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Geo-Virtual Reality and participatory planning

Virtual Landscape position paper

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Abstract

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The research project is carried out within the DWK project Panorama Meerstad and the DLG Virtual Landscape project. This report describes the state-of-art of Geo-Virtual Reality and participatory planning by describing the main lines of spatial planning approaches, participatory planning, communication theories, information and communication technology and virtual reality.

Conclusions from the planning Participatory perspective are given and lead to a synthesis. The synthesis offers the first outlines of a research program. The program focuses upon the definition of geo-virtual reality environments to support participatory planning and the evaluation of this support regarding the users, their personal knowledge of the represented case study area by a 3D scene, the interfaces to interact with a 3D scene and their mutual understanding of representation and interaction.

Keywords: spatial planning, geo – virtual reality, communication, participatory planning, 3D scene

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Foreword

This paper (version 2.0) is not a written in a "write once, run anywhere" fashion. It is meant to be a research position paper about Geo-referenced Virtual Reality (Geo-VR) environments dedicated to the domain of planning and design of spatial areas. Neither is it a static paper. Continuous discussion is needed to adapt and sharpen the research needs of Geo-VR as a reaction upon changing and developing insights into the nature of interactive spatial planning and the way we think spatial plans need to be communicated with actors and stakeholders.

Version 2.0 is based on previous research on the construction of prototypes (chapter 7) and earlier reports and papers (chapters 6 and 7) as well excerpts from thesis reports (chapter 3, 4 and 5).

This version 2.0 is written in support of the Virtual Landscape project, but will be revised to benefit the Virtual New Netherlands research project of the Dutch Bsik research program. The research of the current version is partly paid by the DWK-program 538: Geo-Information.

We would like to thank all VISCOM members who support to this report, especially Arend Ligtenberg, Monica Wachowizc and Jan Dirk Bulens, and the Virtual Landscape members, especially Joost van Uum, Rob van de Velde and Eduardo Dias.

You are cordially invited to react on this version by sending your e-mail to ron.vanlammeren@wur.nl.

Summary

The report brings forward a research agenda considering the support of participatory planning by Geo-Virtual Reality. To realize this mission the following subjects are reconnoitered: planning, participatory planning, levels of participation, communication, information technology and geo-virtual reality.

The planning approach varies between decision-oriented, action-oriented and search-oriented. In each approach the division between the planning subject and the planning object is obvious. The socio-spatial organization represents the planning object. Of importance to understand the process of planning is, besides the socio-spatial organization, the individual cognitive system of a planning involved person.

In participatory planning stakeholders can play both a passive and active role in the planning or decision-making process. However participatory doesn't mean interactive. not all the levels of a participation ladder can be called interactive. Usually the boundary between interactive and not-interactive is drawn between the level of advise and co-produce as defined by Edelenbos J, et al., (1998). In this report the levels of participation of Edelenbos et al. are chosen as a reference.

To understand the individual cognitive system in a participatory planning process the ways of communication are vital. Especially the transactional communication model represents the relational aspects of interactive, participatory planning. All participants or stakeholders are communicators.

Information and communication technology (ICT) supports already in different ways communication. Regarding the Edelenbos reference the transactional model and the role of ICT are related. State of the art ICT-innovations are able to support each of the levels of participation.

Geo-Virtual Reality connects geo-referenced data to the latest multimedia technology, which means that most of latest ICT is integrated and will be of use for participatory planning. It offers outstanding tools to represent the planning object and the planning subject as well as to support the interaction between planning participants and the interaction between participants and the representation of the planning object. The peep-box approach describes the meaning of these tools. It could lead to a promising planning environment by Information intensity, Interaction, Immerse and Intelligence.

The development of such an environment means a Geo-VR development that takes into consideration several research topics of the 3D-scene construction (the representation of the object), the 3D-scene control (the representation of the subject) and 3D-scene experiences (the individual use of the environment).
Each of the topics is illustrated by Geo-VR applications developed by the Virtual landscape partners; the aim of each application and the used development tools are discussed.

A sound concept and implementation of Geo-VR needs experiments and tests of the premises according participatory planning and Geo-VR. Besides the concepts and technologies of Geo-VR improvement a research agenda has to focus on:

- the coding and decoding of geo-information considering the construction of a 3D-scene taking into consideration the stake holder's cognitive system;
- the mutual understanding of stakeholder specific 3D-scenes;
- the nature of experiencing the 3D scene by a certain class of stakeholder considering the phase of participation;
- the type of communication within a multi-user geo-VR environment.
- the interacting or multi-use of 3D-scenes during a participation stage;
- the provision of 3D-scenes by several ICT-technologies like plenary projection, intranet based single-actor sessions or cable-based multi-actor sessions;
- the evaluation of ICT-based geo-VR environments in participatory planning.

1 Introduction

This document contains the results of a preliminary study considering the use of virtual reality techniques (VR) in interactive spatial planning. This study is motivated by the expectations that VR could offer additional, and potentially more powerful, means to communicate and interact with and amongst them who are involved in spatial planning activities.
The Virtual Landscape program, a joint activity of Dienst Landelijke Gebieden, Wageningen University and Research, Free University Amsterdam, University Nova Lisboa and Instituto Geográfico Português, aims to enrich the planning process of 'gebiedsplannen' (integrated region plans) with tools to improve the levels of participation.

This report, presented as the Virtual Landscape position paper, focuses on a research agenda Virtual Reality and Participatory Spatial Planning for the coming years.

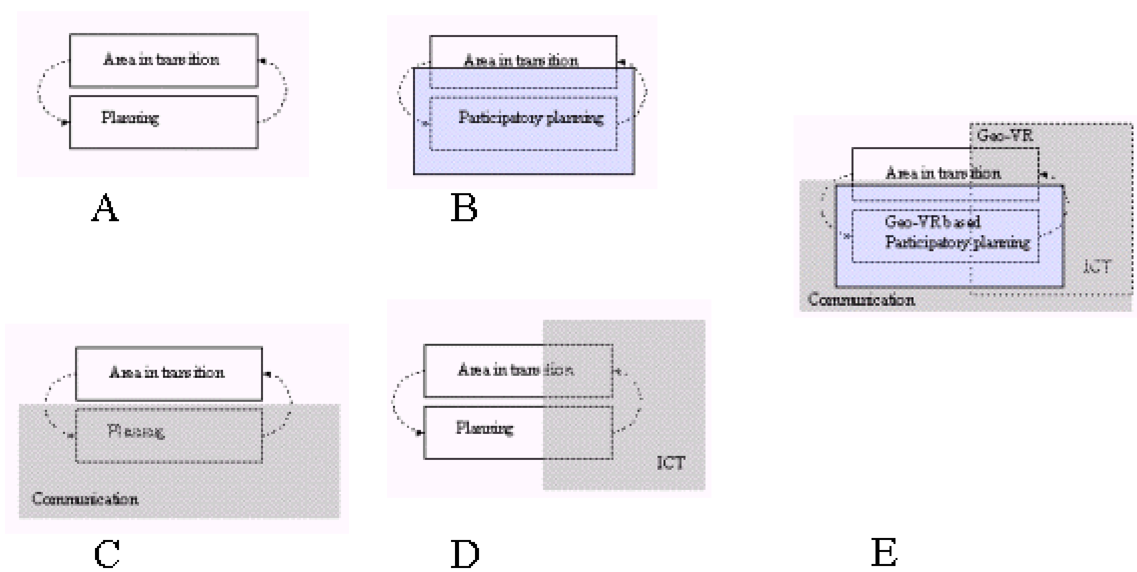

Figure 1.1: the context of the Geo-VR research

Figure 1.1 shows how the subjects presented in this report are related to each other. The report focuses on the research agenda regarding participatory planning supported by Geo-VR (E in fig 1.1). According this objective the following topics are subjects of this report:
Spatial Planning (A);
Participatory Spatial Planning as an extension of single-actor spatial planning (B);
Communication as a base for participatory planning (C);

Information Communication Technology (ICT) to describe the spatial planning subject and to support communication protocols within the participatory planning procedure (D);
the specific ICT application called Geo-Virtual Reality (E)
Geo-Virtual Reality fine-tuned to support participatory planning (E).

This position paper starts the discussion by a short introduction of different planning attitudes (A). The next chapter tries to define the participatory interest of spatial planning (B) by discussing concepts of public participation (C). In the follow-up chapter introduces the levels of participation as found in literature. Chapter five gives a short introduction in communication theory (D) and links communication via information technology to the different ways of ICT-support. That chapter is followed by a brief introduction of Geo-Virtual reality (Geo-VR) by using the peep box approach. Expected requirements needed to implement a Geo-VR, taking into account concepts and definitions are stated. The seventh chapter describes a number of GeoVR-prototypes that show these requirements. The final chapter lists mainlines of a research agenda with respect to the support of Geo-VR in participatory planning (E).

This paper is not a written in a "write once, run anywhere" fashion. It is tailored to the domain of planning and design of spatial areas. Neither is it a static paper. Continuous discussion is needed to adapt and sharpen the research needs of Geo-VR as a reaction upon changing and developing insights into the nature of interactive spatial planning and the way we think spatial plans need to be communicated by multiple actors.

2 Spatial Planning Approaches

The description of a interactive spatial planning process usually offers a theoretical notion to understand and co-ordinate decision-making in order to reach a mutual agreement among actors and prevent what is sometimes called "the tragedy of the commons" (Deadman, 1999). Three leading approaches have been previously identified in the literature (Geertman, 1996) and they will be used to describe the role of virtual reality in interactive spatial planning.

Decision-Oriented Approach

The decision-oriented approach has a strong relation with the Strategic Choice Approach (Friend, 1994). The central paradigm in this approach is that planning is a process of choice in a situation of uncertainty. This uncertainty is present in the knowledge of the planning environment. In this case, one is not sure about the physical and socio-economical structure of the environment and its response upon the actions of actors. Also there is uncertainty about what choices are to be expected in a related field of choice and there is uncertainty about the value of the judgments that are attached to the consequences of decisions. The decision-oriented approach discriminates between operational decisions and planning. Planning is defined as temporary support for the operational decision-making. Such support is necessary because it is considered impossible to judge instantaneously all operational decision in the necessary broader context of society and environment. The goal of planning is mainly to inform actors about future decision-making and make future operational decisions interpretable. A main critique upon this type of planning is it agency-centered view which makes is less suitable in multi-actor environment.

Action-Oriented Approach

Both, Wageningen University and the university Nijmegen, developed the action-oriented approach (Geertman, 1996). In this approach, the assumption is made about the spatial organization as being the result of actions of and cooperation between numerous actors. As a result, the focus is upon relations that exist between actors. Planning is defined as the result of actions between actors, which are part of the socio-spatial system. Their actions need to be compliant to and embedded in the society. Decisions are based upon interactions among actors. This means that the focus of planning is not “per se” on a critical evaluation of the spatial organization itself but on the analysis of the intentional actions and knowledge of the actors involved in planning.

Search-Oriented Approach

Planning as search for direction (reconnaissance planning) is an approach that considers interactive spatial planning as a kind of learning process. In fact it is based on the action-oriented approach but more directed to a prospective forecasting. The process aims to investigate new opportunities for establishing socio-physical and spatial organization. Reconnaissance planning doesn’t aim for an operational decision given but to reveal alternatives and solutions outside the direct scope of the observed problems. It is meant to actors to learn and get a bit wiser (Kleefmann, 1984).

The Socio-Spatial and Individual Cognitive Systems in Interactive Spatial Planning

Actors in a interactive spatial planning process have their own definition of reality based on political, cultural and economic factors that are relevant for them based on the perceptions they have of a spatial environment. In order to be able to analyse this we need to split spatial planning up into two interrelated systems. It is imperative to have in mind the message purpose of the Geo-VR, actors characteristics and motivations, and their way of reasoning within a interactive spatial planning process to ensure a successful interaction between actors and between a stakeholder and the GeoVR implementation. Two systems are important for the analysis of this: the Socio-Spatial System and the Individual Cognitive System (Figure 2).

