

## Virtual Reality in City Planning - A Longitudinal Study

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### ABSTRACT

A city planning project with four participating architectural consortia was followed in 2007 and 2010. The City Planning Office required VR as a compulsory tool. Interviews with representatives of different professions revealed that VR was used to a minimum. Obviously it was not enough to demand to use VR to achieve the advantages it was expected to bring.

### INTRODUCTION

Building Information Models [BIM], Virtual Reality [VR] and other Information and Communication Technology [ICT] systems are predicted to be important steps in the development of the Architectural, Engineering and Construction [AEC] industry. Although there are obvious benefits with many introduced ICT-systems, aimed at supporting inter-organizational collaboration, many introductions meet difficulties. This paper describes opinions from different roles in a AEC-project regarding a city planning project for a central area in Göteborg, Sweden, and discusses how expectations, views and use of VR has changed during a period of approximately three years. The aim is to contribute to better understand how VR affect professions involved in city planning.

### CURRENT DEVELOPMENT

Zhu Y & Augenbroe G (2006) state that AEC projects have strong needs of collaboration and information sharing due to the nature of a arbitrary project to be non-repetitive, temporary and fragmented with multiple stakeholders and project partners.

Each organization in a project has its own specific perspective, language and way to communicate, developed as a result of the organizations visions, tasks and activities. Bullinger et al. (2010) have identified poor communication between different stakeholders as one of the major categories of problems in the architectural planning process. Two (of several) problems that identified in the communication category are 1) End users do not participate in the design process and 2) Different "languages" are used by various disciplines (actors and stakeholders) involved in the planning process. These different "languages" lead to misunderstandings and errors in the planning process.

## AIM OF THE PAPER

Sunesson et. al. (2008) reported from a situation where shaping and rebuilding of a city library were to be planned and decided on. The project in that situation concerned one building, the board of evaluators consisted of laymen, and the request of using VR as a part of the commission was added when the project was already running.

This paper focuses on a project concerning a detailed development plan for a central area in Göteborg, Sweden. The board of evaluators in this case consists of professionals associated with the construction industry. The request to use VR was part of the initial project description.

The aim of this paper is to identify important aspects on the use of VR in this city planning situation in comparison to the situation in Sunesson et.al. (2008), and to identify changes over time.

## THE STUDIED SITUATION

The area in focus is approximately 6 to 8 blocks, located at a river bank, and is considered to be of great importance, and due to large public interest it was preceded by open theme discussions arranged by the local City Planning Office. Four consortia or groups of architectural firms were given an assignment in parallel to produce suggestions for possible future rebuilding of the area. Developing and handing in a VR-model was mandatory. A board consisting of personnel from the municipal authorities and the concerned real estate owners were evaluating the proposals from the different consortia. The final design is composed of ideas emanating from their proposals.

The organizations in focus in this study are: the local City Planning Office, a company aimed at city development (owned by the authorities), the consortia that received the commission, a board of evaluators and 3D artists giving support on software and the city VR-model. This paper focuses on responses from the groups of architects and the board of evaluators.

**Commissions in parallel.** The commission was given to each of the consortia to develop suggestions for a detailed development plan over the area of interest. A city plan does not contain detailed information of what will be built but leaves decision freedom about specific buildings for later decisions when real estate owners ask for permission to build.

The suggestions were to be presented on two occasions, and VR should be used both times. At the first presentation the VR-model should be simplistic, and on the second, the VR-model was to be more elaborate. On the first occasion a predetermined route needed to be shown, but the presenter could also use VR more extensively if he/she wanted while no specific requests were given on the second occasion.

**Virtual Reality.** The city authorities possessed a large 3D-model depicting central parts of the city, and the architects were required to provide models of their

suggestions inserted in this model. The complete models were to be used with a VR-software specified by the city authorities. Two 3D artists, specialized on VR, were supporting the consortia. The consortia were given electronic "HOW-TOs" and instruction/information on the city model and VR-software.

