PRESENTATION OF DESIGN MODELS

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Abstract

CAD systems offer new and improved techniques for the presentation of designs.
This paper presents several of these techniques that are based upon computer-generated images of a 3-dimensional computer model of a design. These new techniques include holography, animating and virtual reality. Some of the techniques that can be improved by CAD systems are paper scale modelling and stereoscopy.

The paper describes:
- presentation purposes, such as showing a design or explaining functional or technical aspects;
- presentation activities, such as modelling a design or generating images;
- presentation techniques, as mentioned above.

There exists a relationship between the purpose of a presentation, the presentation techniques employed and the production activities.
Because production activities can be very time consuming, the purpose of the presentation and the preferred techniques should normally be well specified at the beginning of a presentation production to makethe latter creative productive.
However, since most of the computer-based presentation techniques are still new to most designers, it will be very difficult to make the right specifications of purpose, techniques and activities at the beginning of the production proces.
That means that there is a need for a better understanding of the techniques and for a more flexible way of producing presentations of designs.

Calibre has developed tools to make the production of presentations more flexible.
One of the tools is a program (ModelCom) that converts different 3-dimensional computer models of designs (design models) into models for different programs that are able to generate images.
Another tool is a program (ImageCom) for converting different generated images into image descriptions for different presentation techniques.
These tools are of great importance for Calibre's exploration of various techniques for the presentation of design models. This exploration gives Calibre the unique opportunity to present a varied menu of presentation techniques and related future expectations.

1. INTRODUCTION

A designer can use various techniques to present a design. He can, for example, use handmade sketches, drawings, paintings and scale models. These 'handmade' techniques offer the advantage that they can be used iteratively during the design activities. However, making a striking presentation is very laborious. Projections have to be constructed, colours and shades have to be added and this work has to be repeated for every illustration.
Computer systems are "fond" of repetitive work and there are many programs for generating computer images.
The 'only' thing a designer has to do, apart from making an architectural design, is to 'design', 'construct' and 'manage' a 3-dimensional computer model of his design (a design model) (Figure 1.). Once the design model is available, computer systems can generate several 'computer-made' images which can be used for presentation purposes.

The possibility to generate several different images of a design model can be used to show a design or a (static) design model in various ways.
The possibility to make rapid changes to a (computer) design model makes it feasible to show different designs or a composition, a resolution into elements, or a transformation of the (dynamic) design model.

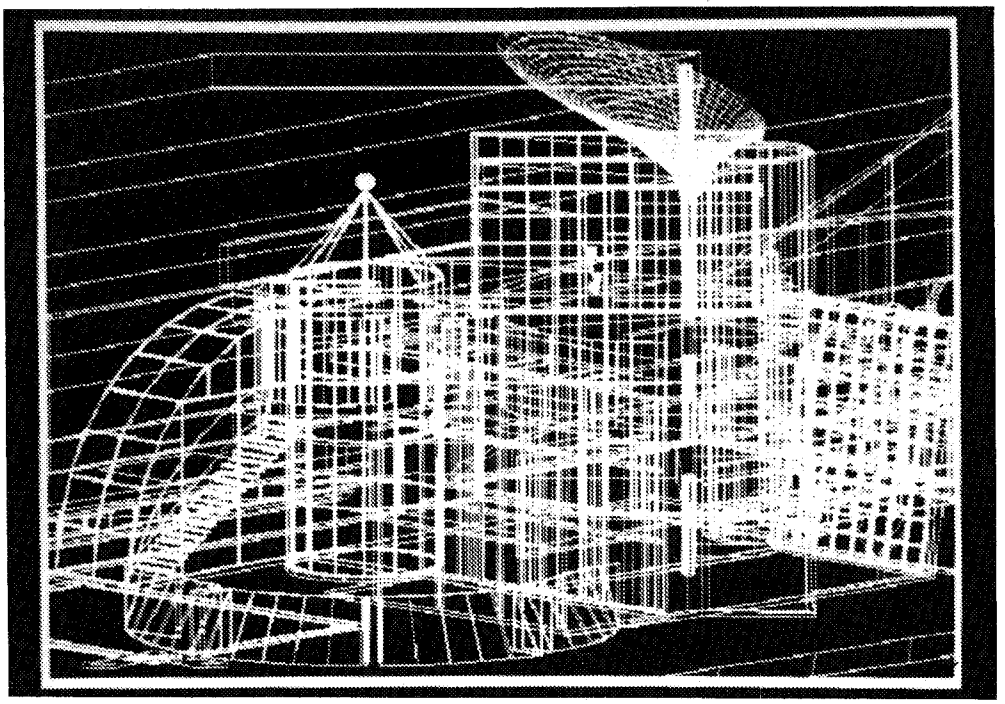

Figure 1. Design model.