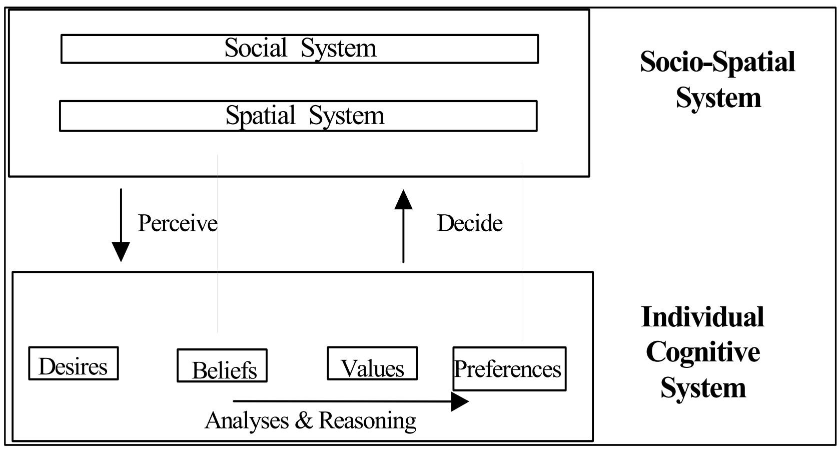

Figure 2.1: Levels of Interactive spatial Planning

Socio-Spatial System

A social system is constituted of political, cultural and economic subsystems. In general we can say that a society needs to continue itself. Maintenance and development of the system is therefore the central goal of a society. Economic processes form an important driving force for the maintenance and developments of a society. Production and distribution of goods and services are the main effects of these processes. A concrete social system consists of individuals, groups and organizations that maintain relations through intentional (co-operative) actions based upon a more or less common set of rules, norms and values and act within the boundaries of the institutions that are derived from it (Kleefmann, 1984). The spatial system is composed of biotic and a-biotic components, processes that alter these components and relations between them. An important difference between social and spatial systems is that the latter is mostly described in spatial terms while the first is not. The socio-spatial organization concept defines social-actions in a spatial perspective (Wisserhof, 1996) and can be used to analyze the interactions between social developments and the spatial system.

Individual Cognitive System

At the level of the individual cognitive system, the ideas, desires and values of individual actors are taken into account. A cognitive system is defined as the general concept that is concerned with "…acquiring information about the world, representing and transforming this information as knowledge, and using this knowledge to direct our attention and behavior" (Lloyd, 1997). Using its cognitive abilities an actor creates his own mental representation of the socio-spatial system. This representation depends on what Schutz calls a "stock of knowledge" based on which the world is put into a context of relevance (Lammeren van, 1994). Each actor maintains a relation with the social-spatial system and among other actors using sensory inputs and speech in order to acquire information about the world.

Desires are considered mental representations of the spatial environment, as it should be in order to fit the "needs" of an actor. Desires are however not generated spontaneously. They are the result of driving forces. Driving forces refer to the motivational aspect of the involvement of an actor in an interactive spatial planning process. The driving forces itself are assumed auxiliary to the model. It can be for example demographic growth that generates spatial claims for new places to live. An actor is (probably) motivated to generate desires if these driving forces relate to his area of concern. In general terms we can say that an actor generates desires if there are driving forces that affect his "universe of discourse".

While observing a spatial environment, an actor encounters many objects. We assume a kind of top down search when identifying objects that are of interest for the actor (Lloyd, 1997). What objects are of interest is identified by the desires in a process of perception. *Perception* is a cognitive process that is involved with detection and interpretation of sensory information.

In the individual cognitive system model the term belief refers to the current state of the world that an actor beliefs is true. *Beliefs* are only true to one specific actor. They form the mental representation of the environment based upon individual perception. The beliefs of an actor are the only references he has to the socio-spatial system. Based upon the beliefs it is possible for an actor to compare to analyze and reason about a spatial environment. It is possible (and most likely) that various actors have different beliefs about the same spatial objects.

Values consist of the set of knowledge that an actor uses to compare its beliefs with desires. Using its values an actor analyses a believed situation to analyze what spatial functions in a spatial environment are not inline its desires. Values are part of the social reality and include not only individual values but also values that are common to a society and values that are the result of communication and negotiation. This process of analyses and inference leads to a set of preferences. *Preferences* determine what changes are possible and desirable to accomplish the desired world of an actor.

According to its mental representation of the world an actor takes decisions and actions. These decisions and actions are the result of a perceived difference between the mental representations of the world as it is (a believed world), and a mental representation of the world as it should be (a desired world). *Decisions* and actions of an actor are therefore intentionally oriented towards narrowing the gap between the "word as it is" and the "world as it should be".

3 Planning: interaction and participation

The terms interactive planning and participatory planning are often used in articles and books about the procedure to realize the physical transformations of rural and urban areas. Frequently

there are no clear differences between these two terms. With help of the definition of interactive participatory planning of Kluskens (2000) the differences between these terms becomes clear. Kluskens divides the term interactive participatory planning in two parts:
Participatory is the process through which the government develops new spatial plans in co-operation with the stakeholders. Participatory expresses the involvement of both the government and stakeholders.
Interactive is the part of the new trend he defines as “close and continuous mutual co-operation” in which knowledge and information is exchanged between the participating stakeholders Interactive expresses the relationship between the government and stakeholders.

Therefore participatory planning is a way of decision-making in which stakeholders can play both a passive and active role. The active role is separately represented in an interactive participatory planning process. The global difference between a participatory and interactive planning process lies in earlier involvement, more influence and more power for the stakeholders.
The public opinion in literature is that not all the levels of a participation ladder can be called interactive. The levels on the highest sports of the ladder are becoming more interactive. Usually the boundary between interactive and not-interactive is drawn between the level of advise and co-produce (Edelenbos J, et al., 1998).

Characteristics of Participatory Planning

The characteristics of interactive participatory planning, defined by Edelenbos and Monnikhof (2001a), will now be discussed.
A first characteristic is the involvement of local citizens, societal organizations and private parties in an early stage of the process, for example right from the start of defining the current problems in a certain area. In not-interactive processes the citizens are not involved at all, or only in late stages of the process in which they can only give comments on a detailed constructed concept plan.
Another characteristic is that the participants, who are involved, have more influence than in a regular process. Several participation ladders are defined, in which the influence of the participants in the process changes.
An important and dominant characteristic of an interactive process is the openness of the process (Pröpper and Steenbeek, 1998, p.293). In an open process the external planning surroundings are involved and will influence the decisions to be made. The combination or integration of local, experimental and specialist knowledge is seen as an advantage, which results in a plan based on scientifically knowledge together with morals and values.
All the participants in an interactive process should primarily have equal influence. According to Edelenbos (Edelenbos, et.al., 2001b), debate and negotiation are important characteristics of such an interactive planning process. By means of negotiations with all the participants, the process must lead to a satisfying result for all the participants.

Interactive Planning Objectives

Klijn and Koppenjan (1999) have globally defined the objectives of interactive planning. Similar objectives or a variation of these objectives are often found in the literature.

The first objective for interactivity in the process of planning and decision-making is to raise the democratic legitimacy. Citizens and societal organizations wish to be involved to have direct influence on the stages in and the content of the process. Within this interactive policy-making, translation of the wishes and interests of the participants into real policies is of particular importance. These policies can be enriched with the local knowledge, morals and values of the citizens and organizations involved.
The second objective is that interaction with participants will lead to a larger ability to solve problems and an improvement in the quality of the created policies.
A third objective is the improvement of efficiency and to build more consensus or public support for certain plans and policies. Project leaders and policy-makers can influence the rising of public support during the process.

Advantages and disadvantages

The mainstream opinion about the advantage of participation focuses on the importance of “local knowledge”. The local citizens have the advantage above the policy-maker that they know the area from a daily-use perspective and over a longer time. Although the local knowledge of the citizens is dominantly based on more emotional *coloured* norms and values; this knowledge has a valuable meaning. The local citizens are the ones who have finally to live and to experience the transformed area. For that reason their opinion, wishes and ideas about the planned change have to be included.
A higher number of participants involved in the process will lead to a variation of ideas and suggestions, because they all have a different view and opinion about their area. Another advantage of citizen participation in the planning process is that citizens get more insight in the problems and possible solutions during a planning process.
When a part of their wishes and ideas are taken along in the final plan for the area, public support is created for the whole plan. This public support is important for acceptance of and co-operation in the final plan. It also minimizes the amount of petitions.

Van Woerkum (2000) has described some disadvantages of interactivity, which are the reason that most governing bodies are still not very interactive in their decision-making.
In the first place interaction means loss of power of the government. When governing bodies start a process with participation, they have to admit that the citizens have some influence in the process.
A lot of conflicts can arise between the different participants, which have often been a reason for not letting citizens participate in the process. Most of the participants will have a different view about the changes that are needed in the particular area. Direct confrontation of all these views of participants at the same time can be quite difficult.
It will take a lot of time to create and realize a structured participatory process, in which every participant can express their view and develop understanding for the other views shared.
Also there will be a lot of formal rules in the planning process that will be difficult to understand for all the participants.
Interaction will never be completely democratic, because a full representation of all the citizens is never complete. Pressure groups or different organizations for nature, agriculture etc will present the opinion of a lot of citizens, but never everyone’s voice can be heard. Because all the participants will influence each other with different views and opinions, interaction could lead to irrational decisions.

An important dilemma is the difference between local knowledge and scientifically knowledge. To come to an agreement with these different types of knowledge about a particular area or issue is very difficult.
A lot of time and effort must be put in the process will the result be a successful and satisfactory.

Interactive plan making in the Dienst Landelijk Gebied

Dienst Landelijk Gebied (DLG) has introduced interactive plan making in the domain of rural re-allocation planning. They intend to realize a qualitative better, more understandable and supported plan by the stakeholders. Such a process of planning could result in more mutual understanding, trust and involvement than with the more traditional planning process.
The basic assumption of an interactive process is to have a better result, by combining and integrating knowledge and experiences of stakeholders.
Interactive processes prefer when the planning case meets the following conditions:
The problems are not urgent
The problems are not described in detail yet
There must be space for involvement of participants
The process must be transparent
The role and influence of the participants and expert must be clear
Besides the above conditions, there must be time, money and expertise available.

Dialogue

The interactive way of making plans for rural areas of DLG has started with Dialogue methodology in 1999 (DLG, 1999 and 2000). Dialogue is a way of making the wishes and problems of the stakeholders understandable and arguable during the process. Goal of this way of working is to involve the stakeholders of the area and to let them influence the process. The Dialogue methodology is based on the basic rules of
intensive contact with the inhabitants of the area,
making the planning process transparent and
to have no predefined result in mind

The Dialogue methodology exists of four stages, which are labelled as start, overture, head dialogue and final stage. In the start stage should be decided whether or not the Dialogue methodology is suitable for the project. This depends on the nature and restrictions of the project and the possibilities and willingness of the participants to cooperate. The possibilities for participants to cooperate in the project depend on in what extent the changes are already determined. In the overture participants can give their opinion about positive and negative aspects of the area. All the reactions will be registered, after which the experts can order and analyse them. In the head dialogue, participants and experts talk and think together about solutions for the main issues from the overture. In subgroups the solutions are more specifically defined. In the final stage experts work out detailed solutions that will be combined into the most successful plans. After the preliminary draft is ready, the participants are sometimes involved in the further developed of the final plan. The commission that is in charge of the project decides which solutions are most suitable for the problem. The final plan is proposed to the participants of the process. The Dialogue methodology often results in plans that fit in the area and are largely influenced by the local people.

During the process participants gather knowledge of different views and opinions about the problem, which results in a larger public support of the plan.

Theoretically spoken the Dialogue methodology is an appropriate method to create interactively plans, but DLG has learned that the Dialogue methodology must not be used too rigidly. Each project of interactive planning shows peculiar problems and has different characteristics. Therefore in each project the methodology of Dialogue will vary. Specific characteristics and requirements of the project and its environment are added to result in a plan that fits the problem optimal.
The three important aspects of interactive planning that DLG always tries to establish are
the right people, in the right function, at the right time in the process
clear statement about the expectations of the participants
defining of the goals of the process

The Dialogue methodology shows similarities with the definition of interactive participatory planning of Kluskens (2000). The term participatory expresses the involvement of both the government and stakeholders in the process. The term interactive expresses the influence stakeholders have in the process, which can vary between the processes. In the Dialogue methodology stakeholders are able to share their knowledge, information and ideas about the area with the other participants in the process.

4 Levels of Participation

An interactive planning process is characterized by the participation of (local) citizens, societal organizations, private parties and pressure groups, also combined to stakeholders. Different levels of public participation are defined during the last decennia. An overview is given of the most quoted and recently used levels of public participation in the planning literature.

