Centre for Geo-Information

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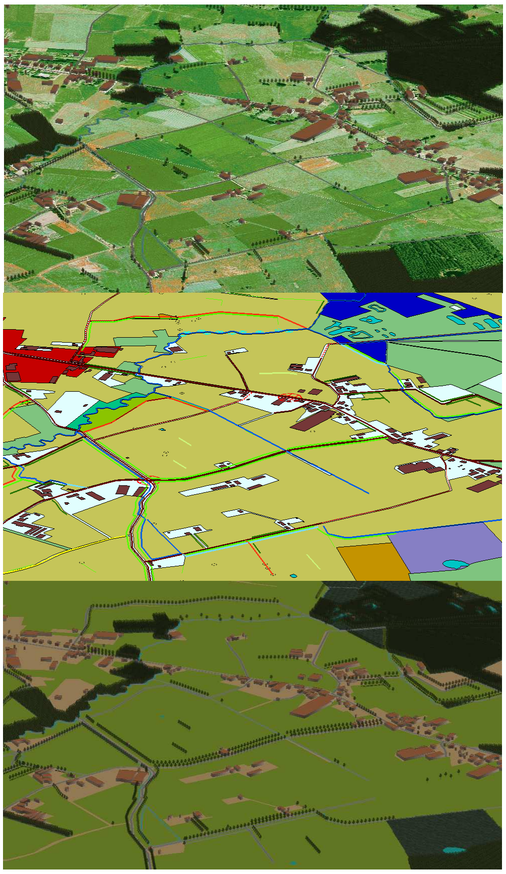
PARTICIPATORY PLANNING REQUIREMENTS FOR GEO-VIRTUAL REALITY

Applied to case study Zondereigen in ArcGIS

Hilbert Davelaar



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Participatory Spatial Planning in Europe

PARTICIPATORY PLANNING REQUIREMENTS FOR GEO-VIRTUAL REALITY

Applied to case study Zondereigen in ArcGIS

Hilbert Davelaar

Registration number 82 09 12 173 120

Supervisors:

Dr. Ir. Ron van Lammeren
Ir. Marjolijn Bloemmen
Ir. Tessa Hoogerwerf

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Foreword

This thesis is one the major steps towards my MSc degree in Geo-Information Science. I worked on this research from August 2004 until April 2005. Mainly two aspects made me enjoy my work during this period. First one is the relation of the subject of my thesis work with spatial planning. Although there are various fields of application for geo-information technology, my attention is primary focussed on applying my geo-information skills and knowledge in the field of spatial planning. Immediate cause is my background in Wageningen as a bachelor in Landscape, Planning and Design. Combining this with a fascination for visualization justifies my choice for the subject of Geo-Virtual Reality in participatory planning. Second aspect which made me enjoy my thesis work is the opportunity to contribute to the INTERREG IIIC-project ‘Participatory Spatial Planning Europe’. Using the PSPE case study rural development project Zondereigen as case study for my own research really enlivened my thesis work, especially the contact and meetings with the project team of the rural development project Zondereigen.

First of all I would like to thank my supervisors Ron van Lammeren, Marjolijn Bloemmen and Tessa Hoogerwerf for guiding me during my research. I especially appreciate their accompaniment and support the three times I have visited the office of the Flemish Land Agency (VLM) in Herentals, Belgium. Of course also thanks to my study advisor Willy ten Haaf for everything he has taken care of and CGI system administrator Marjanne Fontijne for all her help in case of computer problems or when I had to install additional tools for ArcGIS. Last but not least my appreciation goes out to Jeroen Jansen of the Flemish Land Agency, Jo van Valckenborgh of the Support Centre GIS Flanders (OC GIS-Vlaanderen) and all other people of both organisations I have met and cooperated with during my thesis work.

Hilbert Davelaar

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Abstract

With the growing use of Geo-Virtual Reality in participatory planning a problem arises: the unstructured use of Geo-Virtual Reality as a popular decision-making and public communication tool in planning.

To contribute to a more efficient and effective use, this thesis describes theoretical guidelines for the use of desktop Geo-Virtual Reality during the evaluation-choice routine of the participatory planning process. Therefore the planning process is split up into a planning subject and a planning object. This division is used to define the role of Geo-Virtual Reality in participatory planning. Guidelines for fulfilling this role are grouped into following categories: communication, level of participation and actors for the planning subject and visualization, realism, and interaction functionality for the planning object.

The guidelines are used as input for the PSPE case study Zondereigen. The structure and objectives of the planning process of the rural development project Zondereigen are analysed. The results of the analysis are combined with the theoretical guidelines to develop practical requirements for the implementation of Geo-Virtual Reality. The requirements are implemented by using ESRI’s ArcGIS 9.0, especially the ArcScene application included in the 3D Analyst extension. The implementation process is divided into three phases: geoprocessing, visualization and interaction functionality.

Besides the theoretical guidelines and practical requirements, main conclusions of the research are that: it is important to assess the practical requirements for each individual participatory planning process, despite its limitations ArcScene can be a useful software environment when making use of the strengths and geodata is essential for 3D geo-visualization.

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1. Introduction

1.1 Context and background

Spatial planning is becoming more and more a process in which actors participate. The role of a spatial planner is shifting from the expert who makes the technical design to that of communicator (Hidding, 1997). One of the research programs dealing with the issue of participatory planning and communication is the INTERREG IIIC-project ‘Participatory Spatial Planning Europe’ (http://www.interreg3c.net).

‘Participatory Spatial Planning Europe’, or PSPE, is a partnership between ten public bodies from Portugal, Poland, Belgium, Spain and The Netherlands. Main objective of the project is to improve information exchange within spatial planning processes by using modern information and communication technologies and geo-visualizations (DLG, 2004).

This research focuses on the role of geo-visualizations, especially geo-referenced Virtual Reality (GeoVR), as part of the research on participatory planning and ICT carried out by Bloemmen, Ligtenberg and Van Lammeren. They are writing a report on comparative analyses of approaches (Bloemmen et al., 2004).

PSPE is strongly linked to the Virtual Landscape project, especially in the field of GeoVR. Therefore the theory offered in the Virtual Landscape position paper *‘Geo-Virtual Reality and participatory planning’* (Lammeren and Hoogerwerf, 2003) and the PSPE working document of the *‘Report on comparative analyses of approaches*’ will function as a theoretical framework for this thesis.

1.2 Problem definition

As stated this research will focus on the role of Geo-Virtual Reality in participatory planning. Considering this role it is suggested that visualization is the key to effective communication for public participation. It provides a common language for all actors involved (Al-Kodmany, 1999). This is strengthened by the fact that static, animated and virtual images are more powerful and efficient tools for communication than any of the text or graphic formats that have preceded them (Orland et al., 2001).

These visualizations of information are still gaining importance in participatory planning, because latest advances in computer technology provide a unique opportunity to use digital visualization techniques to change and enhance the way the public interacts with design (Al-Kodmany, 1999). This is confirmed by Orland and his co-authors (2001) who state that with the advent of new communication technology, visualization takes an increasing role in environmental planning.

In this field of geo-visualization and participatory planning, Geographical Information Systems are already a widely accepted tool to present the spatial plans to the public. But now Virtual Reality is becoming increasingly important to visualize the future situation (Pleizier, et al., 2004). Furthermore, Schmid (2001) predicts that since public participation has become important, 3D visualizations will become indispensable. Reason is that non-professionals have difficulties reading 2D plans.

With this growing use of modern visualization technologies, like GeoVR, a problem arises. That is the unstructured use as a popular decision-making and public communication tool in planning. This problem is addressed by Sheppard (2001) who asks if ‘we know how to use these incredibly powerful and sophisticated tools appropriately’. Especially for the use of tools with a higher sense of ‘being in’ the environment, like Virtual Reality-technology, it is necessary to develop clear policies and guidelines (Orland et al., 2001).

When applying Virtual Reality in participatory planning, knowledge about how to represent the spatial environment as well as the participatory planning process is required for creating an effective virtual communication environment. Although it is clear that the use of Virtual Reality can be of great value, how to use GeoVR tools for optimizing communication processes is still unknown. This emphasizes the necessity for guidelines. These guidelines need to be translated into requirements for GeoVR tools.

Without requirements, efficient communication through the usage of Geo-Virtual Reality technology is impossible. Involving actors in a planning process only leads to satisfactory results when the tools for communication are developed and used in an appropriate way. If this is not the case the use of GeoVR tools may work contrarily and the process of participation may get very rigid or even fail.

As stated, the development of requirements has to be based on guidelines for GeoVR tools. For analyzing these guidelines the participatory planning process is split up into the planning subject and the planning object. The planning subject is the representation of the participatory planning process (actors, communication, etc.) and the planning object is the representation of the spatial environment (reality). In a GeoVR based participatory planning process Geo-Virtual Reality is used as a tool to establish and support the interaction within the planning subject (interaction between actors) and between the planning subject and the planning object (interaction between actors and reality). This will be made more explicit in the background theory offered in *chapter 2*.

For the development of requirements, participatory planning is considered as a multi-actor decision making process, in which decisions are made according to the general model of decision making processes by Mintzberg (1976). This model identifies three general phases:

1. *Identification*
2. *Development*
3. *Selection*

These phases structure seven routines. The identification phase compromises two routines: *Recognition* and *Diagnosis*. The development phase is described in terms of two basic routines: *Search* and *Design.* The selection phase consists of three sequential routines: *Screen, Evaluation-choice* and *Authorization.*

1. *Recognition:* opportunities, problems and crises are recognized and the need for a decision is identified.
2. *Diagnosis:* issues are clarified and defined and cause-effect relationships for the decision situation are determined.
3. *Search:* search for existing, ready-made, solutions is carried out.
4. *Design:* new solutions are defined or ready-made ones are modified.
5. *Screen:* infeasible ready-made alternatives are eliminated when a search yields more solutions than can be properly evaluated.
6. *Evaluation-choice:* feasible alternatives are investigated and a course of action is selected. The evaluation-choice routine knows three modes:

judgment, bargaining and analysis. In judgment individuals make a personal choice using procedures he or she cannot explain. During bargaining a group of decision makers with conflicting goals select amongst the search results or designs, each exercising judgment. The analysis mode factually evaluates the judgment and bargaining, and is carried out by analysts.

7. *Authorization:* approval is obtained for the decision within the group of participating actors or outside it.

These elements of the decision process are brought together by Mintzberg (1976) to a common base to develop a general model of decision processes. A simplified version of the decision framework is given by Bloemmen et al. (2004). *Figure 1.1* shows the simplified version of the general model of decision processes, in which the search-routine is omitted. In case of spatial planning the search-routine is considered part of the design-routine. Despite being amenable to conceptual structuring, decision processes are immensely complex and dynamic (Mintzberg, 1976). This results in the possibility of various routes and various loop-backs through the decision making framework (Bloemmen et al., 2004). It is assumed that each routine of this decision making process has different requirements for the GeoVR tool to be applied.

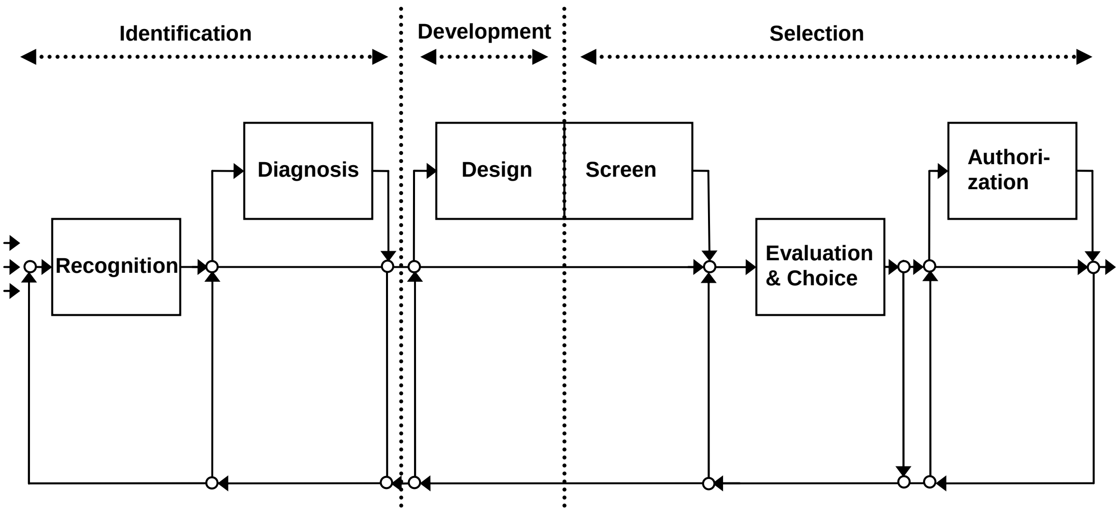

Figure 1.1: **General model of decision processes (Bloemmen et al., 2004; Mintzberg, 1976)**

1.3 Research objective

The objective of the research is to develop and implement requirements based on guidelines for Geo-Virtual Reality in participatory planning processes.

Within this research some restrictions are made. First, focus will be on one routine of the decision making process, the evaluation-choice routine. Furthermore Geo-Virtual Reality is restricted to desktop VR (for elaboration on (different types of) GeoVR see *chapter 2*). These limitations are necessary because otherwise both theoretical guidelines and practical requirements will become too wide and different. The concept of Geo-Virtual Reality in participatory planning will be based on the theory offered in the Virtual Landscape position paper *'Geo-Virtual Reality and participatory planning'* (Lammeren and Hoogerwerf, 2003) and the PSPE working document of the *'Report on comparative analyses of approaches'*. For the development and implementation of practical requirements, the PSPE case study 'rural development project Zondereigen' will function as a case study for this thesis. ESRI's ArcGIS 9.0 is used as software environment for the implementation phase of the case study.

In order to fulfil the objective following research questions need to be answered. There are three central research questions, which are divided into sub-questions.

What are the guidelines for a GeoVR tool when applied during the evaluation-choice routine of a participatory planning process with regard to the planning subject?

- How can actors communicate/collaborate in the process using the tool?
- Which level(s) of participation can be facilitated by the tool?
- Which and how many actors should participate in the process?

What are the guidelines for a GeoVR tool when applied during the evaluation-choice routine of a participatory planning process with regard to the planning object?

- What kind of visualizations of the planning object have to be available?
- What level of detail/realism is required/sufficient?
- What interaction functionalities have to be available?

With which requirements should a GeoVR tool comply for effective and efficient usage in the rural development project Zondereigen?

- What are the practical requirements of an effective and efficient GeoVR tool for the rural development project Zondereigen taking the guidelines from the planning subject and the planning object into consideration?
- On which manner can these practical requirements be implemented in ArcGIS 9.0?
- Are the developed requirements valid?

1.4 Report outline

In *chapter 2* the process of participatory planning and the role of Geo-Virtual Reality within this process are outlined. *Chapter 3* describes guidelines for Geo-Virtual Reality in participatory planning based upon a literature study. In *chapter 4* these theoretical guidelines are applied to a PSPE case study, the rural development project Zondereigen. The guidelines are translated into practical requirements which are implemented using ArcGIS 9.0. In the final chapter, *chapter 5*, conclusions are drawn, some issues of the research are discussed en recommendations are made for geodata en further research.

2. Geo-Virtual Reality in participatory planning

For discussing the role of Geo-Virtual Reality in participatory planning, first the process of participatory planning in general will be addressed (*2.1*). When this process is clarified, Geo-Virtual Reality and the role this technology can fulfil in participatory planning will be discussed (*2.2*). This role will be further defined in the concluding paragraph (*2.3*).

2.1 The process of participatory planning

Participatory planning is a complex process. To be able to study the use of GeoVR in participatory planning it is essential to define this concept properly. Therefore the concept will be split into two parts: ‘participatory’ and ‘planning’. First part to deal with is planning, which refers to spatial planning (2.1.1). Clarifying what makes spatial planning participatory is the second step to define the concept of participatory planning (2.1.2).

2.1.1 Spatial planning

The concept of spatial planning can be approached in many different ways (Kluskens, 2000). Numerous approaches to planning are known (Bloemmen et al., 2004). The three most prominent are, according to Geertman (1996):

- Decision-oriented approach
- Action-oriented approach
- Search-oriented approach

In the decision-oriented approach the central paradigm is that planning is a process of choice in a situation of uncertainty. The action-oriented approach assumes that the spatial organization is the results of actions of, and cooperation between, numerous actors. Planning as search for direction (search-oriented approach) considers spatial planning as a kind of learning process (Geertman 1996; Lammeren and Hoogerwerf, 2003).

Although it is a brief characterization, it shows that fundamental differences between the planning approaches exist. Despite these differences they have something in common. In each approach the division between the planning subject and the planning object is obvious (Lammeren and Hoogerwerf, 2003). To make this division explicit the search-oriented approach will be used.

The search-oriented approach is introduced by Kleefmann (1984). He characterizes it as ‘searching for possible directions of development’ (Kluskens, 2000). This planning approach, also called ‘reconnaissance planning’ is partly based on the conceptual model of action process. In the model of action process Kleefmann (1985) outlines the planning process based on Schutz’ concept of the action process. The action model (*figure 2.1*) knows four moments of action: developing an intentionality, definition of the situation, planning and decision making (Lammeren, 1994; Kluskens, 2000).

In this action model an actor (A) observes (o) from a certain intentionality (1) and then interprets (i) reality (R) by using knowledge and relevance to define the situation, including problems of an area (2). This definition leads to planning of possible actions (3). After a decision (4) is made the actor takes actions towards reality (a) (Lammeren, 1994; Kluskens, 2000).

