Interactive Tools for Collaborative Architectural Design

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ABSTRACT

Today's rapidly changing society is continuously developing towards an increased demand for multi-stakeholder knowledge and influence in the architectural planning and design process. Accordingly, we are working with developing and setting up a partner engaged collaborative design process. It includes active collaboration between users, external partners and designers, and visualizations in conceptual design and scenario building. My research is focusing on integrating visualization technology in these processes by application of digital tools. We have developed a working prototype for an interactive design tool. The prototype is an extremely "easy to use" digital modeling tool called "ForeSite Designer." With this tool one builds one's own spatial environment with elements on a 2D surface. With one command the 2D layout is exported to a lit-up 3D/Virtual Reality world in the computer game "Half-Life". ForeSite Designer has lately been used in a series of workshops together with external users. In these processes ForeSite Designer has played a crucial role as an arena of building spatially arranged concepts of future environments. The results show that it works, and, importantly, promotes a collaborative engagement among the users.

1 THE CONDITIONS FOR ARCHITECTURE AND PLANNING HAS CHANGED

Today's rapidly changing society is continuously developing towards an increased demand for multi-stakeholder knowledge and influence in the architectural planning and design process. Architecture handles large, complex, expensive and long-lived artifacts, and thus engages many participants with different ambitions and interests in planning and design. The design issues often involve complex functional interdependencies, conflicting values and cultural clashes among stakeholders (Strömberg 2001).

During the last decade, mayor changes have taken place in the economy and business, high tech companies, new media, communication and financial services, etc. The impact on society and business from the rapid development of information and communication technology, the fierce global competition, and the restructuring of society on a grand scale give birth to new types of companies, products, and markets. The modern workplace is accordingly characterized by a state of permanent change, development, and reconfiguration, caused by the introduction of new technology, changes in the structure organizational and the financial architecture of work, and new ways of interaction with customers and the external world.

In contradiction to these drives towards rapid change, many organizations and corporations choose, actively or passively, to work in traditional and rather stiff spatial

structures. Often the mental images of one's workplace and how to design it have a power to persist even when the foundations for their existence have changed. When technology support constitutes an increasing part of work, workplace design is no longer just a question of architecture in the sense of spatial arrangement and furniture. Technology support has to be designed and integrated with spatial design. Every single commission must be solved from its own unique requirements.

2 A NEED FOR NEW DESIGN ENVIRONMENTS

When change comes quickly and many stakeholders are engaged in complex design assignment of the spatial arrangement of the workplace, technology and the infrastructure, there is a need for a new way of conducting workplace design. You must design a process that simultaneously takes into account the physical space, the furniture, the technological support and the activities that are going to take place within the workplace. The complex tasks of shaping the modern workplace need a new design process with the active participation from users and different stakeholders (Duffy 2001). Such a design process needs a new approach to carry out, as it requires that people who have competencies within various fields work together simultaneously on the same design task.

In our research group at the Interactive Institute in Sweden, we have during the last year been working with the challenge to design design-processes in architecture that involves users and a manifold of different stakeholders in joint design commissions. Focusing on workplace design our goal is to set up ("Design Lab") and investigate a design process that integrates today's complex and fast changing conditions and the bouquet of multi disciplinary partners who are engaged in the work to shape the modern workplace.

My own research is primarily focused on the study of how the integration of advanced visualization technology into these design environments, by application of digital tools such as 3D modeling and Virtual Reality, can support the design process. These visualizations are introduced in the collaborative design of prototypes and scenarios and in validation of design proposals. For example, in concept design the visualization serve as a tool for scenario building, and in architectural design they serve as a tool for preliminary evaluation.

3 PARTNER ENGAGED COLLABORATIVE DESIGN

3.1 **Limitations in Today's Praxis**

It is our conviction that the workplace of tomorrow more and more will be developed together with the users who are in the centre of change, and who are the holders of intimate knowledge about new ways of working. But user participation in the traditional manner is not always enough. In modern Scandinavian praxis, the users are

asked to give information and formulate demands about their outspoken needs and explicit requirements about their work environment. From this information the architect makes design proposals that is evaluated and finally decided by the management.