Citizen Participation by Arnstein

Manipulation	5. Placation
Therapy	6. Partnership
Informing	7. Delegated

Figure 4.1: Levels of participation

Already in 1969 Arnstein defined different levels of public participation. She described the levels of participation as eight steps of a ladder, divided in the three categories of "non-participation", "degrees of tokenism" and "degrees of citizen power". In the levels of manipulation and therapy, non-participation is described. In these levels people are not able to participate in a planning or conducting program. The levels exist of power holders, who try to "educate" or "cure" the participants, instead of involving them in the process. The level of informing citizens of their rights, responsibilities and options can be the most important first step towards legitimate citizen participation. This level has often been a one-way flow, with no channel for feedback and no power for negotiation. In the consultation level, participants are invited to give their opinions and views. Attitude surveys, neighbourhood meetings and public hearings often do this. In the next ladder step, participants are invited to become member of a committee, although only the power holders maintain the ability to decide. In the level of partnership, participants are able to negotiate and engage in trade-offs with power holders. The last two levels show an increase of participation by the public. In the level of delegated power, negotiations between citizens and public officials take place and can result in citizens achieving dominant decision-making authority over a particular plan or program. In the highest level of participation, people are simply demanding that degree of power (or control). The power guarantees that participants or residents can govern a program or an institution. They are in full charge of policy and managerial aspects, and are able to negotiate the conditions under which "outsiders" may change them (Arnstein, 1969).

Citizen roles in planning by Burke

In "A participatory approach to urban planning" Burke (1979) uses five types of participation, which are variations of the roles proposed by Arnstein (1969). Burke defines the first level as a passive role, which is designed to provide information to the public. This role relies completely on the media, like newspapers, radio announcements and public hearings. In the consultation level, participants provide expert information of the area or

1. Review and comment	4. Shared decision-making
2. Consultation	5. Controlled decision-making
3. Advisory	

Figure 3.2: Roles of Participation by

situation, to improve the effectiveness of the process. Participants in the advisory level can take place in committees, to advise to the board members. In the fourth role participants are acting as partners in the planning process. The intention of this role is to arrive at decisions that reflect the wishes and preferences of all the participants in the planning team. At last the participants have complete authority/control over all policy and planning decisions. The role of the professional staff is to facilitate the process of decision-making, which means they act as advisers and provide information for the participants.

Participation by Dalal and Dent

In 1993 Dalal and Dent have identified seven levels of participation in a local spatial planning process for 'developing' countries. The first level of participation is passive participation. People are informed about the intended transitions and their implementation. At this level the responses of participants are completely ignored.

By the level of "participation in information gathering", people participate by answering questions posed by the authorities which set up the planning procedure. People do not have the opportunity to influence proceedings, as the findings of the research are neither shared nor checked for accuracy (Dalal & Dent, 1993).

1. Passive participation	5. Functional Participation
2. Participation in information gathering	6. Interactive Participation
3. Participation by consultation	7. Self-mobilization

Figure 4.3: Types of participation by Dalal et al

By the level of consultation consults of participants are an integrated part of the planning procedure. Problems, solutions and views are being inventoried, but the participants have no rights in the decision-making moment. The governing body is not obliged to take along the outcome of these consultations.

Another form of participation, which is most characteristic for developing countries, is the participation for material incentives. People participate by providing resources, for example labour, in return for food, cash or other material incentives (Dalal & Dent, 1993).

" Functional participation" means the forming of groups that give their opinion, comments and views on intended transitions that already have been defined by plans. This form of participation takes mostly place in late stages of the process, when important decisions already have been made.

This typology of Dalal and Dent defines "interactive participation" as a separate level. By this level it is meant that participants could control local decisions. They can make themselves action plans. Finally self-mobilisation is the highest level of participation. Participants take initiative independent of the governing body.

Public Participation by the NRLO

Because the typology of Dalal and Dent is not entirely suitable for the planning process in the Netherlands, the National Council for Agricultural Research (Twist, et al., 1998) has reduces this typology to five levels of public participation in development of rural areas (eg. see Kluskens, 2000). These are the levels of Inform, Consult, Advise, co-Produce and co-Decide.
Via the level of inform, participants are informed by the planning authority about initiatives, existing ideas or implementations (even if they already have been decided upon). The information is shared with mainly private actors, without listening to any of the responses.
Via the second level participants in the process are involved in information gathering (used as a source of information). The information is gathered through questionnaire surveys, neighbourhood meetings or answering questions posed by (semi-) public actors. There is no obligation about taking the results of the information gathering into account in the process.

Inform	4. co-Produce
Consult	5. co-Decide
Advise	

Figure 4.4: Degrees of Participation

The level of advise corresponds with the functional level of Dalal and Dent. By this level participants are able to give their opinion about current problems and possible solutions. The authority takes the results in account, but in the final decision-making stage they can leave behind these results with good arguments.
The two highest levels show an increase in public participation. Co-Producing means that the participants and the involved authorities together take care of the problem recognition and search for solutions.
The final level shows a form of participation, in which the development of making policies and decisions is in hands of the participants, where as the governing bodies fulfil the role of advisor.

Participation by Edelenbos and Monnikhof

A lot of variations are made on the participation ladder of Arnstein(1969). Edelenbos and Monnikhof (1998) use a typology that is based on the participation typology of Dalal and Dent and based on four levels of participation: consult -advise, co-produce and co-decide-, which are also a variant of the ladder of Arnstein. Edelenbos and Monnikhof (1998) add the level of Inform to this typology, in which the board and politics determine the agenda of decision-making process, and they do not use the possibilities of input by participants. Edelenbos (1998) uses the same typology for the essay “Development in Science and Technology, ICT: possibilities for guidance and design in rural areas “ in order of the NRLO.

Renewal by Kalk (www.xpin.nl)

The levels of participation used by Kalk (1996) are based on the differentiation defined by Veldboer (1996). Kalk uses these levels to separate projects, based on the influence of the citizens in the process of planning and policymaking. Participants can play seven roles in the ladder of Kalk. The lowest level of participation describes the participant as a customer. The government tries to better inform the participant, and focuses therefore on the agenda of the participant. The participant can also play the role of partner in conversation. The government focuses on an open conversation, with no obligations to the outcome of the conversation. A level higher the participant can deliver ideas for specific policies. To work together with the government on plans for a certain area, the participants must play the role of co-producer. When the participants are the makers of the agenda, an open plan process takes place, in which the participants themselves can come up with problems and possible solutions. The governing body will eventually take the decisions. In the last two levels the participants are respectively partly responsible and completely responsible for the decisions that will be taken and carried out.
The interest in Kalk's approach is based on the fact that he made explicitly a difference between the role of the citizens (or stakeholders) and the role of governing authorities (as initiators and the ones who bear responsibility).

"Citizens as"

1. Customer	5. Maker of the Agenda
2. Conversation-partner	6. Partly responsible
3. Deliverer of ideas	7. Decision maker
4. Co-producer	

Figure 4.6: " Citizens as" by Kalk/Veldboer

Participation by Pröpper and Steenbeek (www.xpin.nl)

Pröpper and Steenbeek (1999) created a typology for local planning issues with five different roles of the governing authorities and the citizens. In the first role the governing authority consults the citizens about a certain problem situation. The citizen is able to give a reaction on the chosen policy for that particular problem. When citizens participate in the planning process, it means that they have the role of adviser. Participants can come up with their own problems and possible solutions.

Role of planning authority	Role of citizen
1. Consulate	1. Being consulted
2. Participate	2. Advisor
3. Delegate	3. Decision taker partly
4. Cooperate	4. Cooperation partner
5. Facilitate	5. Initiative taker

Figure 4.7: Roles of participation by Pröpper & Steenbeek

In the next role, the governing body delegates a part of the decision-making ability to the citizens. Both parties have commitments to the decisions made. At he level of cooperation, the governing body and the citizens have initially an equal influence in the process. With equal input of knowledge and experiences, they try to come up with a plan for the future situation. In the last role, the governing body is only the facilitator of the process. It offers support in money, time, knowledge, expertise and materials, from which the participants can make use. All participants are allowed to make decisions about what problems to deal with and what plan will be executed at the end.

Triangular of the Regional Environmental Centre for Central and Eastern Europe (REC)

The Regional Environmental Centre for Central and Eastern Europe (www.rec.org) has created a triangle, in which the level of participation and the numbers of participants change. The "information" level is the simplest form of participation. Planners keep the public informed about the process of planning and decision-making. The participants have no opportunity for comments or involvement. The next level is up to invite participants to give information and comments, to supply local knowledge for better evaluation of certain planning issues. An official dialogue , between planners (authorities) and the participants (stakeholders), takes place -via the consultation level- to identify issues, problems and concerns. Via the level of "joint planning", both planners and participants, are involved with mutual responsibility for the planning progress and related results. Participants can do this by becoming a member of an advisory group. Via the highest level of participation " citizens control" the participants will control the most controversial issues, by means of a local referendum.

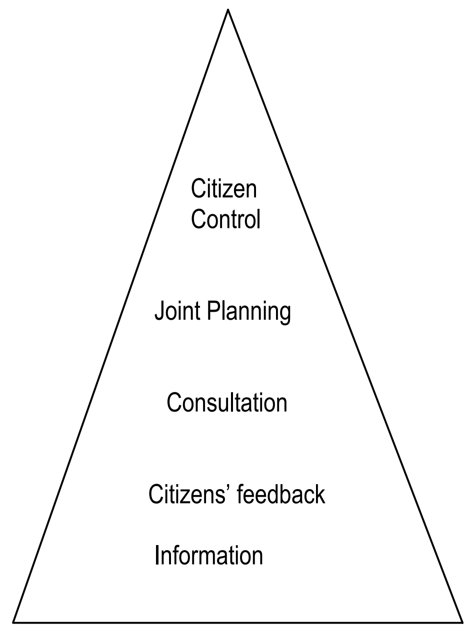

Figure 4.8: Triangle of Participation by the Regional Environmental Centre for Central

Comparison between levels of participation

A comparison of the differences and similarities can be made between these different typologies of public participation in the planning process. For example the first two steps in the ladder of Arnstein "manipulation" and "therapy" are not really corresponding with the levels in other typologies. It may be explained by the fact that Arnstein defined these steps more than thirty years ago, and that they are really suitable for the Dutch culture of public participation.
Burke's redefinition of Arnstein's "review and comment" step shows similarities with the level of passive participation by Dalal and Dent.
Four of the eight typologies have a level called "inform(ation)" and seven of the eight typologies have a level called "consult". The difference in meaning within these levels will be discussed later.
The level of "participation for material incentives" by Dalal and Dent does not correspond with levels from any other, because this level of participation is more appropriate for developing countries, instead of more western countries.

All the typologies of participation have a level, which is labelled “advise”. By this level the participants can come up with problems and possible solutions themselves, and are able to comment and to advise on problems that are already recognized by the governing bodies.
The differences in definitions of the most influential levels are minimal. The level that starts with partnership from Arnstein and ends with joint planning of the REC, is a level in which participants have the power to co-produce the plan, and to make small decisions for which they are responsible. In the level of delegated power (Arnstein), work together (Pröpper & Steenbeek) and co-producer (Kalk/Veldboer) the equality of all the participants in the process of plan making is respected and emphasised upon.

In the most interactive and highest level of participation all participants are able to take most of the decisions themselves. The governing authority acts as a facilitator, who provides time, money and expertise. Participants control the process of planning and decision-making.

Inform and Consult

Four of the eight typologies define “inform(ation)” levels. In these four typologies inform has a slightly different meaning. Arnstein defines the level of informing citizens of their rights, responsibilities and options one the most important first step towards legitimate citizen participation. Inform can be seen as the first level towards some kind of involvement in the process. Inform defined by Dalal and Dent shows the process of gathering information from the participants to use in the process, instead of presenting a planned change in their environment. The definitions of the NRLO and REC are similar and result in a level in which the participants are only informed about the planned change or a change that has already taken place. Feedback or involvement is also here not possible.

The definitions of the consult level are quite similar. All typologies mention the gathering of information through the participants. Information has to be gathered by the form of problems, solutions and views of the participants about their environment. This information is needed to start up a plan for changes in the environment. Only the role of Pröpper and Steenbeek’s consult deviates from this description. In this role the governing body consults the participants about a certain problem situation. The participant is able to give a reaction on the chosen policy for that particular problem. The governing body already chooses the policy and is at the end of the planning process.

