Can simulations in VE support architects and building designers in solving complex design problems?

Jonas af Klercker and Jan Henrichsén
Computer Aided Architectural Design
Technical University of Lund

Abstract

Building design is facing development of industrialization of the production on the one hand and more complex 'One of a Kind' products on the other. This will be for rebuilding of a large stock of existing buildings and what can be left to new production. In both cases the results of the design process have to be solid to guarantee a successful product. In both cases an integrated and careful design process is absolutely crucial.
The demands on the built environment make the systems of buildings more and more complex and have to be handled by a lot of different expertise. To avoid the 'Relay Race' of today the design teams of tomorrow must work much more integrated. To make integrated solutions, which means simultaneous constrains on all systems, the experts of different fields have to understand more of how all engaged systems relate and influence each other.
Communication then consists of complex situations and processes that have to be understood and related to reality. In this aspect a multidimensional Virtual Environment interface has advantages and has been successfully used in design processes in other industries.
In this paper the problems that have to be studied are for example Methodical, Conceptual, Technical and Process economical.

Demands on the future building process

In a time of shift of paradigms such as the not so far off 'Industrialization' and the actual 'Electronics' or what it might be called, it is impossible to scientifically postpone what the evolution will be. You have to make an intelligent guess and start from there.
We want to act in the process of developing the build environment and we have to decide how to proceed. To begin with some solid trends. Buildings have been of importance to society since people became settlers. In all times buildings have

been part of the economic system and have had to be weighed against other demands.
Governmental commissions have stated that the built environment has to be more cost efficient and this is something which we can state to bring with us into the next century. Other factors such as energy efficiency and reuse of materials are already broadly accepted by at least the political establishment.
Computerization and other technical development makes it probable that the process of producing and maintaining the built environment can be made in ways that was impossible with manual and non-electronic methods.
The word Construction suggests that a building always is 'One of a Kind' which cannot be 'mass produced'. Today in for instance car industry maybe 10 out of a production of 300.000 are individually the same. In ship building industry, which also has "small series", industrial methods, have been implemented to a great extent. Industrial methods are also going to be a growing part of the production of buildings.
In many countries what was thought of as a result of an industrialized production of for instance large housing areas from the last decades have been classified as both architectonic and social failures. But then industrial methods only meant large series on all levels and individual variations were difficult to handle. With new information techniques individual variations is not such a problem anymore, which is of special importance to the renewal of all the existing buildings.
The arguments for making 'One of a Kind' buildings in the future have to be special and demands on high complexity must be a good one.

Demands on the Architecture and Building design process

For both industrialized and 'One of a Kind' building production the design process has to provide solid information for the producers. In the first case a mistake is multiplied in the other it can create severe damage. To avoid the boredom of multiple copies the architects have to make variability a natural property of the building systems. In industries like car and ship production the need for careful preparations in the design phase is well acknowledged. The design process has to be improved.
The demands on the built environment are increasing and a lot of technology is developed and used to meet them. This makes the total mass of problems to solve growing more complex, asking for more expertise and more people to be involved. This has caused something like a 'Relay Race' where one consultant gets the baton from one and delivers his contribution to another and so on.
The design process then cannot be linear. The problems which have to be solved make simultaneous constrains on all systems and have to be handled in an integrated way, where all specialties can contribute to find the final solution. This demands that the experts of different fields can understand more of how all engaged systems relates and influence each others and describe his suggestions to the others.

Communication then consists of complex situations and processes which have to be understood and related to reality. In this aspect a multidimensional Virtual Environment interface has advantages over to more traditional flat screen- or paper based techniques which have to be explored.