In our view, this approach is sometimes constrained concerning the ability to integrate the demands of a continual changing work life and the introduction of new technology. The result run the risk of being a confirmation of preconceptions of how work environments used to look like or, at worst, an adaptation to the latest trends in interior design. To handle today's complex design assignments, we think that there is a need for a more simultaneous, flexible, open and engaging design processes. A need for setting up design environments, which integrate users, external partners and designers, and facilitate a new generation of tools to support this creative dialogue and engage the participants in collaborative design.

3.2 **Partner Engaged Collaborative Design**

Our concept of a partner engaged collaborative design process means that users and other stakeholders are involved together in the design work. With partner engaged collaborative design, we are focusing on three aspects of the design process. Partner emphasize on *who* is attending, engagement on the *role* of acting (engaged in relation to participate) and collaborative about *how* it is carried through. It includes active collaboration between users, different stakeholders and designers. 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 work, and advanced visualizations in conceptual design and scenario building. The design process consists of different design tools and design events, such as walkthroughs, video, scenario building and visualizations. Exercises with the aim of revealing the nature of work and surfacing the values imbedded in the work practice, "what is really being done and why," are conducted. From this process of inquiry and documentation of different types of work, participants are invited to conceptualise the new work environment through a series of exercises. From these exercises a number of "scenarios" about potential work environments are developed, which also are visualized in different media. The partner engaged collaborative design process makes sure that different partners simultaneously are given the opportunity to speak and meet in an open dialogue. To the participants the process opens up for learning more about the workplace through design, to be able to better articulate their own understanding and achieve a positive experience of engagement and enthusiasm.

4 DEVELOPING INTARACTIVE TOOLS

The framework of a design process is dependant on the type of design tools that is used. The architectural drawings that are created to describe the building in the traditional process, is a very suitable tool for the professional actors. (Campell D A,

Wells M, 1994). An expanded design group, including customers, end users, tenants, community groups, citizens etc, means that new demands being laid upon the design tools. When the main objective for the outside participants still is evaluating design proposals, these must unite the quality of being an effective design tools for the designers and the possibility to create an understanding for others involved. Different forms of visualizations, such as perspective renderings and scale-models, have therefore been developed to create an understanding and communication around the planned construction work. To further facilitate the communication and the information handling, new digital tools have been introduced, as for example 3D visualizations and Virtual Reality. These facilitate an increased understanding for those people who are unused to the traditional design tools. (Zobel R W Jr 1995).

4.1 **Collaborative Design Demands New Tools**

External participants need for visualizations are most crucial in the early phases of the design process. This is particularly true in partner engaged collaborative design where different stakeholders themselves are engaged in the design work with sketching of different kinds. An inequality in the possibilities to grasp and understand the design proposals which are to be interpreted, creates a situation where an inequality also are established concerning the influence different persons has possibility to achieve on the design process. Here it is important to develop easy methods to transform these sketches into understandable visualizations, without having to spend too much work on producing an arranged, by necessity restricted, selection of the presentation material. How new technique as Virtual Reality may facilitate and change collaborative design processes have been described by (Goodfellow D 1996). We have also found that Virtual Reality used in collaborative design processes is not particularly dependent on explicitly naturalistic representations with for example photo realistic visualizations of an architectural space (Fröst, Warrén 2000). Of much greater importance is the possibility to explore the visual representations without a predetermined conceptual understanding. That put demands on finding suitable methods and tools for analysing architectural VR visualisations and to practically design and develop these in order to be used in a collaborative architectural design process so that they can enhance the creativity of group design work.

4.2 **Design Games**

In a collaborative design process, it can be revealing for the involved “players” to look at the conceptual design phase in terms of a game, with its internal rules and different interests competing with each other (Horgen 1999). We have therefore tested different "design games" in different settings. In these design games the participants have been equipped with sets of cardboard tokens or Lego pieces. These can represent any chosen objects or functions and be arranged freely in different relations with each other. With these pieces different layouts of the future work environment have been arranged, “discovered,” and negotiated.