## METHOD

The major part of the data was collected by two series of semi-structured interviews with representatives from the different participating organizations, viz. 2007 and 2010. Apart from the interviews secondary data, e.g. official documents and newspaper articles were examined. Interviews were held in 2007 with involved representatives from: the local City Planning Office, the company working with city developing, three of the four architectural consortia, the board of evaluators and the two 3D artists that supported the architects using the VR system, then in 2010 interviews with representatives from two of the architectural consortia, two individuals from the board of evaluators and the 3D artists giving support to the consortia, were held. In 2010 had the respondents from the City Planning Office and the company that worked with city developing reached their retirement age and could not be interviewed.

The interviews were semi-structured and conducted as conversations about main areas of interest. A checklist was used to ensure that areas of interest were covered. If needed, the interviewer asked questions leading the conversation into the requested area. The areas and questions were overall the same for the respondents in both series of interviews, but adjusted to some extent to their role and situation.

## INTERVIEW OUTCOMES

**Architects:** The three consortia of architects will be called "blue", "red" and "yellow" in this paper. They consisted of loosely connected architectural firms. The respondents for groups blue and yellow were the same 2007 and 2010. There were different respondents for group red on each occasion but both had worked in the project of interest.

*The respondents' view of why they were invited:* The respondents had different views of why they were invited. None of the respondents presented reasons connected to the ability to build VR models but described other reasons for being invited.

*VR-experience and maturity:* None of the groups of architects used VR as a normal presentation tool to present work outcomes to their clients prior to or in 2007. VR was seen as any 3D animation and the respondents referred to animations or movies as VR.

Group blue reported that they used 3D modeling and other software as common work-tools in their daily work. Producing VR-models was not uncommon. Despite this, they often used other, more "common" media as sketches and PowerPoint for presenting ideas and projects to their clients. They used VR and 3D models to extract material from, as pictures, for use in presentations, and of the interviewed groups of architects, blue seemed to be the group that used computer

aided work most significantly on a daily basis. Groups red and yellow reported that they had knowledge of making VR models within the group, although VR was not their daily work tool. This meant that VR competence was present within at least one firm in each group. All groups reported that using and producing 3D-models was common on a daily basis.

The picture did not change much to the interviews in 2010. Group blue did present VR and 3D as even more common work tools in 2010. The representative also reported increased use of 3D-models and VR as part of their presentations to clients. Representatives from the other groups did not experience any change between years 2007 and 2010. Both of them had participated in one more project where VR was used. Here as a marketing effort rather than a tool for evaluating a project.

*Planning:* None of the respondents in 2007 thought that using VR would affect how to work with the project. Common planning routines should be followed and the VR-model would be built just before each presentation. The respondent from group "red" also presented expectations for shortening the time used in the project, to some degree, due to the fact that some material was present in the city model, provided by the city authorities, that they could use. The development and use of the VR-model was seen more as an "add-on" than an important factor in the presentation.

*Model properties:* In 2007 the dominating thought was that the VR models would not add anything important to professionals. The main expected contribution of VR was the pedagogical role for laymen. VR was considered to better communicate the propositions content to laymen than drawings and sketches. Two of the representatives discussed what it meant to make sketches in VR. Examples such as if possible future buildings should have material on their facades, if there should be windows and doors or illustrated businesses and other activities, were brought forward.

The interviews in 2010 gave insight into what VR could contribute when elaborated. 3D-models and VR were sometimes used by the blue group to support presentations for clients. Group red brought up the possibility of using the model to study sight-lines, effects of light and shadows during a day or how wind affects the area of interest. Group yellow brought up Building Information Models as having the benefit of having one model with all necessary information for many stakeholders, and then adjust the presented content to the need of the participating stakeholder. They meant that many construction companies seemed to identify this as a major benefit. They were unsure if that would give their work higher quality.

*Resource usage and the future:* In 2007 the architects did not perceive how VR could benefit their work more than simplifying communication with laymen. They trusted their professional skills and did not think that VR would affect their work to any great extent. VR was seen as a gadget for marketing although some minor benefits were identified.

The view of the future had changed and developed at the interviews in 2010. Groups blue and yellow stated that VR together with BIM will become a common tool. Yellow stated that their work will not necessarily improve in quality, but it will become more common and also that the understanding of proportions and volumes will be easier in VR. Group red also indicated that VR would become more common but that marketing will benefit most from the increased use.

