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Abstract
The large variety and number of actors possibly involved in urban renewal, makes the design of urban renewal plans a very specific and complex challenge. In this process design and communication tools play an important role. Visual information is believed to help to find out what the design problems are, to understand them and to choose sustainable solutions, because this visual information is supposed to be a common language between the different actors in the process. However, there are indications from practitioners that this visual information is not necessarily perceived the same way by different professionals and non-professionals. In this paper we study in which ways visual information may support the design process or urban renewal and in how far 3D visualisation and GIS-technology may be useful to achieve this task.

1. Introduction
Post-war neighbourhoods in the European Union often fall short of adequate quality to fulfil current needs and are consequently being renovated on a large scale. Many authors pointed out that sustainable urban renewal should include participative design strategies (see for instance Tjallingii, 1995 and Van Dorst, 2005). Participation should lead to a broad acceptation of the renewal plan and therefore to a better involvement of inhabitants in their neighbourhood. In a strategy of participation the aims are shared ambition, perception, understanding and responsibility (Checkland, 1999; van Eijk, 2002). In the Dutch practice the level of participation also depends on the type of design process, which can vary from a blueprint planning to an open planning process. The large variety and number of actors possibly involved in urban renewal, makes the design of urban renewal plans a very specific and complex challenge. In this process design and communication tools play an important role. Visual information is believed to help to find out what the design problems are, to understand them and to choose sustainable solutions, because this visual information is supposed to be a common language between the different actors in the process. However, there are indications from practitioners that this visual information is not necessarily perceived the same way by different professionals and non-professionals. Any representation may be misunderstood by the receiver, due to the form of the message or to the preconceptions of the actors. The ways visual information is used to communicate and to support architectural design emerged in the past two decades as a subject of scientific research. Many researchers studied the use and intelligibility of different kind of

visualisations during design processes (De Vries, 1998; Arias, 2000; Al-Kodmany, 2001), ranging from sketches to 3D-representations and geo-information systems (GIS). However, complex design processes like in the case of large scale urban renewal have not been studied this way yet. The aim of this paper is to study in which ways visual information may support the design process or urban renewal and to study how far 3D visualisation and GIS-technology may be useful to achieve this task. To achieve this goal, we have analysed the use and level of clearness of visual information with respect to:

1. different actors in urban renewal process
2. different phases of the design process
3. ability to communicate information and create knowledge.
4. possibilities for enhancing, using well-know 3D visualisation tools

We have used different approaches to study the role of visual information and to be able to conclude on possible improvements. The first three aspects were investigated through a literature study and partly analysing case studies of urban renewal projects in the Netherlands. There are at least five parties involved in the Dutch urban renewal process: the municipality, social housing associations, inhabitants, architects and technical consultants. For the cases studies, two urban planners of the municipality of Delft, involved with the renewal of the district Poptahof were interviewed, as well as one project managers of the municipality of The Hague and Delft. Interviews were also conducted with a project manager and communication counsellor of a large housing association involved as main partner in the renovation of the district Duindorp and with three consultants of the visualisation department of the municipality of The Hague. Additionally, the past experience of the authors in design processes in which they were involved as well as discussions with consultants and architects were used. The state of the art on modern visualisation techniques was combined with the results of the interviews.

The paper presents the founding as follows: Chapters 2 to 5 elaborate on the used methodology and findings. The results of the investigations as well as recommendations towards future developments are addressed in Chapter 6.