Problem of communication in the building sector

Information technology has put focus on the communication problems of most of the processes in our society. Not least in the building sector with its complex mixture of technical, aesthetic and social parameters have serious consequences of communication failures been revealed.
In many countries the interest of sustainability has put the process of design and construction of buildings in view of a lifecycle. This means that even more 'experts' with different professional culture are involved, and the need for more general communication means even bigger.
There has been a tradition of using visual means to describe buildings and building related problems. The standardizing of drawings and drawing symbols has helped to create the imagination that there might be something like a language of drawings. This has been discussed and developed in research and design theories and also attracted researchers to make use of computers in that field.
The most obvious advantage of the use of visual means in the building process is that by just pointing at a certain spot in an image you can save a lot of time. An image can summarize a long verbal description. The image is also to a great extent independent of which verbal language the observer is using either it is due to profession or nationality.
Single images picture a situation at a certain time. There are not many situations in life which have the duration which is so static that it can be covered with a single image. On the contrary most situations are short intervals of a process. By modern film medias possibilities to describe processes were introduced making a revolution in communication and quite logically digital medias are developed to be used for the same purpose.
Communication so far might to a large extent have been a technical problem but as these problems are solved it becomes more and more obvious that communication also is a human science problem! It is therefore very important for a coming project that researchers with human science background are involved.

Problem of the building design process

The design faze is the period when most constrains have to be analysed, understood, balanced and put into a solution. There is a common understanding that the different actors and designers have to develop their means of communication to be able to find and evaluate design conclusions. One of the

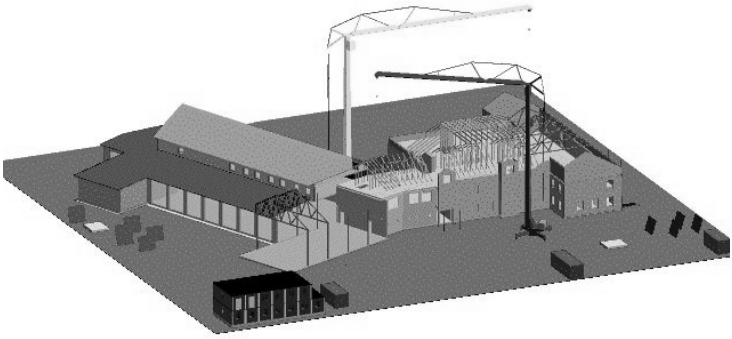

Figure 1: Visual simulation of construction process. Support for site and work planning.

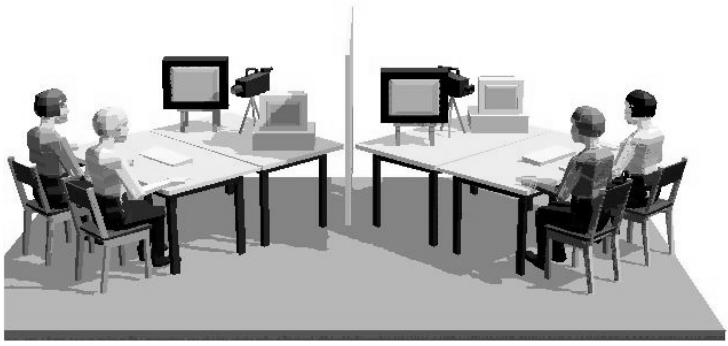

Figure 2: Video conferencing supported by computer simulations, presentations and shared documents.

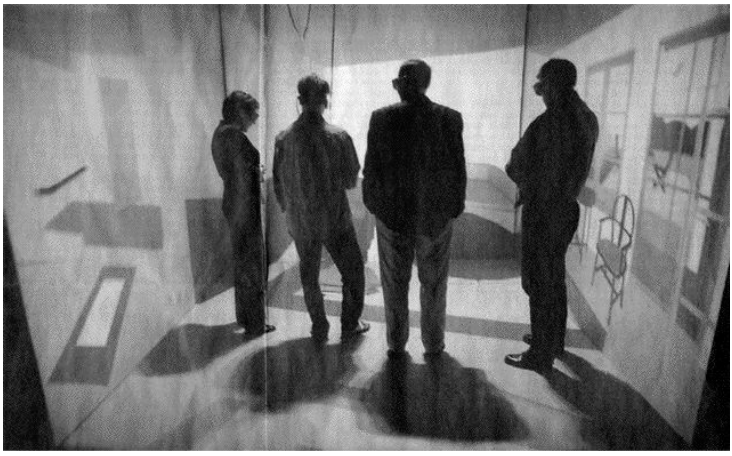

Figure 3: Inside the CAVE. Discussion in immediate connection to experience of the same virtual environment.

