Architects' Visual Literacy

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Abstract
This paper presents a partial summary of my PhD research with the working title: "View preferences and effects - a study of visual language for architectural design within a represented urban context". In contrast to much VR-research that focuses on techniques for the public presentation of a completed design or an existing urban site, this research focuses on the use of 3D-city-models during the architectural design process. The models serve as a source of visual information that can be used to bring the design in a good relation with the yet existing built environment.

In the research, I investigated the possibilities to make a VRML - city-model adaptable in its representation, in order to adhere to both the factual and the imaginative needs of a designing architect. The paper consecutively presents the problem, the conceptual change and development of research questions, the methodology and a brief overview of the research findings.

Introduction
Architects are trained to 'read' drawings. When they read maps, plans, sections and elevations, they are able to empathize with the represented design. With some effort, they can build a mental architectural model in their mind. Architects can imagine the building or the city. Ideally, this mental representation can be explored as it were like a real environment, but it is well known that the memory and imagination can play with facts in several, partially uncontrollable, ways. Facts in the short term memory are limited to seven, plus or minus two, 'chunks of information' [Miller, 1956] and we also know that imagination can be biased by wishful thinking and forgotten conditions. However, with their educated skills to read drawings and to imagine the space, architects could be denominated as 'visual literates'.

New means, such as architectural endoscopy and Virtual Reality (VR) become available to assist the architect to pre-view a design in 'virtually' all its visual aspects. The scale model or the design database represents the design in a more or less detailed and vast way. Faults out of limited awareness and biased imagination can be bypassed by visible facts. The 'visual cues' from scale- and digital models make architectural endoscopy and VR very helpful tools in a design process.

If there is good control over the expressive aspects and the actual facts in the model, VR and endoscopy are relatively reliable media to communicate the visual and spatial aspects of a design. The 'virtual realism' of 3D-models can be beneficial in design development and for mutual understanding between the architect and the client [van der Does, Giró, 1997]. On the other hand, one can question this quality for too much directness and the possible effect that further imagination is pushed aside by seductive or persuading impressions.

In this research, the 'visually-literate' architect and the new 'visually-unlimited' media are brought together.

Problem

In almost every kind of work we have to deal with an increasing amount of information. It is obvious that not all the information can be kept solely in the head. We have to note things down and look things up in agenda's, notebooks, databases and all sorts of documents. The same applies for architects.

Architects have the difficult task to deal with the complexity of cities in order to fit a new design into the jet existing urban context. In order to make the fit, it is a necessity to make both the urban environment and the design ideas 'virtually realistic' (see Figure 1). The virtual realism can help to foresee the real future in which design and the context ultimately come together. The superimposed 'image' of the design within its urban setting gives the architect feedback for further development of the design and it allows for having reasonable communication with the client.

Fig 1: In order to foresee the effects of the design in its future context, both the context and the design ideas have to be made 'virtual realistic'.

Hitherto much research effort has been focussed on the methods and techniques of producing 3D-digital city models. A recent overview of essential 3D City Modelling Research was given during a special session at the 19th eCAADe conference in Helsinki [Dokonal, Martens, 2001]. Papers in this session focussed on diverse and important issues like: 'Developing Standards for the Creation of VR City Models' [Bourdakis, 2001], 'On Building a 3-D City Model with Students' [Dokonal, Martens, Ploesch, 2001], 'Modeling the City History' [Kós, 2001], 'Making and Using a City Model: Adelaide, Australia' [Pietsch, Radford, Woodbury, 2001], 'Welcoming multiple visitors to the Virtual City' [Ennis, Maver, 2001], and 'The 3D-City Model – A New Public Space' [Holmgren, Rüdiger, Tournay, 2001]. Despite the important work on building and deploying the many existing 3D-city models, many questions on the topic of city-model applications and the direct preferences and effects concerning the imagery of 3D-city-models remain unanswered. None of the papers in the conference session nor any other consulted publication on the subject of 3D-city-models focussed profoundly on the actual view-preferences expressed by an architect while using such models. Neither were the direct effects of 3D-city-models on design thinking

investigated in a methodological way. Most studies were linked to real cities, which is straightforward, but fundamentally unwanted for research about architect's visual literacy in which recognition of quality aspects of a represented city plays an important role. After all, the knowledge about the real aspects of the case-city would bias the judgements.