*Changes in the process and work tasks:* All groups of architects stated that working with the project would follow normal routines and that the requirement of using VR was seen as a smaller work task in preparing the presentations. It was also confirmed during the 2010 interviews that there were no major problems in producing the models. According to opinions, however, there were problems with converting files between programs but this problem was not larger than in earlier, common situations.

None of the respondent from any consortium reported having influenced the design of the process for the commission in parallel. They all got the information of the criteria in the description of the commission and tried to adapt to them.

An important remark from one respondent was that the process abruptly took another turn when politicians changed the planned process by making steps in the process official earlier than planned. This brought the process itself more or less to halt.

*Communication and roles in the process:* All respondents from architectural groups reported that their presentations mainly used traditional tools like sketches and Power Point. VR was used at the first set of presentations to present a predefined tour of the area. The 3D artists controlled this tour in the model. Neither the presenters nor the audience asked for any special views or to use the models in any specific way.

However, at the second set of presentations, where more elaborated VR-models were asked for, none of the architectural groups used VR in their presentations. One consortium used a short animation of the area. Sketches and Power Point dominated the presentations.

*Participation:* None of the consortia reported as having any influence on how the commission in parallel was conducted. They were informed about the process on the first introductory meeting and then tried to adapt to this. Two of the respondents said that the instructions regarding the VR-models features was altered to the second set of presentations in that two different models were required to be handed in. One of these should not be as elaborate as the other. The less elaborate one was aimed at communicating with the public. The motivation for this requirement was that the principal thought that detailed models could influence public experience, and that the choices between alternatives can be thought of as between already finalized designs.

**Board of evaluators.** *The respondents' background:* The interviewed members in the board of evaluators were professionals connected to the building and construction sectors. All perceived that they could read and understand blueprints and documentation connected to construction.

Two of them worked in institutions connected to the municipal authority, and one represented a large real estate owner in the focused area. The fourth person was connected to the public company owning the process.

*VR-experience and development:* One respondent had previously used VR in an evaluation process. The purpose was to find out if VR could help present premises to potential customers. It showed that hardware and software were not capable enough at that point.

In 2007 one of the respondents regarded the use of VR primarily as part of marketing new apartments although he also recognized a potential enabling direct

communication and help to focus people's questions in evaluating certain projects. If a person has doubts in how his/her view will be affected by new buildings, it is fully possible to go to his/her apartment and look out of the windows and see the effects. Visualizing realistic conditions can lead to a more accurate discussion about impact.

Opinions in 2010 were more or less the same as in 2007. The respondent that considered VR as having a good potential in 2007 still had the same opinion in 2010 but also mentioned that he experienced that VR was used even less than previously.

*Planning:* The respondents did not think that VR would affect their way of working with the evaluation of the project, and they could not see that VR would give specific or new contributions in the evaluation processes. None of the respondents thought that VR would dramatically change how evaluation processes will be conducted in the near future, but perhaps it will become one tool among others. None of the interviewed members in the board of evaluators thought that VR should be considered more for their own work, e.g. by providing more or better information than blueprints or drawings. The group did not have a plan for how to use VR or for what purposes.

The opinions had not changed much in 2010. The models had been used once by the board of evaluators in a situation where only a few members had attended. Only the real estate owner's respondent could remember having participated at this meeting. VR models were used on this occasion to go to a certain point and look at sight lines to see if the suggestions fulfilled all the criteria that were set up.

*Models features, expression of visions and their pros and cons:* In 2010 two of the respondents stated that a physical model seemed to be best suited for presenting and illustrating re-planned areas. They argued, on the other hand, that it can be difficult to use a physical model all the time, partly because a physical model can only be at one location at one time, and is demanding to move, so it does not fit all situations.

*Resource usage and the future:* The respondents identified clear advantages but also disadvantages of using VR. One board member expressed three main disadvantages for VR: 1) It lacked clear cut thoughts and visions about how it should be used. 2) Without quantifiable advantages it is hard to promote the use of VR. 3) The quality of VR-models is too low for use as a base for making pictures and posters for presentations. The real estate owner's respondent had the same opinions regarding the difficulties of making good quality VR-models. These still cost a lot and their repayment is unclear.