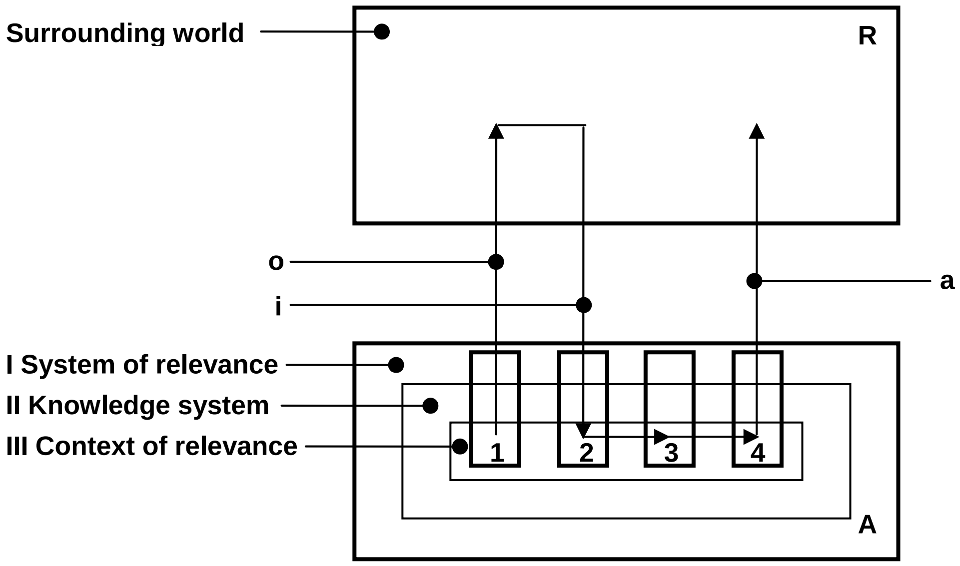

Figure 2.1: **The action model of Schutz after Kleefmann (1985; Kluskens, 2000)**

Studying the conceptual model of action process from the search-oriented approach offers a simple but useful concept of the process of spatial planning. The action model shows a planning process based on the correlation between actor and reality. The model may imply that the action process is linear, but the contrary is true. There is a constant feedback between the different phases (Kluskens, 2000). After interpretation of the model the actor can be regarded as the planning subject and reality can be considered as the planning object. Combining this with the fact that the process is non-linear, results in following simplified model:

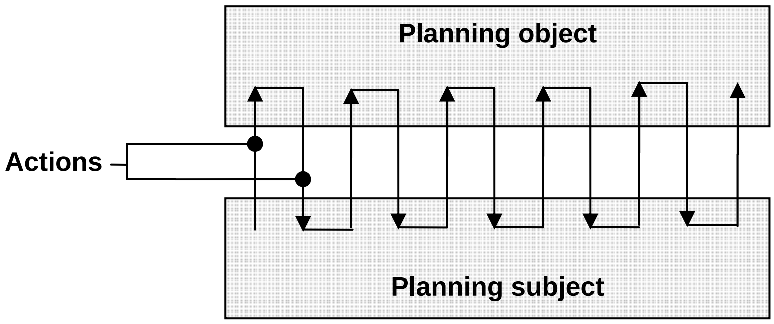

Figure 2.2: **Simplification of the action model**

Figure 2.2 shows a spatial planning process which is based on the correlation between the two parts in which the process is divided: the planning subject and the planning object. The mutual relation is established by actions. This makes spatial planning a non-linear decision making process based upon the correlation between the planning subject and the planning object.

2.1.2 Participatory planning

Now the planning part is demarcated, focus is on the participation aspect of participatory planning. What makes spatial planning, as described in the previous paragraph, participatory? This becomes clear by examining the motives for and definitions of participation in spatial planning.

Spatial planning processes are becoming increasingly more complex. Actors are becoming more interested in getting involved into the planning of the environment they live in (Vullings et al., 2004; Ottens, 2004). In the past decade, actors gained increasing importance in the course of a plan from the first thought of some desired change until the final realization and evaluation of the new situation (Hofschreuder, 2004).

It has become generally accepted that spatial planning only earns success when the basis, namely the people who have to live with the new situation, can follow -or even participate in- the decision making process, i.e. that the decision making process is transparent and understandable (Van Woerkum, 1999; Hofschreuder, 2004). This has to do with acceptance and involvement. Acceptance asks for involvement and involvement often occurs only when people participate in something. In this respect participation is the most obvious route for achieving acceptance (Kluskens, 2000).

So participation in spatial planning is all about involvement of actors. This is confirmed by the main objectives of participatory planning defined by Lammeren and Hoogerwerf (2003) following the reasoning of Klijn and Koppenjan (1999) (Bloemmen et al., 2004):

- Involving actors can raise the democratic legitimacy. Actors involved can directly influence the spatial planning process.
- Involving actors will lead to a larger problem solving capacity and improves the quality of the decisions.
- Involving actors yields more support and consensus for spatial plans and reduces oppositions against proposed spatial plans.

These motives for participation are in line with the definition of interactive participatory planning by Kluskens (2000). The definition also clarifies the difference between interaction and participation. He divides the concept of interactive participatory planning into two parts:

- Participatory is the process through which the government develops new spatial plans in cooperation with the citizens who are concerned, or associated, with the impact of the spatial plan. Participatory expresses the involvement of both the government and the citizen.
- Interactive is the part of the new trend he defines as the close and continuous mutual cooperation in which knowledge, skills and information is exchanged between the participating individuals (actors). Interactive expresses the relationship between government and citizen.

Therefore participatory planning is a way of decision making in which actors are involved. They can play both a passive (participatory planning) and active (interactive participatory planning) role (Lammeren and Hoogerwerf, 2003). The multi-actor character makes the decision process of spatial planning participatory.

The view of participatory planning as a multi-actor spatial planning process is conceptualized by Bloemmen et al. (2004). In the conceptual framework (*figure 2.3*) participatory planning is described as follows:

- Actors observe and perceive a spatial environment.
- Based upon these observations and perceptions they generate a preference for a desired spatial scenario.
- Actors communicate and negotiate their preferences during their interactions with other actors.
- The preferences of the actors serve as input for a final decision making (the decision market).
- The final decisions are implemented in the spatial system.

This concept of participatory planning can be considered as a somewhat simplified multi-actor approach to the action model as shown in *figure 2.1.* The spatial system is comparable to the surrounding world, R. The single actor A is replaced by a social system consisting of multiple actors who, like the single actor in *figure 2.1*, observe and interpret the spatial system. Planning of possible actions (visions) serve as input for the decision making phase, which results in action towards reality or, as in *figure 2.3,* implementation of the decisions in the spatial system.

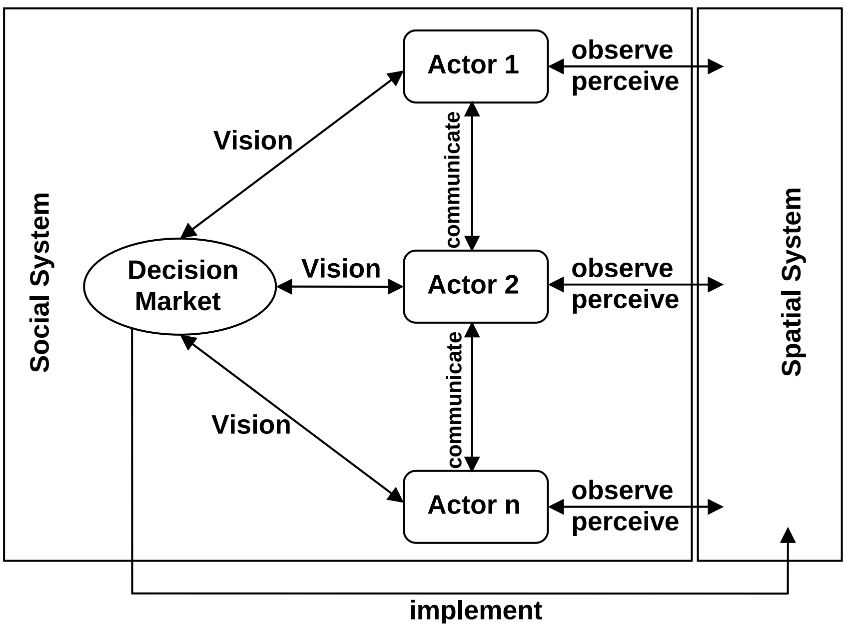

Figure 2.3: **Concept of participatory planning (Bloemmen et al., 2004)**

As in the action model, the division between the planning subject (social system) and the planning object (spatial system) is obvious in this conceptual model. The presence of one to many actors makes the concept participatory. The concept of participatory planning shows that communication is an important process in participatory planning. Without communication transfer of information or knowledge is impossible. As such it is a key characteristic of participatory planning (Bloemmen et al., 2004). Communication processes are elementary for public participation. When communication between the different actors in the process is not functioning appropriately, the process will not lead to any satisfactory result (Lammeren and Hoogerwerf, 2003).

2.2 Participatory planning and Geo-Virtual Reality

Nowadays, computer technologies greatly influence these communication processes. Modern information and communication technology (ICT) supports in different ways communication. Hence innovative technology can be of great value for participatory planning. One of the ICT-innovations which seems to be very useful in participatory planning processes is Geo-Virtual Reality (NLRO, 1998; Lammeren and Hoogerwerf, 2003). In *paragraph 2.2.1* the concept of Geo-Virtual Reality will be discussed followed by the role this tool can fulfil in participatory planning processes (*2.2.2*).

2.2.1 Geo-Virtual Reality

Geo-Virtual Reality connects geo-referenced data to the latest multimedia technology, which means that most of the 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 actors and the interaction between actors and the representation of the planning object (Lammeren and Hoogerwerf, 2003). But what is Geo-Virtual Reality exactly?

Numerous definitions of Virtual Reality exist, but there is almost no standard definition to the term Virtual Reality (Bourdakis, 1997; Mahmoud, unknown). For explaining what Geo-Virtual Reality exactly is, the Peep Box approach is probably the best method. It uses the peep box, made out of a shoebox, we all remember from our childhood (*figure 2.4*) (Lammeren and Hoogerwerf, 2003).

This Peep Box approach is a valuable metaphor to explain the nature of Geo-Virtual Reality. The shoebox refers to the three main components of virtual reality worlds:

- 3D-scene (inner side of the shoebox)
- Geo-referenced objects (elements in the shoebox)
- 3D-scene viewers (peephole of the shoebox)

The approach of Geo-Virtual Reality as a geo-referenced peep box can be widened by creating a responding peep box. Geo-Virtual Reality also offers new capacities based on computational technology: interaction, simulation and feedback. Adding these capacities results in a responding peep box that supports an immersive, dynamic and reflective communication environment (*figure 2.4*).

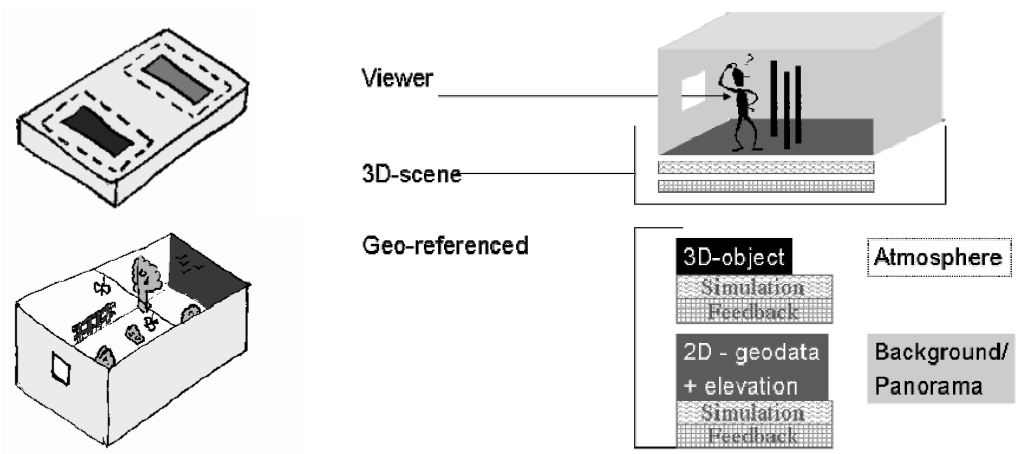

Figure 2.4: **The Peep Box made of a shoebox (left) and the responding Peep Box (right) (Lammeren and Hoogerwerf, 2003)**

To summarize this approach, Geo-Virtual Reality is a virtual environment based on geographical data which can be explored and interacted with. MacEahren et al. (1999) distinguishes four factors that this environment can share with a real environment. These 'I' factors contribute to the virtuality of the environment. The first three are adapted from Heim (1998):

- *Immersion:* the sense of 'being in' the environment.
- *Interactivity:* the possibility to navigate through and manipulate the environment.
- *Information intensity:* the detail with which objects and features of the environment are represented.
- *Intelligence:* the extent to which objects in the environment have a certain behaviour that can be characterized as 'intelligence'.

Nowadays, Virtual Reality embraces a variety of systems from the totally immersive, centralized, single user tools with which it began, to the entirely decentralized, remote and anonymous technologies spawned by the net (Bulmer, 2001). These systems can be classified into two main types according to the degree of immersion and interface in the synthetic environment (Mahmoud, unknown): immersive and non-immersive. Immersive GeoVR has a high sense of 'being in' the environment. This can be achieved by using data gloves and multi-media head-mounted display devices (HMD). Non-immersive GeoVR, e.g. screen based or desktop VR, has a low sense of 'being in' the environment. Mahmoud (unknown) adds a third type of GeoVR: network GeoVR. Network GeoVR is Geo-Virtual Reality technology that uses the internet as communication channel. This recent emerging type is a result of the massive progress in the internet and the continuing integration of Virtual Reality and the internet.

2.2.2 Geo-Virtual Reality in Participatory planning

As mentioned Geo-Virtual Reality is one of the ICT-innovations that seem to be very useful for participatory planning processes. It integrates most of the latest ICT and offers outstanding tools for representation and interaction (Lammeren and Hoogerwerf, 2003). Regarding GeoVR in participatory planning two questions arise. What makes GeoVR more useful for participatory planning than other tools used for participatory planning purposes? And what is the role of GeoVR in participatory planning?

Geo-Virtual Reality is defined in the previous paragraph as a virtual environment based on geographical data which can be explored and interacted with. There are three interesting aspects in this definition for explaining the usefulness of GeoVR in participatory planning: virtuality, exploration and interaction.

Already from only the planning perspective the usefulness of GeoVR becomes clear. Paul (unknown) frames planning in the future by four critical concepts: collaboration, access, virtuality and sustainability. The exact definitions of these four concepts are not of interest. More important is that Geo-Virtual Reality contributes to at least three out of four concepts. Considering the definition, GeoVR contributes to the concept of virtuality. Furthermore GeoVR technology offers opportunities for collaborative planning and design (interaction, manipulation) and a high accessibility (network GeoVR).

The usefulness of GeoVR for participatory planning is strengthened by the fact that, although the technical complexity is relatively high, Virtual Environments cover the utmost stage of participation. Tools like 2D / 3D drawings or multimedia presentations using for example animations are technically less complex, but are not able to support participation to the same degree as Virtual Environments (Bourdakis, 1997).

Another advantage of VR based tools mentioned by Bourdakis (1997), is that VR models allow the user to explore every part of a model and thus minimizes the dangers and misconceptions of bird's eye view perspectives that scale models and computer generated images very often suffer from. Virtual Reality models that can be explored and interacted with, will undoubtedly make the visualization and presentation of ideas at planning meetings or over the internet far more interesting and understandable for the public (Bulmer, 2001). In short, the combination of virtuality and the explorative, interactive character make Geo-Virtual Reality a very useful tool in participatory planning.

The role Geo-Virtual Reality can fulfil in participatory planning is illustrated in *figure 2.5*. It shows a multi-actor planning process which takes place via a virtual world. The virtual world, the GeoVR tool, supports the communication and decision making and functions as a mediator between the actors and the actors and reality (world). The simplified model shows the essence of the role of GeoVR in participatory planning. In reality it is more complex. In the model the interaction between actors as well as the interaction between actors and the world is completely conducted by a virtual world. When actors collaborate at the same place at the same time they will probably also communicate like they do in a 'normal' participatory planning process. However when actors that live in the area are involved, observations and perceptions will be based not only on the virtual environment, but also on the real world.

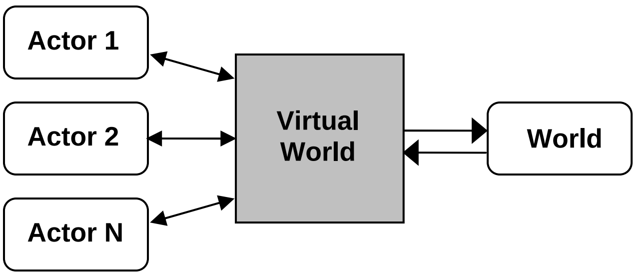

Figure 2.5: **Multi-actor planning in real world via virtual world (after Manoharan et al., 2002)**

Having these remarks in mind, the question is raised what part of the planning process is represented by the virtual world in *figure 2.5*. As stated GeoVR offers outstanding tools to represent the planning object and the planning subject. Is the virtual world object oriented, subject oriented or both? When *figure 2.5* is applied to participatory planning as described in *paragraph 2.1.2*, the issue is whether the virtual world represents the planning object, the planning subject or both the planning object and subject. In case of Geo-Virtual Reality, theoretically all three options are possible. This means that a GeoVR based participatory planning process can consist of four parts. These are, besides the planning object and (multi-actor) planning subject from a general participatory planning process as described in *paragraph 2.1*, a virtual planning object and a virtual planning subject. These four components are shown in *figure 2.6*. The virtual planning object is considered part of the planning object and the virtual planning subject is considered part of the planning subject.

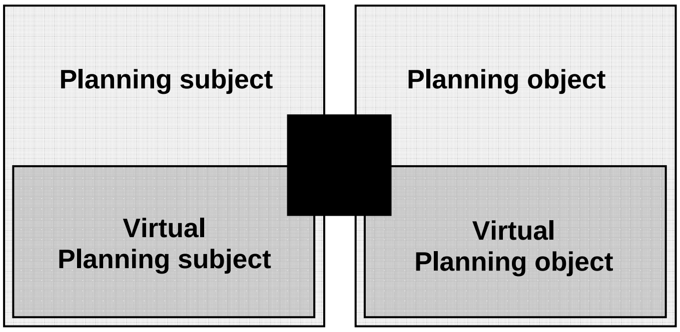

Figure 2.6: **Components of a GeoVR based participatory planning process**

In *figure 2.6* a 'black box' connects the four components. This 'black box' covers the actions we know from the action model *in paragraph 2.1*. Different setups of this 'black box' are possible. Eight conceivable setups are shown in *figure 2.7*. The dotted line encloses the components that are part of the process and the arrows represent the actions between these components. Although the arrows represent different kind of actions, they are shown identical for the sake of simplicity. Attention to the meaning of the arrows will be paid later on. The setup depends on two aspects. First aspect is which of both the real world components also include a virtual counterpart. There are four possibilities: none, the planning object, the planning subject and both the planning object and planning subject. In the first case when there is no virtual component, the participatory planning process can be described by setup A and E. These setups describe in fact a non-GeoVR based participatory planning process similar to *figure 2.3.* Only two components are present in the process and therefore there is no difference between subsequently and parallel worlds, which is the second aspect that defines the setup.