2. IMAGES

The kind of image that can be generated depends on the software that is available (hidden-line, flat or smooth-shaded, rendered or 'rayed'). (Figure 2.)
The information within the image depends on the information within the design model (lines, faces, solids, colours, texture maps, bumpmaps, light sources, views). (Figure 3.)
Of course, it is possible to use the same software for design modelling and for image generation. More common, however, is the use of dedicated (lower cost) design modelling software on several systems and special (more expensive) imagegeneration software on a few dedicated systems.
Specific information such as maps and lights that should be added to the design model for an image, will have to be added using the image generation software, when the modelling software doesnot permit this.
In any case it has to be possible to use one design model with different kinds of systems to generate images.

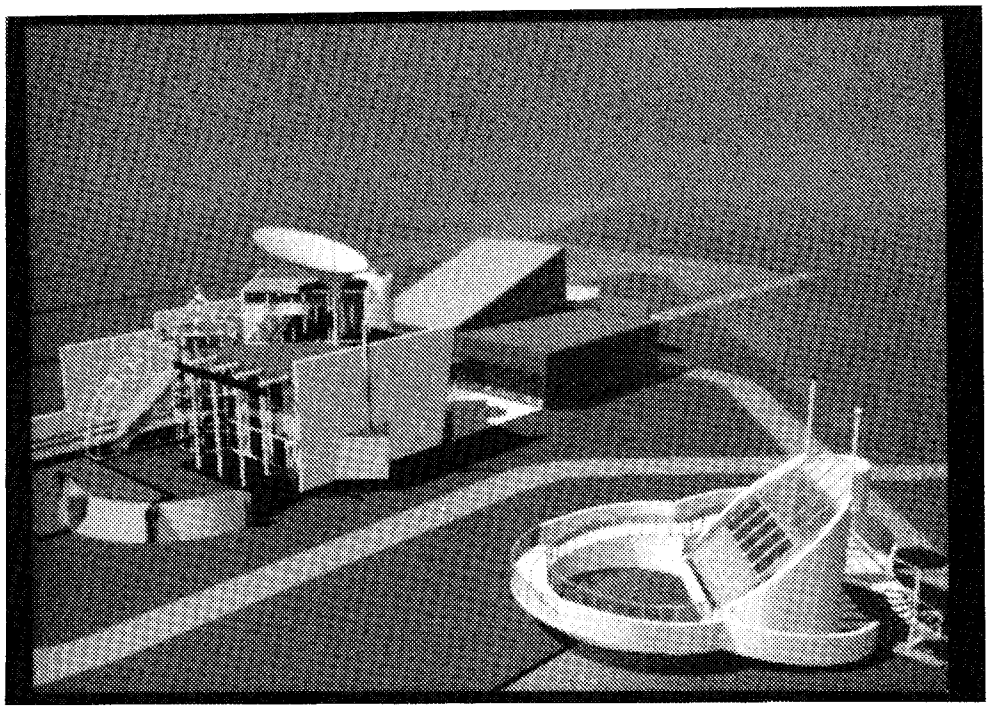

Figure 2. Rendered Image.