*Changes in the process and work tasks:* The only effect that the respondents presented was the one meeting, with few members attending, where they used the VR-models.

The respondents reported the two main presentations as common with the architects presenting their suggestions in a traditional way. A non-agreed discussion emerged with politicians and others involved in the process. VR were not used.

## DISCUSSION

Neither the architectural respondents, nor the board of evaluators, had met VR in professional situations more than with solitary projects. A stated argument for the

low rate of use was that the quality of VR models was too low. A striking observation is that the use of VR is low and that no major increase was noticed between 2007 and 2010. The architects did meet the rules of using VR but relied on the usual way of working. The outcome of the entire planning project could not demonstrate any superiority.

One of the municipal respondents in the board of evaluators stated that there is a lack of vision of how to use VR and a lack of clear quantifiable benefits when used, although several potential benefits were mentioned at the same time. This highlights the importance of continuing research about using current VR-technologies and their benefits rather than developing the technology in striving for more "photorealism" as its only leading star (Heldal, Roupé, 2012).

Few members of the professional board of evaluators attended the meeting where the VR models were used. An explanation for this could be that the professionals trusted earlier experience on reading drawings, and there seemed little advantage in using VR. When comparing these interviews with the board of evaluators in Suneson et. al. (2008), where the board consisted of laymen, that board of evaluators found it more natural to use VR models as a presentation tool. A group of laymen have to put in more effort to understand suggested changes, regardless of which methods were used.

One question raised by architects was what it means to sketch in VR. Participation in commissions in parallel was well-known for architects, and it seems not to be a problem to create VR-models for them, but what it means to design them for a purpose like a sketch is unclear. It is unknown how the user or recipient of VR-models may react to specific attributes in the model. Involved parties in common processes know what a sketch is because that view has developed over decades. A sketch is not aimed at being as realistic and detailed as possible, like a photo, but it is other features that make it efficient in communicating information. How these features should be translated into a VR-model is unclear, and how recipients react is also unclear.

Another point is the combination between public participation and levels of detail. Common arguments are that higher quality in the models and greater level of details per se should simplify public participation. This straight forward thought about quality and participation is questioned in this case. The instructions for how to design the second VR-model were changed because of the hypothesis that too developed VR-models could mislead and negatively influence public participation. "High quality" depends on the situation. The aim in Suneson et. al. (2008) was to decide on the rebuilding of a single building, and in this case a high level of detail was used, which caused no discussion. However, in the situation of this paper "high quality" might have other features. Perhaps already existing parts should be well defined to give recognition and points of reference while planned and discussed areas should be only schematically modeled to not limit or mislead participation. This should then be the opposite of how e.g. Howard and Gaborit (2007) set up their prototype virtual environment.

The supporting 3D artists perceived that the board of evaluators did not trust basing decisions on VR. The interpretation was that the model was too simple in

lacking developed shading and light, making it hard to understand volumes within the model.

When not being sure of how to design and use the VR-models in a situation or uncertain on which benefits will be reached, it is easier not to use VR and keep to well known and controllable ways to present and evaluate AEC-projects without challenge a known situations. Thus, if no one knows what benefits are reached then there is no driving force to change how to work and communicate AEC project. This and obvious barriers in the understanding between the different groups involved in this project is an explanation why ICT was not a success. The organizers of the commissions in parallel had fine democratic intentions in requesting the use of VR but this need and potential use was not known by the other actors. This was probably not understood by the organizers and hence no specific actions were taken to improve the situation.

## CONCLUSIONS

Thus, in the presented city planning project, ICT in the form of VR, was introduced as a compulsory tool for better collaboration and understanding. It was introduced to the participants only as information on the technology and a mandatory request to use VR.

The project did not show any progress in using the ICT over time. The outcome of the planning project could not demonstrate any superiority. Obviously it was not enough just to demand the use of a new technology to achieve the desired advantages.

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