Virtual Reality As a New Tool in the City Planning Process

Kaj Sunesson[**], Carl Martin Allwood, Dan Paulin, Ilona Heldal,
Mattias Roupé, Mikael Johansson, Börje Westerdahl

Chalmers University of Technology, SE-412 96 Göteborg, Sweden

Abstract: The introduction of virtual reality (VR)-models in the city planning process will cause changes in the traditional roles of the involved parties. In order to better understand some of these changes, the events involving the use of VR-models in an architectural competition concerning rebuilding-proposals for the city library in a Swedish city were analyzed. The study shows that VR was introduced into the competition as an extra add-on and that the VR-presentation was experienced as useful by the jury. The transformation of the architects' contributions into VR was experienced as problematic by the architects, partly because they lost full control over the presentation. In the future architects are likely to have to produce the VR-models for their proposals themselves. This may make it more difficult for smaller architectural firms to enter the market but their proposals will be more accessible to a wider group of stakeholders.

Key words: architecture; architectural competition; city planning; construction planning; VR-models

Introduction

New technology often causes disruption and change in established practices. In the future the use of virtual reality (VR) models is likely to increase in the city planning process. This is likely to lead to changes in how the activities and roles in the early parts of city planning processes are carried out. This paper describes the effects of the use of VR-models in an architectural competition evaluation process from the standpoint of different professions, and it discusses how VR can influence the roles of concerned professions, e.g., architects.

(1) Current developments

In modern, high-quality, professional city planning it is not only the visions of politicians that govern the design of urban development. A broader circle of relevant parties should be able to exert an influence. Hall 1996

(reviewed in Ref. [1]) listed four relevant interest categories in the urban planning process: (1) city planners, (2) architects working for clients, (3) the clients themselves and (4) the general public (see Ref. [2]). Such broader participation may lead to better sustainability of the projected constructions since they might better meet the needs of the future users.

The goal of a broader participation in the building process is not easy to accomplish (see Ref. [3]). For example, within the traditional and conventional ways of working with the urban development process, many different types of communication- and decision material (e.g., 2D drawings, sketches and perspective drawings) are used by professional groups [4] and it is sometimes difficult for the public and non-technical specialists to understand from this material what the projects entail.

(2) Previous studies on VR in the construction process

In this context, modern VR-models provide many benefits in the city planning process by offering a representation that is closer to common experience than

other methods of presenting a concept[5]. VR-models can make it possible for all interested parties to have access to a common representational medium, which makes it easier for them to achieve an understanding of the planned building object on the basis of their own common sense. The issue of how VR functions as a means of communication in the urban development process is insufficiently researched (also see Ref. [6]). Although exploratory usability-oriented studies involving VR have been carried out (e.g., Ref. [7]), very few studies have been reported on the role that VR plays in ongoing city planning context (e.g., Refs. [8-12]). This research points to the need for "a more functional and flexible city model where various stakeholders can access and utilize the model according to their needs"[12].

Traditionally architects belong to a specialized profession and, sometimes, work in some isolation from other parties in the building process. The production of sketches and plans for new buildings in specific environments is usually done according to profession-specific criteria, like how best to combine aesthetics, function and form, how the features of the building interact with the properties of the environment, etc.[13] In a more pessimistic approach, Ref. [1] suggested that architects have a reputation for submitting non-realistic perspectives, omitting parts of schemes that are not fully designed and even hiding areas of schemes behind carefully placed trees and other features.

(3) Present case study

This study analyzes a real event involving the use of VR-models in an architectural competition evaluation about suggestions for a large rebuilding of the city library in Göteborg, Sweden (population about 500 000). The focus lies on the implications for the architects of the use of VR in the evaluation process.

The library (see Fig. 1) is placed at Götaplatsen, a square with great symbolic status for the city. Thus, the

Fig. 1   The city library in Göteborg, Sweden

remaking of the library is an issue of great importance to the city. This is also evidenced by the lively debate in the local newspaper that followed the outcome of the architectural competition described below.

