SketchBoX
Martijn Stellingwerff

Most Computer Aided Architectural Design software suits the engineered aspects of design quite well but is lacking as a design medium. As far as sketching is concerned, many architects still rely on traditional media such as pen and paper and scale models. This paper presents a theory concerning design media and the application of typical media aspects in a spatial sketch program. SketchBoX is conceived as an experimental 3D version of a sketchbook. It can be used for the notation of primary forms and structures in ‘architectural’ space. The program consists of several transparent drawing surfaces that can be placed in relation to each other and in relation to models of design or different design contexts. Thus architects and students in architecture might be able to explore more adequately the spatial configuration of the built environment and they can comment within the models of their designs. Architectural group discussions and collaborative work can be enhanced by SketchBoX because visual annotations can be made directly in relation to a 3D model. This paper describes the consequent design considerations and expected use of the SketchBoX program.

Keywords: Exploration, Sketching, Commenting, Media, Creativity.

The nature of Design Media

At the Media department of the Faculty of Architecture in Delft, both traditional and digital design media are taught and explored. The potentials of new and existing design media are tested and new prototypes for design notation and representation are developed. We see computer programs, such as photo-editing software and spatial Computer Aided Design (CAD) software as important but still limited means for creative design. The expression and communication of ideas and other aspects such as collaboration and evocation are beyond the scope of most CAD software. In CAD, most ‘true media aspects’ are not supported. CAD is primarily useful for the creation of documents, databases and for the refinement of sketched ideas.

We educate students to develop their ideas in a spatial way, by means of pen and paper (van Haaften 1997) and scale-models (Breen, Olsthoorn 1993, 1996, 1999). Another important role in design and presentation of architectural design is played by our renewed endoscopy laboratory (van der Does et al. 1998). By means of an endoscope you can get an eye-level image of an architectural scale model. New medical optic endoscope tubes and small video cameras, good scale-models and direct interaction of movements can make architectural endoscopy comparable to advanced Virtual Reality (VR) systems. Simultaneously, we carry out research for better digital media applications. Such media should benefit the development and communication of spatial architectural design ideas.
**Media versus Instruments and Tools**

Instruments are different from ordinary tools because they are precise and refined for a specific task in a specific domain. Media can be distinguished from tools because they are open for different and even unintended uses. Unlike instruments, media are applicable for any domain. Media can represent content and they acquire meaning by the way in which we interact with them. ‘A medium is something which, whereas a tool does as demanded, does not always do as demanded but may as it were “kick back”.’ (Glanville 1994). Design media can add something through the way in which they reflect ideas we invoke by our actions.

Back to the topic of CAD software, we consider CAD as a useful tool. CAAD, which stands for a domain specific kind of CAD (A is for Architectural) can be considered to be applicable as an instrument. The many utility tricks of a modern CAAD program, can be very helpful in the production process of building documents. The influential book ‘Digital Design Media’ (Mitchell, McCullough 1991) does, in this sense, not cover its title, but it gives an extensive overview of computer functionality and available tools. The book is not about openness or evocative and reflective true-media aspects of certain computer programs. Future research should focus much more on the aspects of design media that can enhance creativity, in stead of tools that can enhance productivity.

**Creativity through Evocation and Situatedness**

Innovation is more of the same, except that it is improved. Creativity is one or more steps beyond innovation and goes further than improving the established solutions. Design media can help to make creative steps and they can give insight into what was not yet considered. Media can evoke new ideas. The images of media can stimulate imagination (Breen J. and Stellingwerff M.C. 1998).

Creativity is dependent on several contextual conditions. Amongst others, this has to do with ‘situatedness’, a term introduced by Clancey (Clancey, W.J. 1997). Situatedness is described as ‘where you are, when you do, what you do matters’. Most people have experienced the phenomenon of situatedness at the moment that they got a nice and good idea and suddenly lost it again. When they go back to the place where they first got their idea, they go back to that place in order to remember. This is their appeal to situatedness.

In order to give in to the conditions for creativity and situatedness in a design process, media can visualise contextual information in different ways. Presenting the right view at the right time can be helpful to evoke ideas and possibly a creative step can be made.

**Sketching and reflective conversation**

By sketching, the designer makes a personal drawing or note of certain contextual aspects of a problem which has to be solved. This can be seen as ‘noted situatedness’. Re-viewing the sketch makes it easier to understand the problem. The design problem is externalised by the brain and can be reflected on in a more relaxed and competent way.

