cussed the need to share course material and develop an online textbook and tutorials appropriate in a wide variety of contexts.

A greater challenge than the temporary nature of course materials is the need to keep equipment updated and working well. Even if technical support is available, the teacher has to be not only the actor on the stage but also the stage manager for the performance. With significant costs associated with the equipment, infrastructure, staffing and maintenance, teacher often have to lobby for funding and work on purchase specifications and personnel hiring. To get the equipment in place and working properly, the person needs to have strong cooperative relationships with computer resource managers and support staff as well as connections to authorities involved in funding. The complexity of these additional duties is well described by the SIGGRAPH Education committee (SIGGRAPH 1995).

External Factors: adjusting the big picture
In addition to the introductory course’s content and delivery, the course’s curricular context has needed attention. Providing basic computer literacy training prior to the course could even out the entering students’ backgrounds. Follow-through practice in studios or media classes help fledgling skills to develop. A logical sequence of classes that interweave technique courses with studio application can make the difference between deep learning and shallow exposure. In considering digital design education to be like foreign language teaching (Cheng 1997), our goal is to immerse the students in a culture of computing. Students need to see how the tools enable the work of peers. They need to be exposed to the different software options available to them and understand that different tools are suitable for different tasks. Finally, having strong role models that demonstrate exemplar work could inspire intensive study.

This paper has described the major challenges in teaching our introductory course along with attempted solutions and partial successes. All aspects of the course are affected by changes in technology: the content, its delivery, staff training and necessary equipment. For all these reasons, teaching digital design is a dynamic challenge. By sharing the lessons we’ve learned we hope to illuminate roadblocks and streamline the path for others.

References


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REINVENTING THE DESIGN PROCESS. DIGITAL SKETCHING – PLANAR OR ALLPLAN?
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“We become, what we have […] We shape our tools, but soon our tools will shape us.” (M. McLuhan)

The question whether the design process has changed because of CAAD appears to be very urgent and important today. If it is true, then the next question arises - what is the range of these changes and at which phase of design do they appear?

These methodological questions led to a research project on the process of design. In particular the process of forming emergent ideas, transforming them into pictures, and through documentation, to reality. The paper is part of a doctoral thesis, which investigates more thoroughly the influence of CAAD on design methods.

To simplify the scope of this project, only one exemplary CAAD tool will be examined. ALLPLAN FT was chosen because of its usefulness and flexibility. This paper is focused on design methods and their implementation at different stages of design. These stages are chosen arbitrarily from a wide range of “duties of an architect”. The criterion chosen was the utilization of a “visualization tool” (which can be both – a pencil and a PC) at the process of creating ideas. Using this criterion, one can distinguish a few stages of design mentioned below:

• Ideation phase. It is connected with rapid sketching as well as “brainstorming”. Relevant features of CAAD application are: flexibility, easy tool access and fast modifications.
• **Conceptual phase.** First imaginations are made more precise. Redundant elements and versions are removed. The most important element at this stage is an object-oriented structure, which supports creating and changing basic architectural elements. On the other hand the possibility of creating complex geometry is crucial.

• **Visualizing phase.** At this stage a crucial element is a constant interaction between a 3D model and its visualization. Any changes made to the project have to be seen immediately on a display.

• **Technical phase.** This stage is connected with dimensioning and describing details. All necessary data (2D and 3D) is placed into a project. At this stage relevant features are: data organization, attributes, intelligent descriptions and specifications.

Whatever the approach, decisions made at the beginning of the design process (ideation + conceptual phase) have the biggest impact and are the hardest to undo later. Emphasizing this phase and its practical conclusions does not mean omitting other aspects of an architect’s work.

**Ideation phase**

At this stage it is still the hardest to involve a machine to serve us. One can agree with Scott Johnson, “the core of architectural design is a process of ideation, involving rapid visualization of ideas. This stage of design is typically characterized by the creation of numerous rough, often incomplete sketches.” It is [...] “most central to design, yet is the most difficult to aid.”

Many CAAD platforms offers diverse tools which could be called “sketch” and are supposed to be interactive, but “there is still no substitute for a pencil” (Johnson S. 2000). Even if these tools are quick enough to follow human thoughts, designers put so much effort to “visualize” an idea using these tools, that sometimes they get attached to them.

Some tools are even confusing – e.g. sketching automatically simplified. Trembling lines becomes straight, rough arches – splines, etc. There is nothing worse. The reduction of redundant versions should take place in one’s mind, not in a computer memory. That neglects a basic rule of “drawing by hand” – at the beginning of design (conceptual phase) heuristic methods appear to be fundamental. The diagram line is a symbolic one, and it must be verified empirically.

**Conceptual phase**

As it was told – at this stage CAD aid is the most effective, although its utilization is better in later phases. Ratio of effectiveness \( (t_{w}/t_{t}) \) of CAD design \( (t_{w}) \) to traditional design \( (t_{t}) \) was measured in certain phases (Deperas Z. 1993): searching of information – 1.0, drafting of schemes – 2, 0-3.8, planning of electrical joints – 2.0-5.0, creating variants – 2.0-20.0.