VR-models have been used in urban planning and building design projects in Göteborg for a number of years. At present, the visualization studio at Chalmers University of Technology in Göteborg, works in close collaboration with the City Planning Authority (CPA) in Göteborg to generate a large VR-model covering the major parts of the city. So far two specific projects have resulted. The first is associated with the redevelopment of the city library, further described in this study. To our knowledge, this is the first time that VR-technology has been used in this way for a public building in Sweden.

1   Method

1.1   Participants

In total, ten interviews with twelve informants from the different professions and groups involved in the competition were conducted (CPA, 3; the Jury 3; architects, 4; the 3D-artists who made the VR-model, 2).

1.2   Study design and interviews

Semi-structured interviews were made at the informants' workplaces by two of the authors (except two interviews). Each interview lasted 50 - 90 min and was tape-recorded. The common sections of the interviews included the following:

- The informants' prior experience of 3D modeling and VR. (For the architectural firms the experience of the whole firm was also asked for.)
- A description of the process and communication when the VR-models were produced and used.
- Evaluation of cons and pros of using VR.
- Implication of the future use of VR for professions and evaluation processes.

2   Results

We first briefly describe the main events in the architectural competition as they were reported by one or more of the informants. Next the views of each participating profession as stated in the interviews are presented as aggregated for each profession.

2.1 Main events in the evaluation process

The starting point for the events was in 2003 when the cultural committee and the city library of Göteborg described the need for bigger premises. In January 2006 the CPA in Göteborg was given the commission to develop a new plan for the city library and surroundings. Four architectural firms were invited for parallel submissions of proposals. Each of the firms would develop a proposal (also called contribution) for how a rebuilt city library would be designed.

A jury of eight members was appointed to evaluate the proposals: two from the town council's cultural committee; two from the town council's building committee; two from the CPA; one from a company that administrates official buildings in Göteborg and one from the city library.

From the beginning the architectural firms were not asked to create any 3D or VR-model. On September 29, 2006 the firms were asked by e-mail for digital material, including the CAD models that the firms had developed. All the firms agreed to send their material. The task given to the visualization studio by the city planning office was to make VR-models with all contributions equal in quality. This was at least partly because of the late inquiry about the digital material. A common VR-model was formed as a surrounding environment in which each of the models of the proposed buildings was put (one example in Fig. 2). Each of the contributions could easily be presented while keeping the surrounding environment constant. The system supported on-demand switching between the different proposals when reviewed by the participants.

Fig. 2   VR-model of the present library (left) and one proposal (right)

The four contributions were first presented to the jury in August 2006. The task for the jury was to evaluate the proposals and to use ideas from one or more proposals to recommend how to further develop a final idea. In this paper we sometimes refer to "competition" as a synonym for this evaluation. To fulfill their task the jury had nine meetings, and in one of these the VR-presentation of the contributions was presented and discussed. At this meeting, which took place at the visualization studio, the VR-model was shown on a power wall, and a stereoscopic effect was created by the use of crystal eyeglasses. The jury had two or three further meetings that did not involve VR-presentations.

2.2 City planning authority informants

Experience of VR and 3D This was the first time CPA used VR in an evaluation process. There is no widespread knowledge about VR in the CPA, but some parts/persons have rather extensive experience of VR.

Use of the VR-models in the evaluation process The first initiative for using VR in this project came from the CPA and was put as a suggestion to the jury. The informants' experience was that the use of the VR-models made a difference for how the jury understood the four contributions. The possibility to understand the interaction with the surroundings and to actually see the volumes was thought to have meant a great deal for many of the jury members.

Evaluation of cons and pros of using VR All the informants pointed out the importance of being able to show the planned buildings in VR. One informant focused on the pedagogical aspects of using VR, and noted that it is important to find a quality level in the VR-rendering which is good enough to really depict the content of a proposal but not so good that the general public understands the proposal as completed.