Research about the impact of media on design thinking seems to have jumped from concrete and fundamental research about the initial design phase (hand-drawn sketches) [Schön and Wiggins] and architects' reasoning [Arnheim], to topics about the use of 3D-city models in very specific applications such as historic studies [Alkhoven] or in collaborative design research [Stellingwerff and Verbeke]. Other recent research focuses on technical issues of high-end interfaces in immersive-VR [Kruijff, Donath] and special projections in e.g. a CAVE-system [Klercker af, Henrichsén]. While the new and much more advanced digital media give many reasons to further investigate the impact of design images, most of the current research is focussed on direct benefit of the techniques and immediate production of advanced models and systems. Also, a specific focus on the impact of fast evolving virtual representations on ordinary desktop computers seems to be disregarded. After the traditional design-media research of Schön, Wiggins and e.g. Hamel, the preferences and effects of media in relation to architects are almost neglected in nowadays research.

This lack of research about the preferences and effects of the attractive and newly available technology is reflected in the way it is used. Several presentations (of undeniably interesting efforts to make a 3D-city-model) show the model from a strange heightened viewpoint, just above the building blocks, while it moves at an enormous helicopter speed. Research and common sense would have directed the view to either a well chosen bird's-eye view or a normal person's eye height. On the other hand, it has to be said that many 3D-city models look considerably good in aspects of materialisation and extensive use of photos for texture mapping. However, most 3D-city models get their quality from a good team of

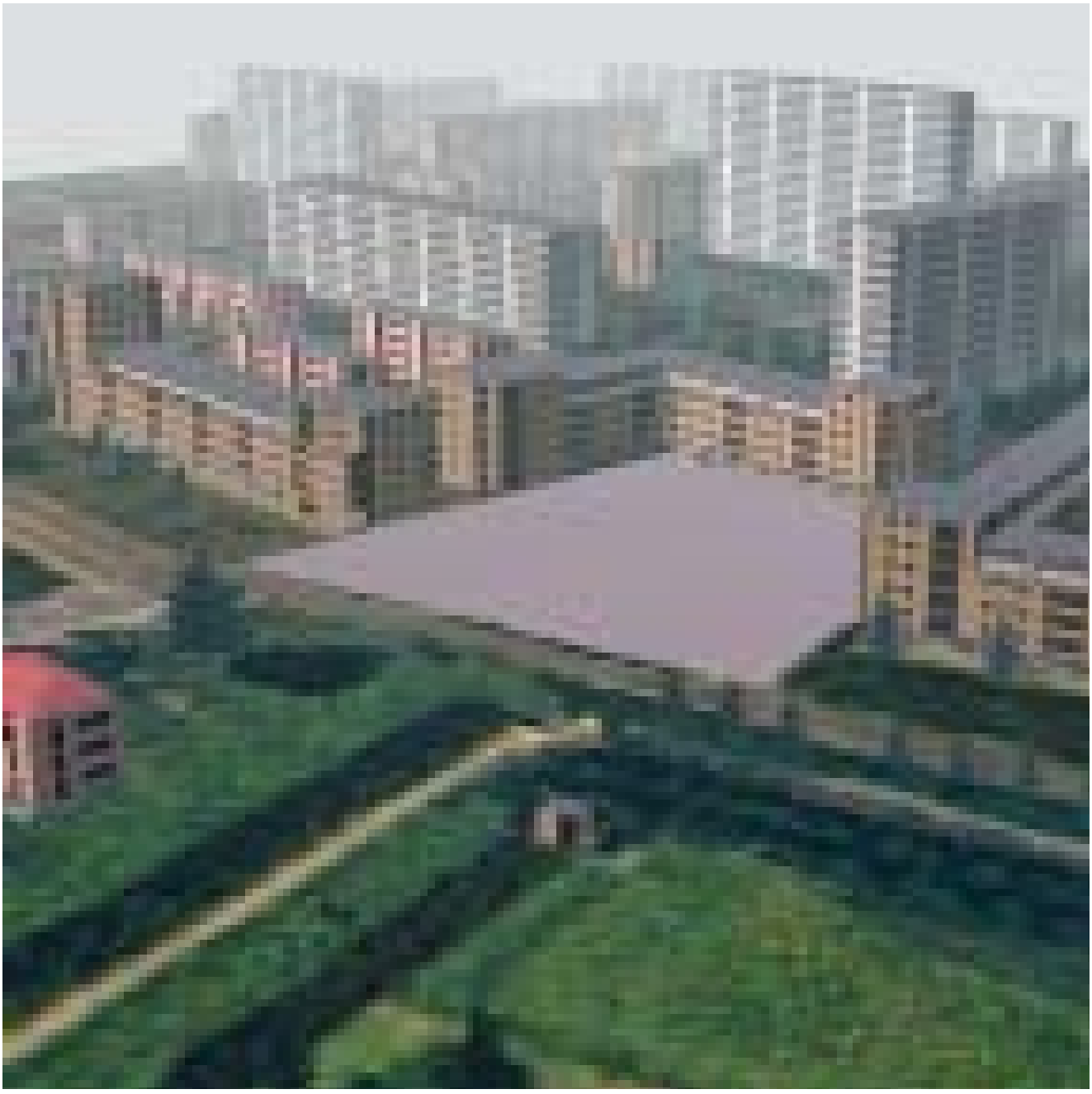
modellers that act as self-educated craftsmen. None of the surveyed researches indicate whether architects actually want to see much realism in the models, neither do we really know how impressions from different models and different representation techniques possibly distort or possibly focus our perception of the real reality.