2. Usability of visual materials for different actors

Intelligibility of visual materials has been studied recently by Luck et al.(2007) and Whyte et al.(2007). Luck et al. (2007) studied real-world design practices in the early stage of a building's design, and more specifically the interaction between the architect and the future occupants and concluded that the participant's confidence in the appearance of the building was gained in conversation rather than by the ability of visual materials to represent a future reality. He also stressed that the perception and interpretation of the artefacts is strongly dependent on the educational background, expertise and training of the participant and that conversation and discussion seems to be the ultimate way to share the knowledge included or not in the artefacts. On the same ways Whyte en al (2007) studied the practices of an architectural design firm and suggested that, to improve design practices, it may be more important to improve rhythm and style of interaction than the interaction media itself. Al-Kodmany (2001) stated that when using low-tech visualization techniques like sketches, map, photographs and scale models, the participants are not able to understand the complex relationship between variables and therefore important decisions on these aspects are left to experts having access to computerized data. Traditional methods appear to work well for simple planning issues but not to evaluate potential designs. According to his study, the

foremost of computerized visualization is that it can accurately represent complex contextual information and design alternatives and make this information understandable and usable by citizens, and leads then to more rapid decision making.

The focus of our study is on urban renewal practices, which may be more complex than the practices described above. During the master plan architects and planners often use pictures and photographs to encourage discussion. However, such reference pictures, if too detailed, seem to smother the discussion. Some actors in the process, like future occupants, neighbourhood associations or even building inspectors in charge of building appearance discuss the reference picture on the characteristics they recognize (like material choice or colour) instead of the characteristics relevant to the architect or planner (building volume for instance) at that moment *(Interview with visualisation department ,municipality The Hague).* Unlike building professionals, inhabitants and sometimes also city councillors, appear to have some difficulties to translate two-dimensional maps and floor plans into a three dimensional image. Consequently, they cannot clearly recognize the real impact of the plan. Professionals like project managers from the municipalities feel that detailed oral explanations are needed by two-dimensional plans (*Interview with project manager, municipality The Hague).* It may happen that professionals from municipalities think that all consequences are clear for the inhabitants while the contrary will appear in the realization phase. A typical example is the realization of city-park "The relief" in The Hague, which was designed enclosed by a wall with double function: as a barrage against polluted soil and as clear park delimitation. Two-dimensional plans, sketches and computer images were presented. The inhabitants were enthusiastic but did not realize the wall will also act as a barrier. The professionals were not aware of this perception and thought this was what the inhabitants wanted. The confusion became obvious only after the realization.

Both the municipality of the Hague and the Housing Association Vestia have reported similar experience with the design of district Duindorp, where participative workshops were organized at the begin of the project to decide how the neighbourhood should look like in the future. It resulted in a report with a basic program of requirement using a lot of reference pictures. After realization, the professionals felt like the main requirements had been fulfilled, while inhabitants were surprised by the results. Most probably professionals had an abstract interpretation of the reference images and of what they mean, whereas the inhabitants relied on the picture as a representation of the final realization (*Interview with project manager, Housing Association Vestia, The Hague).*

The master plan for the district Poptahof in Delft was presented with a clear layout but with abstract colours (*Interview with project manager, municipality Delft).* For the designers the use of abstract colours indicated only a wish to discuss their ideas with the inhabitants. But for the non-designers this drawing had a mixed meaning. Because of the clear layout they thought the plan was nearly final and therefore little interaction was shown. The next step in the design, the urban plan, was also presented to the non-designing actors. It received first only limited comments from the inhabitants of the neighbourhood because the 2D drawings gave a poorly intelligible picture of their home environment. Ultimately the inhabitants were always a step to late in the process.

From interviews with several designers and consultants involved in very different building design projects, it appears that designers often depict visual materials from the view point of their own discipline rather than from the view point of the one presenting the plans. If an architect presenting his plans for the volume of a building adds some plots about green and

trees, just to render it livelier, the present landscape architect will react immediately by discussing the place and sort of the trees, which is not relevant at this moment.

Our study has clearly shown that the clearness of visual materials is different for each actor. Furthermore the perception and understanding of visual material is very dependent on the educational background and training of the actor. Visual material appears to be interpreted from the viewpoint of the own knowledge and interests of the actors. So differences are formed by the precognitions with which visual information is perceived. Design professionals appear to be able to translate to a large extent different visualization forms into a perceived future reality. Non-designer actors experience much more difficulties in this exercise and hardly see the abstraction level visual information should be interpreted. This problem is also encountered by professional designers when the visualization contains elements remote from their own discipline.