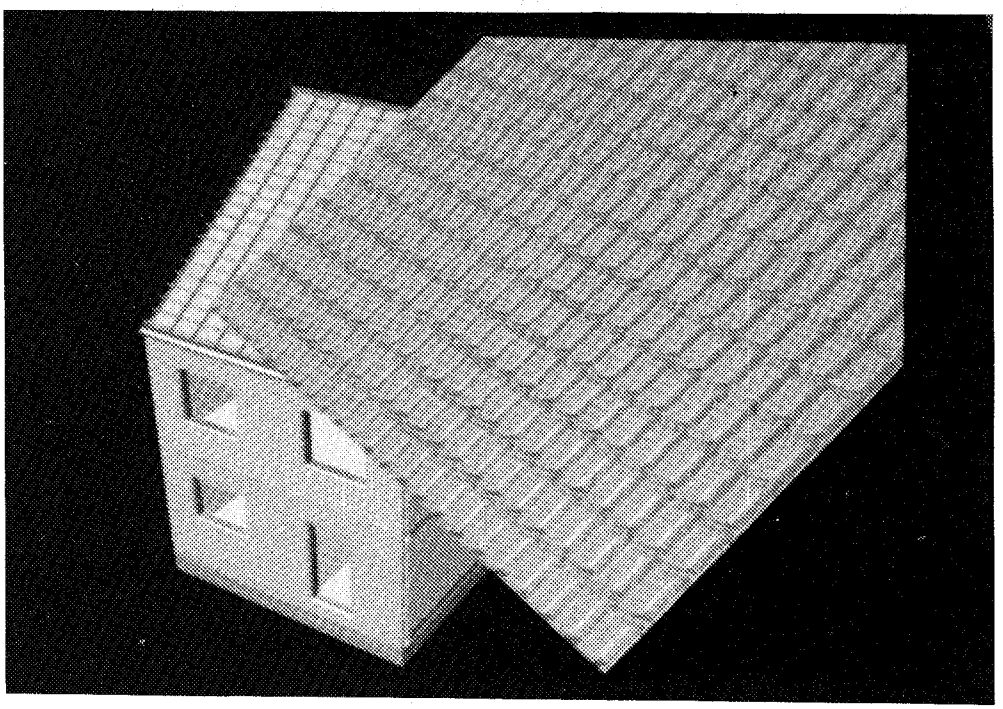

Figure 3. Texture and Bumpmaps.

3. PRESENTATION MEDIA

The format of the image depends on the choice of one of the presentation media that are available, such as:
- computer screens (black and white, colours, resolution, stereo);
- prints (colours, resolution);
- photographs, slides, still videos, holograms;
- audio video animations (images/second, standards);
- virtual reality.

More abstractly, presentation media can be characterised as:
- single-user (computer screens) or multi-user (prints);
- single-task (slide) or multi-task (virtual reality);
- batch (animation) or interactive (holography);
- stationary (video) or portable (photograph).

A designer should be able to choose for the medium that best serves the purpose of the presentation. That means that in this case image data should lend itself to sharing by different kinds of media.

4. PURPOSES

The purpose of a presentation can vary substantially. It can be an illustration of a proces or a product or it can be an explanation of functional (why what) or technical (how what) aspects. It can show organisational, esthetic, structural or physical aspects or aspects related to costs and time.
The illustration or explanation can, for example, be used for the appraisal of the performance or the assembly of the proposed building.
The main purpose of a presentation will, however, be the communication of a design (Figure 4.), a design idea or a construction method (Figure 5.).

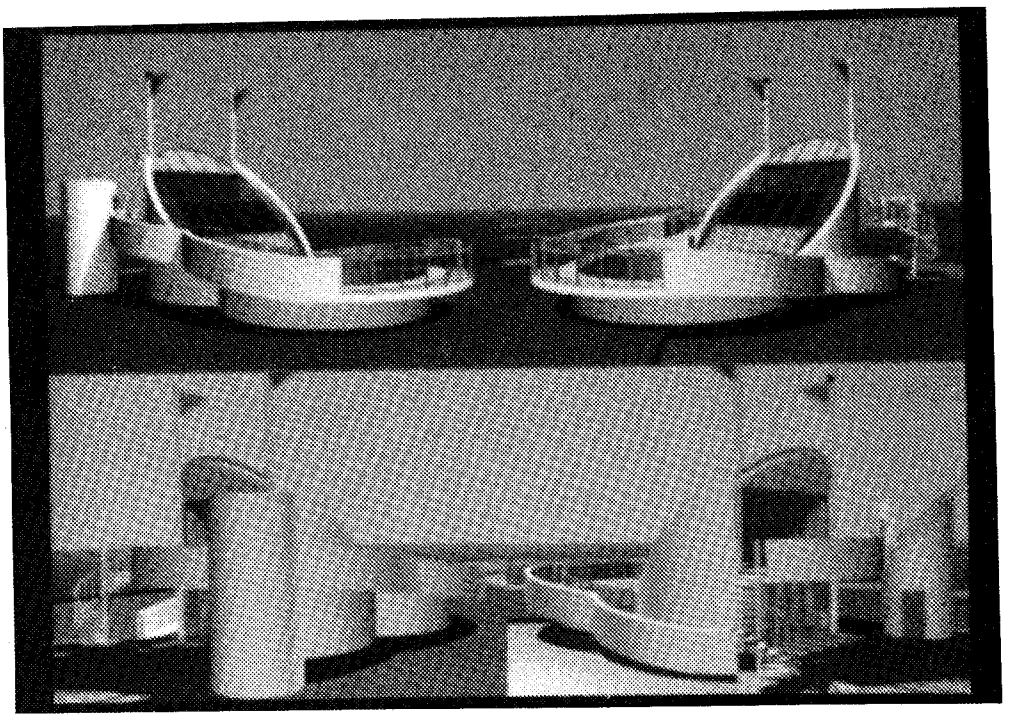

Figure 4. Illustration of a Design.