All the levels defined by the Edelenbos & Monnikhof correspond with a number of levels defined by others. They created five levels, which is less than some other authors and results in levels with a wide scope.

Dialogue versus Edelenbos and Monnikhof

The way interactive planning of DLG is described in Dialogue has several similarities with the levels of participation, described by Edelenbos and Monnikhof (1998). Participants are involved in the stages of overture, head dialogue and the final stage. The stage of overture in which the participants are able to express their feelings about the positive and negative aspects of the area, is related to the advise level of Edelenbos and Monnikhof. The stage of head dialogue shows similarities with the level of co-produce, in which the experts (initiating and responsible authorities) and participants (stakeholders) together talk and think about possible solutions for the area. In the final stage experts work out detailed solutions that will be combined into the most successful plans. The commission that is in charge of the project decides which solutions are most suitable for the problem. The other levels of participation are not represented in the Dialogue methodology, but can exist in the projects in which a regular process is used instead of the Dialogue methodology.

From this comparison can be concluded that several levels of participation can take place in a certain project, just like the amount of interactivity can increase during the process. Still the level of participation and the amount of interactivity suitable within a process depend on the nature of the project and the specific spatial problems (along with available money and time).

Edelenbos&Monnikhof	Dialogue			
		experts	participants	
	Start			
Inform				
Consult				
Advise	Overture			
Co-produce	Dialogue			
	Final			
Co-decide				

Figure 4.9: Comparison of Edelenbos/Munnikhof with Dialogue

Concluding remarks

The previous overview of participation typologies and communication takes place. The typology of Edelenbos and Monnikhof (1998) has been selected as a framework to discuss the role of ICT in participatory planning. The next criteria are taken into account:
Edelenbos and Monnikhof have already made them suitable for the Dutch planning process;
The levels have been defined at a recent date (they are up to date);
The levels have a wide scope, with the result of covering almost all levels defined by others;
The levels are suitable for participation in the development of rural areas;
The number of levels defined seems usable for further investigation (communication and visualisation).

5 Communication

Communication is elementary for public participation in a planning process. When communication between the different participants in the process is not functioning appropriately, the process will not lead to any satisfactory result. From the beginning on the roles, opportunities and obligations of the participants that take part in the process must be stated clearly in order to avoid misunderstandings and disappointments during or at the end of the process. To get a clearer view of the way communication takes place in levels of participation, the process of communication itself will be discussed.

Process of communication

Adler (1997) defines communication as the process of human beings responding to the symbolic behaviour of other persons. All communication consists of a few elements, regardless the setting and number of people involved. A sender starts the process of communication, by transmitting some kind of message that can be any signal to a receiver. Messages can be unintentionally or deliberately.

In the process of encoding messages, the sender has to choose certain words or nonverbal methods to send a message to the intended receiver. The sent message will reach the receiver through some kind of channel, also called a medium, which can be in person, on the phone etc. . The chosen words and channels to send the message can make a big difference in the way the message is received. Under the right circumstances the message is delivered to the receiver intact. The receiver must attach some meaning to the message but there is no guarantee that the message will be understood as the sender intended it to be. The receiver must still encode it, attaching meaning to the words or symbols, which is called decoding (Adler, 1997).

The response of a receiver to a message is called feedback. Feedback can be nonverbal, like smiles and sighs, but also oral or written.

Noise can be a great source of communication failure. Factors that interfere with the exchange of messages between senders and receivers are called noise. Adler (1996) has defined different forms of noise, called physical noise (external sounds that distract communicators), physiological noise (hearing disorders, illnesses and disabilities that make it difficult to send or receive messages) and psychological noise, this is noise which interferes with understanding the transmitted message (egotism, defensiveness, hostility, preoccupation, fear).

Communication model

The process of communication can be translated through different models. Adler (1997) has defined three models that describe the actions of the process of communication.

In the linear model a sender encodes ideas and feelings into some sort of message and then injects them by means of a channel to a receiver, who decodes the message.

The interactive model takes some more steps into account. The term encoding is replaced by the broader term behaviour, because it describes both deliberate and unintentional actions that can be observed and interpreted. The reason for this is that encoding enhances only the conscious

information that is offered to others. People are often given unconscious information by facial expressions, gestures, postures, vocal tones and so on.
These both models do not propose a real view of how communication takes place. Therefore the transactional model is defined. This model reflects the fact that we usually send and receive messages simultaneously; the roles of the sender and receiver that seemed separated in the interactive model are now superimposed and redefined as communicators (Adler, 1997).

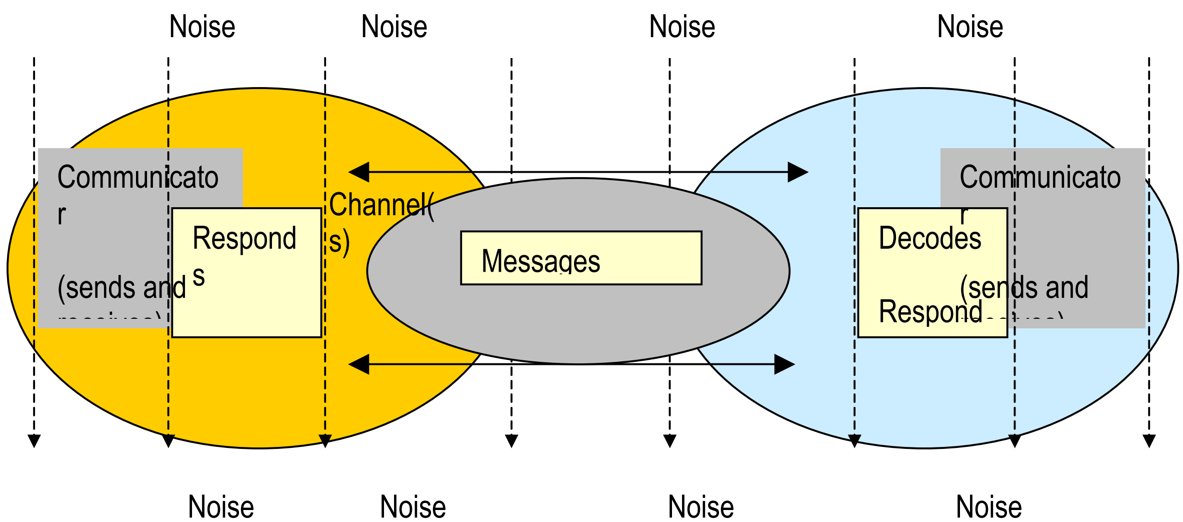

Figure 5.1. Transactional Communication Model (Adler. 1997)

The process of communication for this is fluid and not static. An act of communication cannot be separated from the events that precede and follow, because the act is part of a chain of communication actions within a certain context. Communication isn't something we do to others, but do with others. The transactional model poses that communication is relational, and not individual.

Communication and information technologies

Regarding to the three types of communication processes it is obvious that the nowadays computer technologies greatly influence communication processes. However how they effect and in which way they support such a communication type is still subject of research. The current information and communication technology (ICT) shows several ways to communicate synchronous (sender and receiver meet in the same time frame (eg. by voice dialing) and a-synchronous (sender and receiver are in different time frames (eg. by e-mail).
Some of the technologies are based on linear communication (eg. e-mail, sms). Some tend towards interactive communication (eg. voice dialing, video conferencing) and others try to mimic with transactional ways (eg. chatting, net-meeting, multi-user environments, interactive television). How these and succeeding types of ICT will support participatory planning is one of the other leading questions of this position paper. There is probably a significant connection between a level of participation and the type of communication. With the contemporary and expected state of ICT, it

is obvious that all types of communication could be supported: from mass-communication to peer-to-peer communication.

Communication in the participation levels

In the levels of public participation defined by Edelenbos & Monnikhof different types of communication are presented. Kluskens (2000) defined the expected forms of communication that could support these levels of participation.
Inform involves mostly mass communication; messages are transmitted to a large audience via broadcast and printed media. Personal contact between the sender and receiver does not exist (Adler, 1996). The messages are mostly developed or financed by large organizations, so this kind of message is more some sort of a product delivered to the audience (*sender based*). Many gatekeepers, such as sponsors, editors, reporters etc, control the message.
Consult involves public communication via target groups as an audience; this occurs when a group becomes too large for all members to contribute. One or several persons deliver remarks to the remaining members, who act as audience. A limited verbal feedback can take place. Audiences often have the chance to ask questions and offer brief comments.
Advise involves public communication, see consult
Co-produce involves small group (5- 30 persons) communication, every person can participate actively. Communication by groups is affected strongly by the authority of the leader who intermediates. In a group a majority is able to put pressure on the minority to consent, consciously or unconsciously.
Co-decide involves small group communication, see co-produce

	sender	receiver	
Inform	1	M	
Consult	1	N	
Advise	1	n	
Co-produce	n	n	
Co-decide	n	n	

Fig. 5.2 Relation between Levels of Participation and Involvement [1 = one actor, n = less groups or actors, N = many groups or actors, M = masses of actors (mass communication)]

Remarkable is the traditional relation (fig. 5.2) between the levels of public participation and the differences in communication models. When the amount of interaction and participation of the stakeholders increase, the model of communication seems to shift from mass communication (1: M) towards small group communication (n : n).

ICT-innovations in participatory planning

In this position paper the role of virtual reality (VR) is one of the ICT-innovations, which seems to be very useful in a participatory process for the spatial planning domain.
The Ministry of Economic Affairs (Holland, et al., 1999) has made an overview of traditional and ICT-innovations (figure 5.3). Innovations like the Internet, Group decision rooms and electronic voting systems are often mentioned.
The NRLO, Ministry of Economic Affairs and the Institute of Public and Politics listed several of these innovations. The NRLO (Twist, et al., 1998) has made an overview of ICT-innovations, which could be of interest in each of the different participation levels (figure 5.4) defined by Edelenbos and Monnikhof (2001a).
Although virtual reality is frequently mentioned as an innovative technology to support interactive policy-making, it not specifically categorised in one of the participation levels by the NRLO. A reason could be that VR has been described as an additional innovation to other techniques (Al Khodmany, 2003; Bill et. al., 1999).
It seems to be a technology to support spatial designs for rural and urban areas. Like all ICT technologies it has opportunities to be used in all levels of participation, but it ought to meet level-based goals and requirements. The use of virtual reality in a participatory planning process will be further discussed in the next chapter.

Inform Animations and visualizations Public information systems Interactive teletext Internet
Consult Email Bulletin boards, newsgroups, discussion lists
Advise Tele-meetings Videoconferencing Digital discussions through the Internet
Co-Produce Group decision rooms
Co-Decide Electronic voting Instant referenda

Figure 5.4: ICT-innovations for public participation by the NRLO (1998)

ICT-Innovations Electronic meeting systems Videoconferencing Interactive voting system Electronic survey Internet-debate Internet-newsgroup Interactive GIS Decision conferencing Virtual business systems (simulation visualisation) (computer assisted) Gaming Virtual Reality

Figure 5.3: ICT-innovations by the Ministry of Economic Affairs

Final statements

In the next chapter the phenomenon virtual reality will be further researched, including the role virtual reality can play in a participatory planning process. From this chapter on the following topics have to taken into consideration in the research agenda.
The participatory planning levels of Edelenbos and Monnikhof have to be used as a framework for discussing the role of Virtual Reality in participatory planning.
Participatory planning deals with the related roles and positions of the governing authorities and stakeholders. To fulfill the demands of participatory planning the roles and positions must be well defined on each level of participation.
Adler has defined three types of communication. By some it is stated that successful participatory planning has to be based on transactional communication. Knowing the different ICT approaches this statement could be questionable. However the statement can also become a guiding principle.
The levels of participation seem to include maximum and minimum numbers of participants, for example terms like mass-communication points at this issue. In what way will certain ICT approaches restrict the number of participants in a certain level of participation?

6 Geo-Virtual Reality

The present-day digital technology offers us the opportunity to create digitally a three dimensional look-a-like representation of the real world. It is still a representation, a descriptive model, but as Fisher and Unwin (2002) stated "Virtual reality is the ability of the user of a constructed view of a limited digitally-encoded information domain to change *their* view in *three* dimensions causing update of the view presented to *any* viewer, especially the user".
Italics show interesting words in this citation. 'Their' and 'any' refer to the effect of sharing the view. This is, note this quite well, a three dimensional view and not any longer a two-dimensional cartographic projection.

