A Real Time 3D Environment for Collaborative Design

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Abstract: By setting up collaborative design processes in architecture it is possible to considerably improve the integration of customer needs and ideas into the programming phase of a building project. Our design process includes active collaboration between customers, users and other stakeholders as well as the use of virtual environments in conceptual design. The output from the process is treated as visualised input to the architectural programming. The work presented focuses on developing digital tools to support this collaborative design dialogue. We have developed an extremely "easy to use" digital modelling tool called "ForeSite Designer". The tool enables the users to build layouts of prefabricated components on a building site in 2D. This 2D layout can then instantly be exported to a lit-up real time 3D environment in the computer game "Half-Life." ForeSite Designer has been used in a several design events with different settings. This paper presents the tool and one project where it was utilized. The results show that ForeSite Designer can promote dialogue and collaborative design work among the participants. We have also found that it is important how the virtual environment and its components are visually designed in order to support the dialogue and collaborative design work.

1 DESIGN FOR ARCHITECTURAL DESIGN

1.1 Architectural Programming Rethought

To handle today's speed and unpredictability of change, a new focus on customer needs has emerged in the real estate business. The new focus means a greater attention on the core business of the client instead of the traditional internal technical questions of the building industry. Different methods to identify and map customer expectations have developed, especially within the field of architectural programming.

Today there is a common opinion among representatives for core business and corporate real estate that finished projects often do not meet the goals or add the expected value to the core business. In a recently undertaken study in Sweden it is noted that insufficient programming was ranked the most important reason to malfunctions with the finished building (Granath and Hinnerson 2002). Granath and Hinnerson suggest that discrepancies between goals and outcome are a matter of lack of communication and participation of client and end users in the programming phase. Those who actively participate in projects are happy with the outcome and those who don't are often more unhappy with the result.

There are principally two different ways to regard the role of the programming in the architectural design process. One sees programming as totally separated from the design phase and thinks that it is possible to get hold of the problem independently of a possible solution. With this more traditional view you describe the architectural programming as the exploration and decision process that defines the problems that are to be solved by design. An alternative way, which is in correspondence with the approach in this paper, is to see the identification of the problem as a part of the solution, that means to see architectural design with all its phases as a permanent design process that continues through the whole building project.

Atkin and Özkaya suggest a design model where it is an accepted fact that the solution often evolves before the requirements and that each design decision and solution serves as a new requirement to the next stage of design (Atkin and Özkaya 2002). Requirements and solution worlds are with this view not separated from each other but grow in the same design space. Design requirements act as constrains but are not predefined and analysed but are considered as design evolves. This is in harmony with traditional architectural practice where the programming is often considered as an integrated part of the design. Design can in this way be viewed as input to new design, as a way to reveal and identify requirements for the architectural programming.

1.2 Collaborative Design for Architectural Design

By setting up collaborative design processes in architecture it is possible to identify customer needs and ideas and bring them into the programming phase of a building project (Fröst and Warrén 2000). The concept of collective or collaborate design has been introduced in several fields (Binder et al. 1998). Collaborative architectural design can be regarded as a method of bringing customers, users and different stakeholders together in the design process and in that meeting facilitate the production of new knowledge. Granath means that this also makes them able to take active part in the redesign and in the management of the designed environment that demands change (Granath 2001). He identifies three stages of development for motivation of participation of users in the architectural design process. From democratic motives in the seventies to a concern on the quality of the product/building and in resent years awareness of how important participation is for the learning process inside the client organisation. At the moment we tend to see participation of the users as a way of achieving quality in terms of all three aspects, according to Granath.

2 METHODS AND TOOLS FOR COLLABORATIVE DESIGN

2.1 Partner Engaged Collaborative Design

Collaborative design as identifier of customer needs and producer of input to the architectural programming calls for a “partner engaged collaborative design process” that integrates users, external partners and designers, and which offers new methods and tools (Johansson et al. 2002). Multiple and to some degree competing stakeholders are engaged in the process from the very beginning. It builds on collaborative observation, inquiry, design and evaluation as a way to understand the design task, and advanced visualisations in conceptual design and scenario building. The design process consists of different design tools and design events, such as walkthroughs, video, scenario building and visualisations. From a process of inquiry and documentation of different types of work, participants are invited to collaborative design and conceptualise the new work environment through a series of exercises.

