profitable to leave some space for mistakes in the beginning of design process. We know that many new scientific discoveries were made by accident or failure. (E.g. the vaccination principle invented by Louis Pasteur and his research made on rabies).

Incompletion has the same potential as mistakes. It leaves space for imagination and in this way provokes the designer to create more variants. CAD systems do support neither mistakes nor incompletion, on the other hand they are programmed

to repair incorrect drawings and to finish started actions.

Medium

Although there is the offer of many types of tablets, which support the transmission of sketches into program files, many designers stick to the very traditional paper and pen(cil). Is there also the strong familiarity, based on the experiences from childhood, which remains till adult age? We know that the medium used also influences the visual thinking process as well as other outer conditions. We have not examined yet designing with a tablet, although we expect many problems using it in architectural design. One of the expected problems is zooming within the concept sketch, which might cause the loss of sense of measure.

PROBE 2: Observation in Design Studio

The second ‘probe’ that we set out was to observe students in a design studio on their ideation and concept generation activities.

Task

For one semester we had four Bachelor students in the second and third year of their studies and one Phd student to design a multifunctional house with a Nomad Office inside. They did not know they would be observed and we did not influence them in the way they designed. We followed the three phase design studio teaching schema: (1) analysis, (2) object design, and (3) interior design (1:1 model). The task started with editing the building functional framework introducing this new function for a city multilevel building. After finishing the functional diagrams and having found the optimal place in Prague the students were asked to design the buildings themselves. The buildings were to be sustainable and point to the fact that they house a nomad office, which, as a principle, was claimed to be also sustainable way of office working. It was all meant to be a so called “Gesamtkunstwerk” so at the end of semester a piece of interior was expected together with the whole project.

Design process of the students

In the first phase 'analysis' the students were able to draw the diagrams of the functions by hand and then they transformed them into computer schemas. Additionally they became acquainted with the Moodle learning environment through which they communicated the results. After finishing the initial Nomad Office problem research the students started the work of designing. Three students (ABC) brought computer made pictures and showed them on the screen by the first consultation, one (D) student made an overall concept sketch (see Figure 1) and one (E) student a situation layout sketch.

At the consultation, all of them were asked to edit their designs and to produce variants of the initial idea. Within one month, the students A-D who worked on PC were not able to produce any variant to their initial idea (see Figure 2). Student E was drafting and sketching by hand and was able to react on our arguments.

Description

The communication with the non-sketching students was disabled through the absence of a medium, where drawn comments are possible. When they presented their designs through screen, neither the teacher nor they were able to change on the spot even the minimal amount of design features. Nobody was that skilled in the programs to be as fast as speech

or sketch. As long as the students did not even make notes of what was criticized, their design would not change till next consultation. The student E did not use the computer until her design was obvious and the layouts were solved. For representation of the final form she used a physical scale model. Student E developed her project to the best details and ended up with satisfactory project solution. Students A and B did finish the projects, but the layouts were problematic. Student A, who was the oldest and most skilled in programs, had also the least problems of facilitating changes, but even in his case was not able to make these changes in parallel to the consultation. Student C who worked only on computer did not achieve satisfactory results and seemed also not to be satisfied with it. Student D had not overcome the initial abstract sketch level till the final presentation (see Figure 3). All students were also claiming they needed special conditions to be able to design: music, interior, atmosphere, light (or night).

PROBE 3: Enquiry

As a third probe we set out an online enquiry for students to comment on their media use in the design process.

Characteristics of the questionnaire

A 14 question on-line answer sheet was constructed and placed on a private web page. Beginning with

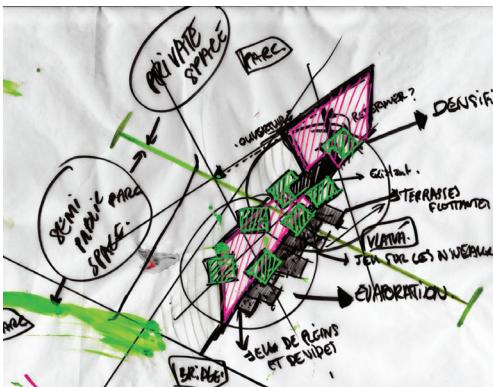
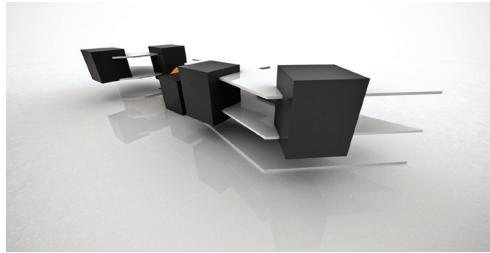


Figure 1
Basic concept sketch made by student D.

Figure 2
Student D's initial idea in 3D rendering.