In this respect an important feature of visualization tools should be a built-in capacity to show the same information on different ways, adapted to each type of actor. Traditional low-tech tools cannot offer this functionality, therefore more high-tech computerized tools seems to be needed. A critical note, however, is that it seems from the literature and from our case-studies that discussions and oral explanations will remain a fundamental issue in communicating and sharing knowledge. Visual representation, no matter which form they have, will probably never be an ultimate medium, but should be used as a support tool, together with a variety of other visual and non-visual methods.

3. Usability of visual materials in different design phases

The usability of visual materials in different design phases of the urban renewal process has not been studied extensively yet. Hartmann et al (2007) stated that 3D and 4D models have advantages for the sequencing and schedule knowledge because the model can be seen from different viewpoint and angles and for different time periods and therefore helps to transfer the knowledge that is possessed by project managers. Al-Kodmany (2001) stated that albeit traditional low-tech methods are limited in the amount of information that can be handled, they are generally more social, participatory and interactive. They are useful when stakeholders have opposing interests and to resolve conflicts. The real-time social interaction surpasses the one of computer simulations. The simplicity of traditional tools encourages the participation of people and is more accessible to most participants. Low-tech methods could therefore be more useful during the first stages of a design where a lot of main decisions must be taken that will have the largest repercussions in the final design. Bendixen et al (2007) stated that sketches developed on the table make it possible to span the different professions present, albeit focusing on few issues at a time, whereas CAD drawings encompass more layers of complexity as well as a future perfect building. Al-Kodmany (2001) also stated that although the more realistic the images appear, the more danger that they will be accepted as truthful, only visualization methods with a high degree of realism should be used because abstract visualizations are not understood by the public. He believes that the emphasis on rendering uncertainties of the design at the expense of realism will result in a failure to communicate effectively.

Clearly, depending on the project, the visualization materials used in different design phases may change. We have investigated several different approaches used in the interviewed municipalities for representing design projects, which will be briefly reviewed bellow:

Reference pictures
Reference pictures, or computer visualisation are often used already in the begin phase. Although it is often believed that reference pictures can help in the design phase, it appears from the interviews that people often focus the discussion on unimportant features. For instance the materials used for the buildings will be discussed whereas the volumes are important. Misunderstandings have been noticed *(Interview with project manager, municipality The Hague)* between professional as well when using too soon detailed pictures. A well-established practice is inviting the inspector for the external appearance of the building at a very early stage to avoid late confusions. The architect shows him/her pictures of the project volumes in which the façade is smoothly curved. The inspector is enthusiastic about the curve, because it is smooth; the architect is happy because he thinks the inspector does agree with the idea of a curved façade. At the end of the project he materializes the curved façade by using facets, by which the façade is not smooth anymore. The inspector thinks is was made a fool, as does the architect after the negative reaction of the inspector.

The housing association Vestia *(Interview with project manager, Housing Association Vestia, The Hague)* decided not to disseminate detailed picture about the plans before the phase of the definitive design because future occupants interpret pictures very literally as "what they are going to get" and not as an example of what is possible. However, reference pictures are of importance later in the design process, when discussion is needed on this materialisation.

Scale models
In the municipality of The Hague, different scale models are used depending on the phase of the process. The scale is usually 1/1000 at the begin of a project, 1/500 at the end. The municipality of Delft starts with a model 1:500 and ends with a model 1:300. During the progress of the project, more details are added, like windows or specific forms. Scale models are a powerful tool in discussions during preliminary design *(Interview with visualisation department, municipality The Hague).* It makes participants more active because they can move objects and play with them. In the past, a laboratory hall was used *(Interview with visualisation department and project manager, municipality The Hague)* in which scale models 1/100 were build with the inhabitants. This hall is not in use anymore, but a modern version of it could be simulation tables as already used in some large German and Danish municipalities *(Interview with visualisation department, municipality The Hague).* In earlier design phases, like the preliminary design, there is a preference of all interviewee to work with scale models and building blocks, because they bear a certain degree of abstraction in itself, that makes that all actors understand that the design process in this phase is about playing with volumes. In Delft the models were appreciated but still perceived as being a bit too abstract.