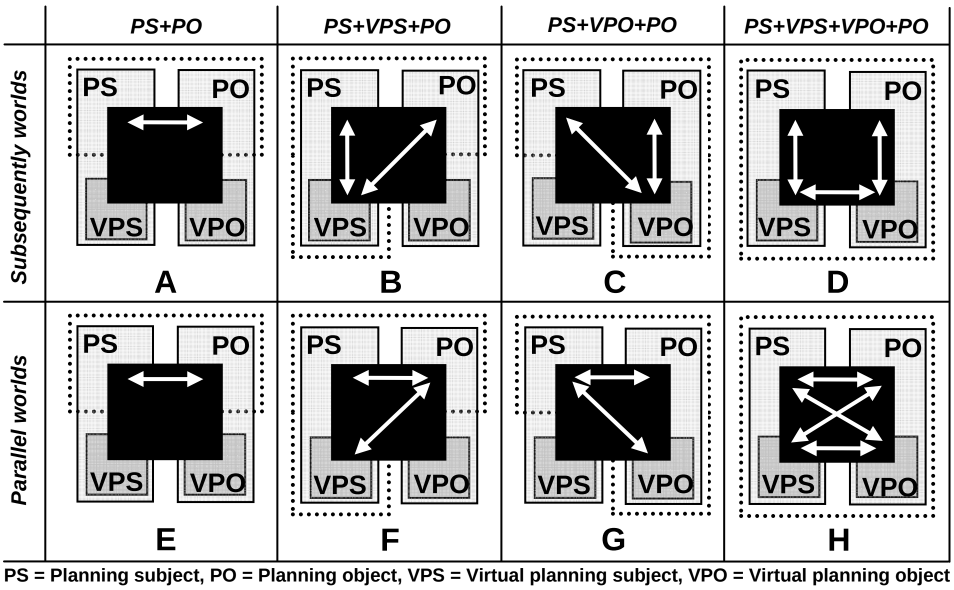

Figure 2.7: **Different setups of a VR based participatory planning process**

In case of the components being considered as subsequently worlds, a VR based participatory planning process can be described by setup B (virtual planning subject), C (virtual planning object) or D (virtual planning subject and virtual planning object). When the components are considered as parallel worlds setup F (virtual planning subject), G (virtual planning object) or H (virtual planning subject and virtual planning object) is most suitable for representing the process. For clarifying the difference between subsequently and parallel worlds, setup C and G can serve as an example.

In both situations there is a virtual representation of the planning object, the virtual planning object. If this virtual planning object functions as an intermediary component between the planning object and the planning subject the process consists of subsequently worlds (C). In case of a virtual planning object at the same level as the real world planning object, these components are parallel worlds in the process. The virtual planning object has the same relation to the planning subject as the real world planning object (G). In other words, in case of subsequently worlds the virtual world functions in between the real world components, while in case of parallel worlds the virtual world functions besides a real world component.

2.3 Conclusion

Two conceptual models from the search-oriented approach, to be named Reconnaissance planning by Kleefman, show that spatial planning is a non-linear decision making process based upon the correlation between the planning subject and the planning object. The process becomes participatory when multiple actors are involved in the process. This concept of the process of participatory spatial planning based on the division between planning subject and planning object will be used as a general framework for discussing the guidelines for GeoVR tools. For discussing these guidelines it is important to define the role of a GeoVR tool in participatory planning.

In *paragraph 2.2.2* it became clear that there are different theoretical setups for this role. Setup A and E describe a general non-VR based process and can therefore be neglected. Furthermore, as defined in *paragraph 2.2.1*, GeoVR is a virtual environment based on geographical data which can be explored and interacted with. This virtual environment can be very useful for supporting interaction between actors as well as the interaction between actors and the environment during participatory planning processes. According to this definition it can be assumed that in case of GeoVR based participatory planning, at least a virtual planning object should be present in the participatory planning process. As a result setup B and F can be omitted.

Which of the four remaining setups (C, D, G and H) is most suitable to describe the role of GeoVR in participatory planning depends on to what extent the planning subject is virtually represented and if components can be considered as subsequently or parallel. For this thesis focus will be on GeoVR as a tool to primary represent the planning object. This approach is best reflected by setup C and G. The expectation is that in practise the division between setups will not be as strict as described by *figure 2.7.* Especially concerning the matter of subsequently or parallel worlds, most of the time it will be a bit of both in practice. Therefore a setup, in which the planning object and the virtual planning object can be both subsequently and parallel worlds, functions as base to describe the role of GeoVR in participatory planning. This setup is a combination of setup C and G from *figure 2.7* and is shown in *figure 2.8.*

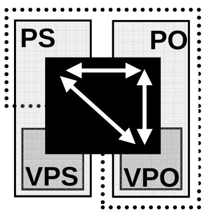

Figure 2.8: **Setup of the role of GeoVR in participatory planning**

The setup shown in *figure 2.8* can be used to describe the role of GeoVR in participatory planning by combining the setup with the concept of participatory planning from paragraph 2.1 (*figure 2.3*). In this setup no virtual planning subject is included. This results in the concept of GeoVR based participatory planning (*figure 2.9*):

- Actors observe and perceive the (virtual) planning object.
- Based upon these observations and perceptions they generate a set of preferences for a desired spatial scenario.
- Actors communicate and negotiate their preferences during their (GeoVR based) interactions with other actors.
- The preferences of the actors serve as input for a final decision making (the decision market).
- The final decisions are implemented in the planning object.
- The changes in the planning object are implemented in the virtual planning object.

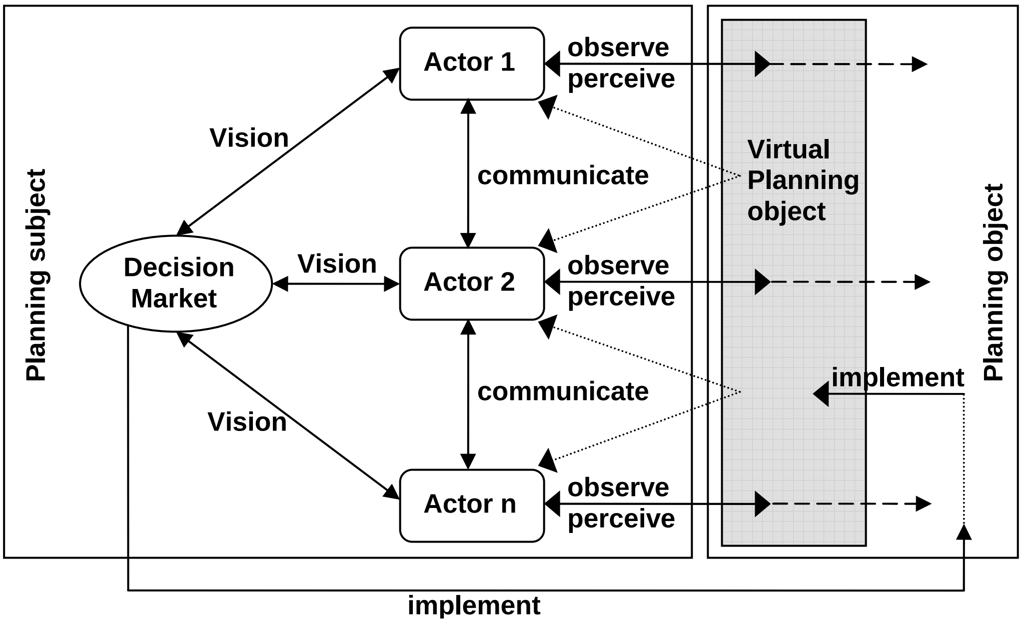

Figure 2.9: **Concept of GeoVR based participatory planning**

Within the concept of GeoVR based participatory planning both subsequently and parallel variants are present. The actors can observe and perceive only a virtual spatial environment which means that the spatial system (planning object) and the GeoVR (virtual planning object) are subsequently worlds. But, besides the virtual spatial environment, they can also observe and perceive the real spatial environment. In that case the spatial system and the GeoVR are parallel worlds. Furthermore the focus of the GeoVR is primary on representing the planning object, but there are also possibilities for communication via the GeoVR tool. This mainly involves communication about the planning object.

In *figure 2.9* the main components of the action model this chapter started with are still recognizable. The actions are represented by the arrows. Major difference is that the actor is replaced by multiple actors (planning subject) and that a virtual counterpart is part of reality (planning object). This is exactly what makes spatial planning in this concept participatory as well as GeoVR based.

3. Guidelines for GeoVR in participatory planning

For discussing the guidelines for Geo-Virtual Reality in participatory planning the division of the planning process into the planning subject (*3.1*) and the planning object (*3.2*), as elaborated in the previous chapter, will be used. The theoretical guidelines will be summarized and concluded in the last paragraph (*3.3*).

3.1 Guidelines for the planning subject

Concerning the guidelines for the planning subject three topics are of interest: communication and collaboration (*3.1.1*), levels of participation (*3.1.2*) and the actors that are involved (*3.1.3*).

3.1.1 Communication and collaboration

In *chapter 2* it was stated that communication is a key characteristic of participatory planning. GeoVR can be used as a tool to support the communication process. But how can this communication process take place using the tool?

In general communication theory the communication process is described by a sender that encodes a message and sends it through a channel. The encoded message is received by a receiver that decodes the message. In bidirectional communication there is a feedback from receiver to sender which is the inverse version of the process described above. During communication noise can be introduced (Adler, 1997; Van Woerkum, 1999; Bloemmen, 2004). This process of communication can be translated by means of three models defined by Adler (1997): the linear model, the interactive model and the transactional model. By some it is stated that successful participatory planning has to be based on transactional communication. Although this statement could be questionable, it can also become a guiding principle (Lammeren and Hoogerwerf, 2003). Therefore the transactional model will be used as the model to describe the communication process. The transactional communication model is shown in *figure 3.1*.

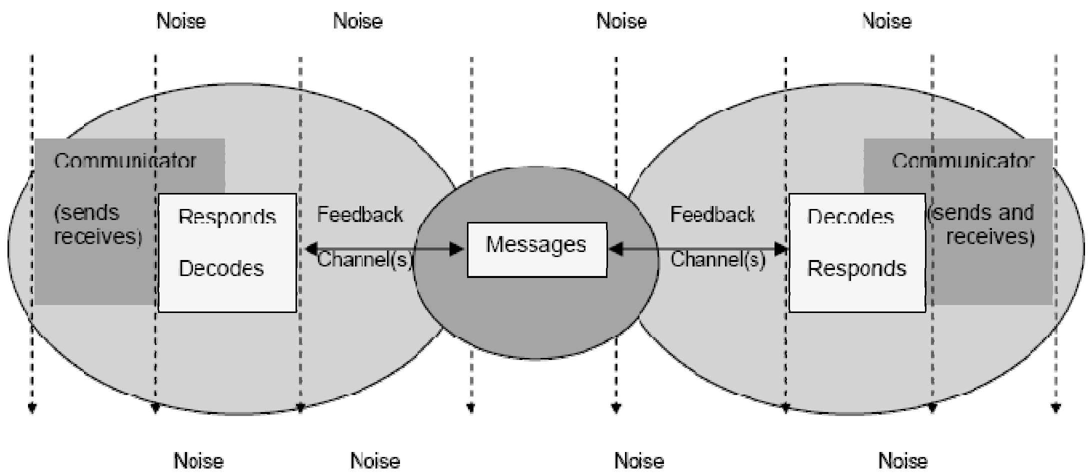

Figure 3.1: **Transactional communication model (Adler, 1997; Hoogerwerf, 2003)**

The transactional communication model reflects the fact that we usually send and receive messages simultaneously. The roles of sender and receiver are redefined as communicator (Adler, 1997). For this, in the transactional model communication is (Lammeren and Hoogerwerf, 2003): a fluid process (and not static), something we do with others (and not to others) and relational (and not individual).

In participatory planning basically three modes of communication occur within the process of communication (Bloemmen et al, 2004):

- *1:1 communication:* interpersonal communication between two actors (e.g. phone call, email, chat, msn).
- *1:n communication:* broadcasting messages from one sender to many receivers using mass communication channels like internet or various (e.g. television, video conferencing, email, spam).
- *n:n communication:* various messages coming from various senders, received by various receivers often using various channels (e.g. chat, discussion forum).

In a participation planning process, the n:n mode of communication is prevalent. Actors communicate and negotiate their spatial preferences often simultaneously acting alternating as sender and receiver (Bloemmen et al., 2004). Although the transactional communication model is not per se designed for 1:n or n:n communication, it shows similarities with n:n communication. In both cases communicators send and receive messages simultaneously.

With regard to communication and collaboration, when using Geo-Virtual Reality in participatory planning also an often used theory on group work is important, besides the above described theory on communication processes. The theory describes a four-category classification of communication protocols, which is based upon the spatial and temporal context of group work activities (Preece et al., 1994; MacEachren et al., 2004).

For GeoVR based participatory planning this means that involved actors can communicate and/or collaborate in four different arrangements as a combination of time (synchronous or asynchronous) and place (local or remote). These four spatial-temporal situations for group work are: Same Place Same Time (SPST), Same Place Different Time (SPDT), Different Place Same Time (DPST), Different Place Different Time (DPDT). Jankowski and Nyerges (2001) elaborate on this theory by describing several advantages and disadvantages of the various meeting arrangements (*table 3.1*).

Table 3.1: **Advantages and disadvantages of the four different spatial-temporal arrangements for group communication/collaboration (Jankowski and Nyerges, 2001)**

	Same Time	**Different Time**
Same Place	***Same Place Same Time*** *Advantage:* • face-to-face expressions • immediate response *Disadvantage:* • scheduling is difficult	***Same Place Different Time*** *Advantage:* • scheduling is easy • respond anytime • leave-behind note *Disadvantage:* • meeting takes longer • difficult to maintain in the long run

Different Place	*Different Place Same Time* *Advantage:* • no need to travel • immediate response *Disadvantage:* • limited personal perspective from participants • meeting protocols are difficult to interpret, difficult to maintain meeting dynamics	*Different Place Different Time* *Advantage:* • scheduling is convenient • no need to travel • submit response anytime *Disadvantage:* • meeting takes longer meeting dynamics are different from normal meeting ('netiquette' instead of face-to-face etiquette)

How people communicate in participatory planning using a GeoVR tool is clear. Which of the four communication protocols has to be applied in general cannot be decided based upon *table 3.1*. This depends on several factors which are different for various participatory planning processes. These factors need consideration in order to choose an appropriate communication protocol or combination. Nevertheless, nowadays the trend is towards different place and/or different time communication. In participatory planning, this is to overcome the inflexibility of meeting time and place of the traditional town-hall meeting or public hearing (Li et al., 2002).

For supporting this type of communication the internet is proposed as a communication channel. In particular, web-based GeoVR is becoming one of the new frontiers for visualization in participatory planning (Al-Kodmany, 2002). In *chapter 2* network GeoVR was already mentioned as a type of GeoVR that results from the massive progress in the internet and the continuing integration of Virtual Reality and the internet (Mahmoud, unknown). When the power of Virtual Reality systems is meshed with the public accessibility of the Internet, a powerful tool for planning and public participation is created. Until the development of network GeoVR, there has been no other tool in planning that can so effectively communicate to a large group of people how planners' and designers' ideas will change the experiential nature of the environment (Massum et al., 2003).

Although there are several advantages when using internet as a communication channel (Kluskens, 2000; Ball, 2002), there are also some disadvantages. Main disadvantages are the lack of face-to-face communication (and as a result non-verbal feedback) and aspects related to technology and accessibility (Kluskens, 2000; Al-Kodmany, 2002). Despite these disadvantages, Li et al. (2002) claim that for really enhancing public participation, GeoVR should be web-based to ensure that most public could get the right to participate in the planning process fairly and freely. Depending on the type of participation this could be questionable, especially for individual cases. However, it can also become a guiding principle given that network GeoVR can support al four communication protocols.

3.1.2 Levels of participation

In the planning literature various models of participation are described. An overview of the most quoted and recently used levels of public participation is given by Lammeren and Hoogerwerf (2003). Based upon a comparison of the described models they select the levels of participation as defined by Edelenbos and Monnikhof (1998) as most appropriate. Reasons are: the levels are suitable for the Dutch planning process and for participation in the development of rural areas, they are up to date and have a wide scope (with the result of covering almost all levels defined by others) and the number of levels defined seems usable for further investigation.

Although not all reasons are that relevant for this thesis, the typology of Edelenbos and Monnikhof will serve as basis for the levels of participation used. This typology has a lot in common with the levels of the National Council for Agricultural Research (Twist, et al., 1998) used by Kluskens (2000) and the classification of Arnstein (1969) as described in the PSPE working document of the *'Report on comparative analyses of approaches*' (Bloemmen, et al., 2004). Combining these sources, the levels of participation can be defined as follows:

1. *Inform:* actors are only informed about the planned change or a change that has already taken place. Main communication mode at this level is 1:n. Feedback or involvement is not possible.
2. *Consult:* actors are involved in information gathering (used as a source of information). The communication is more interactive. Often however it is felt to be a kind of window dressing.
3. *Advise:* actors are able to give their opinion about current problems and possible solutions. The given advice can be used to adjust spatial plans. The final plan is made by power holders. Communication becomes transactional.
4. *Co-produce:* actors are enabled to be active in the design of the actual spatial plan by participating in joint analysis. Decisions are made by power holders. Communication is also transactional, but in small groups.
5. *Co-decide:* actors participate in making policies and decisions and are co-responsible. The governing bodies fulfil the role of advisor. Communication takes place in small groups.

Now that the levels of participation are clear, the question is which of these levels can be facilitated by a GeoVR tool developed for the evaluation-choice routine. The NLRO (Twist, et al., 1998) has made an overview of ICT-innovations which could be of interest in each of the different participation levels, but Virtual Reality is not specifically categorised in one of the participation levels. A reason could be that Virtual Reality has been described as an additional innovation to other techniques (Lammeren and Hoogerwerf, 2003). This does not mean every GeoVR tool has opportunities to be used in all levels of participation. A GeoVR tool has to meet level-based goals and requirements.