The partner engaged collaborative design process ensures that all different partners simultaneously are given the opportunity to speak and meet in an open dialogue. The dialogue between the participants is a key issue. Activity in the process is based on the relevance of the participant’s knowledge and experience rather than on their roles as representatives of different interests (Lindhal 1996). This process open up for learning more about the workplace through design, make it possible to better articulate an understanding of ones own organisation and achieve a positive experience of engagement and enthusiasm.

In accordance with the purpose to use design as a generator of knowledge, which shall be incorporated into the programming process, it is important to distinguish between actual design work of physical artefacts and the use of design to produce conceptual ideas. You must be very clear in the framing of the design commissions regarding what the collaboration really is about. To focus on the conceptual ideas in the early phases opens up for a lot of possibilities and prevents design work to be hindered by lack of relevant information or competence.

2.2 ForeSite Designer - A Real Time 3D Environment for Collaborative Design

The research presented in this paper is primarily focused on the application of digital design tools and real time 3D/ virtual reality into collaborative architectural design settings that includes users and other stakeholders. As opposed to collaborative design between professional design teams, the incorporation of the future users and other stakeholders are rather absent in resent attention on collaborative design and CAAD, and has not found its way into the CAAD community (Achten 2002). His assumption is that during the seventies and early eighties, when participatory design was established as a field of research and practice, the use of computers was not as common as today.

In our case, early experiences with the use of virtual reality Cave led us to the belief that there are alternative paths away from the “high-end” virtual reality. Modern real time computer game engines (Quake, Half-Life, Serious Sam etc) are advanced real time 3D modelling and representation tools (Fröst, Johansson and Warrén 2001). Based on a commercial computer game, we have developed our own working prototype for an interactive sketching tool. The prototype is extremely “easy to use” and is named “ForeSite Designer” (FSD). FSD enables the users to “sketch” architectural layouts on a building site in 2D on the computer screen (Figure 1). This 2D layout can then instantly be exported to a real time 3D world in the computer game “Half-Life”. Like in several other modern computer games the visual qualities in Half-Life are sufficient for architectural representations, at least when the design problems still are in a schematic design phase. Half-Life produces a lightened real time 3D environment with low detailed geometry and high quality texturing (Figure 2).

The idea is to work with 2D images that one can freely choose, combine, copy and arrange in many different ways. The images can represent a wide variety of different elements according to the possibilities in a modern computer game. It can be physical building elements as walls, windows, furniture etc but also entities as images, sound, animated textures, text, persons with pre-programmed behaviour etc.

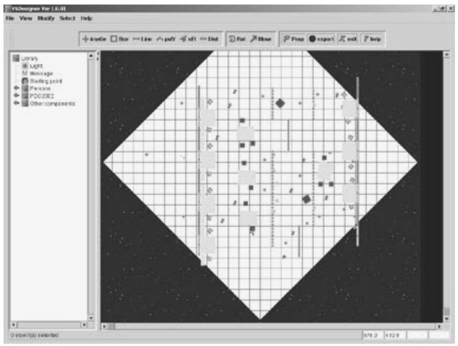

Figure 1 ForeSite Designer with Playground (Chalmers Studios)

FSD consists principally of two libraries connected to each other, one that contains 2D images to be placed on the playgrounds and one of predefined geometrical 3D objects or entities in Half-Life (Figure 3). A rectangle in FSD can for example be connected to a table in Half Life.

When using FSD you start with choosing a specific “playground”. The playground can be everything from an abstract empty scene to an elaborated architectural space. On this playground you are now able to work with different figures and prefabricated components. They can be acquired from the FSD component library or specially built and tailored for this special occasion. You select the components in a menu next to the playground. Now you can click on the playground where you want to place your component. It is possible to move, rotate, copy etc the component. You can also draw lines and squares on the floor to mark certain areas, measure distances between components, write down notations or messages etc. The playgrounds can have default lighting but it is also possible to actively insert light sources and in that way use light as a building element. When you want to transform your 2D layout to a real time 3D environment you compile it by clicking the compile button and within 30 seconds to 2 minutes you can enter a Half-Life world. By just closing Half-Life you are back on the 2D playground in FSD and are able to go on with the design work, modify the design etc. It is always possible to go backwards in the process and return to old versions, which are stored.