Figure 3
Student D's final presentation.



the age, we asked the respondents about their attitude to hand sketching and Computer Aided Designing. In the end we asked them about their opinion on new Czech architecture and allowed them to comment on any topic from the sheet.

The goal of the enquiry was to find out the present stage of sketching activity of the students at FA ČVUT Prague and their attitude to CAD in the design process. The enquiry was online only because it was targeted to students in Bachelor and Master studying program, who live on the web a lot.

Preliminary results

The main question was, if the students think, that CAD designing could replace sketching. Until now, 10% of respondents think it could. This is the answer of those students, who use the computer more than hand sketching and their CAD knowledge is proficient. Nevertheless 100% students still matched the box "Yes, I am sketching." Most students would sketch in the beginning of the project to make their inner vision clear. Most students also think they would appreciate training in sketching.

Among expected results from this questionnaire was the ratio of age and level of education and the sketching ability. We observe that no matter how young students are, they still more or less sketch. They like designing with the help of the program they chose to work with, but they would like to be faster. This supports the above mentioned theory that CAD tools are still too complicated to work intuitively with them.

The new computer generation has definitely better computer skills than the "draft generation"

and therefore the teachers are looking for a tool, which enables sketching on computer. The most interesting temporary result says that nobody uses a tablet for concept sketching (contrary to for example graphic designers or industrial designers). We can only guess why: is it because of the price? Are the students so conservative in using paper? Or is it the features of the paper that attract the designer's eye and hand?

PRELIMINARY GENERAL CONCLUSIONS

In the literature review we found arguments which prove that the process of sketching is inevitable in the creative design process. We think that we should respect this and go towards sketching in the design studio teaching methods using new technologies.

The aim is to combine creative visual thinking and communicating the initial concept sketches between students and between students and teachers. We are focused on sketching and the front edge of the designing process, though we allow the idea of optimal fusion of sketching and CAD systems, no matter if classical or parametrical.

For this purpose different tablets are to be tested, but maybe some general tablet problems are awaited to be identified. We want to point out the advantages of this technology, describe them and introduce them into the educational process of architectural design.

COLLABORATIVE EXPERIMENTS ETH-ČVUT

We were fortunate enough to obtain a grant for a stay at ETH Zürich, which allows us to work at the ValueLab and do collaborative design projects between ETH and ČVUT. Two groups of students will cooperate on one project via distant communication. The way they behave in the terms of sketching will be observed and the creative and communication sketching practices will be combined to produce interesting results. The point is at which stage the students switch to computer modeling and if they would, how it affects the project evolution.

Zürich-Prague connection

The facilities at ETH Zürich in the Value Lab are state-of-the-art systems for collaboration, consultation, and education (Halatsch, Kuntze and Schmitt 2009). Even though the systems are high-level, they are designed to work together with parties who do not have such high-end equipment available. Therefore it is possible to evaluate both the effect of Tabletop and Replay at ETH Zürich in collaboration with ČVUT Prague. For ETH Zürich it has the benefit that the range of possibilities of the Value Lab can be tested, and for ČVUT Prague it has the benefit that people can become acquainted with the advanced technologies available in the Value Lab.

During the period at ETH, we aim to set up four experiments:

1. Stand alone experiment Replay and Tabletop at ETH Zürich. The purpose of this experiment is to become acquainted with the ValueLab and the available infrastructure. We will try it for team designing and presentations, and identify the conditions for successful collaboration (which types of collaboration and what kind of topics, range from small scale designs to urban planning).
2. Online experiment ETH Zürich- ČVUT Prague. The purpose of this experiment is to test the communication channels, which regular technology (Skype, touchpad, video making programs, etc.) can be used with ValueLab. Student groups in ETH and Prague will function in a pilot design project to make the first breakthrough. We aim to determine the required level of design and CAD skills to work successfully in this context.
3. Stand alone experiment at ETH Zürich. The purpose of this experiment is to develop the way of using the technology in some other way than usual, and to specify the topic for a collaborative design seminar based on the conditions at ETH. In this experiment we will set up the concrete topic for the final experiment and prepare it for the students.
4. Online experiment ETH Zürich- ČVUT Prague. The

purpose of this experiment is to have a collaborative design studio with a real topic. Possible topics may be sustainable modern architecture in historical cities such as Prague, addressing the garbage problem of the planet, representing Switzerland in the Czech Republic, or other). The whole project will be recorded and analyzed.

Expected results of the experiment

From the experiments we hope to gain well-founded insight in the communication processes between students in collaborative design settings. We will study their ways of communication, the media that are used, and the impact of the technology in the design process. On the technological level we hope to understand what technologies work well together. On the pedagogical level we hope to establish a productive strategy for such collaboration.

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