Relating the decision making routines of Mintzberg (1976) from *paragraph 1.2* to the levels of participation as described above results in *table 3.2.* This table shows the participation during the decision making routines for each of the levels of participation. It is important to realize that in all five levels of participation the decision making process still includes all six routines from the decision framework. The difference between the levels of participation can be found in the participation of actors during the different decision making routines.

Table 3.2: **Participation during decision making routines for each level of participation**

	Recognition	Diagnosis	Design	Screen	Evaluation-choice	Authorization
Inform						
Consult						
Advise						
Co-produce						
Co-design						

	No participation
	Participation possible
	Participation

When participation is restricted to the level of inform during the complete decision making process, there is hardly any participation. Besides being informed after the decision making process is completed, the only possibility for actor involvement is during the recognition routine. In case actors are also used for information gathering (consult) they participate in the recognition and diagnosis routine. Another possibility in this level of participation is that actors are also consulted during the evaluation-choice routine, although they will only function as a source of information and there influence will be minimal. If this influence can be considered truly participative, the level of participation is advise. For the two remaining levels of participation, co-produce and co-decide, it can be stated that participation of actors can be found almost throughout the whole process. The only difference is the participation of actors during the authorization routine. When actors co-produce they can participate in all decision making routines except the authorization routine. Participation during the authorization routine only takes place in the highest level of participation, co-decide.

3.1.3 Actors

Within the planning subject, one more issue matters for efficient and effective participation in planning processes: the actors that are involved. Actors can be characterized by two aspects. First, it is important which actors are involved (and which not). Secondly, the number of actors involved influences the process. To start with the number of actors, the relation with both already discussed issues from within the planning subject is interesting.

The level of participation is important for the number of actors that can participate. An increasing level of participation generally decreases the number of actors that can play a role. Causes are an increasing complexity of the communication, an increasing number of conflicts arising from an increasing number of actors and related to that the increase in time needed to judge and negotiate the desires, visions and preferences of the actors (Bloemmen et al., 2004). Furthermore, concerning communication, not only the complexity increases with an increase of the number of actors. More important is that with an increase of the number of actors the efficiency of communication decreases (Preece et al., 1994; Ottens, 2004).

On the other hand, with a low number of actors involved the risk of missing out on certain actors is present. If actors that want to be involved are not able or allowed to participate, this will negatively affect the process of gaining support for the developed spatial plans. From this point of view involving as much actors as possible is the most likely approach. Combined with the restrictions coming from the levels of participation and communication, careful assessment of which number of actors to involve is required. For this assessment also the communication protocol has to be taken into account. Having the advantages and disadvantages as describes by Jankowski and Nyerges (2001) (*table 3.1*) in mind, it is clear that involving more actors is easier with DPDT communication in comparison with SPST communication. With DPDT communication the scheduling is easier and there is no need to travel. The other two communication protocols are in between.

Besides the number of actors, which actors are involved is also of importance. Not only group size, also group composition matters (Koontz, 2003). When embarking on an interactive process it is of utmost importance to consider who will be participating in the process. In general it is hard to name which actors have to be involved. This differs for individual participatory processes. Anyhow, each process knows the risk of forgetting an important actor. It is of major importance to include all varied interest groups and actors with opposing interests. When some actors are not present or represented, it will be impossible to build the required level of consensus between actors or groups of actors. A diversity of actors has a positive effect on the understanding between actors and a full picture of the opinions of important actors can only be build when all actors are brought together. Only then it is possible to motivate all actors involved and get their interest (Ball, 2002). Therefore at least a cross section of interest groups and actors is necessary.

3.2 Guidelines for the planning object

Concerning the guidelines for the planning object three topics are of interest: visualization of the planning object (*3.2.1*), realism of the visualization (*3.2.2*) and available interaction functionalities (*3.2.3*).

3.2.1 Visualization

With regard to the visualization of the planning object it is widely argued that if the planning disciplines want to be better understood by the public, they have to work with and in three dimensions. 3D visualization is one of the most natural ways to communicate; the real word is three-dimensional as well. Non-professionals have difficulties reading 2D maps. Though it is clear GeoVR pays up to this demand for 3D visualization, there are more facets when it comes to the visualization of the planning object. It is not realistic to assume that any single type of visualization as such would satisfy all user requirements (Sarjakoski, 1998).

Gagehan (1999) describes four barriers to the development of effective exploratory visualisation tools. One of these barriers is the orientation of the user within the virtual environment. In a virtual reality environment the orientation of the user is more problematic compared to more traditional cartographic products. The user just sees a part of the environment, only what is in his field of view (Groetelaers, 2002). Cartwright (2001) also names the orientation as a critical aspect of virtual environments. When viewers become lost within the space, a virtual environment fails as an interface.

For improving orientation within a virtual environment Cartwright (2001) suggests that, based on several authors, both three-dimensional and conventional two-dimensional map views should be shown simultaneously, providing both synoptic and immersive viewpoints. This is confirmed by Hoogerwerf (2003). Her research shows that though the possibility to visualize information three-dimensional, a need for two-dimensional information is still present. A two-dimensional map can be helpful for orientation during visual interaction, for example by showing a symbol that indicates where the user is and in which direction he looks or moves (Groetelaers, 2002).

This is supported by a multi-view approach to support interaction within virtual environments proposed by Verbree et al. (1999). The multi-view approach is based on three types of visualization: plan view, model view and world view (*figure 3.4*). The plan view shows a conventional two-dimensional map. The model view gives a bird’s eye view on a partly symbolic and simplified 3D world. The world view is an immersive view of a virtual world, and provides the most realistic view of the environment. The user sees the model from a certain position within the model itself. The three views can be used simultaneously or intermittently (Germs et al., 1999).

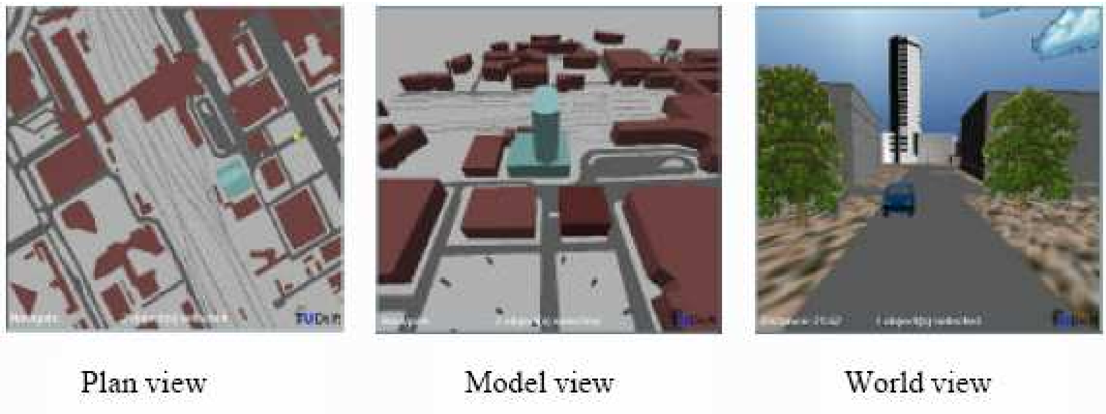

Figure 3.4: **Multi-view approach: three types of visualization (Verbree et al., 1999)**

When for improving orientation a three-dimensional (model view or world view) and a two-dimensional view (plan view) are shown simultaneously as advised by Cartwright (2001), the presence of the two-dimensional map may not be bothersome. The map should not reduce the sight or distract the attention. Also the presence of a 2D object in a 3D environment should not be confusing. Is has to be clear that the map is only a tool and not an object that is part of the virtual world (Groetelaers, 2002).

3.2.2 Realism

An important issue in 3D visualization is the level of detail. At first sight, it seems most likely to visualize an environment as realistic as possible. But we should not allow ourselves to be guided simply by what the technology can do (Appleton and Lovett, 2003). Instead, we should face one of the challenges in 3D visualization: determination of the appropriate balance of realism and abstraction for different geospatial application domains, different users, and different tasks (MacEachren et al., 1999). The question is how realistic the scene has to be to serve the purpose of the visualisation (Pleizier et al., 2004).

Visualizations can contain the most important information for a specific purpose without being highly realistic (Lange, 2001). If some information can be made clear also with a lower level of detail this saves a lot of superfluous work, money and time (Hofschreuder, 2004). This is reinforced by the fact that a drawback of visualizations is, that they can be so realistic and persuasive that they become misleading for people (Al-Kodmany, 2002). It is even stated that, for participatory planning purposes, too much realism will frighten the audience and decrease the will to participate. On the other hand, a small amount of realism will confuse the participants and decrease the ability to orientate (Pleizier et al., 2004).

At the same time, research from Hoogerwerf (2003) shows that orientation and navigation in realistic visualizations seems difficult, even when a 2D-map of the area is available. Concerning the readability of 3D landscape visualizations, research done by Hofschreuder (2004) suggests that the more realism, the more help it offers to the users of a 3D tool. But this only applies up to a certain level of realism. More realism added to the visualisation does not offer more help. These remarks raise the question what is the most appropriate level of realism for a GeoVR tool applied during the evaluation-choice routine in a participatory planning process?

The need for realism varies in the levels of participation. In her study on realism requirements for Virtual Reality Hoogerwerf (2003) makes a comparison between the suitability of three types of visualization for the different levels of participation. The types of visualization used are abstract, semi-realistic and realistic (*figure 3.5*). Overall conclusion is that a need for detailed and realistic visualizations is seen in the first (inform, consult) and last (co-decide) levels of participation. For the levels of advise and co-produce less detail and realism in the visualization seems necessary.

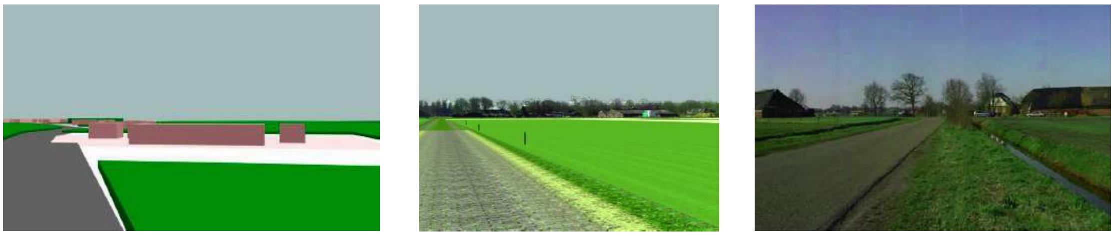

Figure 3.5: **Examples of abstract (left), semi-realistic (middle) and realistic (right) visualization (Hoogerwerf, 2003)**

Arguments are that during the first and last levels of participation, visualizations are used for inventory of spatial problems and presentation of proposed plans. These applications require detailed and readable visualizations to recognize the area and understand proposed spatial changes. In the levels of advise and co-produce applications are analysis of the current and future situation and design of several future scenarios. In order to point out problem areas and develop scenarios for spatial changes less detail and realism is required. Too much detail and realism would probably work out confusing and distracting for the participants (Hoogerwerf, 2003).

Further elaboration of the most appropriate level of realism is possible. For example, it is argued that 3D geo-objects must be differently generalized in order to emphasize and enhance the visual impression gained for different purposes (Meng, 2002). Furthermore, the level of detail can be considered equivalent to the 'I' factor information intensity as discussed in *paragraph 2.2.1.* In their description of information intensity, MacEachren et al. (1999) do not consider the detail with which objects and features of the environment are represented, as being a static characteristic of a virtual environment. For enhancing the virtualness of GeoVR the level of detail needs to be dynamic. Increasing proximity to an object should allow a user to see increasing detail, as it does in the real world. Also from a performance point of view a multi-resolution approach may be necessary (Verbree et al., 1999). This results in a multi-resolution virtual environment where the level of detail, with which objects or the environment are visualized, is a function of the viewing distance. A practical solution for creating such an environment is to have discrete distance thresholds within the virtual environment which, when they are crossed, move the viewer to a new level of detail (Brown et al., 2002).

Despite these requirements concerning the level of realism, it is important to realise that data is essential for landscape visualization. Nowadays a lot of 2D data is or will be collected. But for 3D visualization 3D data is preferably. Furthermore, many datasets are either not sufficient in resolution or do not cover the needed information for 3D visualization (Lange, 2001). Therefore, when creating a GeoVR environment is it important to keep in mind the general rule that often, the greater the realism, the weaker the link is to underlying data or scenarios (Orland, 1994).

3.2.3 Interaction

A prime consideration in any participation planning process is how well the tools that are employed, engage the targeted participants (Al-Kodmany, 2002). Therefore which interaction functionalities have to be available is an important issue. It is not just a matter of implementing as many ways to interact as possible.

First, the environment has to be kept simple. Virtual Reality has the potential to be highly engaging and interactive, but can also be confusing if too much information is presented at once (Al-Kodmany, 2002). Furthermore, too much interaction possibilities can lead to too much (and unwanted) involvement of participants. This is illustrated by Pleizier et al. (2004) with an example: as soon as people are allowed to fly by themselves and look at the spatial plans, they will try to find their own house in the future situation. This person might then see that the plans are going to affect the view from his or her house and therefore not agree with the plans. This would not have happened if this person had not been allowed to fly home, but instead only in a certain area.

Consequently, it is essential to carefully asses which possibilities of interaction have to be available when developing a GeoVR tool for a certain purpose. Based upon the work of Heim (1998) and MacEachren (1999), interactivity of a virtual environment is described in chapter 2 as the possibility to navigate through and manipulate the environment. Besides navigation and manipulation several other possibilities of interaction exist.

Groetelaers (2002) has described eight functionalities of interaction with Virtual Reality, which are closer related to desktop Virtual Reality. In this description a virtual environment functions as an interface linking virtual reality and GIS, with tools available to make sure the participant can interact (Hoogerwerf, 2003). The interaction functionalities are:

- *Explanation:* the method of connecting the visualization of the geographic and thematic data with the data, from which it is built up.
- *Orientation:* the ability to ascertain the location of the user in the geographical data, in time and the view direction.
- *Navigation:* the ability to move through the geographic and thematic data as well as through time.
- *Selection:* the ability to choose a part of the geographic and thematic data.
- *Manipulation:* is the ability of changing the geographic data (move, rotate) without changing the geometry or topology of individual objects.
- *Adaptation:* the ability of changing geographic data, including the geometry and topology of individual objects. Thematic data can be changed also.
- *Questioning*: is the ability to see not visualised, stored information.
- *Analysing*: the calculation of new values based on the geographic data, to determine trends and connections.

Comparing these interaction functionalities with the GeoVR factors for experiencing a 3D scene (Lammeren and Hoogerwerf, 2003) makes it possible to add another interaction functionality: elaboration. *Elaboration* can be defined as the ability to supplement the virtual environment with additional information. Although also the GeoVR factor movement does not appear in the list of Groetelaers (2002), movement is seen as being part of navigation.

All aforementioned interaction functionalities can be categorized as interacting in a 3D scene. Besides interacting in a 3D scene, Lammeren and Hoogerwerf (2003) also distinguish interaction of a 3D scene. *Interaction 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. Examples of interaction of a 3D scene are 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 (e.g. monitoring) (Lammeren and Hoogerwerf, 2003).

Both interaction in and interaction of a 3D scene deals with the interaction of actors with a virtual environment. For a GeoVR tool used in participatory planning process, it is also important to record the feedback of actors as they interact with the virtual environment. A GeoVR tool should enable them to record thoughts, emotions, and preferences at different points along the way as they evaluate a proposed development (Al-Kodmany, 2002). *Feedback* is therefore, besides the ten different types of interaction with a virtual environment, an eleventh possibility of interaction and can be defined as being the ability to react on the information offered in a virtual environment.

3.3 Conclusion

Concerning the communication it can be stated that successful participatory planning has to be based on transactional communication. In this participatory planning process, the n:n mode of communication is prevalent. This means that communicators, the actors that are participating, send and receive messages simultaneously. For collaboration there are four different protocols, which all have there advantages and disadvantages (*table 3.1*). Despite the fact that deciding which protocol is most appropriate depends on several factors which are different for various participatory planning processes, the trend is towards different place and/or different time communication. For these types of communication/collaboration the continuing integration of Virtual Reality and the internet is of major importance. There has been no other communication channel in planning that can so effectively communicate to a large group of actors. At the same time the internet can function as a communication channel for all four protocols. Nevertheless, each individual participatory planning process requires consideration about the most appropriate protocol and channel for communication and collaboration.

For the level of participation being facilitated, there are different options as well. *Table 3.2* shows that a GeoVR tool applied for participation during the evaluation-choice routine can primarily facilitate the three highest levels of participation: advise, co-produce and co-decide. Whether the level of participation is one of these three levels of participation depends on the level of influence of actors during the evaluation-choice routine. When the influence of actors is restricted to evaluation (judgement) by giving comments on possible designs the GeoVR tool will be more suitable to facilitate the level of advise. The given advice is taken into account and can be used to adjust spatial plans, but can also be left behind with good arguments. When the actors can really influence the choices made for giving feedback on the designs (judgement and bargaining), co-produce or co-design are the most related levels of participation.

Which and how many actors should participate depends even more on the characteristics of an individual case as result of the relation with the level of participation and the way of communication and collaboration. Restrictions for the number of involved actors combined with the need to minimize the risk of missing out on certain actors creates a demand for careful assessment of the number of actors to involve. This risk of forgetting an important actor can be further reduced by paying attention to the group composition. It is of major importance to include all varied interest groups and actors with opposing interests. Therefore at least a cross section of interest groups and actors is necessary.

With regard to the visualization of the planning object it is clear that for supporting interaction within virtual environments, from an orientation point of view, a two-dimensional map has to be available. This is the plan view in the multi-view approach of Verbree et al. (1999). The other two views they propose for supporting interaction is a model view and world view (*figure 3.4*). The three views can be used simultaneously or intermittently. When a three-dimensional view (model view or world view) and a two-dimensional view (plan view) are shown simultaneously the presence of the two-dimensional map may not be bothersome.