Schön and Wiggins mentioned a ‘reflective conversation with materials of a design situation’. ‘A designer sees, moves and sees again. Working in some visual medium - drawing, in our examples - the designer sees what is ‘there’ in some representation of a site, draws in relation to it, and sees what has been drawn, thereby informing further designing.’ (Schön and Wiggins 1992).

Sketching is interaction in optima forma. The medium is filled with represented knowledge and key information for a specific problem. While the sketch is produced, the information on the medium is re-read and interpreted, the designer can take creative steps and re-draw, reflect and refine the ‘sketchy’ ideas. Through a series of iterative loops the sketching designer might be able to create an innovative design from scratch.
**New approaches**

The time span from Turing to 2000 has brought a wide variety of tools to the building industry. In terms of document production and project management, IT has achieved a lot. Generally the CAAD industry has brought very robust and useful tools. Many of these were developed in a metaphoric reference to real world phenomena (e.g. desktops, cut-copy-paste, layers and magnifying glasses). Such metaphoric software aspects do enhance and innovate the original tools, but they do not create new phenomena. Looking ahead, we should not only go on with making such enhancements, but we should create deliberate new applications without the mimic-like reference to what already exists. A non-metaphoric approach will lead us to new and useful developments that are not possible or thinkable without computers.

As far as sketching is concerned, the metaphorical approach results in a mimic of pen and paper on a computer screen. The result might include all brush strokes and paint effects and many other drawing enhancements, but it is not epoch-making. In contrast, as an example, the Electronic Cocktail Napkin program (Gross, 1994) provides a real new ‘intelligent sketching paper’ by adding trainable recognition and pattern matching to the mimicked drawing process.

**SketchBoX development**

The initial idea for the SketchBoX program derives from two considerations by which metaphoric sketch-paper in a computer could be transformed into powerful new concepts. In the first place, sketch-paper in a computer can be placed in relation to 3D-space. The sheets of paper are not exposed to gravity and do not hang askew. Secondly, paper which is mimicked in a computer can be perfectly transparent. This makes it possible to trace and draw in a very good relation to 3D represented objects.

Besides these two aspects of ‘paper’ in a computer there were some beliefs and views about the phenomenon of sketching which weighed in the design of the program. In the first place, sketching should not be surrounded by too many drawing limitations. In CAD programs it is often an advantage to have limitations like snapping effects and collision detection, but in sketching such programmed limitations would only bother the designer to express his or her ideas. Secondly, sketches should evoke further ideas by the quality of their images. This is still difficult in some cases. In the SketchBoX program, the drawing speed reduction as a result of a high

---

**Table 1 (right). A new approach for CAAD after 2000.**

<table>
<thead>
<tr>
<th>Turing to 2000</th>
<th>Beyond 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>keyword:</strong> robustness</td>
<td><strong>keyword:</strong> creativeness</td>
</tr>
<tr>
<td>Many metaphors for existing tools enabling better ways of:</td>
<td>What has been achieved PLUS unprecedented Instruments and Media for:</td>
</tr>
<tr>
<td>• Document production</td>
<td>• Multi-disciplinary collaboration</td>
</tr>
<tr>
<td>• Data / File Management</td>
<td>• Synchronous group interaction</td>
</tr>
<tr>
<td>• VR-viewing</td>
<td>• Situatedness and Evocation in VR</td>
</tr>
</tbody>
</table>

That kind of approach transforms the initial tool into a new medium with unprecedented possibilities.
resolution drawing is substantial. On the other hand, the evocative value of semi-transparent colours in the sketches is lucrative.

The first prototypes of the SketchBoX program resulted from an ongoing programming exploration in which many ideas were tested, refined, rejected or combined. After a year of experimenting, more programming experience was gathered and certain goals could be reached. Implicit questions about new media for design within a 3D-environment were asked. This resulted in three program variants which now (afterwards) can be introduced by headings of explicit questions. Each variant is the result of a non-metaphoric process and potentially brings new aspects and added value to computer aided design.

**What if … I could draw on the walls of the city?**

The answer to this question can possibly be explored with the first SketchBoX program variant in which you can put semi-transparent ‘wallpaper’ on the faces of a 3D model and draw on it.

The program makes it possible to have a VR walk through a modelled city, a street or a building and add ‘faces’ on walls and on the ground. The faces consist of three adaptable image layers. First there is a background with a plain surface of a semi-transparent or opaque colour, this helps to distinguish the ‘wallpaper faces’ from the wall or floor behind. Then there is a texturemap layer which represents a grid, a dot or a hatch pattern. The pattern can help you as a guiding layer for a freehand sketch. Finally, on top, there is a layer on which you can draw with ordinary bitmap drawing tools (e.g. freehand line, straight line and filled area). The combination of the three layers provides a wallpaper on which you can draw and trace in relation to a context model depicting parts of the built environment or a design.