The main problem and focus of my research is about the visual literacy of an architect while he or she uses and works with a 3D-city model. The research does not chart and solve the whole problem, but it is an attempt to follow up rigorous researches of design media in the (recent) past [van der Does / Schön].

Research questions

The research started with a lot of questions. At first the questions were invoked by the emergence of a new and tempting medium: Virtual Reality. The initial enthusiasm about VR and its 'limitless possibilities' was raising questions of technical and practical nature. How can we best get the existing real world represented and available in a digital model? How can architects design within the represented context? And how can we reduce the model in order to get more rendering speed? These questions were 'most interesting' from before the research started till about 1998. The answers and insights from such questions can be found in the work of e.g. Bourdakis, Ennis and Donath.

Then my questions changed. I decided to focus on 'desktop VR', which connects more to the daily technical practice in architecture offices. I chose VRML as core technology to build a laboratory test system and I wanted to find possibilities and hidden qualities in the use of VRML as a non-immersive kind of visual representation medium. The questions were much more focused on the available choice of impressions and the effect of different kinds of visual representations. What is the effect of colour- compared to black and white-representations, what is the effect of the angle of view in a perspective rendering? How does the rendering of 'fog' and 'transparency' help in the understanding of spatial images?



Eventually, the focus of the research became much more human related. The search for the ‘right view at the right time’ (compare to the ‘right tool at the right time’ PhD research of [Yi-Luen Do]) is about architects' view preferences and their visual literacy. Such preferred views, represented on the computer screen, have their impact on the ‘point of view’ in the mind of the architect. When does the designing architect want a view from above, and when is an eyelevel view preferred? When and how do the design-ideas come up? Are the ideas and the flow of thoughts directly linked to the view? Can we speak of a visual literacy of architects? How can the interaction between a designer and the applied design-media be understood? With such questions, the development and understanding of new visual language aspects became the final goal of the research.

Research method

After making many small case studies and tests on different aspects of the research, a big final test was prepared, in which several prototypes were investigated by a number of invited architects. These ‘test participants’ were given tasks related to phases of a design process. According to their ‘visual needs’ and by means of the prototypes, they could change visual aspects of an urban context-model. They could place their design-model within the context-model and they could also evaluate other designs for the site.

A VRML-model was made of a non-existent neighbourhood, the central part of the model in the test comes from a form-studies exercise for first year students. The students get the model in wood and they can place their design in it. The assignment asks for a strategic composition of volumes within an exterior space. "The edge of the residential area is 'indented' with a large open space between the building blocks. Formerly this was intended to interweave the cityscape with the landscape. The city council wants to build, but there is no space to extend the city. Then she decides to charge for a professional study about increasing the city density. The open space at the edge of the city is one of the area's, which is assigned for this study." [Translated digest from the form-studies guidebook 'MORV' by Bernard Olsthoorn.] . The model of the form-studies exercise was

extended to a 25 times larger area. The design for this larger model was based on structural analyses of an aerial picture of Delft. With a technique that can best be compared to 'sampling' in modern pop music, several parts of the aerial picture were recomposed into a new urban fabric.