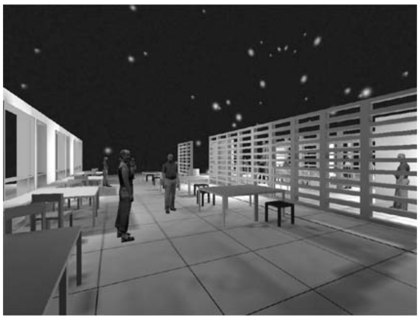

Figure 2 Real Time 3D in Half-Life (Chalmers Studios)

FSD is developed and optimised for the use of unskilled persons who has between a half and three hours to learn and use the sketching tool. This is a big advantage when working with diverse groups who has very diverse computer knowledge. FSD is in accordance with this purposely made very simple and there are a lot of things that FSD, compared to “professional” 3D software, cannot do.

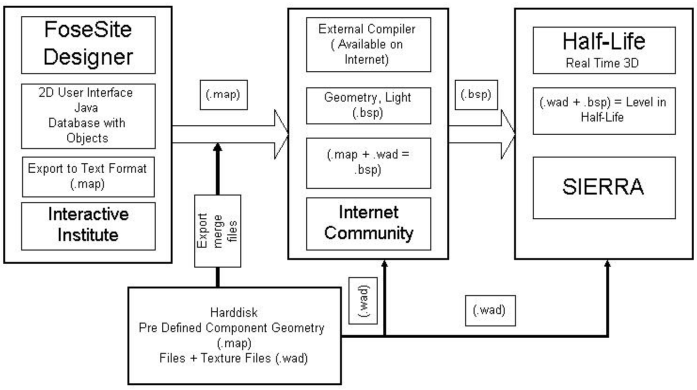

Figure 3 Relation ForeSite Designer – Half-Life

Earlier work where we have been employing various visualisation tools in collaborative design of architectural spaces has shown that virtual reality immersiveness provides a good common ground for evaluation of design proposals. It is however, according to our experiences, less supportive for developing new design suggestions (Fröst and Warrén 2000). To be able to be active in reflective design discussions, participant's needs to share a birds-eye-like observer perspective that enables them to grasp a conceptual totality, which is not available when immersed in a particular design vision. In FSD the 2D interface gives a good overview for collaborative design decisions and the real time 3D a good environment for evaluation.

3 CHALMERS STUDIOS

ForeSite Designer has during the last years been used in several projects together with external users, partners and other stakeholders. In these processes ForeSite Designer has played an important role as a design tool and facilitator of dialogue and collaborative work (Fröst 2002).

Together with the Department of Architecture at Chalmers University of Technology, Göteborg, Sweden, a two-day workshop was conducted with the goal to find new solutions to the student studios for architectural education. The background was that the Department of Architecture had a pressure on itself to save money and realized that their amount of available space was high compared to others departments at Chalmers. Was it possible to leave the "one drawing table per student" concept and instead develop a table sharing concept with the support of new technology as laptops etc? This opens up to a totally new way of interpreting the spatial needs for learning architecture.

We worked together with a group of fifteen students of architecture (year 3 and 4). They went through an event driven design process starting with a collaborative enquiry exercise. This was performed as a plenary reflection on a student produced photo documentation from their existing studios and work environment. In this session qualities, which were important to keep in a change process, where identified, discussed and prioritised.

Figure 4 Group Work with ForeSite Designer

The next step was to let the students design their own “dream workplace”. This was a sort of “brainstorming” where everybody was given great freedom to develop his or her individual dreams. The ideas were presented to the group. From this aspiration phase we went on to the negotiation phase and introduced the students to a “design game”. The participants were equipped with sets of cardboard tokens and given the task to build their future studios in small groups. The tokens could represent any chosen objects or functions and be arranged freely in different relations with each other. In parallel they were offered ForeSite Designer as a modelling and visualisation tool (Figure 4). Non of the “playgrounds” was related to a specific building, the aim was only to develop conceptual solutions focusing on functions, qualities and their relation to each other. The groups worked both with the digital and the analogous sketching material during half a day. The workshop summed up in a plenary presentation. The groups presented their work on the wall and invited the other participants to a walkthrough into their new virtual studios (Figure 5).

Figure 5 Presentation with Walkthrough

The result from the workshop was four developed conceptual proposals of future studios, which are illustrated in plans and as 3D models. The proposals can of course not be copied when the project continues, but they can be used as an information source for identifying important qualities that are to be incorporated into the programming process. As in other collaborative design projects, there is also another important outcome. The participants, representatives of the future users of the new studios, gained a new awareness and knowledge of themselves as part of the school of architecture and what they actually do when they work, that is, when they are learning to become architects.