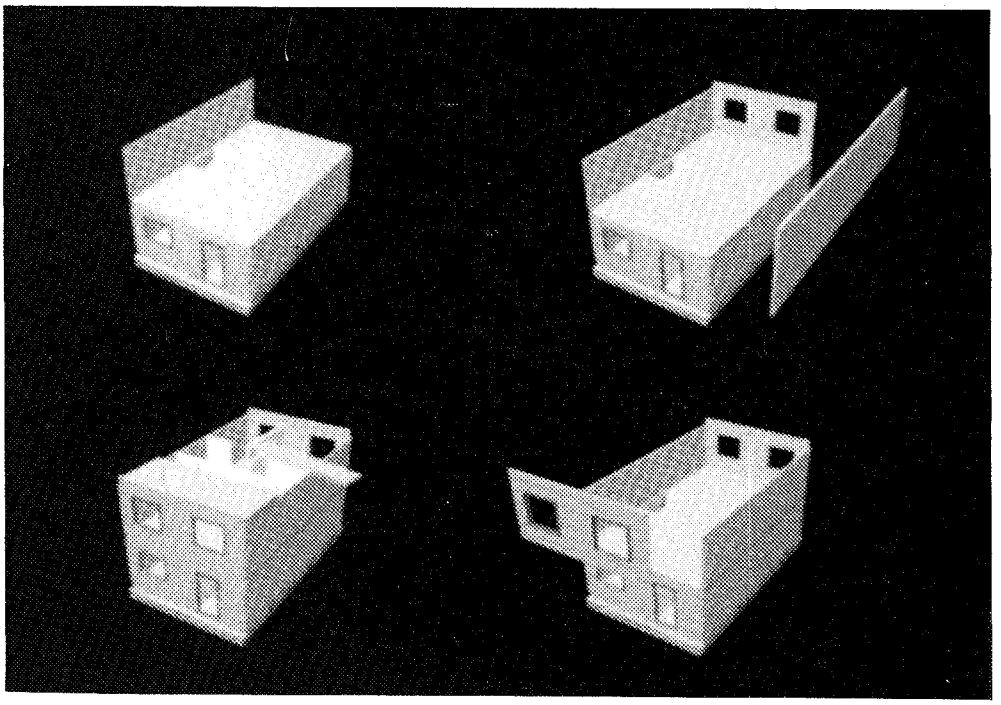

Figure 5. Explanation of a construction method.

5. DESIGN MODEL

To 'design', 'construct' and 'manage' a 3-dimensional computer model of a design is very time-consuming. To make this time and effort more productive it should be possible to (re-)use the same model for different purposes and by different media.
At the moment different programs and different media require their own description of the model. To accommodate these programs and media the model data will often have to be translated or converted.

Technically this seems easy to solve. Functionally, however, it is of great importance, and has proved to be very difficult, to guarantee the consistency and completeness of the different descriptions of one design model or of a specific part of this description that is needed for a specific application.
For presentation purposes the descriptions should at least be complete and consistent with the components and attributes in the model, the sub-models, the colours (and maps), the light (sources) and the views.

A model or image converter should be able to deal with this.
It can be asumed that a presentation does not add anything to a design, but care has to be taken to ensure that a presentation does not 'forget' anything.

6. MODELCOM AND IMAGECOM

Calibre has developed a special tool to communicate different design models between different computer systems (ModelCom). This program allows the designer to work on the design model iteratively and to delay the specification of this model for the generation of images.
Another tool that has been developed is a tool to communicate different model images between different presentation media (ImageCom). This program gives the designer the opportunity to generate several images that can be used by different presentation techniques later on.

The ModelCom and ImageCom programs are used intensively between and during the processes of design modelling (with different programs), image generation (with different computer systems) and presentation recording (with different media).

7. PRESENTATION PRODUCTION PROCESSES

As implicitly stated earlier, a computer model has to be 'designed', 'constructed' and 'managed' like any other (technical) product. Normally, much time and effort is spent on the construction only, forgetting about the design and management of that model.
To be able to design and manage a computer model, a designer should be aware of the possibilities of different modelling techniques and their consequences. This will give him the opportunity to predict what the model should look like in order to get the right results and what could happen with the model in the future.
Education in techniques for the presentation of designs, models and images education in other CAD applications in the building process itself.
For example, Calibre offers courses to second and third year students on graphic computer systems (drawing and modelling), computer graphics and data structures (modelling and generating images) and multimedia (presentation techniques). These courses deal not only with the products (such as models, images or presentations) but also with the processes or activities to produce them.