Maps
Two-dimensional maps with provisional plans are preferred by building professionals in the begin phase because they don't fix any detailed solution. At the same time these building professionals *(Interview with project manager, Housing Association Vestia, The Hague, municipality The Hague and municipality Delft)* doubt whether these two-dimensional plots are really understood by inhabitants. Using them in combination with scale models is preferred.

Excursions and other alternatives

An alternative for reference pictures, used in large renewal projects like Duindorp is organizing excursions in other neighbourhoods to develop ideas *(Interview with project manager, Housing Association Vestia, The Hague).* However, excursions are expensive.
In Delft there were positive reactions from inhabitants for a comic strip type of presentation of the plans in the early phase of the project. The municipality of Delft also used collages as a mean to give inhabitants insight in the living environments that could be created without fixing it.

3D- visualizations
Computer images may be perceived as being to polished *(Interview with visualisation department, municipality The Hague)* and therefore not reliable. Three-dimensional representations may also be confusing if the viewpoint is not the one of the inhabitant walking in the street *(Interview with project manager, municipality The Hague).*A view taken from an observer above the building for instance may be very nice for a marketing aim, but most inhabitant will probably not be able to draw conclusions about how it will be experienced from the street. Combining computer images with realistic elements of the present situation appears to help a lot in understanding the image. A computer animation in which the existing tram was integrated tend to give the non-professional actors more grip on the design *(Interview with project managers, municipality Delft).*

Our interviews have revealed an interesting observation, i.e. the level of visual detail is understood by the actors as having a relationship with the stage of the project. Abstract forms and hand drawings are tools for the beginning of the project. More details and clear computer drawn lines depict a finished design. Style of drawing may have an implicit message, but this implicit message is not necessarily understood the same way by professional and non-professional actors. A good example is the use of reference pictures. They are very intelligible but can also provide to much detailed information and are then not usable. The design process runs from abstract to details, the visual information should support this and still provide every actor with as much information as necessary to make it intelligible. Our study tends to refute the assumptions of Al-Kodmany (2001) that, for a good communication between actors, realism should be preferred to the expression of design uncertainties. A logical outcome of our interviews is that there should be more research on intelligible ways to represent design uncertainties.

4. Communicating information and creating knowledge

Whyte et al (2007) introduced the concepts of frozen materials and fluid materials. The first ones are used to keep records and to consult or distribute information to specific actors. The second ones are used to define design problems, to comment and modify a design and to explore design solutions. The patterns of freezing and unfreezing visual materials appear to play an important role in design practice by orchestrating the practices of the various architects, engineers, designers and managers. Bendixen et al (2007) came to comparable conclusions using the terms stable and malleable materials instead of frozen and fluid. Ewenstein et al.(2007) described also two main features of visual representations: a symbolic one aimed at communication (capturing and sharing information) and a material one, aimed at interaction (developing knowledge). De Vries et al (1998) stated that Virtual Reality would replace 2D user interface of Computer Aided Architectural Design (CAAD) tools because the traditional CAD interface forces users to think on how to achieve something rather than on what to achieve. The latter would be better supported by Virtual Reality (VR) technology because it gives immediate feedback in the form of spatial representation and enable the

combination of art and intuitive design with engineering knowledge and practice. However, VR technology appeared to be less suitable than CAAD technology for the production of traditional communication documents and to have poor performances in the final design stage. According to the literature, visual information appears therefore to have two main functions. The first is a function of communication in which existing information is used and passed to the different actors. The second is a function of creation of knowledge in which possible design solutions are tried out in order to come to a final design. A final design can be considered as the result of all knowledge that has been created during the design process.