Future for VR and effects on professionals The informants thought that VR will be used much more in the future. The CPA informants saw a potential for increased participation and communication with stakeholders due to the pedagogical potential of VR as a communication tool. Furthermore, they also mentioned possibilities to simulate the effects of lights/shading at different times during a day and over the seasons of a year. In the future realistic simulation of noise, particles in the air and other aspects will increase the quality of the simulation.

2.3 Jury informants

Experience of VR and 3D Two of the informants had some experience of participating in tasks similar to this one in judging new buildings. All three use computers regularly but all had little or no experience of VR or 3D-graphics.

Communication and preparation of the VR-models None of the informants reported exerting any influence on how the VR-model was to be shaped.

Use of the VR-models in the evaluation process Some of the informants thought that it was somewhat inconvenient to have to travel to another part of town to look at the model. The informants reported no particular expectations when attending to this meeting.

The VR-presentation gave much information but the informants felt that it would have been too much effort to have used it in more meetings referring to having to use the crystal eyes when viewing the model and having to pay attention to people pointing to the power wall instead of just discussing. They all also reported being satisfied with not having to manage the model themselves during the show. None of the informants seemed to think that it would have been very important to have used the model more than this time. One of the informants mentioned that the model did not include the interior of the buildings and that this was an important part of the evaluation.

Evaluation of cons and pros of using VR The credibility of the VR-models was rated high. One statement was that the VR-model was seen as giving a good presentation of how the contributions would appear in reality. It was also reported that the jury referred back to the VR-model in later meetings when they discussed different matters. All the jury informants criticized the aesthetic aspect of the model. One saw a risk that even the foundations of the architect's idea of the building could be missed, because the model seemed finished in a sense but was not good enough to "explain" what the architect had in mind when designing the building. The informants all confirmed the 3D-artists' view (see below) that the VR-model did explain the size, the volume of the building, and its interaction with the surroundings (as Fig. 3).

Future for VR and effects on professionals All informants thought that VR will be a part of future evaluation processes. One of them thought that VR is an important tool because it can explain the content of the blueprints for persons not used to these. Another informant thought that VR use will place more demands on future contributions. This will put higher demands on the architects and how contributions are developed. One informant stated that for the architects VR will imply one more interest group (the general public) to take into account.

2.4 Architects

Experience of VR and 3D All architects said that their knowledge about VR was "small". They did not know what possibilities the technique provides or what features they could ask for. All three architectural firms had some knowledge about 3D-CAD and other 3D possibilities. To some extent all firms used 3D on a daily basis for presenting their jobs. One firm had personnel for making its 3D-illustrations. A second firm made some smaller illustrations in-house but hired help for bigger ones. A third firm hired help for most of its illustrations.

Communication and preparation of the VR-models None of the firms criticized the use of VR to visualize the proposals. All the firms experienced that the information about the use of VR as a tool for presenting proposals and the request for the material came abruptly and late. They had all made the sketches and drawings that originally were asked for when the inquiry about their 3D-material came. Before sending in the material, one of the firms "cleaned" the model so that less information could be misinterpreted. All three firms stated that it took them about 8 h of work to prepare the material before sending it off.

Fig. 3   VR screenshots from one proposal showing the proposal inserted in the surroundings and examined from different viewpoints

Two of the firms recalled feeling worried about the lack of control over how their proposals would be rendered. The communication between the firms and the 3D-artists when the VR-models were produced consisted of one or two e-mails with screenshots that the architect firms could give a response to. Some phone calls were made to clarify particular questions.

None of the architectural firms saw the model before the VR-models were shown to the jury. Two of the firms felt that the screenshots did not do justice to their contribution.

Use of the VR-models in the evaluation process

The architectural firms did not think that the use of VR was important for the jury's decision which they thought was made according to other types of criteria.