Guidelines for the visualization of the planning object can be further elaborated by the required level of detail. When we relate the conclusions from the study on realism requirements for virtual reality of Hoogerwerf (2003) to the decision making routine of evaluation-choice, the most appropriate level of realism corresponds most with the realism proposed for the participation levels of advise and co-produce. Though a GeoVR tool applied during the evaluation-choice routine can also facilitate the level of co-decide, the realism requirements for this GeoVR will probably have most in common with the requirements coming from the levels advise and co-produce. The applications in the levels of advise and co-produce as described by Hoogerwerf (2003), analysis of the current and future situation and design of several future scenarios, are more similar to the activities undertaken during the evaluation-choice routine. As a result the conclusion is that for a GeoVR tool applied during the evaluation-choice routine in a participatory planning process, there is no need for detailed and photorealistic visualizations. Less detail and realism, for example as shown by the semi-realistic visualization in *figure 3.5,* is sufficient. If it serves the purpose, realism requirements of visualization can be extended to for example a multi-resolution environment or different generalization of 3D objects. Probably more important is to realize that data is essential for landscape visualization and that often the greater the realism, the weaker the link is to underlying data or scenarios.

Final issue is which interaction functionalities a GeoVR, when applied during the evaluation-choice routine, should offer. One of the most important functionality that should be available is navigation. For evaluation, an actor should be able to explore the virtual environment by moving through the current situation and possible future solutions. When exploring virtual environments the importance of orientation in virtual environments was already noticed in *paragraph 3.2.1*. This shows the necessity for a functionality that helps an actor to orientate. Further support for exploring the virtual environment can be offered by interaction of the 3D scene. If this functionality is available, an actor can for example choose which data or objects he wants to visualize in the virtual environment. When evaluating a virtual environment it is important that an actor is able to give feedback and that this feedback is recorded (Al-Kodmany, 2002). This need for the interaction functionality feedback within a GeoVR tool was already mentioned. Especially for the evaluation-choice routine feedback from and to the participating actors is of utmost significance. This feedback can be used to make a loop-back to the design routine or, if the level of participation is co-produce, to make choices.

The interaction functionalities navigation, orientation, interaction of the 3D scene and feedback can be considered as crucial for the evaluation-choice routine. The process can be further improved by adding one or more of the interaction functionalities selection, questioning or elaboration to a GeoVR tool. Selection offers the possibility to select a certain part of the virtual environment to give feedback on or to visualize in more detail. For improving the exploration of the virtual environments questioning and elaboration can offer the possibility to provide the actor with additional information. This additional information can improve the evaluation and choice made. For the evaluation-choice routine, the interaction functionalities explanation, manipulation, adaptation and analysing are superfluous. Most of the interaction functionalities can be fully available or restricted in some way. Whether there is a need for full implementation or restricted possibilities depends on the characteristics of each individual case.

Based on these conclusions and as a summary of this chapter, 12 guidelines can be defined for the evaluation-choice routine during a GeoVR based participatory planning process. The guidelines are shown in *table 3.3.* The guidelines are coded using roman numbers. These numbers are used in next chapters for referring to the guidelines. This list is not meant to be complete and the context in which the guidelines are developed in this chapter should not be neglected.

Table 3.3: **Guidelines for the evaluation-choice routine during a GeoVR based participatory planning process**

	Guidelines for the planning subject
I.	Successful participatory planning has to be based on transactional communication
II.	Although there is a trend towards DP and/or DT communication, each individual participatory planning process requires consideration about the most appropriate communication protocol (STSP, DTSP, STDP or DTDP)
III.	If possible the internet should be used as a communication channel
IV.	The tool should facilitate one of the three highest levels of participation: advise, co-produce and co-decide
V.	Depending on the characteristics of the participatory planning process, an appropriate number of involved actors needs to be chosen
VI.	At least a cross section of interest groups and actors should be involved in the process
	Guidelines for the planning object
VII.	It is important to implement a multi-view approach in which different views can be shown simultaneously or intermittently
VIII.	For orientation a two-dimensional map has to be available showing both the location and view direction of the user
IX.	The level of realism which should be aimed at is semi-realistic (it is important to realize that often the greater the realism, the weaker the link is to underlying data or scenarios)
X.	A multi-resolution approach should be used from both a virtualness and a performance point of view and if it serves the purpose different generalization of objects is allowed
XI.	The interaction functionalities navigation, orientation, interaction of the 3D scene and feedback have to be available
XII.	Further improvement of the interaction functionality is possible by adding interaction functionalities like selection, questioning and elaboration

4. Requirements for GeoVR in Zondereigen

In this chapter the theoretical guidelines for Geo-Virtual Reality in participatory planning as described in the previous chapter, will be applied to the PSPE case study Zondereigen. The rural development project Zondereigen and participation within this process will be discussed (*4.1*) followed by *paragraph 4.2* about the practical requirements for Geo-Virtual Reality and the results of the implementation.

4.1 Rural development project Zondereigen

This paragraph is mainly based on the position paper (VLM, 2004a) and the work plan (VLM, 2004b) of the rural development project Zondereigen as well as on information gained during meetings with the project team of the VLM. First the general structure of the rural development project will be reviewed (*4.1.1*) followed by the participatory part of the process and its objective (*4.1.2*).

4.1.1 The planning process of the rural development project Zondereigen

The Zondereigen region is situated in the north of Flanders, Belgium just northeast of the city of Antwerpen on the border with the Netherlands. In this mainly agricultural area the Flemish Land Agency (VLM) is involved in the rural development project Zondereigen. Within this project 'land consolidation' is used as a planning instrument. Land consolidation as a rural development project reshuffles, amongst others, parcels of arable land within a previously defined area. It aims at continuous, regular and easily accessible lots situated as close as possible to the farm. In the framework of the rural development of the Zondereigen region, the 'Land consolidation Zondereigen' has a multifunctional character. This means that besides agricultural improvements, the objective is to contribute to the quality and/or quantity of other types of land use, like nature, landscape, water and recreation as well.

The procedure for the land consolidation project is divided in two phases. In the first phase an inquiry is done concerning the purpose of land consolidation. In the second phase the land consolidation is executed. The phases are elaborated in *figure A1* of *Appendix A*. The planning process shown in this figure can be considered as the decision making process of the rural development project Zondereigen. If we compare this process with the general model of decision making processes by Mintzberg (1976), a similarity is noticeable. The inquiry concerning the purpose of land consolidation represents the first general phase of the model of Mintzberg, identification. The inventory, study and description of the land consolidation framework are comparable to the activities undertaken during the routines included in the identification phase, recognition and diagnosis. These activities are the identification of the need for a decision and determination of the decision situation. Both other phases of the model of Mintzberg are enclosed by phase II, execution of land consolidation. The development and selection phase cannot be recognized in the decision making process of the rural development project Zondereigen as shown in *figure A1.* The routines these phases are composed of are gone through during the sub phase 'draft version of working plans'. It is indicated that in this sub phase the application of Interreg IIIC PSPE takes place. The structure of the planning process presented by *figure A2* of *Appendix A* can be regarded as the process followed during the sub phase 'draft version of working plans'.

The routines the development and selection phase are composed of can be recognized in *figure A2.* The design routine is represented by the creation of the 'working plans of Land Consolidation Zondereigen'. It is not clear whether a Screen procedure is part of the procedure. After this step the local population contributes through a participation process. The action phase of this participation process can be seen as the evaluation-choice routine. Results of this phase can be used to adjust the working plans or as input for the final draw of the working plans which can be considered similar to the authorization of the land consolidation. Comparing both figures with the decision making framework of Mintzberg (1976) makes clear that participation during the planning process of the rural development project Zondereigen mainly occurs during the evaluation-choice routine of Mintzberg. Furthermore in the figures shown in *Appendix A* hardly any loop-backs are recognizable in the planning process. It is assumable that in reality various routes and loop-backs are part of the process. The relation of the (sub) phases of the planning process of the rural development project Zondereigen with the decision making framework of Mintzberg is visualized in *figure 4.1*. For indicating whether actors can participate the same colours are used as in *table 3.2*.

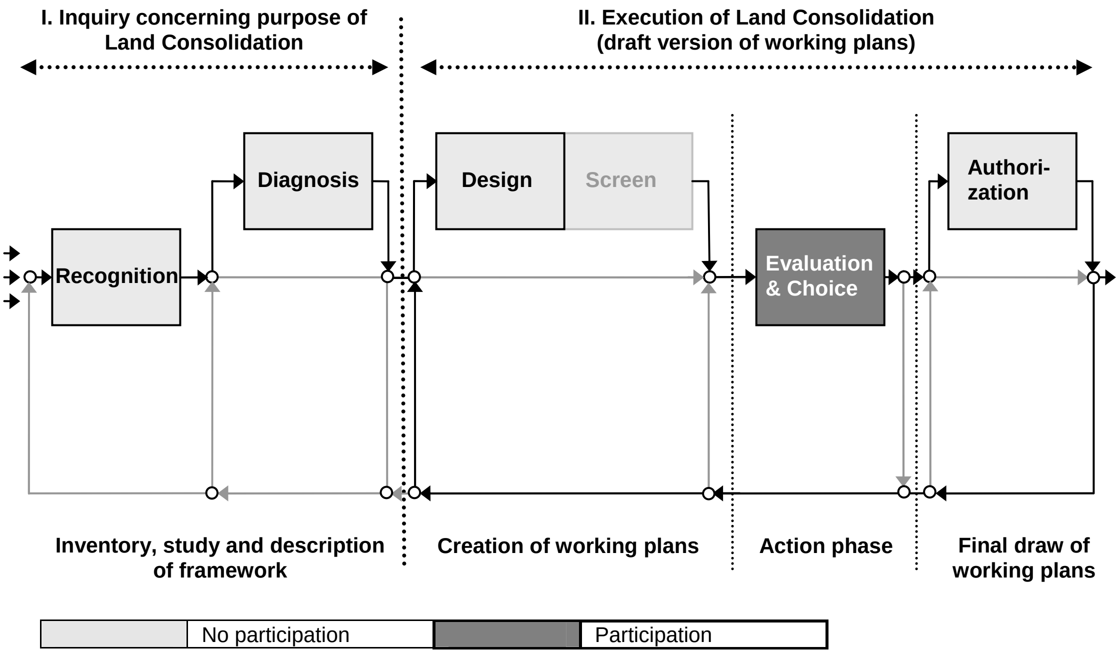

Figure 4.1: **Decision making routines and participation in the planning process of the case study Zondereigen**

The current status of the planning process is that the preparatory phase of the contribution of local population through a participation process is being executed. The outlines of the participation process are drawn. These will be discussed in the next paragraph (*4.1.2*). The rural development plan Zondereigen, presented in *figure 4.2,* serves as input for this participation phase. To give an impression of the Zondereigen region some photographs of the region are included in *figure 4.3*. This rural development plan will be translated into planning measures. For this, it is essential that the region itself participates so that the regional identity will be translated into the planning measures based on strong local support. This participation will be facilitated by different techniques, for example Geo-Virtual Reality. The use of Geo-Virtual Reality for the facilitation of participation and interaction will be further discussed in *paragraph 4.2.1*.

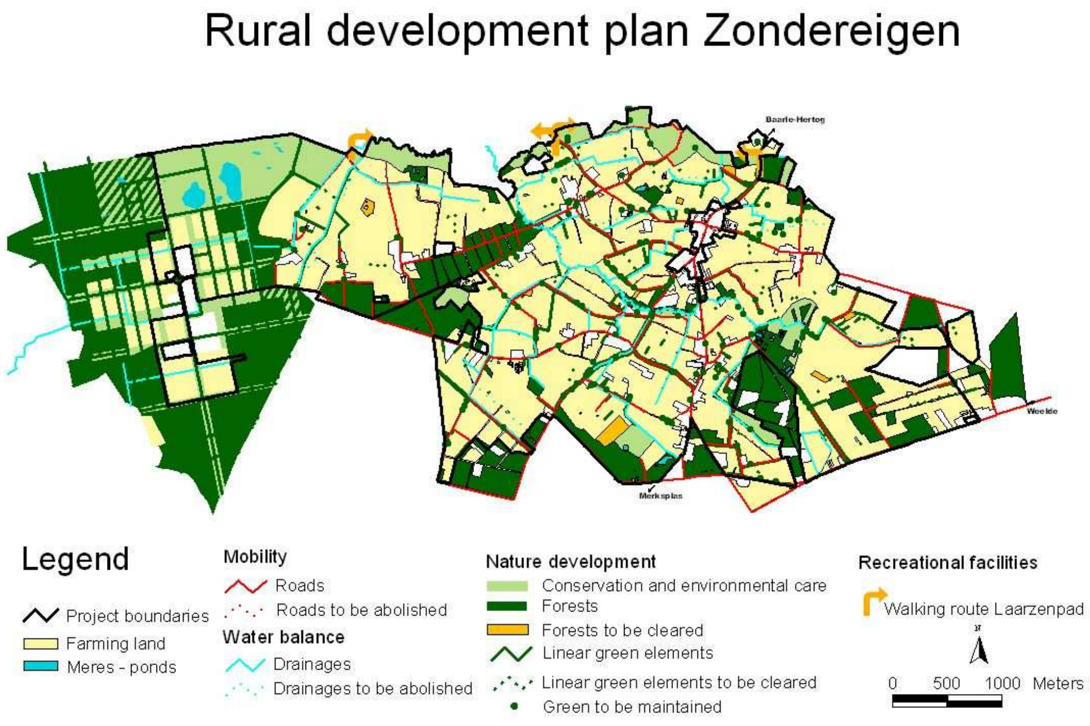

Figure 4.2: **Rural development plan Zondereigen (VLM, 2004a)**

Figure 4.3: **Impression of the Zondereigen region**

4.1.2 Participation in the rural development project Zondereigen

As pointed out during the discussion of the planning process of the rural development project Zondereigen, it is essential that the region itself participates in creating a final draw of the working plans. The success of a land consolidation plan depends, amongst others, on the participation and interaction between all actors. Participation and advice of all concerned is considered as a necessary prior condition to the drawing and realization of a master plan. For the rural development project Zondereigen the Flemish Land Agency (VLM) is responsible for the draw up and the preparation of the participation process, in collaboration with the competent authorities and those responsible for policymaking. How is the structure of this participation process being proposed by the VLM? The structure will be discussed in relation with the guidelines for the planning subject as defined in *chapter 3* (*table 3.3*).

The outlines of the participation process are shown in *Appendix B*. In these outlines four groups of actors are distinguished, namely a policy group, an official group, a midfield group and a group of non-organized individual citizen. Each group is rated for its importance to the process and how easy the party is considered to be involved in the process (*table B1*). Also an indication of number and type of actors is given. Although this information is valuable, according *guideline V* and *VI* it is important to further determine who is participating and who is not when applying GeoVR. More significant is the level of participation of each group during each step of the planning process. *Table B2* shows that actually only during step 4, when the participation process is passed through, the planning process can be regarded as fully participatory. During step 6 also all groups of actors are involved, but the participation is restricted to the lowest level of participation, inform.

The roles of the groups of actors during the different steps of the process are shown in *table B3*. According to *table B2* the level of participation during step 4 is intended to be co-produce for all four groups. Despite this, the role of both the midfield group and the group of non-organized individual citizen is described by contributing regional expertise, getting a basis for local support and expressing individual interests. This raises the question if the level of participation during step 4 can be described best by co-produce or that participation of one or more groups of actors is restricted to the advise-level. This matter is interesting regarding *guidelines IV*.

The flow of information as it is intended for the planning process joins up with the level of co-produce during the action phase of the participation process. Definition of the flow of information is related to the procedure for the land consolidation project, as shown in *figure A2* in *Appendix A*. The input of ‘Sustainable Rural Development’ is established by politicians. During both phases that include the working plans as well as the preparatory and evaluation phase of the participatory part of the planning process, official and political level are responsible for the final decision, while the midfield and non-organized civilians are only informed, consulted or give advice. For the action phase the flow of information can be characterized by the political and official level drawing up the plans together with the midfield and the non-organized civilians.

When taking the levels of participation as starting point, some doubts are raised. According to the definitions used for indicating the levels of participation (*table B2*) the answer to the question depends on whether the actors are only questioned and asked to give advice (advise) or if they are also asked to assist in making deliverables (co-produce). But in *chapter 3* it was concluded that if the influence of actors is restricted to evaluation by giving comments on possible designs, this situation is most related with the level of advise. This means that, during the evaluation-choice routine of the decision making process, given advice is taken into account and can be used to adjust spatial plans, but can also be left behind with good arguments. When actors can really influence the choices made for giving feedback on the designs the level of participation is either co-produce or co-design. It is questionable whether, when passing through the participation process, the influence of the actors will be great enough to reach the co-produce level of participation. Nevertheless, with co-produce as well as advise, the level of participation is in line with *guideline IV* for the planning subject.

Last aspect on which the planning process is outlined is the method of communication (*table B4*). The communication and interaction with and between the actors is intended to result in alternative proposals, recommendations, remarks, conditions, etc. To accomplish this, the type of communication is dialogue for all four groups of actors. For actors on policy level main communication modus is 1:1 and for actors on official level 1:n. N:n is the main communication modus for the other two groups of actors, the midfield and the non-organized civilians. Based on this information the intended way of communication can be considered as transactional communication. According to guideline I this is a condition for successful participatory planning. No outlines are defined yet for the communication protocol and channel (*guideline II* and *III*). Meeting arrangements are not clear and are considered dependent on the process architecture.

Now the necessity for participation and the structure of the participation process are made explicit, the objective of participation in the rural development project Zondereigen needs to be clarified. When it comes to participation, the problem is that the threshold raised by technical plans causes an inadequate use of the opportunities for participation. Therefore the objective is to increase the involvement into the rural development project by lowering the threshold to participate. This objective serves a fourfold purpose. The intension is to stimulate the empathy of the government with the local actors, to increase the contribution of knowledge by the local actors, to stimulate the empathy of the local actors with the government and to make the procedure of the planning process as clear as possible for the local actors.

In general the tools for fulfilling this objective are provided by the objective of PSPE, which is to improve participation within spatial planning processes by using modern information and communication technologies and geo-visualizations. In the rural development project Zondereigen the use of techniques that will make (the variants of) planning measures and the impact of it spatially visible, gets a central place. The techniques have to be tailored to the requirements of the relevant target group, permit interaction, and be accessible as to guarantee an equal participation. The Flemish Land Agency (VLM) suggests developing a Geo-Portal, a 3D Viewer and a virtual tour. Employing a Geo-Portal conforms to guideline III, but especially in case of the last two suggestions Geo-Virtual Reality can make a contribution. In the next paragraph the role of Geo-Virtual Reality in the rural development project Zondereigen will be further specified and practical requirements will be formulated and implemented on basis of the theoretical guidelines described in *chapter 3*.