The 'samples' were 'photoshopped' together into a new aerial picture of the hypothetic area. The area is characterized by a 15 degrees rendezvous of two orthogonal structured areas. The edge of the city still looks like a real Dutch cityscape with a mixture of fifties till nineties residential buildings and the typical high level of 'functionally subdivided space'. The area, just outside the original border of the city, is filled with some greenhouses, a villa-park, a long road with a mixture of freestanding houses and company buildings and a large park. The hypothetical building-area and its context was specially designed for the research experiment. The aim was to make it a realistically mimicked Dutch neighbourhood with enough interesting features for an architect to relate the design to the context.

The aerial image was used in AutoCAD to trace over the building geometry. The outlines of the buildings were 'extruded' to building blocks and further processed in 3D-Studio-Max. Then the models were exported to VRML. The VRML models were edited in a text editor, in order to give them the right structure of layers and to add specific adaptable representation aspects. The final model consists of several parts which can be switched on and off in order to get the right view. The view settings can be chosen by means of an icon menu. The object transparency and the atmosphere (fog) in the model were made parametrically adaptable. The empty building site within the urban context model is represented as an unarticulated flat, grey, area.

While ‘wandering’ through the virtual model, the architects could express their view-preferences in terms of characteristics (such as: the abstraction or detailed-ness of facades and whether or not there were trees and scale puppets visible), environment characteristics (such as: fog and transparency) and specific viewpoints (such as:

eye-level-views or an animated helicopter-view). Several times the architects were questioned about their spatial understanding of the urban site and along the process they could make first sketches and express their design ideas. After the virtual site visit, each architect made a design for the open area in the urban context and in a second research session the design was to be judged in relation to that context. In this second virtual walk, the architects again expressed their preferences and talked about their visual understanding. During the experiment, the model images on the screen were captured and the sound was recorded. This resulted in six illustrated interviews with architects. Thus the research gave many insights in architects' view preferences and the 'design-process-effects' of the views.

The flow of the test was arranged by means of a research protocol.

The further set-up and execution of the experiment, can be described if five main points:

1: Choice of participants, invitation and scheduling
The choice of the right participants for the test was crucial. The research handled with new techniques and the design tasks were quite demanding. Therefore the following participant profile was made: "the participants should work as architects or should be working at an architecture related firm (such as a visualisation office or a school of architecture), they should regularly work with CAD programs or kinds of visualisation software, they should be unbiased

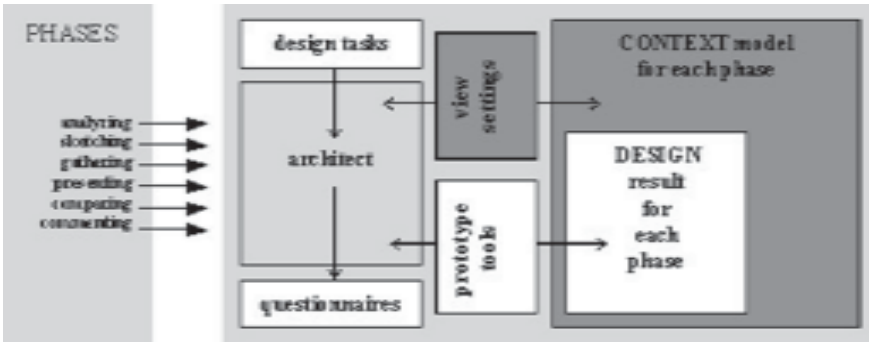


Fig 4: Scheme of the test in which the architect interacts with the Context-model in order to make an appropriate design. The actual focus of the research is on the effects and preferences of different view-settings and the use of several prototype tools.