A CAAD program at this stage should be able to manage diverse design versions. It should have a flexible data structure that corresponds to user expectations. The key to efficiency and usefulness is a design philosophy and inner data organization. Judging by Allplan FT, the general rules of good inner CAAD organization are:

• **One database:** set of projects, pictures, layers and macros, which are usually placed on server.

• **Office standard:** well-developed structure of unified fonts, line-weights, symbols, layouts, etc.

• **Layer set:** predefined structure of layers divided into functional groups

• **Files:** simplify the complex structure of a building. Usually one file means one floor. Connection with other layers easily enables the separation of structural elements.

• **3D data combined with 2D data:** Architectural elements are three-dimensional, but some of them do not need a spatial representation, e.g. areas, door symbols, descriptive part. It is important that all of them create a fully-integrated, synchronous database, which can be used as well for a bill of quantities, as for visualization.

The second question that must be considered at the conceptual phase is: what are the 3D-modeling possibilities and limitations of the CAAD platform? There are many taxonomies of modeling already done (e.g. Mitchell), but this paper will focus on three, methodologically different methods of modeling, which are offered by Allplan FT:

• Object-oriented, parametrical modeling (architecture)

• 3D-solid/surface modeling – traditional

• Advanced modeling – e.g. GEO, window, staircase, rafter framing

A complete set of fully parametric walls, windows, columns (even chimneys) serve to produce conventional elements. [Figure 2.] They can be modified in the same dialog-window as they were created. They contain only “desired” types of data. For example, at the conceptual phase it is unnecessary to specify the material for a bill of quantities because it
is irrelevant work and yields nothing. All these (qualitative or quantitative) “technical data” can be put into the 3D model later. In most cases parametric modeling is sufficient, especially when an architect wants an OpenGL real-time control of the model. However, for final rendering or drawing a complex geometry, a traditional 3D modeling process will be better.

3D solids can be used in two ways - "as they are" or they can replace their “rough” parametric equivalent. It could happen, for example, when old-fashioned columns are used. Important preliminary parameters are: the height and diameter, later a detailed cap and base may be necessary, but it must be told, that the “visual quality” of parametric objects is far worse then full detailed 3D solids. They offer much easier changes instead. As Lorenza Barabino writes: “when element is done with 3D solid modeling simply changes can be difficult to perform by altering the characteristics of its components. Often, it is easier to cancel and do it ex novo”.

Third mentioned method of modeling is connected with tools specific for Allplan FT. The “working-idea” can be described as “holistic, intelligent, object-oriented solution”. This method offers a closed system such as the GEO-module. As a result what is obtained is not only a mesh, which can serve for a rendering, but also contour lines, cross-sections, and road profiles – if inserted. Even a quantity of earth for digs and mounds can be computed.

Visualization phase
Virtual models are timesaving and economic. Different versions can be easily compared without wasted paper, glue, or cardboard. Moreover, due to an OpenGL technology, we gained a reliable tool. Allplan FT offers a real-time OpenGL technology as well as still renderings, animations, light study, and vector shading. [Figure 3] These are tools, which replaced earlier sketches, hand-shaped elevations, computing sun studies, etc. It is not feasible to describe them here, but one issue must be discussed. These attractive pictures should never become a purpose for themselves – they only help in understanding a future building and avoiding costly mistakes.

Technical phase
To obtain a building-permit, an architect must assemble and submit to a building department a set of building documents. The difference between an idea, a model, and a documentation of a building is obvious. But here we have to realize how to make the last step: to transform a 3D model into technical drawings. [Figure 3] There are few elements in this stage.

Assumption, that virtual model was constructed with a professional knowledge of building structure and its elements – walls have proper width, ceilings are not made of cardboard, etc.

Distinguishing and naming rooms. As an attribute we place a description containing name, number and area. Of course attribute will show only defined rooms and can vary due to drawing-scale and expected information.

Placing 2D information – mostly furniture arrangement, but also sewer system, water mains, etc.

Dimensioning and other descriptions – this is strictly “flat” information. Dimensions can be obtained in a full- or semi-automated way. Descriptions must be added manually, but if we dispose of pre-defined objects, they may be “retrieved” from it.

Elevations and cross-sections – are supposed to be automatically generated. There exists a misunderstanding that contemporary CAAD applications can only auto-generate elevations and sections, but that every detail must be placed manually. Computer will not solve insulation instead of a human...

Bill of quantities, specifications. Generally can be generated from a model, but their value depends on precision of material definitions. Sometimes there is not enough time to complete these data after a conceptual phase.

Conclusion
Architects moved their workshop to computers. As a benefit they got better efficiency and, according to Gehry’s words, “gained more control”. Simultaneously some problems arisen – new work organization, new “contraptions” at offices, simplification of some tasks (drafting, copying), specialization and so on. Despite all good and bad aspects of computers influence, “we’re now able to demonstrate design notions that would have been impossible (to convey) in the past.” (Kyun Kim, AIA) and that is progress.

References

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