4.3 **ForeSite Designer**

During the past year we have worked with the task how to integrate the experience from use of the design games into the development of an integrated modelling and VR-visualization tool. The endeavour is to investigate how a digital design game would work and how its usefulness could expand when it could be possible to transfer the 2D cardboard pieces to a 3D/Virtual Reality world (Fröst, Johansson, Warrén 2001). We have therefore developed a working prototype for an interactive tool to be used in collaborative architectural design processes. The prototype is an extremely "easy to use" digital modelling tool (an application written in Java), called "ForeSite Designer" (FSD). FSD enables the users to build spatial worlds of prefabricated components on a building site in 2D on the computer screen. This 2D layout can then instantly be exported to a lit-up 3D/Virtual Reality world in the computer game "Half-Life." The idea is to work with 2D images ("cardboard tokens") that one can freely choose, combine, copy and arrange in many different ways. In this way you are invited, as in the design games earlier described, to collaboratively work together with building an environment. 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.

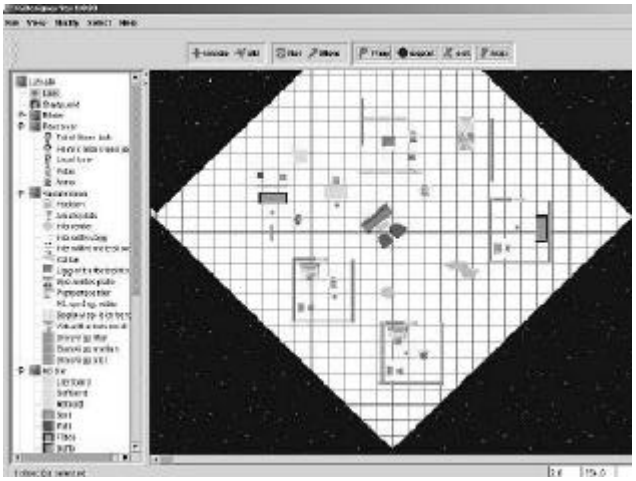

Figure 1. **The 2D playground in ForeSite Designer**

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 the different 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 just click on the playground where you want your component to be placed. It is possible to move, rotate, copy etc the component by choosing this

option on the menu at the top. 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.

FSD is developed and optimised for the use of unskilled persons who has between a half till three hours to learn and use the design tool. It is designed for providing untrained, non-professional participants with a tool for rapid interactive designing and evaluating ideas in collaborative settings. 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.

5 THE EXPERIMENT OFFICE – A PROJECT EXAMPLE

Together with four different partners (IBM Sweden – Information Technology, Vasakronan - Real Estate, Kinnarps - Office Furniture and Telia Research – Communication Technology) the Interactive Institute are setting up an Experiment Office for the future workplace. It will be a real work environment where different project organized companies will be invited to try new workplace arrangements and technology. The partners are providing the office with what they can deliver respectively and which are in the forefront of their own products, modern office space, furniture, supporting technology etc. In this project, the partners anticipate to establish a platform for cooperation and development of new products and concepts, which can be implemented and tested on a workplace in operation.

5.1 **A New Mission Demands New Methods**

The mayor role of the Interactive Institute in this project was to develop the concept of the Experiment Office through a series of three design workshops, which were carried through during autumn 2001. The challenge was to bring together four different companies with a diverse group of persons and competences on a common task. Their commission was to outline the essence of the project, to explore the relationship between space, technology and actions and to develop new office solutions for the office of the future.

Each of the three workshops had a different focus. The first aimed at setting the "stage" for future office work, the second introduced the "props" for supporting activities in the form of IT products. The third workshop had the main purpose of staging a number of scenes weaving the story of the future office from the perspective of the individual worker, and conveying a shared conceptualisation of future office workspace and technology. FSD was used as an interactive design tool in all three workshops. It was predominantly a similar setting in all of the workshops. They started with a collective reflective session, where different design artefacts as video cards etc where utilized. During the second half of the workshops, FSD where facilitated as a design tool. This exercises where performed as group work and the

participants where divided in five to six smaller groups with three to four members per group. The workshops where finished with a collective large screen presentation of the Virtual Reality worlds which had been built in the groups. Creating scenarios was central in tying the design process together. The presentations where all accompanied by short scenario stories about what eventually could happen in the modelled work places.