Summarised these processes are:

1. Design Specification, comprising:
   - a process phase, detail level (subject, components, objects);
   - geometry (shape, size and topology);
   - attributes (esthetic, structural, physical, cost and time aspects);
2. Design Modelling comprising:
   - environment (set-up and settings);
   - model (static, dynamic), sub-models (layers);
   - characteristics (kind, appearance, behaviour);
3. Image Generation comprising:
   - kind (hidden line, ray-traced) (determined by design model)

- format (print, photograph) (determined by presentation media)
- relation (mono, stereo, multi-image)

4. Presentation Recording (and Playing) comprising:
   - media (users, tasks)
   - interactivity
   - portability
5. Design Presentation comprising:
   - illustration (process, product)
   - explanation (functionality, techniques)
   - communication (ideas, results)

As in a building process several phases can be recognised for each process:

a. Design Phase:
   with special attention to completeness and consistency of the model, the image or the presentation;
b. Construction Phase:
   with special attention to efficiency and effectiveness of the model, the image or the presentation;
c. Management Phase:
   with special attention to quantitative (as little as possible) and procedural (as late as possible) aspects of the model, the image or the presentation.

8. PRESENTATIONS

Although it could be interesting to discuss these productionprocesses and phases in detail, this paper wil focus more on the use of different presentation techniques and the future consequences and expectations techniques.

To show "objectively" the differences between the various presentation techniques one specific design model was used: our model of the Dutch House of the Future (Figure 1.). This house is modelled with different CAD programs (e.g. AutoCAD, MicroStation). The models were used for the generation of the different images with different systems and software (e.g. Wavefront, 3D Studio, RenderStar 2) (Figure 2.). Different media were used to record these images (e.g. Laser Video Recorder, Audio Video Studio).

The presentations, which are discussed here consist of different images. These images can relate to each other in various ways. A single image can, of course, be used independently. Two images can give a 'stereo' view and several images can create an animation.

9. SINGLE IMAGE PRESENTATION

For the presentation of a design (model) a designer might want to use different independent images. These images can be based upon an approximation of reality (e.g.

illustrations) or on a transformation of the model (e.g. paper model drawings). To generate images (e.g. rendering) and to record a single-image presentation (e.g. printing) many well-known techniques are available.

9.1. Illustrations

Different techniques are available for making illustrations that have an effect close to reality. Artists make their well-known handmade illustrations and computer experts are able to superimpose beautifully generated (artificial) images in colour-scanned (natural) images. The main difference between the two is that the computer expert can easily make more than one different image of the same model (Figure 4.).
One or more computer-generated images still cannot beat a scale model, as is often the opinion of designers.

9.2. Paper model drawings

That is why development of a program that can easily make a paper scale model drawing based upon a computer model of a design has started. At the moment this program can readily different kinds of 'wire lines'- design models (in DXF format). Once a designer has designed and constructed his design model he can identify the parts of that model of which he wants a paper scale model. Different parts can be used to put the complete scale model together or they can be used, later on, to make necessary changes to the scale model.
Façade drawings (and hatch patterns) can be added automatically or manually to the paper model drawing before this drawing is sent to a printer/plotter.
Tabs will be added automatically, their size depending on the plot scale chosen, and they can also be added or removed manually. (Figure 6.).
All the knowledge integrated in the program was obtained by making all the necessary drawings from the first computer-generated scale model drawings and learning all the existing rules from an expert scale-model designer (Ir. Victor Veldhuisen van Zanten).
At the moment the program is commercially available and can already compete with other techniques that are available for scale models. However, the same technique can also be used to generate paper model drawings of more complex shapes, such as, meshes, and better looking models, by making use of rendered images. These possibilities will place this program far ahead of other, more conventional techniques.