In the same publication (chapter 2, Fisher, 2002) the overall definitions of Virtual Reality and geo-information show how fresh and innovative this research domain is, which is not only based on graphics (Tufte (1990), Kaark et.al. (1999)). Reading all this the metaphor of a peep box (Lammeren, 2002) is popping up.

The peep-box metaphor

In our childhoods we all have been challenged to create a peep-box. Such kind of peep box was made out of a shoebox. The inner faces of the box formed the boundaries of our personal virtual world we tried to create. These faces were decorated with pictures cut out of glossy magazines or coloured yourself. One or more holes were usually cut out of the top face (the box cover). These holes were coated with coloured transparencies to create a fairylike atmosphere. In the box itself a number of elements were placed. By example pictures glued on cardboard or coloured cardboard figures hanging on a string that represent flying birds. In fact these elements were meant to create tableaux within the box to imitate three dimensional real world experiences. When you finished the construction of the peep-box you finally looked through the peephole (in the front face of the shoebox), which gave you the experiences of being in another world.

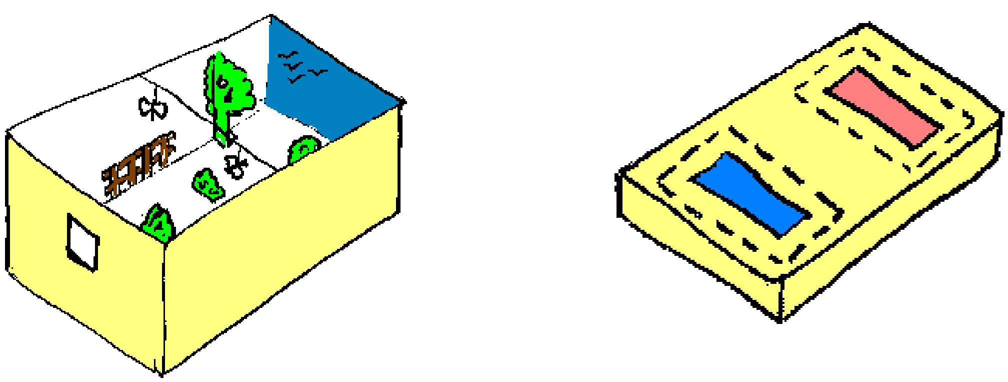

Fig. 6.1 The Peep Box made of a shoebox

This peep box approach is very valuable metaphor to explain the nature of virtual reality. The shoebox itself refers to the three main components of virtual reality world.

The inner side of the shoebox could be compared with the digitally modelled 3-dimensional scene (3D scene). A 3D scene could have the shape of a box, or a hemisphere or any other volume;
The inner side of a shoebox can be given an atmospheric impression (foggy, dusk, clear blue skies, nights, and so on). Cellophanes on the front cover are no longer in need;
Within this volume and part of the 3Dscene several digitally defined objects could be placed. Objects could be simple and complex geometries in combinations with digital pictures (bit-maps). For example, the inner sides of the top and side faces could be 'mapped' by digital photo's. Some of these objects could represent lights. Initially all of these objects are of a static nature.
The peephole, the interface between the user and the world, is nothing else than the 3D-scene viewer. The type of viewer could vary, in contradiction with a peep box.
The shoebox has its own dimensions but if we do speak about 3D scenes and geo-information (geo-VR) it means that the 3D scene and all its objects are geo-referenced. By example the bottom inner face of the peep box does could exist in a 3D scene out of a two-dimensional cartographic projected geo-data set in combination with a 2,5 dimensional elevation data.

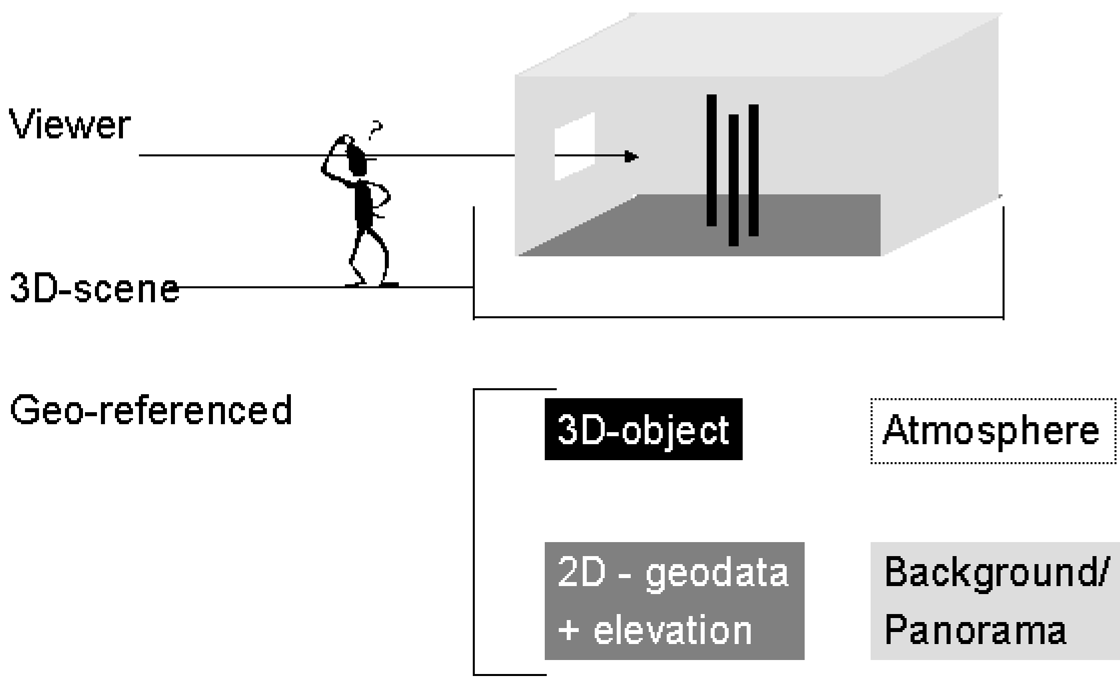

Figure 6.2 The Peep Box approach of Virtual Reality

But geo-VR is not merely a (graphical) representation of a geo-referenced peep box. It also offers new capacities based on computational technology items: interfacing, data fusion, data representation, simulation and feedback.

Interfacing in this report refers to the user and the ways that the user can interact with a 3D scene. In this case the 3D-scene viewer (viewer) could supply a lot of interesting functionalities to interact by. The viewer provides two ways to interact: interaction <u>in</u> the 3D scene and interaction <u>of</u> the 3D scene. Interacting in the 3D-scene means that the user has the immerse experience to be in the virtual world. Interacting of the 3D scene means that the viewer is used to define settings of the viewer mode that could influence the way the 3D scene will be experienced.

Interaction in the 3D-scene as such could be subdivided in several classes of interaction [eg. Schneiderman (1998), Billinghurst (1996),Wachowicz, et. Al (2002): movement, navigation, orientation, selection, explanation, elaboration and manipulation.
Routes can predefine movement, but the most important benefit of VR seems free movement through the 3D scene. In fact by this way of interaction one has the impression to be in the peep box and walks, flies or even crawls through the 3d-scene. More dedicated forms of free-movement are based on navigation (directed move to) and orientation (where to move to).
Movement, navigation and orientation mainly deal with the geometric domain of the 3D-scene. To interact with the thematic domain geo-referenced objects of the 3D scene starts with the selection of any object. When an object has been selected, explanation about the meaning of the object will be a next opportunity or more information about the object can be asked for via elaboration. Elaboration could be realized by linking other object related information fields (do think of web sites) that could be activated by clicking the object-link. The manipulation of the selected object could be one of the special items of a 3D-scene. Manipulation in this case means: moving an object, deleting an object, copying an object, creating a similar object or even modifying an object.

Interaction of the 3D scene includes defining: the geo-referenced extent of the scene; the number and nature of object types of the 3D scene; the visual representation of the objects; the inner-atmosphere; the modes of interaction in the 3D scene and a number of other accessories (eg. monitoring).

Above is mentioned that a 3D scene could exist out of different geo data sets. Some of these data sets are geo-referenced in a two-dimensional way, either 2,5 or three-dimensional. All of these data types could be integrated in a 3D scene. This integration do we call geo-data fusion. The simplest forms of geo-data fusion are bitmaps of real world phenomena (eg. Photographs). The most complicated are 3D compound-objects that are geo-referenced and *mapped* by bitmaps (again small digital photographs). Depending on the kind of data-fusion one could create different levels of near-realism.
In fact geo-data fusion is narrowly related to the representation of real world phenomena. Comparing it with the shoebox one should think of the combination of glossy magazine pictures and self created objects out of plasticine. Paint or pictures out of the magazines decorate the last ones (eg. the bitmaps).

The elementary virtual reality thus is based on the 3D scene based on geo-data fusion that can be used by a number of interaction tools. However, a 3d-scene becomes much more powerful by simulation and feedback mechanisms. Simulation offers changes of the 3D-scene by pre-defined algorithms. These algorithms are connected to a certain class of the 3D scene objects. The user can trigger the simulation. Examples are given by hydrological simulations, growth simulations, economical simulations, etc. .
The simulations suggest a sequence of events in time and by locations. The simulations could be extended by data quality information.

To know or to understand the impact of the simulations any feedback mechanism can be connected to the 3Dscene. The feedback mechanism essentially analyses the effect of the simulation and, depending on the modes of the 3d scene, will show visually or by sounds the impact of the simulation. A lot of geo-data analyses tools can be used to check the possible effects.

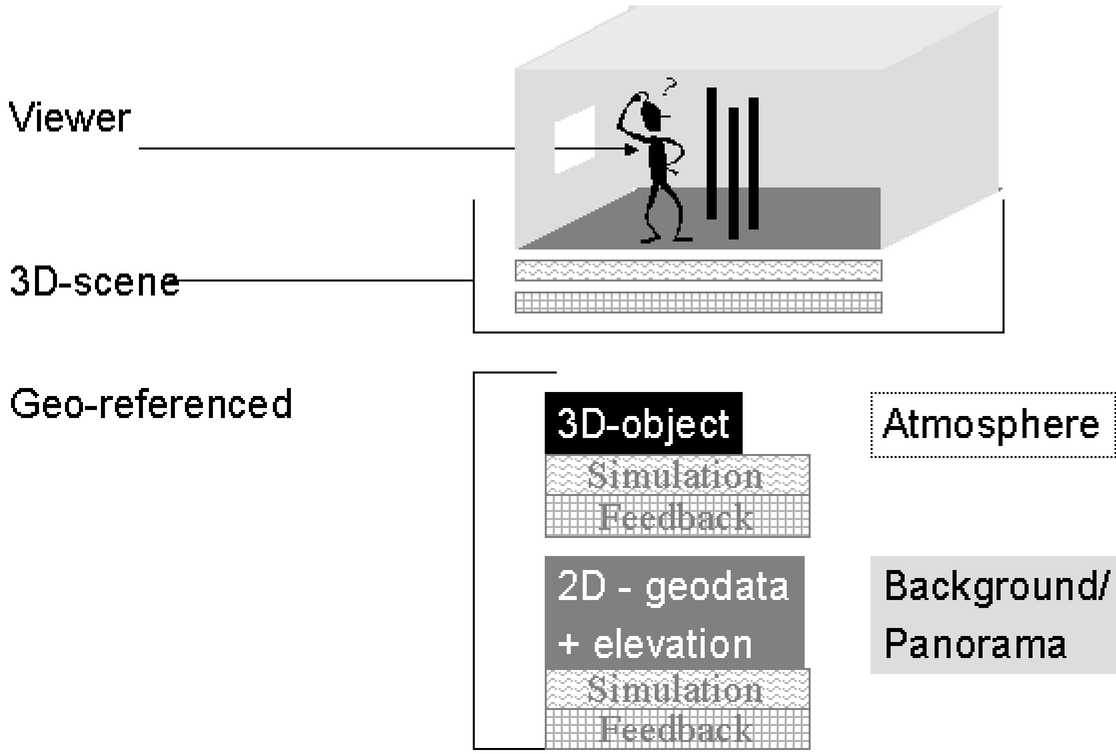

Figure 6.3 The responding Peep Box

So far, we have seen that virtual reality, and in fact geo virtual reality (GeoVR) exists of several components that can be illustrated by the metaphor of the peep box. The expected importance of the GeoVR is explicitly based on interaction, simulation and feedback. These three functions offer a peep box that supports an immersive, dynamic and reflective research and communication environment.