4.2 GeoVR in the rural development project Zondereigen

The role of Geo-Virtual Reality in the rural development project Zondereigen and the practical requirements for the application of this technology will be discussed In *paragraph 4.2.1*. In *paragraph 4.2.2* the results of the implementation of these practical requirements will be presented, which are meant as a contribution to GeoVR for the rural development project Zondereigen.

4.2.1 Requirements for GeoVR in the rural development project Zondereigen

The outlines and objective of participation in the rural development project Zondereigen as discussed in *paragraph 4.1.2* can be combined with the concept of GeoVR based participatory planning as described in the conclusion of *chapter 2*. Therefore based on this conclusion the role of GeoVR in the rural development project Zondereigen is considered equal to the general setup shown in *figure 2.8.* This results in *figure 4.3* which shows a simplified model of the GeoVR based participatory planning process of the rural development project Zondereigen.

- Four groups of actors (policy, official, midfield and citizen) observe and perceive (virtually) the Zondereigen region.
- Based upon these observations and perceptions they generate a set of preferences for a desired spatial scenario.
- Actors communicate and negotiate their preferences during their (GeoVR based) interactions with other actors.
- The preferences of the actors serve as input for a final decision making (the decision market; according to the outlines of the participatory planning process only the official and policy groups are allowed to decide).
- The final decisions are implemented in the Zondereigen region.
- The changes in the Zondereigen region are implemented in the virtual Zondereigen region.

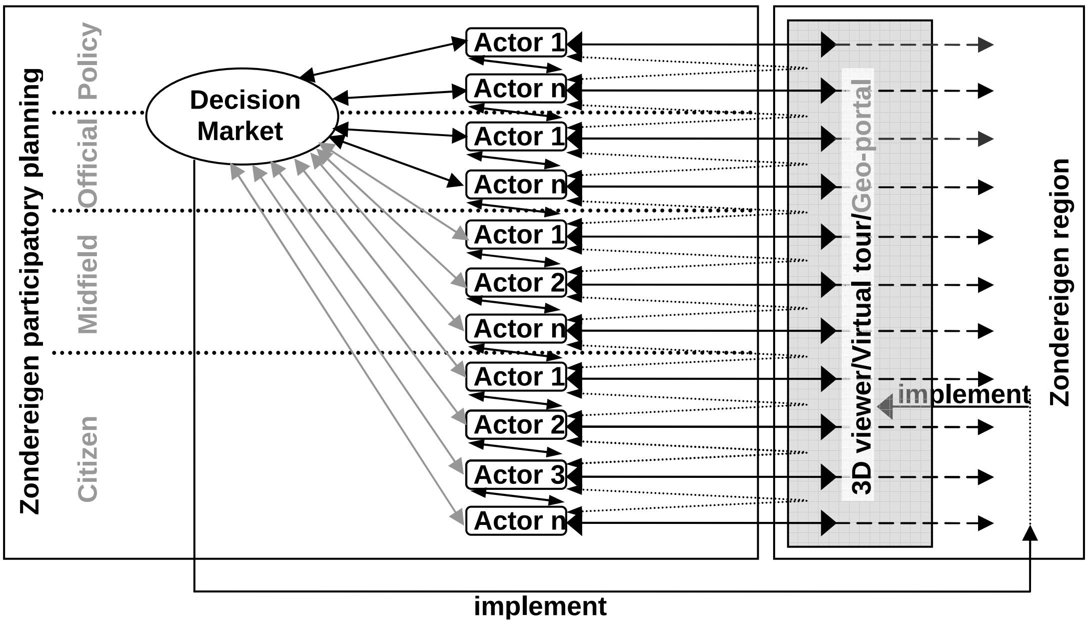

Figure 4.3: **GeoVR based participatory planning in the case study Zondereigen**

For fulfilling the role defined in *figure 4.3* efficient and effective practical requirements for the implementation of GeoVR are important. First step when it comes to Geo-Virtual Reality for the rural development project Zondereigen is the development of a 3D Viewer. The 3D Viewer has to make (the variants of) planning measures and the impact of it spatially visible. Therefore, the 3D Viewer should provide the actors with an overview of the Zondereigen region for both the current and future situation(s) in relation with the intended measures of the rural development plan. Practical requirements for the 3D Viewer can be formulated based on the theoretical guidelines for Geo-Virtual Reality in participatory planning (*chapter 3, table 3.3*), the described structure and objectives of the rural development project (*4.1.2*) and the above described role of GeoVR in the case study Zondereigen.

For providing the actors with an overview of the Zondereigen region the 3D viewer should at least offer a view equal to the model view from the multi-view approach of Verbree et al. (1999). According to *guideline IX*, the level of detail of the 3D visualisation which should be aimed for is semi-realistic as in the research of Hoogerwerf (2003). Aimed at because in case of inadequate data the greater the realism the weaker the link is with underlying data, scenarios (*guideline IX*) or even reality. If it is possible some kind of multi-resolution approach should be implemented, from both a virtualness and a performance point of view. Furthermore, when it comes to realism different generalization of 3D objects is allowed (guideline X). In the rural development project Zondereigen some aspects are more important than others. For example, buildings can be considered less important than trees. Therefore buildings can be visualized more abstract than trees. Trees are part of measures intended in the rural development plan, while the function of realistic buildings in the visualisation would be primary to support recognition and orientation. For orientation within this 3D Viewer, simultaneously with the world view, a 2D map (plan view, Verbree et al. (1999)) should be shown with a symbol showing the location and view direction of the user (*guideline VIII*).

This orientation support joins up with the interaction functionality orientation, which is one of the four interaction functionalities which are considered most important for a GeoVR tool applied during the evaluation-choice routine (*3.3*). The other three are navigation, interaction of the 3D scene and feedback. First the user should be able to move freely to explore the virtual environment displayed by the 3D Viewer. For making the navigation more realistic, it has to be restricted by collision detection for the surface as well as 3D objects. When viewing the virtual environment also interaction of the 3D scene should be allowed to some extent. The user should be able to choose the object types shown in the 3D scene, the visual representation of the objects, and whether the 3D viewer shows the rural development plan, the current situation or a future situation. For stimulating the (n:n) communication and interaction with and between the actors (which is intended to result in alternative proposals, recommendations, remarks, conditions, etc), the actor viewing the 3D scene should be offered the possibility to give feedback. It these interaction functionalities are implemented *guideline XI* is fulfilled.

These practical requirements for a 3D Viewer can be expanded for making a contribution to the virtual tour. The virtual tour concentrates on the area surrounding the village of Zondereigen and not on the whole region of the rural development project Zondereigen. Motive is that this increases the social involvement and interest. The virtual tour should emphasize the identity of the Zondereigen region. Various themes of the rural development project should come forward. These themes include archaeological inheritance, traffic safety and accessibility, nature, water, recreation and landscape. Especially for contributing to the elaboration of the themes traffic safety and accessibility and recreation the functionality of the 3D Viewer can be further expanded. In order to show the effect of planning measures like the development of a walking route or increasing the traffic safety and accessibility, the 3D viewer should provide the possibility to see the virtual environment by a world view. This is the third view from the multi-view approach of Verbree et al. (1999), which is important to implement (*guideline VII*). To show for example different tracks, it should be possible to restrict navigation to a predefined path.

Although not all planning measures intended by the rural development project can be visualized by Geo-Virtual Reality, a contribution can be made also to the elaboration of other themes. Therefore the interaction functionalities can be expanded (*guideline XII*) by offering additional information. This can be done by the interaction functionalities elaboration (additional information is shown within the virtual environment) or questioning (the user is able to see not visualized, stored information). Questioning is probably the best option. In this way the actor can get different types of additional information on the planning measures. For example for the theme archaeological inheritance the actor can ask for a simulation of the historical situation or photographs or a video of examples of equal archaeological inheritance existing elsewhere. This will help to increase the understanding and involvement of actors into the planning measures of the rural development plan. This interaction functionality can be further strengthened by a navigation functionality that guides the actors to the hotspots in the virtual environment. Therefore the possibility to navigate through the 3D Viewer by predefined viewpoints is also required.

The practical requirements as described in this paragraph are all related to the guidelines from the planning object. This corresponds with the conclusion in *chapter 2* that the focus for this thesis will be on Geo-Virtual Reality as a tool to primary represent the planning object. Furthermore, the outlines of the planning subject are already defined to a large extent (*4.1.2*, *Appendix B*). Only aspect which remains undecided in *paragraph 4.1.2* is the communication protocol. Although when it comes to the method of communication (*table B4)* some outlines are defined for meetings, the exact spatial-temporal character of these meetings is open to question. For the rural development project Zondereigen it will probably be a combination of protocols. At least one traditional meeting (Same Place Same Time), but also a Geo-Portal (Same Place, Different Time/Different Place, Different Time) will be part of the process. Though it is not stated that this Geo-Portal should include the 3D Viewer and the virtual tour, enabling Geo-Virtual Reality to be communicated using the internet as communication channel would make these tools even more powerful (*guideline III*).

4.2.2 GeoVR for the rural development project Zondereigen

For the implementation of the practical requirements for Geo-Virtual Reality in the rural development project Zondereigen ESRI's ArcGIS 9.0 is selected as software environment. Although other more specialized 3D visualization or Virtual Reality packages that probably offer more functionality are available, ArcGIS Desktop is chosen because it is a common software package for organisations involved in GIS. Furthermore, the full implementation process can be executed within one software environment. At the same time a contribution is made to the exploration of ArcGIS as a tool for visualization within participatory planning processes. In this paragraph the results of the implementation process of the practical requirements for Geo-Virtual Reality in the rural development project Zondereigen will be presented. The implementation process is described in *Appendix C*.

Main result of the implementation of the practical requirements is a visualization of the Zondereigen region in ArcScene which can be explored and interacted with. Although the aim was to create a semi-realistic visualization, due to the quality of the available geodata this proved not possible. The realism of the visualization is somewhere in between the abstract and the semi-realistic levels of realism as defined by Hoogerwerf (2003). For the exploration and the interaction functionality the default interface offered by ArcScene is chosen to function as the basic interface. Where necessary, and possible, additional functionality is added in order to enhance the GeoVR tool. A screenshot of the visualization in ArcScene is shown in *figure 4.4*:

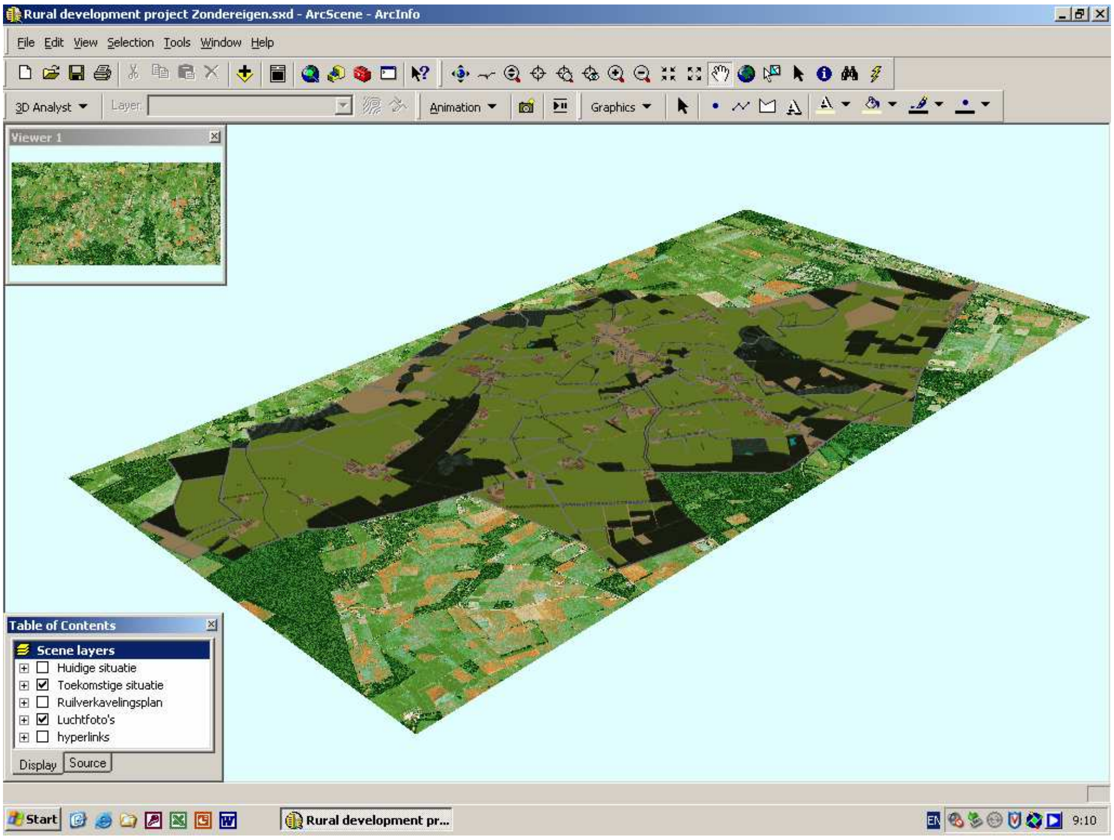

***Figure 4.4:* The visualization and interface provided by ArcScene with a plan view (top left) and a Table of Contents (left right)**

By using the Table of Contents (TOC) the user is able to switch between different visualizations. Visualizations of the rural development plan as well as the current and future situation of the Zondereigen region are available. Furthermore the user can choose whether the land use is visualized using an aerial photograph or a polygon layer. If close to the surface the aerial photograph can be too coarse. Moreover displaying the aerial photograph at a reasonable resolution decreases the performance of the visualization. Also from a performance point of view, the user is able to change the visualization of forest from 3D trees to extruded blocks, by switching the visualized layers. Different available visualizations are shown in figure 4.5.

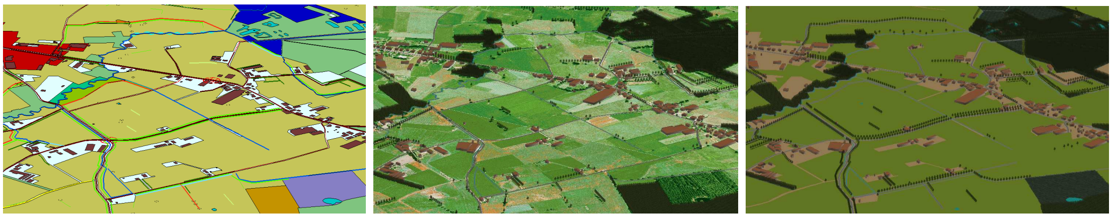

Figure 4.5: Different visualizations: the rural development plan (left), the current situation (aerial photograph; middle) and the future situation (polygon layer; right)

For exploring the visualization the user can use the default navigation functionality offered by ArcScene which is available on the Tools toolbar. The Navigate button allows users to rotate the data in 3D, zoom in and out, and pan the data. With the fly tool it is possible to fly through the scene in any direction and move forward or backward at different speeds. Due to the limitations of ArcScene, orientation support is restricted to a plan view which is not linked to the perspective view (model view/world view) and does not show a symbol with the location and view direction of the user.

To contribute to the virtual tour two other types of navigation are also available: navigation using predefined viewpoints (bookmarks) and navigation using a predefined path (animations). By running an animation the user follows a predefined path, in the Zondereigen case by a world view. By choosing a bookmark the user is guided to a hotspot in the Zondereigen region. These bookmarks are used to guide the user along the hyperlinks available in the visualization of the Zondereigen region. The hyperlink layer can be switched on and off using the TOC. The hyperlinks can be activated using the Hyperlink Command which is the lightning sign on the Tools toolbar (see *figure 4.4*). This tool is not available within ArcScene by default. Instructions on how to add this tool are offered in *Appendix D.* Using the hyperlinks and the Hyperlink tool the user can get additional information or the possibility to give feedback on the rural development plan. The targets of the hyperlinks have not been part of the implementation process.

There is one major problem with running animations. As soon as the scene comprises a lot of data performance problems caused by the rendering time originate. As a solution the animations are exported into video files. Although this solution goes beyond what is considered Virtual Reality, it can be of value for the Zondereigen case. To illustrate what is possible, these videos are worked out with Windows Moviemaker into one video file showing two animations at the same time together with a map showing the location and view direction. The same principle is applied to animations showing the same path for the current and future situation.

Figure 4.6: **Example video agricultural and bicycle traffic for the future situation**

This paragraph has briefly described the results of the implementation process of GeoVR for the rural development project Zondereigen. More information on both the results and realization of these results is available in *Appendix C.* The results are available on CD-ROM with the author.

4.3 Conclusion

The routines of the decision making framework of Mintzberg (1976) are recognizable within the intended spatial planning process of the rural development project Zondereigen. Participation during this planning process mainly occurs during the evaluation-choice routine of Mintzberg (*figure 4.1*). The objective of this participation is to increase the involvement of actors into the rural development project by lowering the threshold to participate. The outlines for the participatory part of the process are already determined. These outlines include the actors, the role of these actors, the flow of information, the level of participation and the method of communication. Most notable is the level of participation. According to the outlines of the participatory planning process the intended level of participation is co-produce. Considering the influence actors will have during the process, it is questionable if the participation level of co-produce will be reached. Based on information gained during meetings with the project team of the Flemish Land Agency (VLM) the conclusion is that in the actual participation process at the utmost the level of advise will be reached.

The tools for fulfilling the objective of participation in the rural development project Zondereigen are according the objective of PSPE in general: modern information and communication technologies and geo-visualizations. For supporting participation in the Zondereigen case the VLM wants to employ three visualization tools: a Geo-Portal, a 3D Viewer and a virtual tour. The role of these tools can be considered equal to the general role of GeoVR in participatory planning as defined in *chapter 2* and is shown in *figure 4.3.* This is where the theoretical guidelines for Geo-Virtual Reality described in *chapter 3* join up with the case study Zondereigen. The guidelines are combined with the objectives of the 3D Viewer and the virtual tour to describe the practical requirements for the development of these tools in *paragraph 4.2.1*. Focus of these practical requirements is on the representation of the planning object. This corresponds with the conclusion in *chapter 2* that the focus of this research is on Geo-Virtual Reality as a tool to represent the planning object. Furthermore, as indicated the outlines of the planning subject are already defined to a large extent.