most promising possibilities are the virtual environments, which have a great potential for supporting visual communication in this field.
So far most actors in the building process except architects use 2D geometry for their calculations, simulations etc. Some specialists in ventilation, energy and electricity do not even take part in the early stages wanting to make just one solution on the final architectural design.
For an architect it is the most natural to use the CAAD-object model as a base also for VE. So far the geometry of VE has been looked upon to be so special that it needs its own modeller, which needed its own operator. Now as VR software is available which runs on NT systems and can import geometry in for instance VRML format, the situation has changed. During a course in modelling for VE possibilities to use CAAD models were proved possible and even economically favourable.

Intentions of the TUL {ACCOLADE} project

The intentions of the TUL {ACCOLADE} team are:

- to develop interactive design activities involving designers from different actors of the building process where VE is used to support collaborative solutions on critical problems as for instance combination of different elements.
- to find methods to simulate and visualize dynamic factors in the built environment such as different activities and flows, changes in time, etc.
- to learn and develop from collaboration with the other participants of the {ACCOLADE} project.
- to be able to use VR in education of architects and other actors in the building process.

About {ACCOLADE} research projects and process

The idea of {ACCOLADE} as an EU project is to support collaborations over the national borders. This will mean that the collaboration process is as important as the results. From this standpoint it is an advantage if the national projects have similarities and need not necessarily to be unique.

Questions to be researched in a future {ACCOLADE} project

In the concept of using VE for collaborate architecture and building design the questions which have to be considered are:

- Methodical - How can VE be used?
- Conceptual - Which are the necessary elements for understanding and collaborating?
- Technical - Which are the demands on the techniques?

- Process economical - Which are the arguments for spending money on VE?

Problems of interest to be developed for a future research project

1. Possibilities to **describe and visualize complex processes** both in constructing and/or maintaining the building and within the user activities. TUL took part in an environmental research project, in which computer supported animated images were used to support planning and a better understanding of a production process (Akselsson, K. R., Bengtsson, P., Johansson, C. R., af Klercker, J).
2. **Different Virtual Environment software.**
   What is typical? What can be useful? VE software experts explains to VE amateurs and we discuss. Examples: TUL collaborates with the Swedish software company Opticore. OPUS, is an example on a VE software, which is largely used in the car industry, and has different facilities to offer 'behaviours' etc. It runs on Unix (IRIS) as well as Windows NT and imports VRML. This means that object based models from Archicad can be exported/imported to OPUS and be adjusted on an NT platform and then displayed in a CAVE interface on an IRIS. NEMO can be downloaded on the internet (www.nemo.com). NEMO imports 3D studio format.
3. **Interface to simulate the movement of the observer** in a CAAD model on VE. At the eCAADe 2000 conference people from Weimar and Liverpool showed some interesting examples on different solutions. Glove- and joystick solutions are not the most natural metaphor. TUL can contribute with a very simple software example used in the OPUS software.
4. **One, two, several screens.....**
   Photographers and perspective view designers are familiar with the problem of narrow view angles. The standard computer perspective used in most 3D software has nothing like a wide angle or fish eye lens. It is limited to 60-65 i. For the experience of space this is probably a serious and limiting problem. Lately installations consisting of two or more screens have been introduced at exhibitions and installed in some labs. The state of the Art in this field has to be described. This could be one of the issues {ACCOLADE} teams could share. Some persons with an overview start a discussion. Anders Fohlin, SGI in Gothenburg, is such a person.

Reference

- Akselsson, K. R., Bengtsson, P., Johansson, C. R., af Klercker, J. Computer aided participatory planning. In Karwowski, W. & Rahimi, M. (eds.) Ergonomics of Hybrid Automated Systems II, Amsterdam: Elsevier.