In our case studies we have discussed the power of the different visualisation materials. Scale models and more abstract two-dimensional maps are preferred by building professionals in the begin phase *(Interview with project manager, Housing Association Vestia, The Hague, municipality The Hague and municipality Delft)* because they don't fix the discussion on detailed solutions but allow for the creation of knowledge by trying out several solutions. In the current practice, the same visual representations are used to create knowledge and to communicate information to different actors but will not be understood the same way by the different actors. A line drawn has always a definitive character. One can describe a doubt in words but in a drawing this doubt can only be expressed in a more abstract way that is not understood by everyone. Every line drawn suggests a fixed solution, also when it is only one of the possible solutions. More abstract models give more freedom in interpretation but are often less intelligible.

Designers and other professional actors are starting a design process with setting the design problems. A set of uncertainties and a lack of knowledge about what the final solution will be is a common property of this design problem. Should we renovate or rebuild? Can we make the density higher or lower? These uncertainties are inevitable but emphasise at the same time those aspects that delimit the problem. Visualizations in urban renewal will probably improve if the significance of the existing unchangeable environment would be visualized too.

Designer should be aware of the importance of a good timing for spreading information and should make a difference between communication of information and creation of knowledge. One of the problems in collaborative design is that both may be strongly mixed. As stressed in Arias (2000) it is important of being able to represent multiple perspectives from the different stakeholders, to support learning as a shared and collaborative activity and to support interaction and reflection. In the complexity of urban renewal one may consider to fine-tune the information according the precognitions of the receiver. This may for instance lead to a set of different drawings for the inhabitants or for the municipality. Information may be the same, but not the representation. In current urban renewal processes top-down design is applied but it doesn't represent the way of thinking of all actors in the process. In communication with inhabitants one may use a bottom-up approach. Inhabitants essentially understand the small scale (housing or street level), and this fact has not been integrated yet by designers. However, there is research needed to find out in which ways abstracts design solutions at a large scale (neighbourhood for instance) may be translated into something intelligible to inhabitants. Perhaps the design process itself should be changed by adopting cocuurent top-down and bottom-up processes.

5. State of the art in 3D-visualization and GIS- technology

As mentioned above the urban renewal process is strongly dependent on the good presentation of ideas, which is closely related to the used communication tools. Although many physical

models, booklets and other printed materials are still prepared, the use of computers is progressively increasing. Various reasons contribute to this phenomenon: from budget considerations (price of hardware is dropping daily), through technical possibilities (various software for realistic visualisation of large data sets, offering extended functionality) to human acceptance. Arriving at a good decision in urban renewal is more than simple presentation and visualisation, however. Very often the designers have several alternatives to compare, or they have to study existing situations to define problems and discover driving forces to be used as a basis for the design process. Such tasks require tools for analysis. Presently, the most elaborated tools to integrate and analyse information with spatial extend are the Geographical Information Systems (GIS). Therefore this section presents the state of the art in both GIS and visualisation.

GIS has been historically developed as a system for managing (storage, editing, analysis and visualisation) of real-world data. In this respect GIS has proven to be the most sophisticated system that operates with the largest scope of objects (spatial and semantic) and their relationships and is able to provide means to analyse them. Strictly speaking, the tasks or the functions of a GIS are specified as (Raper and Maguire, 1992): data capture, data structuring, data manipulation, data analysis, and data presentation. Indeed, three-dimensional GIS aim at providing the same functionality as the traditional 2D GIS. Unfortunately, such 3D systems are still not available on the market. When some 3D functionality is available it is mostly 3D visualisation and animation, analysis and editing of 3D objects are predominantly 2D. At the moment a variety of different software such as GIS (ArcGIS, MapInfo, Intergraph), various viewers (GoogleEarth, TerraExplorer, ArcScene), Computer Aided-Design (CAD)(Bentley, AutoCAD), Database Management Systems (DBMS) (Oracle Spatial, PostGIS) provides tools to describe real-world objects but none of them possess functionality that can be attributed as 3D GIS. Some of the packages are better in visualisation (viewers, CDA), others in editing and manipulation (CAD), third software is advantageous for data storage (DBMS) or provides tools concentrating on analysis (GIS). Due to the variety of deficiencies in systems to handle 3D objects, the data are often spread between several systems depending on the most performed tasks. For example, one system is used for data storage and another for 3D visualisation. Indeed, this situation often faces inconsistency problems, which not only complicates the work of the specialists but also results in data losses. Much research is devoted to resolving these problems, which however is outside of the scope of this paper. Generally, 3D GIS is not seen anymore as a separate software package but as a technology (software and hardware) that should provide 3D functionality (Zlatanova and Stoter 2006).