The practical requirements served as input for the implementation process in ArcGIS 9.0, which is divided into three phases: geoprocessing, visualization and interaction functionality. Despite not all guidelines and requirements are implemented due to data quality restrictions and ArcGIS limitations, the results presented in *paragraph 4.2.2* can be valuable for application in the evaluation-choice routine of the rural development project Zondereigen. Although the results are not used for validation of the guidelines and requirements, the implementation phase (*Appendix C*) has been a valuable exploration of ArcGIS as a tool for visualization within participatory planning processes. Based on experiences gained during this exploration the functionality of ArcGIS 9.0 for 3D visualization can be criticized. The evaluation focuses on visualization and interaction functionality in ArcScene. The data preparation performed during the geoprocessing phase using the ArcToolbox and the Modelbuilder will not be taken into consideration.

Concerning 3D visualization the strength of ArcScene is that the 3D Analyst extension ArcScene is part of, fully aims at visualizing georeferenced data. This makes visualization of geodata an easy and quick task in ArcScene compared to specialized 3D visualization software packages. Despite this the realism of the visualization depends heavily on the resolution and detail, both geometrically and thematically, of the visualized geodata.

Adding elevation to the terrain is easy. Display of the elevation differences can be controlled by the raster resolution of the base surface the height are obtained of, setting a vertical exaggeration or using a Z unit conversion to place heights in the same units as the scene. For more realistic visualization it is possible to symbolize points, lines and polygons with 3D symbols using 3D objects and textures. Via the Symbol Selector default 3D objects and textures are available or can be imported. It is possible to import OpenFlight (.flt), 3D Studio (.3ds) or VRML (.wrl) models as 3D object and several image formats as textures. But when using 3D symbols there are drawbacks compared to more specialized 3D visualization software packages. Texture mapping is not as advanced as for example in 3D Studio Max and when using a large quantity of 3D objects ArcScene runs into performance problems. Rendering performance can be improved by controlling how each layer is rendered.

Also concerning interaction functionality ArcScene has some strengths and weaknesses. Created visualizations can be viewed in ArcScene using different viewers with different view settings (perspective, orthographic). Additional viewers can be added to the main viewer. This provides the user with different viewers which can be used intermittently and simultaneously. A user can navigate within the viewers using the default navigation tools available. Because any link between the viewers is lacking using viewers simultaneously is not very worthwhile. Only purpose of using viewers simultaneously can be orientation support. An additional viewer set to orthographic can function as a plan view to support the world or model view provided by the perspective main viewer. This can be worthwhile just because actually no functionality is available by default in ArcScene to create a plan view which is linked to the perspective view to support users when ascertaining the location and view direction in the geographical data. Another functionality missing when navigating in ArcScene is collision detection.

On the other hand, interaction of the 3D scene is one of the major strengths of ArcScene. Using the Table of Contents (TOC) within ArcScene the user is able to choose which scene layers are displayed and if necessary how these layers are displayed. This makes it very easy for a user to change the content and appearance of the visualization or to switch between different visualizations and compare these visualizations. Furthermore it is easy to create and view predefined viewpoints using the bookmarks in ArcScene. For another type of restricted navigation, predefined movement, ArcScene is not very competent. Most of the time standard animation procedures are not advanced enough to efficiently creating satisfying animations. Running animations can cause problems as well due to performance problems. A solution is exporting the animation to a video file (.avi or .mov). The Export to Video function in ArcScene works fine in contradiction to the 2D or 3D export functions for creating images or VRML files. When exporting 2D or 3D, 3D objects fail to export.

A shortcoming of ArcScene is the lack of a Hyperlink tool, which indeed is available in ArcMap and ArcGlobe. By installing the Hyperlink Command (see *Appendix D*) it is possible to implement an interaction functionality allowing users to give feedback or to view not visualized, stored information. Besides viewing not visualized, stored information (questioning) it is also possible to supplement the virtual environment itself with additional information (elaboration). With for example the 3D Graphics toolbar the virtual environment can be supplemented with 3D text or 3D object, for example city or street signs.

Unfortunately is it not possible to share ArcScene visualizations using the internet as a communication channel. Exporting a scene to VRML could make the distribution of the visualization much more powerful, but as long as the result is as bad as in the 3D export of ArcGIS 9.0 exporting to VRML is no option. Also freely distributable software like ArcReader and ArcExplorer offering the possibility to view and interact with 3D scenes is not available (yet). Other possibilities which could enhance the visualization in ArcScene for participatory planning purposes include for example the MapAnimator 3D extension and stereo viewing option. Although the MapAnimator 3D extension is not freely available it can possibly improve the creation of animations within ArcScene. From a Virtual Reality point of view the possibility to change the Viewing characteristics in the View Setting to Stereo View is interesting. Providing users with devices for stereoscopic viewing could make the visualization more immersive and therefore realistic.

Besides the evaluation of ArcScene as a tool for participatory planning another major conclusion from the implementation phase is that 3D visualization of the Zondereigen region in ArcScene has justified that data is essential for visualization. When discussing the theory about realism of visualizations in *paragraph 3.2.2* it was noticed that nowadays most data is 2D, while for 3D visualization 3D data is preferably. Many datasets are either not sufficient in resolution or do not cover the needed information for 3D visualization and therefore generally the greater the realism, the weaker the link is to underlying data or scenarios. These are exactly the problems faced during the visualization of the Zondereigen region.

5. Conclusion, discussion and recommendations

In this concluding chapter first the results from the previous chapters will be related with the research objective and questions and some main conclusions will be drawn (*5.1*). In *paragraph 5.2* some aspects of the research are discussed followed by *paragraph 5.3* with some recommendations for geodata en further research.

5.1 Conclusion

Theoretical guidelines for a GeoVR tool when applied during the evaluation-choice routine of a participatory planning process are developed for both the planning subject and planning object (*chapter 3*). Therefore the GeoVR based participatory planning process is considered as a process in which a planning subject, a planning object and a virtual planning object are both subsequently and parallel worlds. The setup of this role of GeoVR is shown in *figure*s *2.8* and *2.9.* The guidelines are translated into practical requirements for Geo-Virtual Reality by matching them to the objectives of the rural development project Zondereigen (*paragraph 4.1*).

Due to the focus on GeoVR as a representation of the planning object, for the implementation principally the guidelines for the planning object are used. The guidelines for the planning subject are compared to the intended realization of the participatory planning process as defined by the outlines (*Appendix B*). ArcGIS 9.0 has been used to implement the requirements for the Zondereigen case study (*paragraph 4.2, Appendix C*). This means that the research objective has been met and most of the research questions are answered. Only question which remains unanswered is whether the developed guidelines and requirements are valid. The validation phase is not executed due to a lack of time and the difficulties faced when implementing all of the practical requirements.

The development and application of the theoretical guidelines in practise can be summarized by *table 5.1* and *table 5.2.* The guideline number and keyword refer to the guidelines as defined in *table 3.3. Table 5.1* shows the guidelines for the planning subject and the main findings concerning the outlines of the intended participatory planning process in the rural development project Zondereigen.

Table 5.1: **Guidelines for the planning subject in relation with the outlines of the case study Zondereigen**

Guidelines planning subject		**Case study Zondereigen**
Nr.	*Keyword*	*Outlines (4.1.2)*
I.	Transactional communication	Dialogue and for midfield and citizen groups n:n, can be considered as transactional
II.	Communication protocol	Not clear, no meeting arrangements specified
III.	Communication channel	Not clear, but Geo-Portal as a tool, so internet as communication channel (also for GeoVR?)
IV.	Levels of participation	Although the intension is co-produce, the expectation is advice
V.	Number of actors	Number and type of (groups of) actors are specified, but require further determination in case of GeoVR. Depends heavily on other characteristics of the planning subject.
VI.	Cross section of actors	

The translation of guidelines for the planning object into practical requirements and the implementation of those requirements are summarized in *table 5.2*.

Table 5.2: **Guidelines for the planning object in relation with the requirements and implementation for the case study Zondereigen**

Guidelines planning object		**Case study Zondereigen**	
Nr.	*Keyword*	*Requirements (4.2.1)*	*Implementation (4.2.2)*
VII.	Multi-view approach	Model view	Default perspective view
		World view	No (no walk functionality in ArcScene)
		Plan view	Orthographic view
VIII.	Two-dimensional map	Two-dimensional map	Yes, but not linked
		User location and view-direction	Not possible in ArcScene
IX.	Semi-realistic	Semi-realistic visualization	Aimed at, but not fully semi-realistic mainly due to data quality restrictions
X.	Multi-resolution	Multi-resolution approach	Not possible in ArcScene
		Different generalization	Yes, e.g. trees more realistic then buildings
XI.	Required interaction functionality	Navigation	Default navigation (no collision detection)
		Restricted navigation	Bookmarks Animations (workaround)
		Orientation	See guidelines VIII
		Interaction of 3D scene	Through default TOC
		Feedback	Hyperlinks (targets not developed)
XII.	Additional interaction functionality	Questioning	Hyperlinks (targets not developed)

According to *table 5.2* there were two limiting factors for the implementation of the requirements: ArcGIS and data quality. Concerning ArcGIS, ArcScene proved to be a somewhat limited software environment for the implementation of Geo-Virtual Reality according to the guidelines and requirements for participatory planning purposes. Without workarounds it is impossible to implement all of the requirements. On the other hand also some major strengths of ArcScene have been found when used for participatory planning purposes, especially concerning the visualization of geodata. Therefore despite the limitations, ArcScene can be a useful software environment for certain participatory planning purposes when making use of these strengths. Also if necessary, it is possible to extend the functionality of ArcScene, but this can require additional skills or can be very time consuming.

Furthermore, difficulties faced during the implementation process were not only caused by the limitations of ArcScene. During the visualization phase of the implementation process, geodata was another limiting factor. Therefore a major conclusion is that when it comes to Geo-Virtual Reality in participatory planning, the quality of the available geodata is essential for the construction of a virtual planning object. The realism of the visualization depends heavily on the resolution and detail, both geometrically and thematically, of the visualized geodata. In case of more detailed geodata, it would have been easy to visualize the Zondereigen region more realistic. It is important to notice that this lack of detailed geodata is a general problem and not specifically for the rural development project Zondereigen.

Besides the development and implementation of the requirements, the case study has proved that the decision making framework of Mintzberg and the theoretical concepts developed in *chapter 2* are applicable in practise. In *paragraph 4.1.1* the planning process of the rural development project Zondereigen is translated into the decision making framework of Mintzberg. This has made clear that the focus of this thesis on the evaluation-choice routine matches the participation in the rural development project Zondereigen. The setup of the role of GeoVR in participatory planning and the concept of GeoVR based participatory planning as well as the planning approach based on planning subject and planning object are also applied to the case study in *paragraph 4.2.1.* This means that the subject-object oriented approach for GeoVR based participatory planning including the subsequently and parallel virtual and real worlds as brought forward in *chapter 2* is applicable to practise. Whether the approach also applies to other GeoVR based participatory planning processes remains questionable.

Furthermore, the Zondereigen case study has demonstrated that it is important to assess the practical requirements for Geo-Virtual Reality for each individual participatory planning process. Already during the discussion of the guidelines it became clear that the practical realization of the guidelines heavily depends on the characteristics and objectives of an individual case. The guidelines are derived from theory and are in some cases very general. For effective and efficient usage within an individual participatory planning process, they have to be matched to the characteristics and objectives of the case. Each participatory planning process has its own characteristics and objectives which results in case specific requirements. Therefore the practical requirements as described for the rural development project Zondereigen are not right away applicable to other participatory planning process.

5.2 Discussion

Having these conclusions the question is whether the problem regarded as motivation for this research has been solved to some extent. In the introduction the problem is described as follows: ‘with the growing use of Geo-Virtual Reality in participatory planning a problem arises: the unstructured use of Geo-Virtual Reality as a popular decision-making and public communication tool in planning.’ A solution to this problem was given by citing Orland et al. (2001): ‘especially for the use of tools with a higher sense of ‘being in’ the environment, like Virtual Reality-technology, it is necessary to develop clear policies and guidelines.’ Looking back to the results of the research it can be said that the problem is far from solved. A contribution has been made to the development of the guidelines. But this contribution focuses on a small part of what can be considered as participatory planning and Geo-Virtual Reality.

The role of Geo-Virtual Reality in participatory planning is demarcated in *chapter 2* as a tool to primary represent the planning object which can be both subsequently and parallel to the planning object (*figure 2.8* and 2.9). Nevertheless, the discussion about the role of Geo-Virtual Reality in participatory planning stays interesting. What part of reality is virtual and what part is not virtual? And if there is a virtual world, is this a parallel or a subsequently world? Probably, for the current situation the role of Geo-Virtual Reality in participatory planning is represented best by the setup chosen as a basic assumption for this thesis. However having in mind the trends in information and communication technology, it is likely that this will change in the future. These trends will probably also result in the application of more advanced types of Virtual Reality in participatory planning processes. This research focuses on Desktop VR. In view of the trends the question is whether the guidelines and requirements are also applicable to more advanced types of Virtual Reality. These remarks result in some new research challenges which will be addressed during the recommendations.

Also concerning the implementation process some issues can be discussed. First remark is one about the software choice. For the implementation ESRI's ArcGIS 9.0 is used as software environment. Maybe if other software was used during the implementation process, the primary results would have been better. Despite this, the exploration of ArcGIS as a Geo-Virtual Reality tool within participatory planning processes by using ArcScene has been fruitful. A lot of possibilities as well as impossibilities of ArcScene for the use in participatory planning are uncovered. Furthermore, with regard to the visualization created, is it important to realize that the actual visualization is 2,5D and not 3D. No distinction has been made between 2,5D and 3D in this research. The ultimate goal always was 3D visualization. But nowadays there is still a gap between the geodata available for 3D visualization and the geodata required for 3D visualization. This makes it very difficult, if not impossible, to create a truly 3D geo-visualization.

5.3 Recommendations

The recommendations can be split up in two groups: geodata recommendations and recommendations for further research. The geodata recommendations originate from the experiences gained during the visualization of the Zondereigen region. As already stressed in the conclusions, the quality of the available geodata is essential for 3D visualization. In the Zondereigen case study there was a lack of geometrical as well as thematical detail for 3D visualization in the datasets. From this geodata point of view, the rural development project Zondereigen is not a case on its own. In the near future it is important to try to close the gap, described in the discussion, between the available and required geodata for 3D visualization. Realistic 3D visualization requires more detailed geodata than 2D visualization. Because of the trend towards 3D visualization, it is important to change the attitude towards geodata more into a 3D direction.

For further research there are a couple of recommendations. The first one is the validation of the guidelines and requirements described in this thesis. The validation phase is not executed due to a lack of time and the difficulties faced when implementing all of the practical requirements. Validation, for example through a survey or questionnaire, is valuable for increasing the scientific significance of the guidelines and requirements. For further research it is also recommended to focus on the other routines of the decision making framework of Mintzberg as well. In this thesis focus is only on the evaluation-choice routine. For this thesis the assumption is made that each routine has different requirements for a GeoVR tool to be applied. It would be interesting to develop guidelines and requirements also for the other routines. This will make clear whether the guidelines are different, or more or less the same for each routine.

As already stated in the discussion, this research focuses on Desktop VR while in the future probably the application of more advanced types of Virtual Reality in participatory planning processes will grow. Therefore research on additional guidelines and requirements from more advanced Geo-Virtual Reality technologies will be worthwhile. Besides the guidelines and requirements for Geo-Virtual Reality in participatory planning, the approach of the role of Geo-Virtual Reality in participatory as brought forward in *chapter 2* is an interesting item for research. Although the role of Geo-Virtual Reality in participatory planning is limited to a combination of two of the setups from *figure 2.7 (figure 2.8* and *2.9)* for this thesis, the initiated discussion about this role remains an open book. Future research could focus on this subject-object oriented approach for GeoVR based participatory planning and sort out whether this approach is useful or applicable in practise. Especially concerning the subsequently and parallel virtual and real worlds.