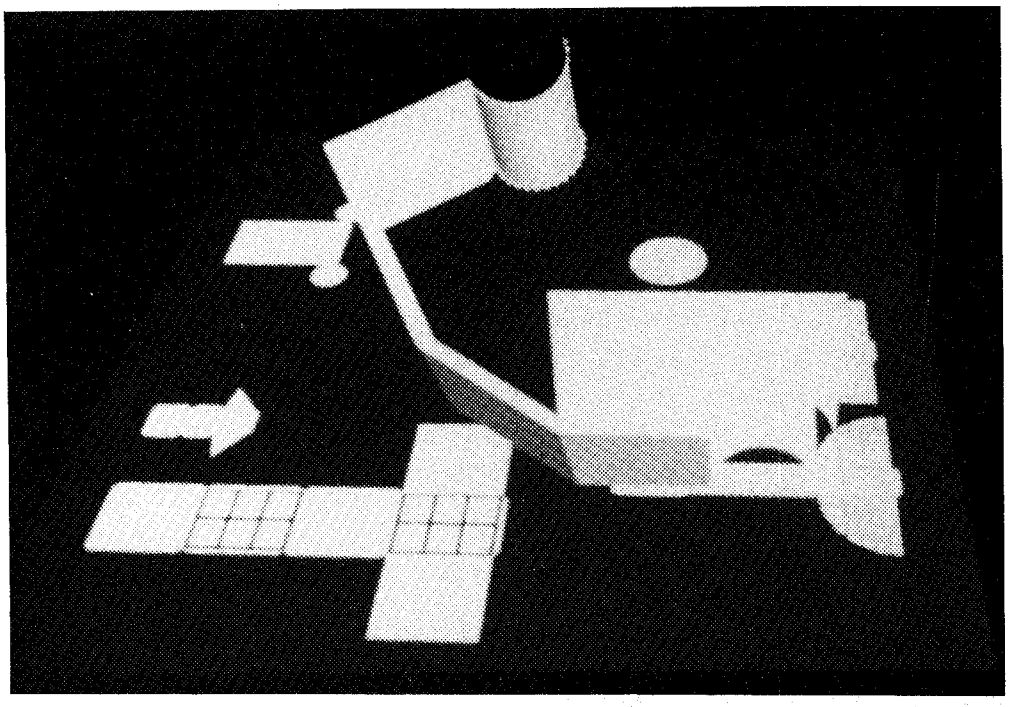

Figure 6. Paper scale-model drawing.

10. STEREO-IMAGE PRESENTATION

For the presentation of 3-dimensional aspects of a design (model) a designer might want to use stereo images. These images can also be based upon an approximation of reality or they might show a transformation of a design (model). However, generating the images in the right way calls for a clever approach to eyepoint, focus point and view-angle definition. To reproduce the images special media are needed (e.g. a stereo viewer or stereo-computer screen). A special medium that can be used to store several stereo images is a hologram. To date, several holograms of non-physical existing computer models have been successfully made, one of them even with colours. The use of more stereo images of the same (static) model improves the 3-dimensional perception of that model.

10.1. Stereo views

The possibility to generate and use stereo images improves the 'return on investment' of a 'cost and time' investment in designing, constructing and managing design models. The stereo techniques improve the presentation of 3-dimensional aspects of a design proposal. Experiments have been performed with different stereo techniques, such as stereo images in a stereo viewer, red and green images on a computer screen and corresponding red and green glasses, and 'full'- colour images on a dual computer screen with different polarized glasses (Figure 7.).