The I-factors

With respect to these functions Geo-Virtual Reality creates a virtual environment based on geographical data and develops a much more involved way of interacting with data than a 2D environment. In Geo-VR users become part of the dataset and part of a digital world, where they can explore and interact with the data. Heim (1998) has defined different factors that a virtual environment can share with a real environment. These 'I' factors are called immersion, interactivity and information intensity. MacEachren (MacEachren et. al.,1999), has added a fourth factor of object intelligence to the 'I'-factors.

The 'I'- factors: Immersion

Immersion describes the sensation of 'being in' the environment (MacEachren et al., 1999). Immersion in a virtual environment depends on the type of virtual reality that is used. There are several types of virtual reality that create partial immersion, which give the feeling of "looking at" a virtual environment. A few types provide full immersion, which is the feeling of " being in" a virtual environment. The different kind of virtual reality types can be categorized based on the amount of immersion they provide (figure 6.4).

Partial Immersion	Full Immersion
- Desktop VR/WoW	- Head Mounted Display
- Video Mapping	- Binocular Omni-Orientation Monitor
- Panoramic Screens	- 6-sided CAVE
- Mixed Reality	
- 3/5-sided CAVE	

Figure 6.4: Categories of partial and full Immersion

The 'I'- factors: Interactivity

The second I-factor is called interactivity. Interactivity, from Heim's (1998) perspective, refers to enabling the user in a virtual environment to change the viewpoint (e.g., through body and head movements and corresponding head-tracking). Changing in position of the body and parts of the body are important. Interactivity refers mostly to what is called navigation. Another part of interactivity is scene manipulation. The user is allowed to manipulate characteristics of the environment components. The manipulation of the objects can be separated in different categories, like

Full object change (delete or add an object)
Object position change (interaction with object by picking it up and rotating it in the hand)
Object attribute change (change colour, bitmaps and thematic attributes)
Object query (derive quantitative and qualitative information related to the objects)
(Heim 1998, MacEachren, et. al.1999)

The 'I'- factors: Information Intensity

The third "I"-factor is the information intensity. This factor deals with the levels of detail in the geographical related virtual reality (GeoVR). When objects in a virtual environment have more detail, the virtualness of the environment will be enhanced. A level of detail is required that corresponds with the expectation we have of real world objects at particular distances (MacEachren, 1999; Verbree, 1999). Also when the distance between the user and an object decreases, the user should be able to see more detail, just like in a real environment.

The 'I'- factors: Intelligence of Objects

MacEachren, et. al.(1999), has added a fourth "I" to this list, called intelligence of objects. The intelligence of objects refers to the extent to which objects in the environment have a certain behaviour that can be characterised as "intelligence". The realism of the virtual environment can be enhanced when objects have some kind of behaviour that corresponds with the behaviour of objects in the real world. In the "peep box" metaphor this intelligence of objects take care for the behaviour of the different objects and some of the feedback aspects.

Research topics of GeoVR

Based upon the peep box approach and the use of GeoVR in participatory spatial planning several topics are important to assess the effectiveness and usability of virtual environments taking into consideration the four "I's ".

3D scene construction	**3D scene control**	3D scene experience
Geo Data Fusion	Experience modes	Movement
Object preparation	Scene selection	Navigation
Information intensity	Geo data extent	Orientation
Scene representation	Object types	Selection
Simulation	Scene immersion	Explanation
Feedback	VR accessories	Elaboration
Control Tools	Reference mode	Manipulation
Experience Tools		

Table 6.1: The GeoVR topics

These three groups of GeoVR topics are an extension of the work of Heim (1998) who initially distinguished four factors (MacEachren, 1999) and Wachowicz (2001) who extend the ideas of Heim by 3 factors. The different items belonging to a certain topic are extracted and derived from Egenhofer and Kuhn -3D scene experiencing-, El-Kodmany (2001) -3D scene control-, Verbree et. al. (1999), Lovett (2002), Batty and Smith (2002) and Brown et.al. (2002) -3D scene construction-.

We use these topics to group research items that are of interest for the construction of a Geo-VR that supports participatory planning. These items are rather generic and not "per se" all are of relevance. The ones that are particularly interesting to be tackled during the current stage of the project have to be selected by the interest of the "gebiedsgerichte" planning approach.

To mention some research items based on table 6.1:
Scene selection means that constructors of a GeoVr scenes, or Users who will define themselves a 3D scene, should be able to select geo-data, objects, simulation models, viewers and feedback mechanisms, etc.
Research items that include this topic are:
interfaces with GIS and geo-data
look-up structures for 3-d objects based upon attribute en geometric information in geo-data
tools to build a peep-box that are closely integrated with GIS

Construction				**GeoVR factors**	
Control tools		Control			
Experience tools		Experience modes		Experience	
Feedback		VR accessoires		Manipulation	
Simulation		Reference mode		Elaboration	
Scene represent.		Scene immersion		Explanation	
Info Intensity		Geo data extent		Selection	
Object preparation		Object types		Orientation	
Geo data fusion		Scene selection		Navigation	
				Movement	

Table 6.2 The hierarchy of GeoVR topics

Scene presentation means that a constructor of a GeoVR scene is able to prepare a certain sensation of immersion by knowing the communication channel. Immersion means that a person perceives oneself to be encapsulated by, included in and interacting with a virtual reality environment (Witmer and Singer, 1998). A normal computer monitor provides little sense of immersion. A CAVE however does this a lot better (figure 6.4).
Research items that include this immersion sensation are:

- alternative interfaces to a computer (3d-glasses, gloves etc).
- navigational aids.
- sound and odour.

Information Intensity deals with the levels of details (i.e. information about objects) in a GeoVR (Brown et. al., 2002). The best example is that information is hidden when a user is away from an object while increasingly a more information (detail) is added when you approach it.
Research items that include the topic are:

- automatic aggregation and des-aggregation.
- streaming techniques and compression (eg. multi-resolution pyramids).
- minimal requirements on information requirements for communication of spatial information.

Manipulation means ways to provide users can directly manipulate the 3D scene and its objects. This factor seems especially of interest when using VR for (collaboratively) designing spatial plans (collaborative engineering).
Research items that include the topic are:

- design of toolboxes to provide user to interact with their virtual environment
- change the position of 3d objects
- remove 3d objects
- place 3d objects
- change the geometry of 3d objects

A very interesting but underexposed factor is *elaboration* (sometimes refers to as *augmented reality, but augmented reality is also synonymous for the scene presentation)* . With augmented

reality supplements the real world with additional information (Kraak *et al.* ,1999). A particular promising aspect of AR is the potential for collaborative environments (Billinghurst, 1996).
A research item that include the topic is:

- the use of avatars to assists collaborative work in a virtual environment

Simulation refers to the change of objects (object behavior). In most VR publications object behavior is just seen as animation. We like to express that animation is just one mode (fixed movement !) . Of much more interest is simulation of objects as result of a certain type of interaction with the user of the 3D scene.
Research items that include the topic are:

- coupling of geo-process models to VR-objects en scene / environment
- making objects reactive or sensitive to user interaction

Finally, simulation could be based on *Autonomous Agents.* These type of software is usually capable of having its own actions and internal states (autonomy), reacting to environmental changes or other agents actions (responsiveness) until they complete their tasks (social ability) (Weiss, 1999). Agents raise some appealing possibilities for assisting users in interpreting GeoVR's. Outside the field of GeoVR, autonomous agents are being used in the form of avatars. The SALIX prototype demonstrates the use of autonomous agents in understanding vegetation growth within a virtual geographic landscape.
A research item that include this topic is:

- the role of agents to support and guide the actions of the planning participants within the 3D-scene

7 Geo-VR applications

We have touched already a number of these factors during our research on VR. We will briefly discuss a number of prototypes of GeoVr application that have been developed the past three years. The following are of interest:

- Geodata 3D viewer
- Carto 3d Vis
- Virtools Meerstad
- ModelLink
- Salix-2
- Martes

Based on the GeoVR factors, we have evaluated the prototypes in terms of their effectiveness and usability to facilitate science and decision-making in acquiring spatial knowledge (Wachowicz et al 2002). The results emphasize the use of the Web as the medium means of communication.

GEODATA 3D VIEWER (Bulens et. al., 2000)

Access to geospatial data sets is increasingly being done through Web-enabled systems. This has proven to be the fastest way to strategic and valid geospatial data sets, since they can be retrieved by a variety of users. In the GEODATA 3D VIEWER prototype, the user can make a selection of an area of interest through Web Mapping functionalities provided by the server (fig. 7.1). The map server application handles the request for data retrieval. This application retrieves the requested data into one geospatial data set and transfers it to the user client side. The geospatial data set can contain data layers with different thematic information. In our example, three data layers are available: land use, soil, and elevation.

A Web browser allows the user to select the area of interest, and it provides the selection of the geospatial data set and its 3D display using VRML-file format. Once the user has requested the geospatial data for a certain area of interest the server retrieves the relevant data layers from the database. As a result, a GeoVR environment is created. The data layers are visualised on top of each other following a procedure that drapes the thematic information on its geometrically corresponding 3D surface data.

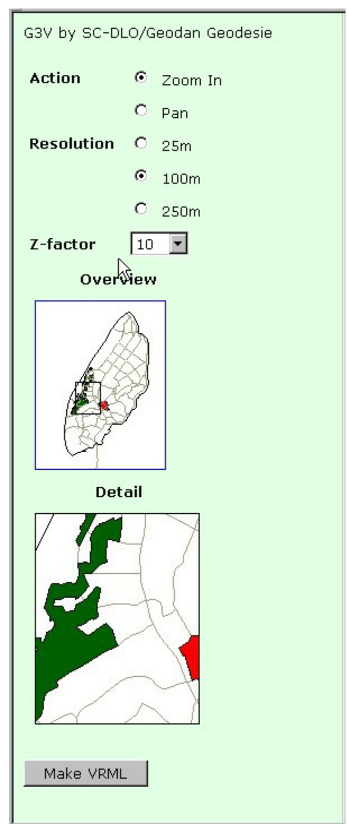

Fig. 7.1: The selection window

Data layers can be separated and examined individually by activating a Java button. In case of availability of groundwater table information, the landscape surface can be constructed by subtracting groundwater depth from the ground level surface.

Information intensity is presented in different colours on the surface. A legend is used to explain the meaning of each data layer used for the construction of the GeoVR environment. Showing a legend in this stage has proven to be an easy-to-use metaphor, since the users are very familiar with it from traditional cartography. The prototype has also shown that shading the 3D scene affects the role of colours. In the next version of the prototype, we are looking to tackle this application problem by using cursor interaction. By moving the cursor through the 3D-scene, the dynamic visual display of the thematic information will be shown. VRML-viewers very often offer possibilities to turn off shading.

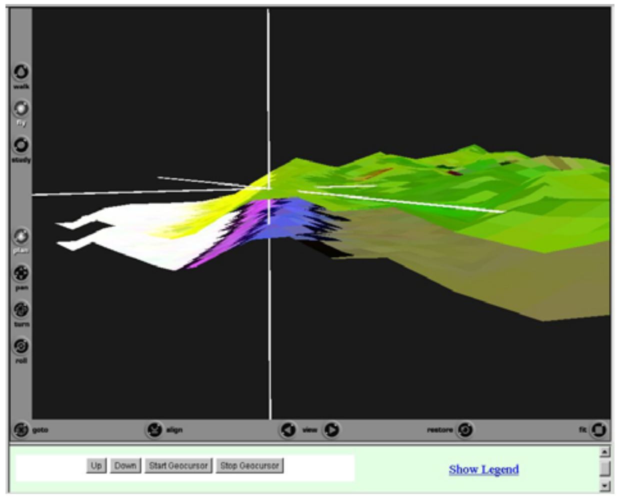

Fig. 7.2: geometric pointer

Construction				GEODATA VIEWER	
Control tools	□	Control			
Experience tools	■	Experience modes	■	Experience	
Feedback	□	VR accessoires	□	Manipulation	□
Simulation	□	Reference mode	□	Elaboration	□
Scene represent.	□	Scene immersion	□	Explanation	□
Info Intensity	■	Geo data extent	■	Selection	■
Object preparation	□	Object types	□	Orientation	□
Geo data fusion	■	Scene selection	□	Navigation	□
				Movement	■

Table 7.1 GeoVR topics of the Geodata 3D Viewer

VRML was used as the language to describe a 3D model. Geo-VRML was not available when we were developing the prototype. In Geo-VRML, rules are available to reference your GeoVR environment to real-world co-ordinates. Extra functionalities are available to perform spatial queries and spatial analysis. The implementation was carried out using Map Objects (ESRI) in order to perform zooming and retrieve the co-ordinates of our area of interest. These co-ordinates were used as a reference to extract data from the data layers stored in the database. A geo-cursor was implemented to query x, y and z co-ordinates directly from the VRML. Our next step is to handle map projects in building GeoVR environments.