5.2 **Relating pre identified components spatially**

In the first workshop the commission for FSD was to facilitate a playground where the participants could place images in relation to each other. The participants had been acquainted with the images in an earlier exercise where each image was associated with a video snippet. Each video snippet represents a scene from an office workplace. The task was to identify relevance and prioritise between the images. Given was a playground/scene that was an empty floor 25 x 25 meters, situated in an abstract desert environment. Signs with numbers related to images from video snippets where at hand as building components. To support the building with images a small set of wall elements where also available. The spatial relation between the components were placed in focus when the possibility to quickly alter between 2D and 3D representation in FSD where utilized and you where able to walk around among the images. The participants took the step from prioritisation to spatial relating components that constitute an office workplace.

Figure 2. **3D/Virtual Reality. Walking around among images. Workshop 1**

5.3 **Making scenes for stories about work**

In the second workshop FSD was utilized to support the building of spatial scenarios for stories about modern office work. FSD were equipped with a set of prefabricated stages (which were based on the discussions and conclusions from workshop 1). The stages were accordingly more elaborated than in the first workshop and illustrated

three different types of structuring the spatial relations or abstract conceptual stages: "the path", "the nerve centres", and "the eye". With these scenes the participants were asked to firstly choose a relevant one for their intentions and secondly to arrange and furnish a modern workplace with its physical components and technical support structure intervened. The “props” provided where deliberately designed to be open or with a “low level of detail” The reason was that we wanted the discussion to still be dealing with principle qualities and not “drown” in details, and as shown by Brandt (Brandt 2001), the more detailed a model the more detailed discussion. Building components consisted of simple geometrical forms e.g. cubes, tetrads and the technical infrastructure where represented with signs which the name of a certain equipment or service (for example “presence manager”) which could be placed on the scene. It was also possible to write and ad new signs. The participants modelled a stylised workplace with reception area, common work areas, meeting places, private workplaces etc. The stories where mainly focused on situations in daily work when a certain event, for example a costumer meeting, takes place or a problem suddenly occur; someone is ill and the meeting has to be taken over by someone else. A central feature in this exercise was the possibility to populate spaces with virtual persons. The presentations where conducted as promenades around the office together with an “actor”, accompanied by the performance of the story.

Figure 3. **Interior scenery created with ForeSite Designer. Workshop 2**

5.4 **Building concepts of spatial solutions**

In the third workshop the commission was to build an actual concept of a working environment for the Experiment office. The preconditions were that a specific space of ca 170 m^2 was given as the place where the Experiment Office should be built and realized. In accordance with this the premises where modelled as an actual 3D representation with doors, windows etc. Through the window you cold look out on the surrounding buildings and environment. Interior walls, furniture and other utensils

where built as scale models with stylised geometries. This time the technical support systems where visualized in two ways. As building components when they had a physical representation. A large screen projection screen for remote collaboration was for example shown as a wall with an animated texture applied to it. When there was no physical correspondence, as with a Wireless Local Area Network, WLAN, it was represented with a sign, which could be placed out freely. In this final workshop, the participants built complete virtual concept proposals of an actual office layout that integrated information technology solutions.

Figure 4. **Interior from a concept proposal of the Experiment Office. Workshop 3**

6 HOW FORESITE DESIGNER CAN SUPPORT PARTNER ENGAGED DESIGN

6.1 **Visualizations open up to mixed-use practices**

In the world of architectural design, sketching and the use of sketches are the real heart of visual communication, essential to design work and communicating ideas. Designers talk and sketch simultaneously, not just with one another but also with other stakeholders in the design process. In these way visualizations opens up to mixed use practices. The drawings and sketches structure the work process and are the building blocks of technological design and production. The visual representations act as tools for organizing the process from design to production and in that way serve as glue between individuals and between groups. Visualizations shape the final design product but influences also the structure of work and who may participate in it (Horgen at al 1996).

6.2 **Offering an arena for team-building and negotiation**

The concept of "boundary objects" was first introduced by Leigh Star (Star 1989). A boundary object in science is a material object that facilitates the coordination of scientific work, because specialists while being simultaneously readable by generalists can interpret them in a focused way. 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 allow for both more specific and restricted readings of codes to be embedded within a more universal one. Design sketches (and drawings) are in this sense boundary objects that help integrate different perspectives and establish an arena where negotiations can be held.