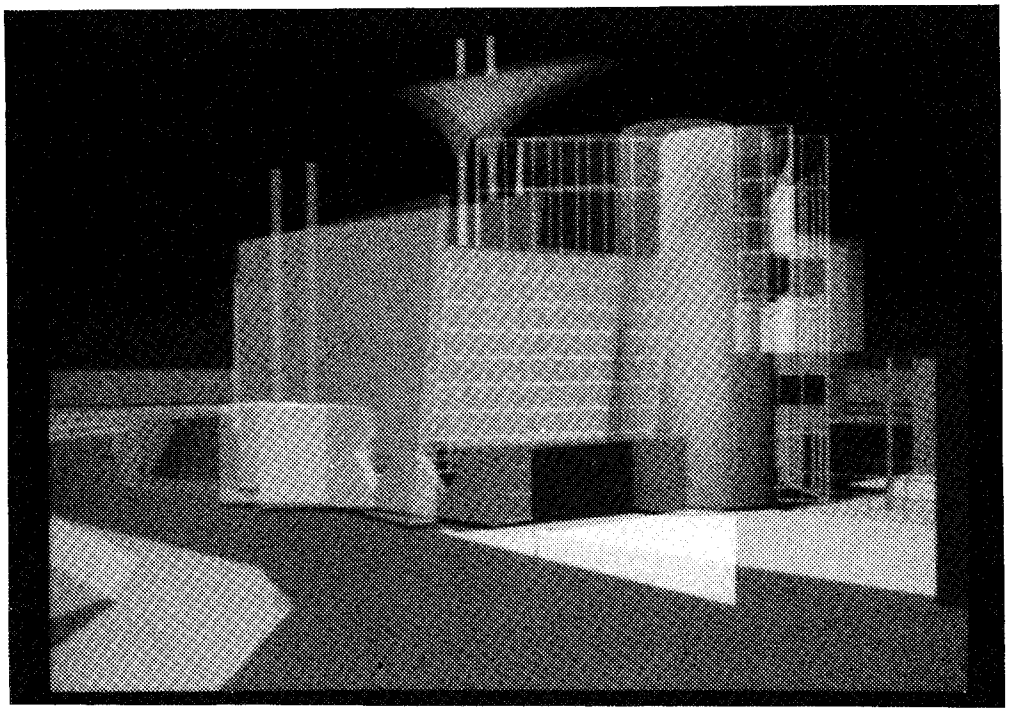

Figure 7. Stereo images.

10.2. Holograms

The next step in this case was to combine different stereo images in one computer generated hologram. Unlike the paper modelling technique, the holography techniques are not easy to understand.
A 'normal' hologram is a recording of the splitting of parallel light caused by an object placed within the holographic set-up.
In this case making a hologram of a design requires a scale model of the design that will fit into this set-up.
That, of course, is an extra step and why would anyone want a hologram when a scale model already exists?
In our case a computer model of the design was used. This model is used to generate different closely related stereo images. Each image pair will then be recorded on two strip-shaped parts of the hologram. Different image pairs will be recorded in the same way and will give the viewer the opportunity to look at different but related stereo images. The relation between the different image pairs was such that the eyepoint and focus point of a image moved along the 'design model' in a straight line perpendicular to the line between the eyepoint and focus point. Because a single hologram can only record 150 images or 75 related image pairs, the length of this straight line is still limited (Figure 8.).This means that a viewer can hardly see the sides of a 'larger' model.

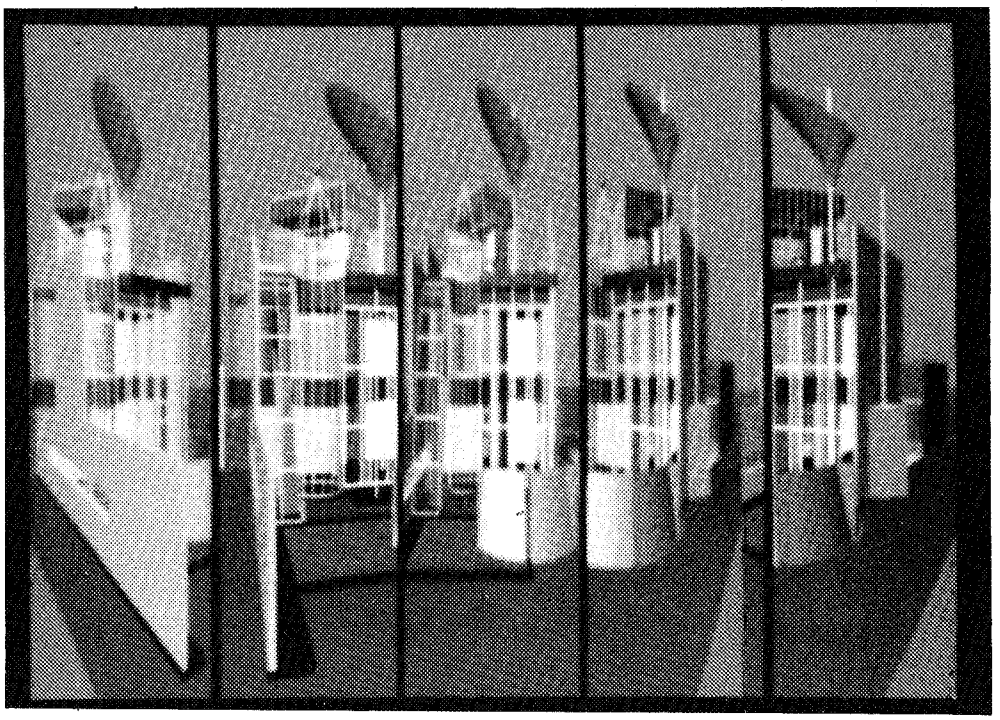

Figure 8. Hologram images.

On the basis of this experience experiments recently started with computer-generated holograms having different starting points. The main objective was to find out if some freedom could be gained by omitting the stereo effects.
The first so-called animation holograms have been made. One hologram circularly showed a horizontal 'walk' around half of a static computer model using greater steps than were originally possible. The other hologram showed different closely related design models recorded with the same eyepoint, viewpoint and view angle. In fact vertical movement of the viewer's position caused the viewer to see an explosion of the model into different flying components.
When more details of animation holograms are known, an attempt will be made to combine the different techniques by making a hologram of a walk around an exploding design model in 'full' colour.
An advantage of holograms of this kind is that they are portable, while the 'animation' can be controlled interactively by the user.