As mentioned above, with no exceptions, any software can create a kind of 3D visualisation using different tools. The 3D effect can be obtained generally in two distinct ways i.e. using photo images (normal and/or panoramic) or 3D models, which can be further explored using desktop computer (mouse and screen) or specific hardware devices and environments (see-through glasses, virtual auditoriums, etc.). Photo images, being a copy of the real world, are easily perceptible. Panoramic photo mages visualised in an appropriate browser (viewer) supply an extended functionality, i.e. they allow users to ‘look around’ from a given point. Such a technique is widely accepted for tourist purposes (e.g. www.cyclomedia.nl), housing (e.g. funda.nl), etc. The most significant drawbacks of static images can be summarised as: 1) the images reflect the reality in a given moment (in the morning, in the summer, etc.), 2) they provide a view from a particular location, and 3) there is no tools to perform analysis on the photos.

To overcome these drawbacks, various techniques have been used during the years. Static images have been made with certain percentage overlap/shift, which allows for creating of 3D stereo views. Panoramic images are combined with 2D maps or 3D models to give an impression of walking along a street or inside a house (Zlatanova, 2000). Animation (video) can also be seen as attempt to increase the degree of immersion with the recorder reality. They provide better perception, but the walkthrough is still anchored to a specific predefined path. Animations can be easily created from 3D models.

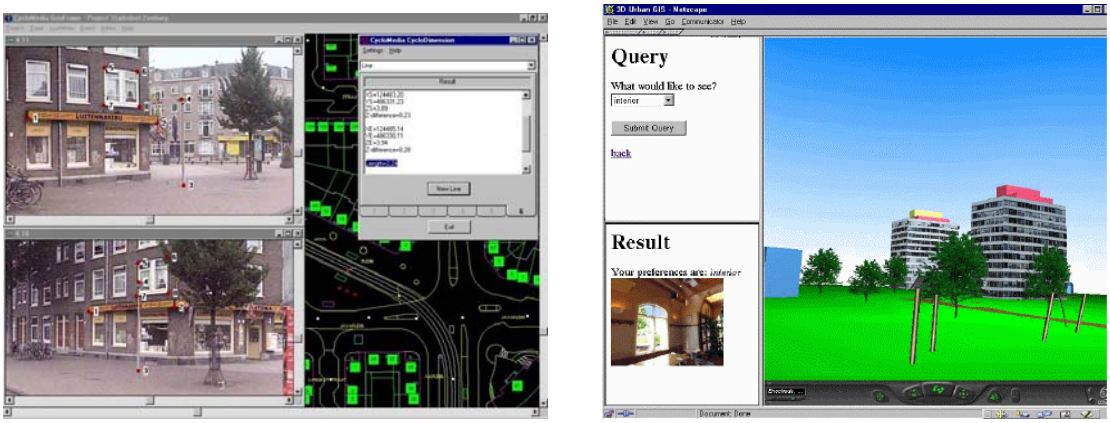
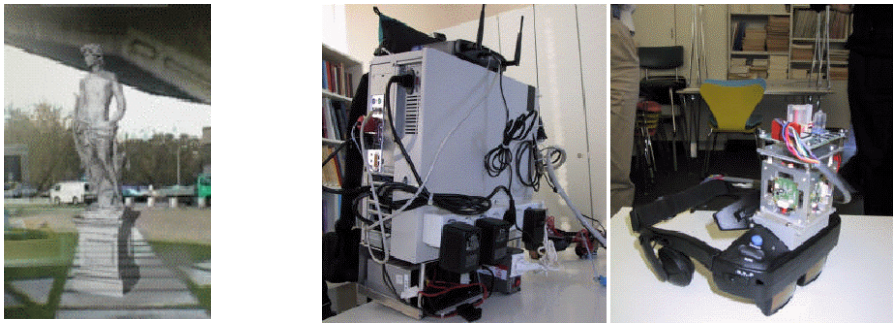