CARTO 3D VIS (Bulens et. al., 2000)

The CARTO 3D VIS prototype is an extended version of the GEODATA 3D VIEWER in order to introduce interactive functionalities that allow users to select different levels of information intensity (Beukema and Breedijk, 2000). The first functionality (extension) was developed to create dynamic legends containing different levels of detail, which are activated according to the spatial scale of the GeoVR environment. The second functionality was developed to create a “cursor information” that supplies the information upon user request. The user can move the cursor around the GeoVR environment and gather information about each object or objects in a cursor panel. Finally the orientation functionality was developed to create a geographic orientation in a 2D cartographic view (the worldview) that indicates the area of interest, the direction of the user sight, and the compass orientation (geographical north).

Construction				CARTO 3D VIS	
Control tools	■	Control			
Experience tools	■	Experience modes	■	Experience	
Feedback	□	VR accessoires	■	Manipulation	□
Simulation	□	Reference mode	□	Elaboration	□
Scene represent.	□	Scene immersion	□	Explanation	□
Info Intensity	■	Geo data extent	□	Selection	■
Object preparation	□	Object types	□	Orientation	■
Geo data fusion	□	Scene selection	□	Navigation	□
				Movement	■

Table 7.2 GeoVR topics of the Carto 3D VIS

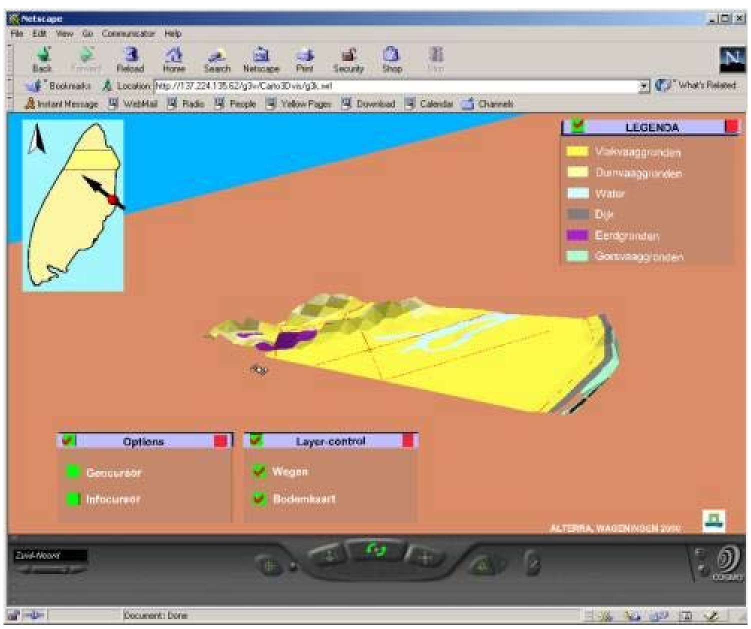

Fig. 7.3 Carto3D

By adding these tools we have improved the ways users can retrieve different levels of information and navigate within a GeoVR environment without loosing their geographical orientation. Our next step is to handle map projects in building GeoVR environments.

MODEL-link (Wal et. al., 1999)

Geo-Process Models (GPMs) are formal representations of changes in a system that occurs over time. The adjective "geo" refers to a model that calculates spatial changes as well. According to Kemp's description (1993) these formal representations are mathematical models. In this case, GPMs calculate spatial behaviour: streaming of liquid on a terrain, erosion, crop growth, traffic patterns, urban sprawl, animal dispersion and so on. GPMs are computer programs that perform spatio-temporal modelling considering the processes on the surface of the Earth. Klein (1990) gives an overview of this research area.

A considerable diversity of approaches and solutions has been developed and many GIS software tools exist, as well as modelling software tools. One example is Agro-Ecological models, which are programmer-specific, they have their model assumptions hard-wired into the program, and they are sparsely explained according to any standard. Attempts to improve this situation have led to a proliferation of incompatible modelling environments in addition to a proliferation of incompatible models (Muetzelfeldt, 1999).

The main objective for developing the Model Link prototype was to create a GeoVR environment, as a “player” for GPMs. "Generic" was the key requirement for the player. It should be possible to just plug in any model and play it. The only requirement was that the models should have a standardised format.

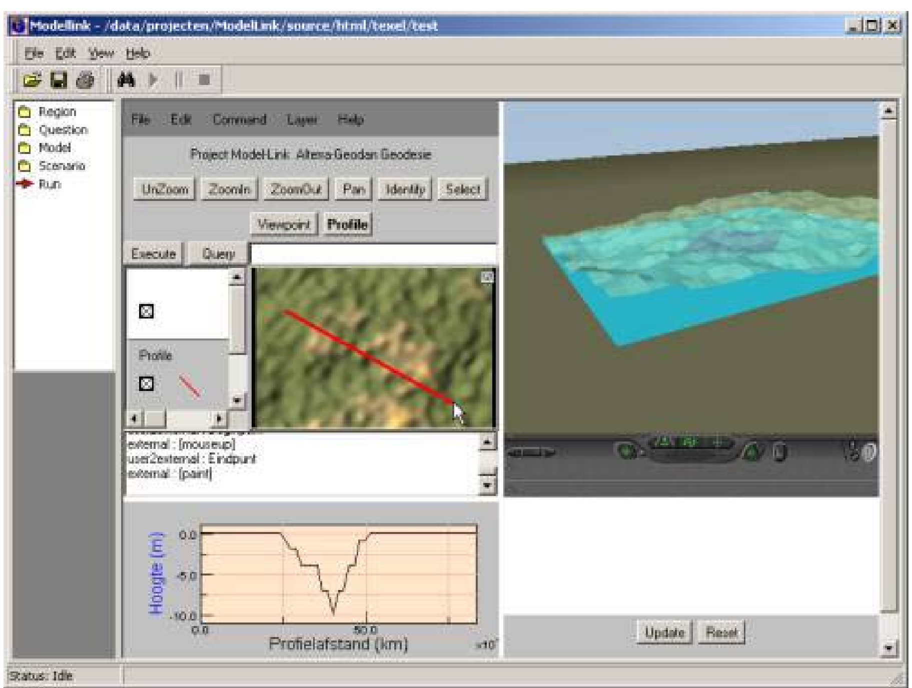

Fig. 7.4 The Modellink 3D interface

This "playable" functionality allows three interactions with the GeoVR environment:
Feed with process parameters and area of interest.
Control the actions of the GPM using scenarios.
Visualise the results of the GPM:

The users are required to have at least a-priori knowledge of these basic functionalities. The prototype consists of a GeoVR environment with an integrated decision module based on expert rules which define the use of available data and/or GPMs, a kernel for computations and a multimodal interface for interaction and visualisation of outputs. The multimodal interface consists of a 2D geo-viewer for an overview of the selected area (navigation and geo-referencing), a 3D virtual environment to examine changes in space and time during simulation and a graph window to present specific model outcomes.

Construction				Model link	
Control tools	■	Control			
Experience tools	■	Experience modes	■	Experience	
Feedback	□	VR accessoires	□	Manipulation	□
Simulation	■	Reference mode	□	Elaboration	□
Scene represent.	□	Scene immersion	□	Explanation	□
Info Intensity	□	Geo data extent	□	Selection	□
Object preparation	■	Object types	□	Orientation	□
Geo data fusion	□	Scene selection	■	Navigation	□
				Movement	■

Table 7.3 GeoVR topics of Model link

MEERSTAD (Dias et. al., 2003)

Has been developed to support the Dialogue procedure.

Construction				MEERSTAD	
Control tools	■	Control			
Experience tools	■	Experience modes	□	Experience	
Feedback	□	VR accessoires	■	Manipulation	□
Simulation	□	Reference mode	■	Elaboration	□
Scene represent.	□	Scene immersion	□	Explanation	□
Info Intensity	■	Geo data extent	■	Selection	□
Object preparation	■	Object types	■	Orientation	■
Geo data fusion	■	Scene selection	□	Navigation	■
				Movement	■

Table 7.4 GeoVR topics of Meerstad

Fig. 7.5 The Meerstad interface

The Meerstad application exists of a multi-resolution scene. The user can experience the scene by different movements. Flying and coming closer to the ground level (lower viewpoint) gives more visual detailed information. The icons on the lowest part of the window offer the user different ways to move through the model and to acquire different references and a link to other media formats (sounds, pictures and www-links).
The scene exists of related multi-resolution aerial photo's, geo-data and 3D-objects.Via light effects the horizon fades away.

MARTES (Lammeren et. al., 2003_2)

Has been developed to extent the relation between an autonomous simulation application and a 3D scene that represents the simulation results. MARTES is a prototype that links a landscape ecology based simulation animal behavior (in this case of the species Martes) to a GeoVR. In the MARTES application the 3D scene shows the movement of the Martes individuals in their habitat. The number of individuals can be increased.
The 3D scene is based on a geo data fusion of geographical data sets and 3D geo-referenced objects. The objects are simulated via an application interface. There are different scene

representations possible and even scene selection is possible. There are two reference modes. One represents the users view and the other the view from a selected animal.
In fact there is a very limited set of 3D objects available; objects that represent the animals and objects that represent landscape elements like trees.
Movement through the 3D scene is only possible for the user. The user is able to select animals and the user is able to put new objects (animals or landscape elements) in the 3D-scene. New animal-objects, placed in the 3D-scene, are immediately related to the simulation model. The landscape elements placed in the 3D-scene are not coupled at all !

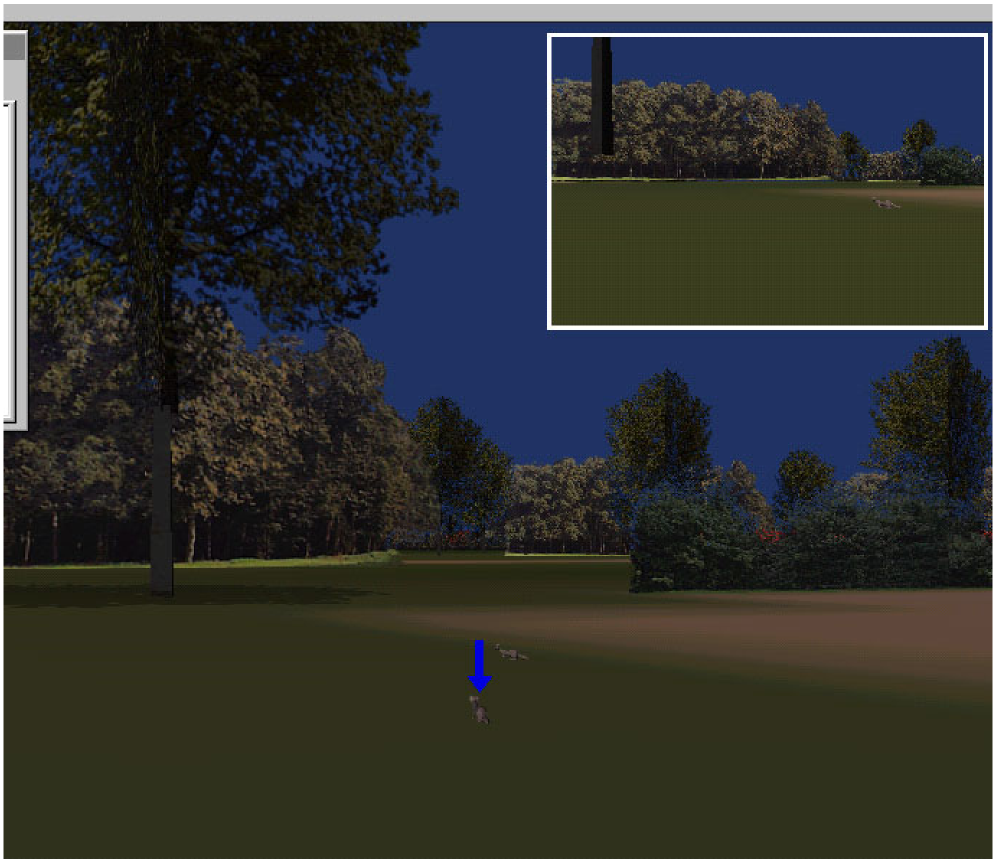

Fig. 7.6 The Martes Interface: the window upperright shows the view through the eyes of a Martes. The main window the view through the eyes of the researcher (1.80 above field level).