For this work we are making use of the holographic facilities of the Dutch Holographic Laboratory. This company is working on a kind of holographic printer that will be able to produce embossed (printed) holograms based upon 3-dimensional design models.

11. MULTI-IMAGE PRESENTATION

For a presentation that would offer an explanation of the design (model), instead of just an illustration, we shall need a dynamic design model. That means that various images of different ,but closely, related design models are needed. The differences between the models should make possible an explanation of, say, the assembly of a building or the ideas that were put into the design. In this case different models (model changes) have to be devised (designed, constructed and managed) and different images have to be generated in a properly related manner. Various programs are available to make life easier in this connection but it still means a great deal of tedious work. Special attention must be paid to the design, construction and management of the presentation itself. Computer animations are a well-known example of a Multi-Image presentation although too many examples only show a static design model.

New in this field is a combination of Stereo-Images and Multi-Images in Multi-Stereo-Images or Virtual Reality. Experiments have started with our Virtual Reality system, known as Cardinal, which is based upon transputers and special processors for generating different stereo images at 'animation' speed. A special feature of these systems is that , as far as possible, they avoid 'artificial interfaces', such as keyboards and make use of sensors (related to head or eyeball position) to determine the eyepoint and/or focus point. A gesture-controlled (or joystick-controlled) 3D pointer can help the designer to make changes in the objects and see the results (e.g. it gets lighter when a window is made larger) in real time.

The use of Multi-Image presentations can improve understanding of the functional and technical aspects of a design (model).

11.1. Animations

Animations can be used for an illustration of a (static) design model or for an explanation of a design by using different models and effects.

For the construction of an animation, with audio and video animation, much time and effort has to be spent generating many images. For high-quality, almost realistic, animation each image will demand a great deal of computational power and time.

Each image will have to be recorded and the sequence used to do so is the same sequence of images as a viewer will be able to see. Experiments have been performed with different image techniques, with colours, textures, background images, audio and video effects and so on (Figures 4., Figure 5.).

Once the final presentation was recorded the viewer could only turn it on or off and forward or backward. In other words, the viewer could not really determine what to investigate himself. Of course we could use our computer systems for a real-time animation on the computer screen itself, but the kind of systems that were available did not permit the use of more complex models for this purpose.

11.2. Virtual Reality

The problem of the interactivity of a presentation was mainly a financial one and could fortunately be partially solved by the recent purchase of a Vision Vitual Reality system with VPL peripheral equipment such as the well-known eyephone (Figure 9.). This system offered not only computational power, but also a continuous stereo view of the design model and a mostly sensored, more natural way of inserting variables such as eyepoint and focus point.

To begin with this system is used for 'walking through' or 'flying around' a 'static' design model. However interesting this can be and however many improvements have already been defined (based on the first criticisms from various designers), this possibility can never be an end product. This system and the underlying approach to the use of computer systems have much more potential.

The computational power can also be used to employ dynamic models or, in other words, to give the user the opportunity to make changes in the design model. For example, he/ she could move furniture around or change the size and/ or location of a window. The system would in this case recalculate the stereo images and perhaps show the effects of the changes on the lighting situation.

To do this the user (previously the viewer) needs a 3-dimensional pointer which can be controlled in a 3-dimensional environment. To do this the stereo images are essential. To make changes in the model without having to use all kinds of different (artificial) commands, the model components have to be defined as 'objects' in an 'object-oriented environment'. This gives the user the opportunity to select a certain command by selecting a component in a certain way. For example, selecting a window component by pointing at a corner enables the user to reposition that corner, while pointing within the same window could activate the 'move window' command.

A designer could in fact almost really "walk through" his/ her design and make some changes while doing so. Once accustomed to that phenomenon he/ she can invite the structural analyst on the same design model to work jointly on some problems. In this case a multi-user environment is created and real interactive communication between different participants in the building process can start.

12. CONCLUSION

The main conclusions of this paper are:

- there is a wide variety of presentation techniques availble to designers;
- the functionallity of these techniques is very promising but depends greatly on the ideas and skills of the designer;
- special courses are needed on the subjects of design presentations and presenation techniques;
- further development of virtual-reality systems is very important because these systems add a third dimension to the design environment and they involve different presentation techniques.