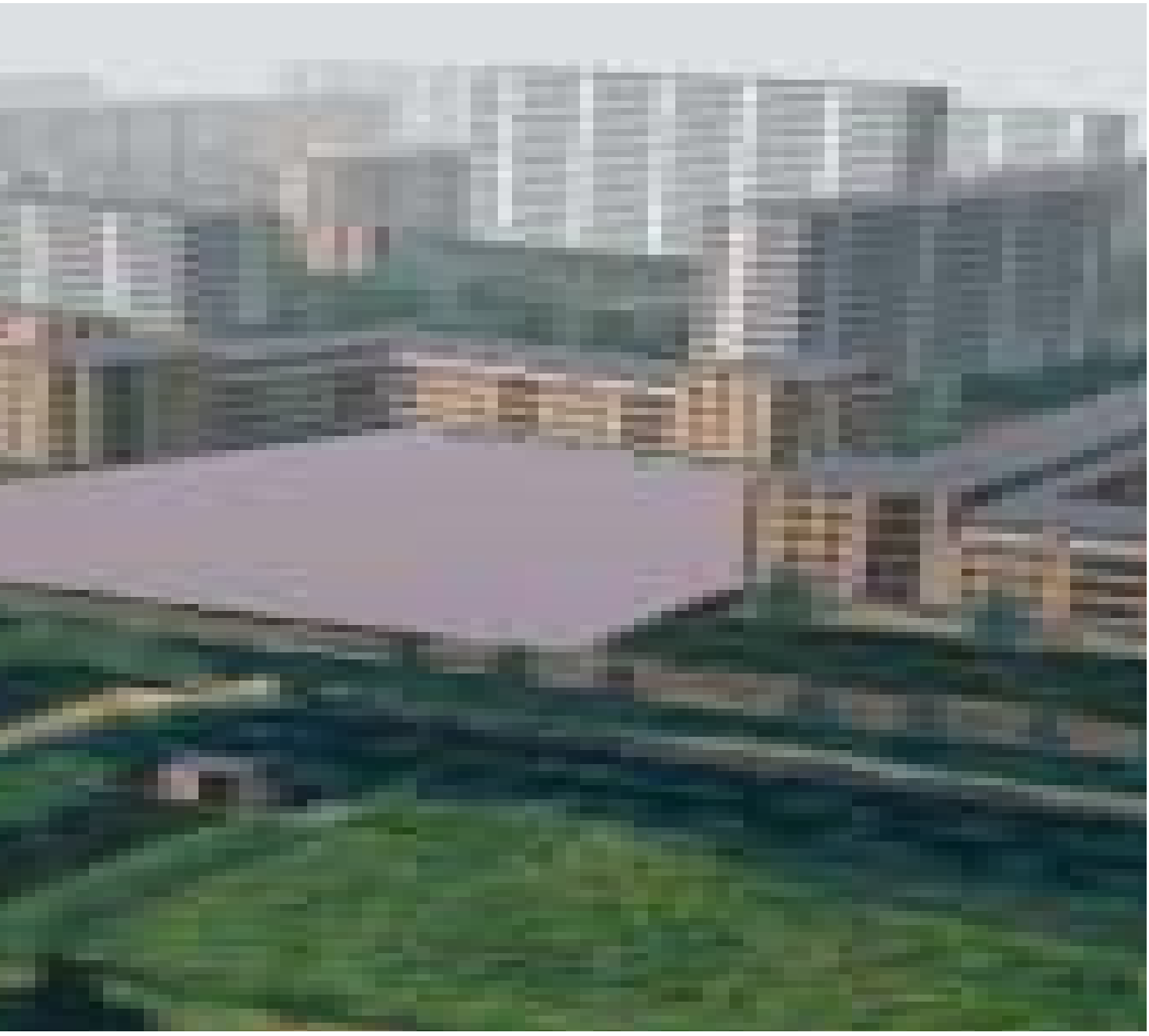
by detailed knowledge about aspects of this research and should be willing to spend about two days of their time for the research." This participant profile suits the target group for the tested prototypes and it may be expected that such participants are willing to spend time for the tests as they understand the purpose of the research.
After an invitation, the participants were provided with some guiding information, which enabled them to prepare for the tests and gave them previous instructions for the use of icons, the various tools, the mouse and the keyboard in the test system.

A schedule was made in order to place all appointments within a four-month timeframe. This included two visits to the Delft Faculty of Architecture for tests at the research laboratory and a 'take home' design task.