The MARTES project showed that direct links to simulation models are possible to create. Even if the simulation model has been developed in a very peculiar programming environment. However developing such kinds of links are still tough work to do.

Construction				MARTES	
Control tools	■	Control			
Experience tools	■	Experience modes	■	Experience	
Feedback	□	VR accessoires	□	Manipulation	■
Simulation	■	Reference mode	■	Elaboration	□
Scene represent.	■	Scene immersion	□	Explanation	□
Info Intensity	□	Geo data extent	□	Selection	■
Object preparation	■	Object types	■	Orientation	□
Geo data fusion	■	Scene selection	■	Navigation	□
				Movement	■

Table 7.5 GeoVR topics of MARTES

SALIX (Lammeren et. al. 2001, 2003-2)

Autonomous agents can assist users in understanding GeoVRs. SALIX prototype is an example of using agents to assist users in the creation of and interaction with 3D models of vegetation growth within a virtual park management. The prototype contains simulation agents for landscape architectural and interactive virtual park management. The purpose of park management is to accompany plantation and vegetation growth in such a way that a certain future landscape architectonic scenery will be obtained. Park management is the link between design and reality.

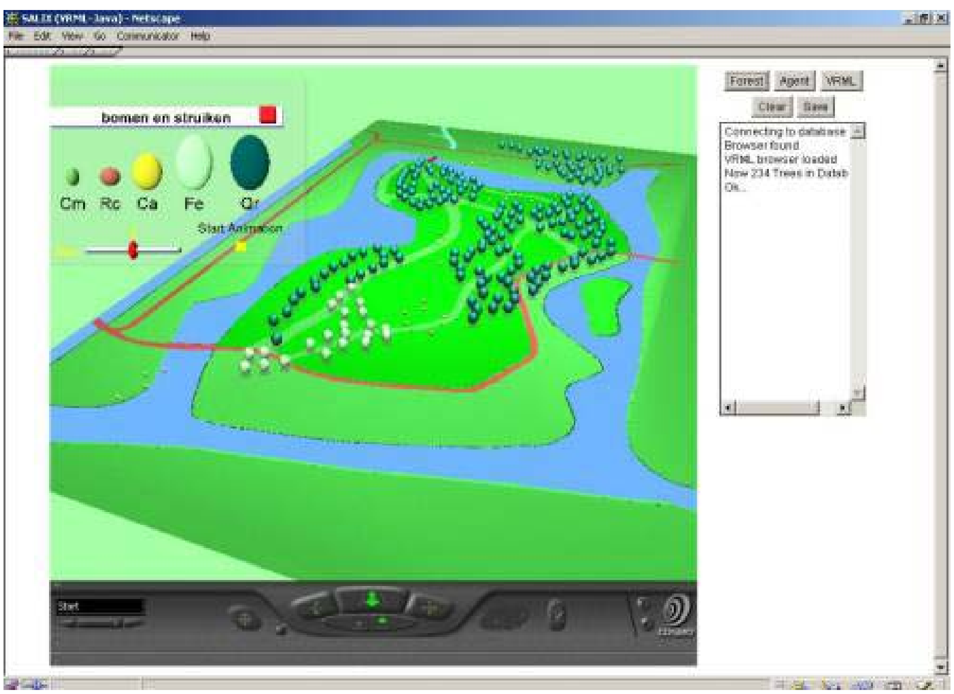

Fig. 7.7: The Salix main user interface

The GeoVR environment offers the opportunity to observe a real-time vegetation growth simulation in a control environment. The research challenge relies on developing reliable simulation models for the vegetation growth. For the development of SALIX prototype, the focus was given to the interactive use of a 3D simulation of an architectural vegetation plantation. Descriptive digital growth patterns for different species of trees and shrubs were used for the visualization of the vegetation growth. The 3D model is a mix of bitmaps for details and simple geometric objects are used as input for the simulation growth. An agent that incorporates specific growth characteristics according to geometric changes and seasonal changes manages each species. The user can interfere by executing a certain control measure, for example excluding one or more plantation objects (in fact editing the model on the fly). Five different species of trees were used in the GeoVR environment. The “Prins Berhard Bos” was used as the display area.

Construction				SALIX	
Control tools	■	Control			
Experience tools	■	Experience modes	■	Experience	
Feedback	■	VR accessoires	■	Manipulation	■
Simulation	■	Reference mode	■	Elaboration	□
Scene represent.	■	Scene immersion	□	Explanation	□
Info Intensity	□	Geo data extent	□	Selection	■
Object preparation	■	Object types	■	Orientation	□
Geo data fusion	□	Scene selection	□	Navigation	■
				Movement	■

Table 7.6 GeoVR topics of SALIX

The GeoVR environment represents the 3D visualisation of plantation and vegetation growth using autonomous agents and interactive manipulation of individual plantation objects (trees and shrubs). The prototype will become available on the Web.

CONCLUSIONS BY PROTOTYPING

Table 7.6 summarizes all research activities to exploit the GeoVR factors so far.
We can see from this table that currently some items have not been subject of any research activity. Other factors, like control tools, experience tools like selection and movement, have been elaborated on, but not extensively. Most factors have been subject in one of more prototype development. So far not any research has been spent on 3-scene control items like scene immersion by eg. multimedia, geo data extent and scene selection. The 3D-scene experiencing topics, elaboration and explanation, have not been subject of any research at Wageningen. However according these topics there are numerous examples.

Construction				VR factors	
Control tools	intense	Control			
Experience tools	intense	Experience modes	moderate	Experience	
Feedback	moderate	VR accessoires	moderate	Manipulation	moderate
Simulation	intense	Reference mode	moderate	Elaboration	not
Scene represent.	moderate	Scene immersion	not	Explanation	not
Info Intensity	moderate	Geo data extent	not	Selection	intense
Object preparation	moderate	Object types	moderate	Orientation	moderate
Geo data fusion	moderate	Scene selection	not	Navigation	moderate
				Movement	intense

not moderate intense strong

Table 7.7 An overview of current GeoVR topics research activities

8 Research: Geo-VR in interactive spatial planning

More formally we can look at VR as a computational model of reality that can be used to study the reality. It perhaps can also been seen as a new paradigm for human computer interaction. One is not sitting behind a computer anymore but the computer presents reality more directed to the real-world perceptions of people or the computer application is integrated with the reality one perceives. Considering the analysis of interactive spatial planning the question still is " how can VR be beneficial for interactive spatial planning?" This question can be answered on two levels. The first one is the level of participation between stakeholders in planning processes. Participation should support, as we have seen by Dialogue, to create a consensus, an understanding of each other or gathering arguments in favour and against a proposed spatial situation.

The second level applies to each individual stakeholder that tries to construct and to recognize his or hers perception of the real world.

At the first level the assumption is that VR might be beneficiary to create a common environment that can be better understood by the actors. The use of VR makes it easier to represent spatial information closer to the way people observe and perceive them in the real world. The gap between how a "real world" is observed and perceived and a modeled or represented world seems to become smaller. This could improve the stakeholder roles in participatory planning processes.

The second level is related to the assumption that people are better be able to relate the perception they have of a VR representation to the real world and vice versa. The image of the world they create depend less upon prior knowledge about cartographic symbolization. This might lead to fewer differences about what is actually proposed in a plan and what individual stakeholders perceive. In other words the beliefs represented in figure 2.1 of an individual actor might be less biased by cognitive dissonance during the observation and perception process. In turn this might lead to a faster divergence towards a conclusion at a group level because less time need to be spent in clarifying the used representations.
However to construct a sound concept and implementations of Geo-VR that we can use to experiment and test our premises demands a Geo-VR research agenda.

This research agenda is based on three components:

- the GeoVR topics (see chapter 6)
- a communication model for the individual stakeholder as well for a number of stakeholders (see chapter 5)
- the public participation phases (see chapter 4)

The GeoVR factors are presented in chapter 5 and do exist of the three factor classes: construct, control and experience (figure 8.1).

Construction				**GeoVR factors**	
Control tools		Control			
Experience tools		Experience modes		Experience	
Feedback		VR accessoires		Manipulation	
Simulation		Reference mode		Elaboration	
Scene represent.		Scene immersion		Explanation	
Info Intensity		Geo data extent		Selection	
Object preparation		Object types		Orientation	
Geo data fusion		Scene selection		Navigation	
				Movement	

Figure 8.1 The GeoVR topics

The transactional - communication model is in fact nothing else than the model of Adler presented in chapter 4. This model focuses on coding and decoding of information, as well as the bias of the coded information (figure 8.2) and the channels to exchange the messages.

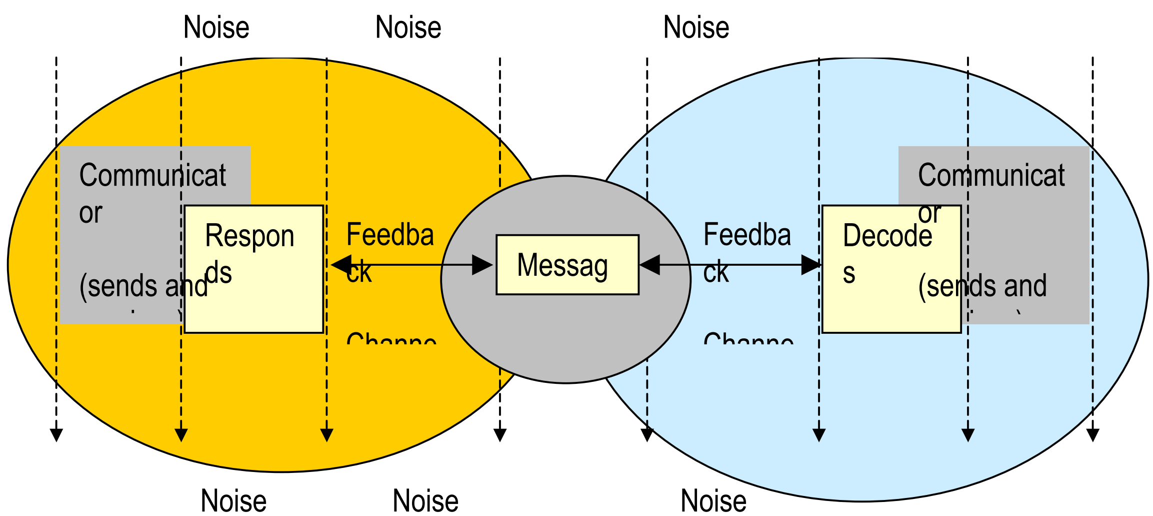

Figure 8.2 Transactional Communication Model (Adler, 1997)

The participation phases will be, generally, based on the NRLO phases as has been explained in chapter 3. More detailed, the focus will be on the Dialogue approach of DLG (table 8.1).

NRLO	Dialogue		
		experts	participants
	Start		
Inform			
Consult	Overture		
Advise			
Co-produce	Dialogue		
	Final		
Co-decide			

Table 8.1 The NRLO participation phases

Based on these three components GeoVR in participatory planning research agenda can be extended into the following overall subjects:

- the coding and decoding of geo-information considering the construction of a 3D-scene according the stakeholder's cognitive system;
- the mutual understanding of stakeholder specific 3D-scenes;
- the nature of experiencing the 3D scene by a stakeholder class considering the phase of participation;
- the type of communication within a multi-user geo-VR environment;
- the interacting or multi-use of 3D-scenes during a participation stage;
- the provision of 3D-scenes by several ICT-technologies like plenary projection, intranet based single-actor sessions or cable-based multi-actor sessions;
- the evaluation of ICT-based geo-VR environments in participatory planning.

Each of these research subjects can be refined by setting up prototypes and use these prototypes in an empirical setting. The empirical information could give such information that theories could be improved or even redefined.

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