Evaluation of cons and pros of using VR All the firms thought that the screenshots did not really show their proposals in an aesthetic manner.

Future for VR and effects on professionals All the firms thought that VR will affect their work in the future and that VR will be a common tool. Two firms explained that it could be a better way to express their proposals. The third representative said that it is not clear what value VR will provide and that VR just means "more of the same" of what is going on today. He thought that it will be necessary to use VR in order to be noticed.

2.5　3D-artists

Communication and preparation of the VR-models The quality of the material that was handed over from the different architectural firms differed. Two proposals were made in Google Sketchup with a low level of detail. One firm's model was made in architectural desktop and was of better quality, while the fourth firm's model was made in Archicad and had high quality. Due to the different levels of quality, different levels of effort had to be put down. The Archicad model could be put straight into the VR-environment. Most work had to be done on the Google Sketchup models. All the four contributions were rendered in VR in parallel.

When making the models, the 3D-artists sent screen dumps to the architectural firms and asked for feedback, and in a few phone calls specific questions to the firms were asked. The 3D-artists had 60 h to finish all the VR-models. The time was sufficient, except that because of the vast use of glass material in some of the proposals, additional time had to be spent on implementing a better representation of glass.

The communication between the architectural firms and the 3D-artists mostly concerned material. The 3D-artists perceived a discrepancy between what was seen as important in the conventional posters and in the VR-model. As an example they mentioned an entrance that in one sketch was depicted in a white and more blurred way than the rest of the building, but was considered extremely important in the VR-model.

The 3D-artists were not aware of the criteria for the evaluation when preparing the VR-model. Overall, the 3D-artists thought that the communication with the architectural firms had worked well and they had received no feedback to the contrary.

Use of the VR-models in the evaluation process During the VR-presentation one of the 3D-artists controlled the showing of the model. The members of the jury could direct what perspectives and which parts of the model were seen by instructing this person, and the jury used this possibility.

Evaluation of cons and pros of using VR in the contest From the evidence of the communication between the jury members during the meeting, the 3D-artists concluded that the use of the model had given a broader understanding about the size and volume of the contributions. Also, the interaction with the building's surroundings seemed to be clarified.

Future for VR The 3D-artists predicted that VR will be much more used in future city planning projects. Widespread use of VR may demand that a common model of the surroundings is available. Without such a model, the cost will be high for making VR-models of every proposal with surroundings and terrain. The possibility to compare proposals is also impaired if there is no common terrain model.

Effects on other professionals The 3D-artists anticipate that VR will be so common in the future that architects will have to use it in order to pursue their profession and will have to make VR-models themselves.

3　Discussion and Conclusions

The notion that VR will influence the architectural profession is supported by our results, but exactly what the effect will be is not equally clear. The discussion by Ref. [1], reviewed in the introduction, about the future role of different professions in the urban construction process, was to some degree well taken, but although VR may give the general public a better opportunity to understand the proposal and to influence the construction planning process, this does not imply that the architectural profession has to be "downgraded" as suggested by Ref. [1]. The architects in this study tended to think of VR more as a new tool that gives a possibility to express their ideas more than as a threat to their profession. However, the view from one of them that VR might be a necessary demand for being

noticed, without adding any substantial value, is worth considering as a sign that more may be at stake.

Another important conclusion from this study is that there were many indications that VR could have been more efficiently used in the evaluation process. For example, the small amount of input to the production process from the architects might be due to their lack of experience of VR. As reported above, it was not obvious to the architectural firms what response they should give to the screenshots they were sent from the 3D-artists. Since the architects did not have a chance to view the VR-rendering of their contribution before it was shown to the jury, it is not clear whether they would have proposed changes. Better preparation of the architects and the jury for their participation in the production and evaluation of VR-models in the evaluation process can help the architects to more fully realize their visions and the jury to better satisfy their need for information about the future building.