2: Three tests about context exploration
All participants visited the research laboratory twice for tests with the virtual urban context model. The participants were confronted with a model of a hypothetical urban context. In order to get familiar with the architectural aspects of the site, they were asked to 'interact' with the model as much as they could. This interaction was structured by means of tasks linked to three design phases: analysing the context, sketching over the context and gathering essential context images. During the third phase, essential images had to be gathered. These images were printed and handed out as a reference for the actual design session at home. The three design phases and accompanying tasks formed the core of the first session at the research laboratory. Necessarily these tests were embedded in a range of 'rituals', by which the participants were guided and observed. Before each test actually started, there were instructions and some chances to try out the typical tools and aspects of the system. During the test, a short guiding questionnaire was used in order to investigate intermediate opinions of the participant.

3: Design-task at home
Between the first and the second test, the participants had to fulfil a design-task at home. Although this part of the experiment took place

Fig 2 (page 143) and 3: Impressions of the context model.



without the direct control of the researcher, there was no fear for biasing effects. The given urban context was fictitious, so the impression of the site could not be influenced by a real impression from a site visit. All impressions came from the interaction with the model during the first session and from the gathered images.

As design ideas have a certain incubation period, the given time for the design task at home should lead to a more balanced opinion of the participants. The participants were asked to make notes of what they thought about the urban context and the way it was represented in the test system. They also had to provide the sketches they made during the design session. The results of the design task should make it clear if the perceptual understanding of a virtual represented urban context can fulfil the demands of an architect for contextual information and inspiration. Here should be remarked that it is not the intention of the research to make a real site-visit in a real architecture design process unnecessary.

The focus of the research is on the primary visual investigations of an architect in order to understand the characteristics of a site and in order to judge the appropriateness of a specific design for that site. So the design creation activities, as how they develop in some time during this phase 3, are less important than phase 2 and 4.

4: Three tests about design in context

Before the second test session at the faculty started, the result of the design task of each participant was merged into the context model. This provided a combination model, by which the actual interplay of the design and its surrounding context could be explored. During their second visit, the participants had to perform again several tasks according to three phases: presenting a design within its context, comparing different designs for a specific context and commenting, making annotation and arguing about design in context. Similar to the tests in the first three phases, the tasks were accompanied by appropriate instructions and short questionnaires about the intermediate opinions.

5: Documentation and evaluation of results
By means of four different result sources (the interviews, the behaviours, the design sketches and the actual design results), the many findings of the research were collected, valued and interpreted.

Research findings
The research provided many answers and several unexpected insights. In advance of the PhD thesis, the overview in this paper is kept short and just indicative, while it takes many more pages to accurately ground the conclusions.

The view-preferences for personal use in the design process differ from the preferences for communication with clients.

As architects are already trained in reading abstract drawings, they often want to see similar abstract views in virtual reality models. The abstractness of form without texture enables them to focus on specific spatial aspects of the design and the site. In the communication with the client, the participating architects preferred to make the design as clear as possible, while the representation of the urban environment (the urban context) could be shown in a less realistic way. In order to achieve this, the use of transparency was an unexpected means to suppress the presence of the environment. Also a black and white representation of the surroundings in combination with a coloured design was preferred.

Other interesting results of this research are concerned with the differences between ‘overview’ (birds’ eye view) and ‘insight’ (eye-level view) and about the emergence of initial design ideas while observing the different model impressions.

Most surprising was the way in which the initial design ideas quickly rooted into the architects’ narrative.

It can be concluded that such research needs to be continued in order to discover the important role of ever-new design media on the thought processes of architects while they use the new media.

Quality of a digital model is too often considered to be equal to features that support realism in the images. Realism is only one quality. Unrealistic, schematic or reduced aspects proved to be other qualities in the representation of a city-model.

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Note

The choice for the Virtual Reality Modelling Language (VRML`97) as a freely available and standardised language for building the research prototypes, proved to be a good one. At the start of the research the modelling language was just approved by the ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission). Just in time, the graphic processor-chips became capable to render the VRML scenes in an acceptable number of frames per second. VRML became an open file export format in many CAD programs and other kinds of

visualisation software. VRML is quite easily editable and proved to be ideal for the production of my prototypes for research experiments. A strong community of ‘nerds’ at the comp.lang.vrml newsgroup were helpful to give solutions to many VRML programming problems.