**What if … I could relate my sketchbook pages spatially?**

The program variant linked to this question makes it possible to put drawing planes in 3D relation to each other and in relation to context of spaces and objects represented in a 3D model.

Similar to the wallpaper program variant, you can draw on semi-transparent surfaces, but in this case the surfaces can be placed free in space. This variant provides 12 drawing surfaces which can be moved and rotated in relation to each other. Thus you can create and explore spaces that exist between the drawing surfaces. As you can draw lines and rectangles in many colours and in filter-like transparent colours, you can easily get the impression of doors and windows in a wall, without difficult Boolean operations.

Difficult in this program concept is the fact that the drawing can be obstructed by other surfaces which are in between. How to draw on a surface which is...
not immediately in front of you? This has been solved by the user interface which provides a planar projection of a selected surface. While you draw on the planar projection, the drawing also appears on the surface placed in 3D.

What if... I could place a sheet of tracing paper over the PC-screen?

Of course it is possible and efficient to sketch with tracing paper over printed computer images, but a more integrated way of doing this is provided by the third variant of the SketchBoX program.

While exploring a VR model, you can activate a semi-transparent drawing surface between you and the model. On the drawing surface you can make annotations very similar to the way you would do with a marker on a plotted architectural CAD drawing. The annotations will be stored together with the viewpoint co-ordinates. This makes it possible to exchange the drawing and annotations in an exact relation to the model. Thus a shared point of view is created and remarks based on a complex 3D model can be understood more consistently.

All SketchBoX variants have been programmed in Java-Script and Virtual Reality Modelling Language (VRML). The information of sketches can be related to a VRML model which is placed on an Internet file-server. For future versions of the program it is envisioned that the information of the sketches themselves and their spatial placement in relation to the model can be exchanged by means of direct Internet protocols or as an attachment to an E-mail.
This enables the program to be used for synchronous and a-synchronous collaborative sketch sessions and virtual annotation work. For further information about the development and use of the program, you can look at: http://www.bk.tudelft.nl/users/stelling/internet/programs.html

**SketchBoX in use**

Essentially in all variants of the SketchBoX program you can place a drawing surface in relation to a 3D VRML model. This allows you to draw in reference to a simulated context. The context of the drawing can be a representation of the real world (e.g. the surroundings of a building site) or it can be a 3D-CAD model of a design option.

Each program variant has its own characteristics and utility in the design process. The ‘wallpaper variant’ (2.1) allows direct drawing actions related to the surfaces of a model. This is assumed to be useful for analyses of the built environment and building design and makes it possible to sketch over the form and structure of spaces and objects. Thus it might become possible to investigate influences of surrounding surfaces on the spatial articulation of urban spaces.

The second variant in which drawing planes can be placed in relation to each other, makes it possible to evaluate bigger ‘design interventions’. By placing a drawing surface within a represented urban space, it becomes possible to explore the impact of certain forms, structures and colours in that space. By moving the drawings in relation to each other, one can explore the influence of height, depth and width of a space in relation to the surface characteristics.

In the third variant of this sketch program several 2D sketch surfaces can be placed over a 3D model. Each surface is related to one single point of view. This is assumed to be useful for making annotations related to a design proposal. By binding the viewpoint to the sketch, the annotations of e.g. a contractor can be understood in direct relation to the model. Actually this is a way to bring more objectivity in the communication of comments to design, because the subjective point of view is shared along with the comments.

At the moment the three SketchBoX variants are being tested in a PhD research about ‘Design in Context’. Next year a test among students is scheduled. Based on the results of protocol analyses in which architects and students will be involved, further developments of the program will be made. Further results will be reported at the next eCAADe conference.

The here presented concept of sketching in three dimensions, refers to the above described media aspects. On the one hand the development of the program is an attempt to introduce a transformation of the concept of sketching, on the other hand it tries to adhere to the typical quality aspects of sketch media which can be summarised as: related, direct and unrestricted.

**References**


J. Breen and M.C. Stellingwerff, Imaging Imagination, workshop held during the 3rd EAEA conference in Delft. 1998, Results and descriptions at [http://www.bk.tudelft.nl/media/eaea/imim/](http://www.bk.tudelft.nl/media/eaea/imim/)


R. Glanville, Representations Fair, Honest and Truthful” in Materialy Konferency Jne, conference proceedings on computers in architectural design, 1994, Technical University of Bialystok, Poland.