Kathryn Henderson (Henderson 1999), in order to emphasize visualizations in their role as network organizing devices, developed the concept of "conscription devises". Henderson has studied the use of assembly drawings in the engineering factory. She finds that these drawings play an important role in tying together engineering work, as they are circulated between the different groups in the factory. As they are circulated they get annotated and modified, and in this way they carry the imprints of their interpretations. She calls the drawings conscription devices as they form the glue that ties the activities of the different groups together. A digital visualization might also 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. 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. In the Experiment Office project, FSD functioned as a tool for visualizations, which enabled joint conversations at the same time as it allowed for flexibility, and ambiguity that made the collectively produced results suitable boundary objects.

6.3 **Promote a multiparty design dialogue**

In a design process that involves a diverse group of stakeholders, all with their own expertise, it is an endeavour to create a common language, a ground on which the different partners can found a dialogue. The interactive work with FSD illustrates the seeing-moving-seeing design cycle, which is observed by Donald Schön (Schön 1992) as a reflective conversation with the design material.

It is not obvious how such a conversation can expand from the individual designers mind and turn into a collaborative enterprise. Ehn have suggested to see multi-person design sessions as a meeting of language games, and have argued for the need to create shared design artefacts that can span the gap between these language games (Ehn 1988). A conclusion from the Experiment Office workshops is that FSD could help producing such design artefacts.

Figure 5. **The participants work collaboratively with building the Experiment Office**

6.4 **Driving the joint design work forward**

One of FSD s main purpose was to drive an innovative design process forward and develop new solution for a future office. FSD needed to play the role of supporting the creative group work that was conducted. The grounding exercise with the images *identified* the components to play around with. To start a design discussion you need to place all the components at hand, make them "tangible". The images and video snippets speeded up and concentrated this process. They *constituted a common reference world* for the participants by trigging individual comments which where processed in collective reflection. When the participants shared experiences with the rest of the group they started to build a *common world of design components*. The components where in this way identified and associated with collective agreed connotations. The playgrounds forced the participants/players to make *priorities* between the different components. ForeSite Designer Virtual Reality feature opened up for the possibility to *relate* the components spatially to each other and to build spatial arrangements with the components. First very schematic but in the later exercises it was possible to represent a working integration between space and technology. Active scenario building, from both the participants and the design team, helped in tying the components socially together, filled the arrangements with meaning, made non-fits manifest and initiated *change and development* of the components and their relations.

6.5 **Facilitating interaction between reflective distance and engaged immersivenes**

Earlier work where we have been employing various visualization tools in collaborative design of architectural spaces, has shown that visualizations that allows for an immersive engagement with an envisioned environment creates a fruitful ground for joint evaluations even with very diverse groups (Fröst, Warrén 2000).

Immersivenes provides a good common ground for evaluation of design proposals. It makes you engaged and promotes an animated spontaneous discussion, which parallel the conversation that takes place when visiting a physical, real world space. In such a conversation comments are trigged by the multitude of comprehendible information that you meet. Immersivenes is however, according to our experiences, less supportive for developing new design suggestions. 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 decisions. The 3D/VR world that is produced puts one in an immersive relation to the spatial arrangements and their consequences. Thus the tool enhances a constant change in perspective of a design problem and facilitates understanding and very active engagement among the design participants.

6.6 **Envisioning possible futures**

Figure 6. **Presentation of the built concept proposal on large screen display**

FSD proved to be a sufficient tool for expanding emerging ideas and gain a better understanding of the complex nature of office work. During the relatively short exercises the participants succeeded in building elaborated spatial configurations, which was innovative and had managed to integrate space and technology in a meaningful way. It is obvious that there were differences between the list of qualities, which was formulated in discussions before the modelling session, and the final result. One conclusion is that this is due to the fact that the actual design of the virtual scenarios forced the participants to combine different ideas, negotiate and prioritise. When the work was concentrated on layout and 3D representations there where greater focus on spatial disposition of the office. In the scenarios the participants where more able to formulate the roles played by the information technology support. When the scenarios are acted out in the Virtual Reality world the integration between space and technology actually are tested. FSD here operates as a tool for "Envisioning possible futures" (Binder et al 1998).

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