Figure 1: Cyclomedia panoramic images (left) and panoramic browser integrated in 3D web software (Zlatanova, 2000)

3D models provide the largest flexibility in interacting, exploring, editing and analysing. But in contrast to photo images, 3D models always lack the real-world realism, which often is seen as the greatest problem in communicating ideas. To increase the realism of 3D models, two different directions have been followed by researchers and developers, i.e. creating of virtual reality or augmented reality environments. It has been always difficult to define what exactly the terms Virtual reality (VR) and Augmented Reality (AR) include. The most significant difference is related to the size of the 3D model. While in VR 3D models are created for the entire part of world of interest, in AR systems only the new elements are modelled and imposed in the real world. The rationale behind this is twofold. First, real environments contain much more information than is possible to model and simulate by computer. Secondly, knowing that the end goal is to enhance the real-world task, it would be better to keep the user's feeling of being in the real world as much as possible.

Furthermore, the nature of the visual interface between computer and user is different. Both VR and AR systems give the user a sense of immersion ensuring that the user receives a consistent set of sensory inputs. However, because the user looks at the virtual world, there is no natural connection between the user's location and the virtual world. Thus any inconsistency the user perceives, are less visible and the user adapts to them. Using AR system the user is in the real world and his/her location and the speed he/she moves have critical impact on the precision of the projected virtual models in the filed of view. If the AR system cannot compensate for fast movements of the user, the shape of the virtual object can be distorter and even completely lost.

Although very attractive, the AR systems are still not widely used since they require specific hardware (Figure 2) and dedicated software. More information on this subject can be found in the UBICOM project (Ubicom).



a) b) c)

Figure 2: AR systems built at TUDelft: a) view in the see-trough glasses; b) and c) the hardware needed for the AR system.

The large majority of systems dealing with 3D models are practically a kind of VR environment but with different level of realism and degree of interaction with the model. Figure 3 illustrates different approaches to improve the realism, i.e use of photo images, draped on the 3D model (left) vs. computer generated texture.

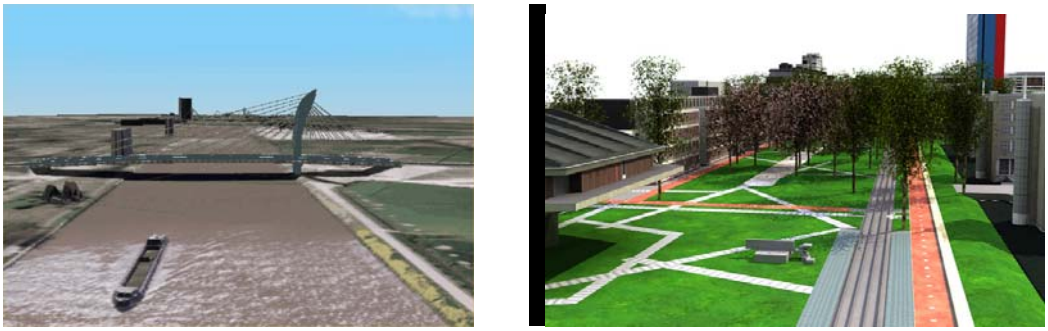


Figure 3: Levels of realism: realism obtained with real photo images and using colour and computer generated textures.

The devices for interaction and exploration can also vary from a simple mouse to an auditorium allowing for stereo vision (figure 4, left) and CAVE (figure 4, right) in which different view of the 3D model is simultaneously projected onto the walls and controlled with special handlers.