The virtual environment in the Chalmers studios case was designed with the purpose of being non-realistic. The playground was a square 25 x 25 meters with a modular system of one meter as floor pattern. There were no roof or exterior walls, the place is somewhere under the night sky. Components and furniture had an abstract “Mondrian-like” look with sharp volumes and primary colours.

In this project, ForeSite Designer played a crucial role as an arena of building spatially arranged concepts of future environments. In that process, the collaborative sketching and evaluating promoted an active dialogue between the participants. The result indicates that ForeSite Designer is able to promote a collaborative engagement among the users, and in that engagement also stimulate the development of new ideas.

4 CONCLUSIONS AND DISCUSSION

How then, does ForeSite Designer support dialogue, team building and creativity in a joint process as the one just described? In the world of architectural design, sketching and the use of sketches are the real heart of visual communication, essential to design work and communication of ideas. Designers talk and sketch simultaneously, not just with one another but also with other stakeholders in the design process. Why are sketches and visual representations, in this case the FSD real time 3D environment, so powerful?

Leigh Star has introduced the term “boundary objects” into design theory (Star 1989). It is objects that allow members of different groups to come together for some common endeavour, though their understanding of the object of their mutual attention may be quite different. They may be shared but they do primarily tie together the different collaborating groups by allowing different interpretations within each sub-community. Design sketches and visualisations could in this sense be regarded as boundary objects that help integrate different perspectives.

Henderson explores the role of visualisations in the design work made by engineers (Henderson 1999). Through observations in two engineering settings, she sees design work very much as a question of handling collective knowledge. Designers use visualisations both to organise work and knowledge, at the same time engage, and organise resources and power. Designers talk and sketch simultaneously, not just with one another but also with other stakeholders in the design process and with those who are responsible for the production. In these way visualisations opens up to mixed use practice. Henderson’s concept of “conscription devises” is to underline visualisations in their role as network organizing devices. Visualisation might work as a conscription device when it is created and adjusted through group interaction with a common goal. To participate in the design process, actors must engage one another and interact through visual representation of the conscription devise. They focus their communication in reference to the visual device. And in this way they become tied to each other and part of the team. The conscription device focuses on the design process while the boundary object focuses on the product. Henderson also develops the idea of visualisations as “meta-indexicals”. By that she means that visualisations, by referring to a multitude of codes on different levels, are extremely flexible in their interpretation and facilitates multiple readings. In that way they function as holding grounds where codified and un-codified knowledge can meet, and establish a negotiation space for both tacit and manifest knowledge. The chameleon, meta-indexical elastic quality of visualisations facilitates mixed use practice, multi visual competency, and enhance the creativity of individual and group design work. Visual representations establish an arena where negotiations can be held.

Sketch-like virtual environments as in FSD can, if appropriately designed, be very powerful as facilitator for collaboration around concept expansion and evaluation in architecture. They function both as tools for expanding individual ideas and interactive communication tools simultaneously. Their interpretation can freely jump between different grammars, produce meaning on many different levels and in that way refer to a multitude of codes. They can build on well-known examples, refer to established knowledge and codes (styles) and juxtapose it with new invented components. This could be the “meta-indexical” role of real time 3D visualisations, which allows them to be more than the sum of their parts.

We have found in earlier studies that virtual environments used in collaborative design processes are not particularly dependent on explicitly naturalistic representations with for example photo realistic visualisations of an architectural space (Fröst and Warrén 2000). We have also found that low detail performance of sketch-like real time 3D models often promotes discussion and creativity. It is therefore most important that the visual design of the virtual environment and its components is made to support an explorative design dialogue.

5 FUTURE WORK

In the future we will continue the work with developing virtual environments where multi disciplinary design groups are supported in specifying design requirements with visual modelling as the design driver. Based on the discussion, it is challenging to examine how real time 3D visualisations in architectural design could be developed and visually designed, to promote the establishment of collaborative design arenas, support dialogue and enhance the creativity of individual and group design work. As a hypothesis for future work we assume that architectural real time 3D environments used in conceptual phases of a collaborative design process should:

- Have an information density coordinated with the design task.
- Be visually open – not offer a finished world.
- Support a multitude of interpretations.
- Have a conscious reference to visual metaphors.
- Be designed with an awareness of their relation to conventional codes and connotation systems.

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