Our study shows the importance for all parties in the city planning process to be clear about how VR will be used in the evaluation process. Clear information should be given to all parties early in the process about how the VR-models are to be produced and, on this basis, how they should best be interpreted. In this context it is noteworthy that the architects expressed worry that it was someone else who would transform their proposals into VR and that the proposals could be distorted in the process. To increase the efficiency of similar evaluation processes, we recommend a meeting between the included parties prior to the process where possibilities and limitations of the technology used are presented and discussed.

VR is likely to be used much more in the future and then architects will probably have to learn to produce VR-model themselves. This could be a disadvantage for small architectural firms because more knowledge, time, and money will be needed to enter the market.

References

[1] Bourdakis V. Virtual reality: A communication tool for urban planning. In: Asanowicz A, Jakimowitz A, Eds. CAAD – Towards New Design Conventions. Technical University of Bialystok, Poland, 1997: 45-59.

[2] Lyytinen K, Hirschheim R. Information systems failures－A survey and classification of the empirical literature. *Oxford Surveys in Information Technology*, 1987, **14**: 257-309.

[3] Borning A, Freidman B, Kahn P H. Designing for human values in an urban simulation system: Value sensitive design and participatory design. In: The Eighth Biennial Participatory Design Conference. Toronto, Canada, 2004.

[4] Al-Kodmany K. Visualization tools and methods in community planning: From freehand sketches to virtual reality. *Journal of Planning Literature*, 2002, **17**: 189-211.

[5] Westerdahl B, Suneson K, Wernemyr C, et al. Users' evaluation of a virtual reality architectural model compared with the experience of the completed building. *Automation in Construction*, Elsevier, 2006, **15**: 150-165.

[6] Lange E. Issues and questions for research in communicating with public through visualizations. In: Buhmann E, Paar P, Bishop I, Lange E, Eds. Proceedings at Anhalt University of Applied Sciences Trends in Real-Time Landscape Visualization and Participation. Wichmann Verlag, Heidelberg, 2005. www.masterla.de/conf/pdf/conf2005/11lange_c.pdf2006.

[7] Roussou M, Drettakis G. Can VR be useful and usable in real-world contexts? Observations from the application and evaluation of VR in realistic usage conditions. In: Proc. HCI International 2005, 1st International Conference on Virtual Reality. 2005.

[8] Caneparo L. Shared virtual reality for design and management: The Porta Susa project. *Automation in Construction*, 2001, **10**: 217-228.

[9] Frost P, Warren P. Virtual reality used in a collaborative architectural design process. In: Banissi E, Bannatyne M, Chen C, Khosrowshahi F, Sarfraz M, Ursyn A. Eds. Information Visualization. Proceedings, Fourth International Conference on Information Visualisation (IV'00). Malmö Univ. Coll., Sweden, 2000: 568-573.

[10] Manoharan T, Taylor H, Gardiner P. Interactive urban development control with collaborative virtual environments. In: Thwaites H, Addison L Eds. Virtual Systems and Multimedia. Proceedings from the Seventh International Conference on Application. Dept. of Computers & Electronics, Heriot-Watt University, Edinburgh, UK, 2001: 809-818.

[11] Buchecker M, Hunziker M, Kienast F. Participatory landscape development: Overcoming social barriers to public involvement. *Landscape and Urban Planning*, 2003, **64**: 29-46.

[12] Fleming D, Horne M, Thompson E M. Virtual reality urban modeling – An overview. In: 6th International Conference on Construction Applications of Virtual Reality. 2006. http://itc.scix.net/cgi-bin/works/Show?b3c8.

[13] Svensson C, Tornberg E, Rönn M. Arkitekttävlingar, gestaltningsprogram och arkitektonisk kvalitet. Working Paper, TRITA-ARK-Forskningspublikationer 2006: 1. Skolan för arkitektur och samhällsbyggnad, Kungliga Tekniska Högskolan, Stockholm, Sweden, 2006.