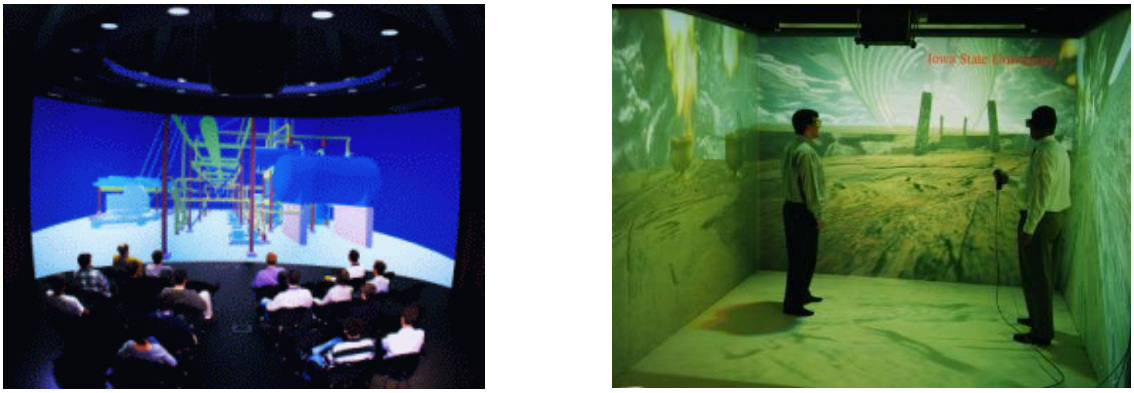


Figure 4: Auditorium and Cave

Generally, most of the institutions all over the world can afford only desktop systems equipped with keyboard and mouse. This practically means that software developers have to ensure sufficient tools for interaction and allow models with high level of realism to be visualised. A variety of software is already available on the market or on Internet, offering such tools. Browsers that can zoom, fly over, walk through, examine and other browsers that can edit and third that can search for attributes. Google Earth is one of the last developments, which complies with the requirements of desktop VR. The environment provides a large degree of realism thanks to the aerial and satellite images used to texture the surface. Additionally the user can browse through the whole globe, a concept which is very attractive for large public.

6. Conclusions and recommendations

In this paper, we have reported our investigations on the use of visualisation tools in the urban renewal design process considering different actors and different processes. Our case studies as well as literature review have shown the misunderstanding as a major problem in current urban renewal design practices. The way visual information is presented to the various actors is of critical importance for the correct communication of ideas and discussion of alternatives. In this respect, we firmly believe that many of the discussed misunderstandings can be avoided by using multiple computer generated representations, which can be adapted with respect to the needs/expectations of the users. Computer models able to provide multiple presentations (2D, 3D, images, videos) are in many cases readily available. The presented state of the art in imaging technologies has clearly shown many different possibilities.

GIS technology, in the development of which the search towards more and more realistic images plays a main role, could gain in usability and intelligibility if it would also take into account the needs for different kind of images in different phases of the design and for different actors. In view of the desired features of visualizations, like the possibility to deal with a high complexity level and to represent what already exists and will not be change throughout the urban renewal process or like the possibility to add new knowledge into the existing system and to represent only parts of this system in multiple perspectives, GIS technology is believed to become a powerful tool in future urban renewal processes. GIS has already well-developed analysis tools that can also be employed in urban renewal. For example, additional tools can be developed that provide functionality similar to some of most successful manner of communication mentioned above (e.g. possibilities to see alternatives in the design).

However, next to technical problems and the problems of linking different datasets to each other, attention should be paid to the fact that, if simulation is too complex, manipulating the tools will remain in the hand of programmers rather than the public. Interaction, when there is only one computer present, is impossible and systems like CAVE can only be successful on a large scale is their price is low. Furthermore, the combination of several low-tech and high-tech visual methods appears in our study to be still necessary to a good understanding. It would be interesting to develop geo-information systems and 3D-visualizations that would possess features of low-tech methods and would be able to visualize design uncertainties.

The next step in our research is building models and selecting appropriate visualisation environment, which can be used in the exchange of ideas in urban renewal processes.

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