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Appendices

Appendix A Planning process case study Zondereigen

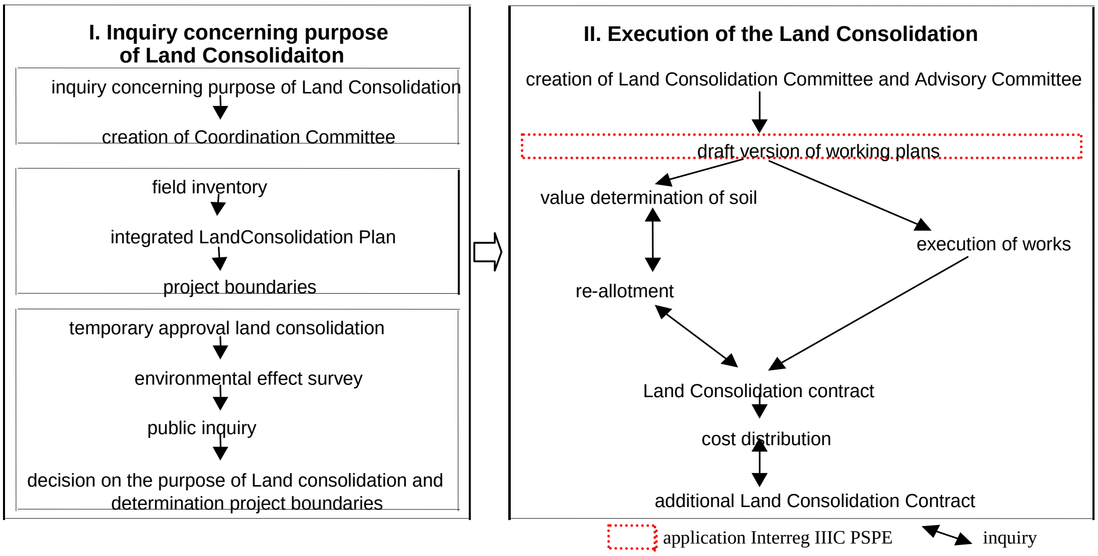

Figure B1: **Procedure for the land consolidation project (VLM, 2004a)**

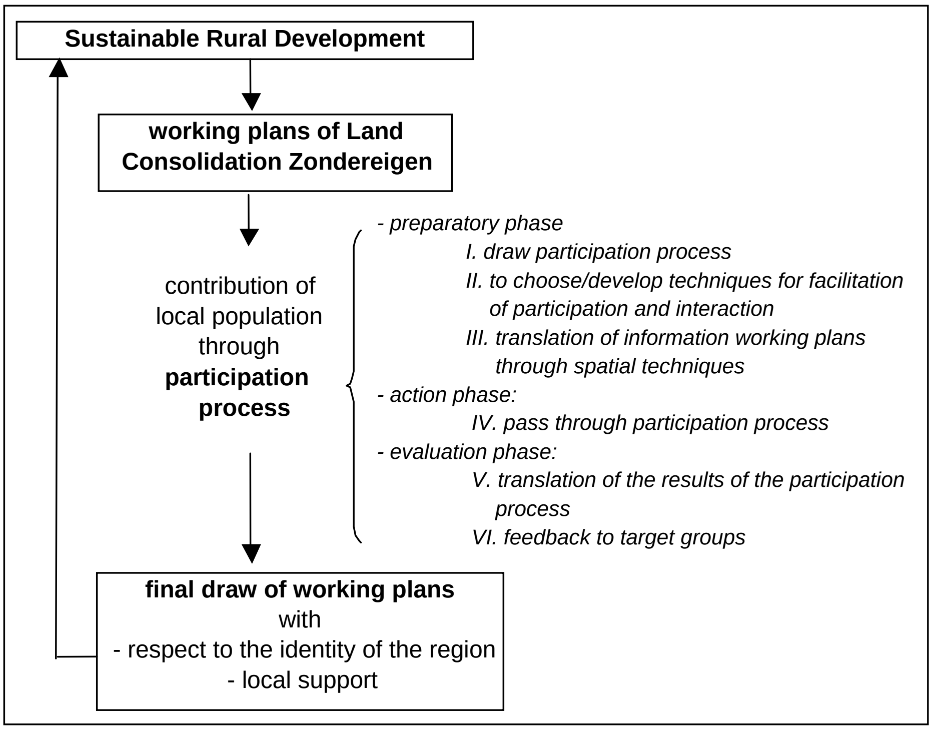

Figure B2: **Procedure for the land consolidation project (VLM, 2004a)**

Appendix B Outlines participation case study Zondereigen

Table B1: **Characteristics of the parties involved in the process (VLM, 2004a)**

Name party	Number of people	Importance of party**	Access to party**
policy	competent minister, selection regional and those responsible for local policy	3	2
official	selection competent persons from relevant administrations* (coordination in land consolidation committee)	2	1
midfield	grouping of representatives of relevant interest groups (coordination in land consolidation committee)	1	1
non-organized/individual citizen	Very large: - owners: ca.600 - users: ca. 300 - neighbours: ca. 2500	2	3

* Relevant administrations: agriculture, nature, forests, hydrology, cultural-history and environment, recreation, ** Number 1 indicates the party is considered crucial to the process or easy to involve. Number 5 indicates the party is not considered important to the process or difficult to involve in the process.

Table B2: **Levels of participation of parties (VLM, 2004a)**

0	*no involvement*	*The party is not involved (lowest level),*
1	*inform*	*The party is inform in a one way communication,*
2	*consult*	*The party is asked questions, but is not allowed to decide,*
3	*advise*	*The party is asked questions advice to a party, but is not allowed to decide,*
4	*(co) produce*	*The party is asked to assist in making deliverables, but is not allowed to decide,*
5	*(co) decide*	*The party is asked to (co) decide on deliverables (highest level).*

Name step/phase/routine	policy	official	midfield	non-organized/ individual civilian
1. draw participation process	1	2	2	0
2. selective choice/development techniques for the facilitation participation and interaction	1	2	2	0
3. translation information planning works through spatial techniques	1	1	1	0
4. pass through participation	4	4	4	4

process				
5. translation of the participation process results	5	5	3	0
6. feedback to target groups	1	1	1	1

Table B3: **Role of parties in the process (VLM, 2004a)**

Name step/phase/routine	policy	official	midfield	non-organized/ individual civilian
1. draw participation process	Follow-up	Competent for the execution of spatial claims per sector; contribution professional know-how	Contribution regional expertise; Get a basis for local support	
2. selective choice/development techniques for the facilitation participation and interaction	Follow-up	contribution professional know-how	Contribution regional expertise	
3. translation information planning works through spatial techniques	Follow-up	Follow-up	Follow-up	
4. pass through participation process	Determines spatial claims through policy; competent to decide	Competent for the execution of spatial claims per sector; contribution professional know-how	Contribution regional expertise; Get a basis for local support	Contribution regional expertise; individual interest; basis local support
5. translation of the participation process results	Determines spatial claims through policy; competent to decide	Competent for the execution of spatial claims per sector	Contribution regional know-how; Get a basis for local support	
6. feedback to target groups	Follow-up	Follow-up	Get a basis for local support; Follow-up manage-ment	individual interest; basis local support

Table B4: **Method of communication (VLM, 2004a)**

Name party	Communication modus	Type of communication	Meetings
policy	1-1	dialogue	per phase 1 meeting
official	1-10	Dialogue in the land consolidation committee	per phase minimal 1 meeting
midfield	10 – 30	Dialogue in the advisory committee	per phase minimal 1 meeting
non-organized/ individual civilian	30-100	Dialogue during the participation process	Dependent on process architecture

Appendix C Implementation of GeoVR for case study Zondereigen

In this appendix the implementation process of the practical requirements for Geo-Virtual Reality in the rural development project Zondereigen will be described. For the implementation ESRI's ArcGIS 9.0 is selected as software environment. Although other more specialized 3D visualization or Virtual Reality packages that probably offer more functionality are available, ArcGIS Desktop is chosen because it is a common software package for organisations involved in GIS. Furthermore, the full implementation process can be executed within one software environment. At the same time a contribution can be made to the exploration of ArcGIS as a tool for visualization within participatory planning processes. The implementation process is divided into three phases: geoprocessing, visualization and interaction functionality.

Geoprocessing

The geoprocessing phase is mainly performed by making use of the ArcToolbox and the ModelBuilder. The ArcToolbox is dockable in any ArcGIS Desktop application. It provides access to tools that are stored on disk. These can be system tools (tools installed by default) or custom tools, such as models or scripts. A model can be build to run a number of tools at one time. The ModelBuilder is used to create models in ArcGIS (ESRI, 2004a). An overview of the core elements of the ModelBuilder is shown in *figure C1*.

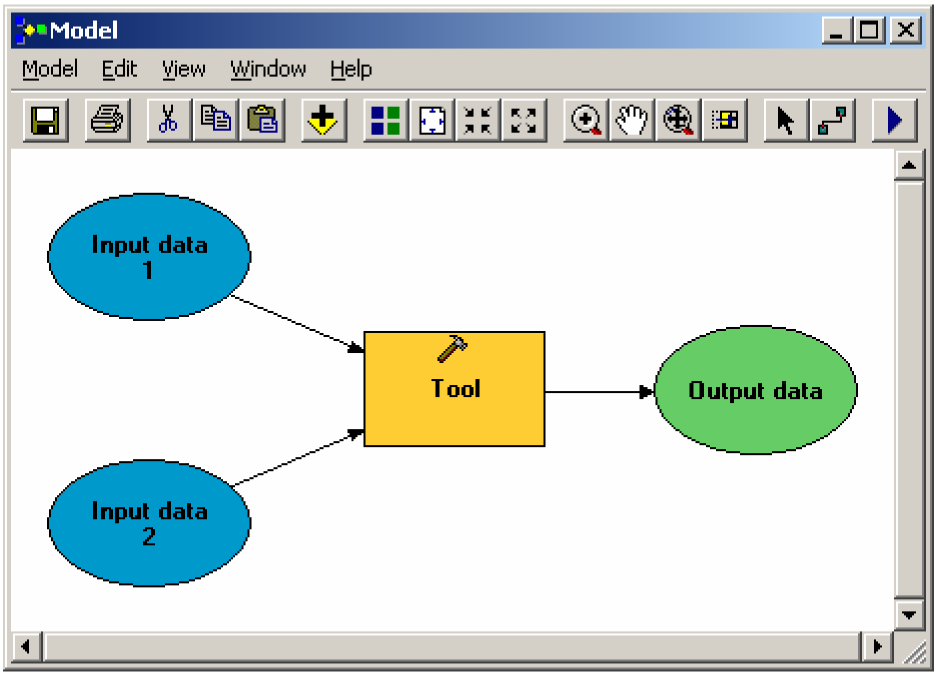

Figure C1: **The ModelBuilder of ArcGIS**

A model consists of one or more processes. In *figure C1* the setup of a process is shown. One ore more datasets are used as input for a geoprocessing tool. This can be a script or other model too. Execution of the process results in the output data. This output data can be used as input for a subsequent process. In that case the output data can be considered as temporary data most of the time. For the visualization of the rural development plan Zondereigen the tools from the ArcToolbox are used as input for the ModelBuilder to create four models which process the input data into output data, ready for visualization. Three models are used for processing the data of the rural development plan and a fourth model is used for processing the elevation data and aerial photographs. Because of the complexity and size of the geoprocessing models only the main structure of the four models will be discussed through generalized processes and examples.

For the geoprocessing of the rural development plan data, six shapefiles function as primary input data. These datasets include land use (polygons), buildings (polygons), roads and waterways (lines) and various landscape elements divided over three shapefiles (lines, lines and points). This data is prepared by the first and second geoprocessing model. A generalization of one of the major processes which can be found in both models is shown in *figure C2*.

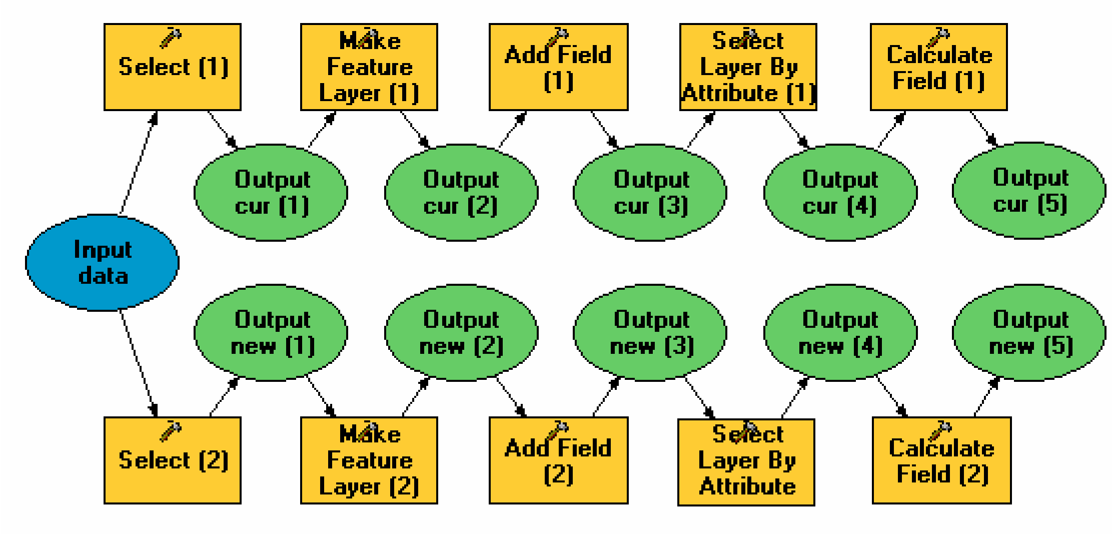

***Figure C2:* Generalization of the reconstruction process of the current and future situation and adding textual information for visualization**

The objective of these processes is twofold. The data of the rural development plan defines the intended planning measures and not for example current and future situations. Visualization of the current and future situation requires scenarios describing these situations. Therefore by selecting the appropriate features from the input data both the current and future situation is reconstructed. This can be illustrated by an example. Planning measures intended as described by the rural development plan data include roads to be maintained, roads to be improved, roads to be abolished and roads to be constructed. In the current situation only the roads intended to be maintained, to be abolished or to be improved exist and are therefore selected to create a dataset including all roads present in the current situation. In the selection for the future situation the roads intended to be abolished are replaced by the roads to be constructed, which results in a dataset describing the future situation for the roads. This example applies to the other datasets as well. For the land use data this procedure is performed three times (land use, natural areas, forest). For the buildings dataset the procedure is redundant, because the rural development plan does not affect buildings.

Next general step is to supply the output data of the Select tool with textual information which can be used for visualization. To be able to apply the Select Layer By Attribute tool for making selections without exporting it into a new dataset first the Make Feature Layer tool has to be applied. Inserting the textual information requires an extra text field in the attribute table, which is created by the Add Field tool. The textual information is inserted by selecting the appropriate features with the Select

Layer By Attribute tool followed by the Calculate Field tool which defines the added information used for visualization. Depending on the required number of visualization categories these last two steps are repeated a number of times. For the roads and waterways this procedure is intertwined with adding and calculating another field defining a buffer distance used in the second geoprocessing model to buffer the lines representing roads and waterways. This buffering is done because the resulting polygon features represent also the width the roads and waterways will be visualized with in the virtual environment. This is useful for other operations. Furthermore the roads and waterways are separated using the Select tool to make sure they do not interfere at intersections.

Data conversion is another major process executed during the preparation of the rural development plan data. To create data suitable for visualization different conversions are applied. The linear green elements are converted from lines to point by interval. There is no tool available within ArcGIS which offers this possibility. Therefore the Convert Paths to Points (lines to points) tool from Hawth's Analysis Tools is used. How to install this toolbar is described in *Appendix D*. Disadvantage is that it is difficult, if not impossible, to incorporate this tool in the ModelBuilder. As a result the preparation of the rural development plan data is split into two geoprocessing models. The conversion of the linear green elements is done manually after running the first geoprocessing model and before running the second geoprocessing model. The linear green elements are converted with an interval of 10 and 3 meters for respectively all lines defining the linear green elements and lines defining the linear green elements with undergrowth. Goal of this conversion is to make it possible to visualize linear green elements using 3D Marker Symbols at certain predefined distances.

With the same motivation the polygons defining natural areas are converted into points using the Feature to Raster and the Raster to Point tools. Creating a temporary raster with cell size 5 results in point features at a mutual distance of 5 meter. 3D trees or plants can be assigned to these points to create a visualization of natural areas. Visualizing all natural areas within the Zondereigen region by 3D Marker Symbols can cause performance problems when navigating in the 3D scene. Having this in mind, it is possible to visualize forest by turning the polygons defining forest areas into blocks by extruding the polygons. Forest texture can be added to this block, but the result is far from realistic. The texture is shown on top of the block, while the texture is stretched on the sides of the block. To be able to fix this problem the polygons are converted into lines using the Feature to Line tool. With this data it is possible to create lines with a vertical orientation and a width equal to the height of the polygons defined by setting an offset. Adding texture to both lines and polygons results in a more realistic 'block' representation of forest, useful in case performance problems occur due to too much 3D trees. The three different options for visualizing forest are shown in *figure C3*.

Figure C3: **Different options for visualizing forest and buildings**

Figure C3 shows that if the third method described for visualizing forest (line with vertical orientation and polygon with offset) is applied too for visualization of buildings (*middle and right*), the result is more realistic compared to the extrusion of the footprints *left*). Therefore for the buildings too, the polygons are converted to lines using the Feature to Line tool. Besides this, there is another advantage when applying this method. Blocks created by extruding polygons can be problematic when elevation is assigned. The blocks are kept completely level and as a result their height regarding the surface is variable and in case of elevation difference, blocks can disappear partly under the surface. When the polygons are assigned a certain offset and the sides are created by vertical orientated lines this problem is solved. This is illustrated in *figure C4*. Disadvantage of this method for the visualization of buildings is that roofs of buildings are bent according to the surface. For the Zondereigen this will not be a problem, because it is a quite flat area. In *figure C4* the elevation is exaggerated.

***Figure C4:* Difference between normal extrusion and line poly method**

Furthermore if necessary, datasets including point features representing trees (forest or linear green elements) are erased with the buildings, roads and waterways. An example of the effect of these processes is shown in *figure C5*. In this example the rural development plan data is not accurate enough. The visual effect caused by this inaccuracy is much greater in case of 3D visualization then when showing the rural development plan two dimensional. As a solution the trees interfering with the building are erased. The Erase tool is also applied for waterways, with the roads as erase features. This reduces the chance of waterways interfering with roads at intersections. Other operations performed during the preparation of the rural development plan data are of minor importance or will be discussed further on in the next paragraphs.

***Figure C5:* Example of effect of erasing point features representing trees: rural development plan (left), visualization with all point features (middle) and visualization without erased point features (right)**

The output data of the first two geoprocessing model steps is used as input for the third model together with datasets describing the planning measures from the rural development plan and one including the hyperlinks for the area. This third geoprocessing model clips all the data with the area of interest, the final step of the geoprocessing of the rural development plan data. The structure of this process is shown in *figure C6.*

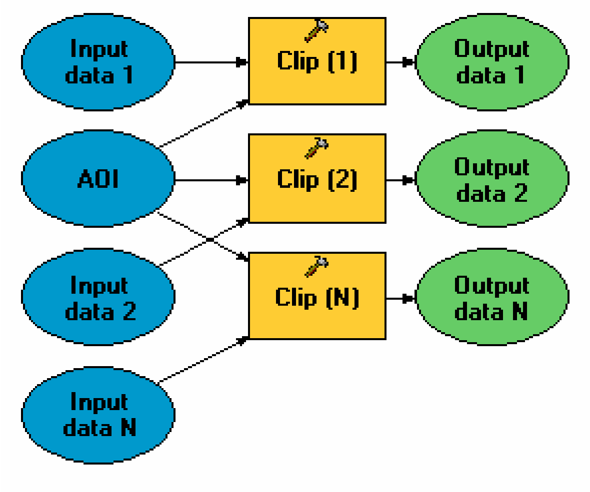

Figure C6: **Generalization of clipping the output data of the first two geoprocessing models with an area of interest**

In the fourth model the elevation data is clipped with the Clip tool for rasters by a rectangle described by coordinates which surrounds the Zondereigen region. Four aerial photographs falling within this region are appended using the default Mosaic To New Raster model and clipped like the elevation data. The structure of these processes is shown in *figure C7.* For the elevation data only the clipping part of the process is applicable. This means the input elevation data is the temporary raster.

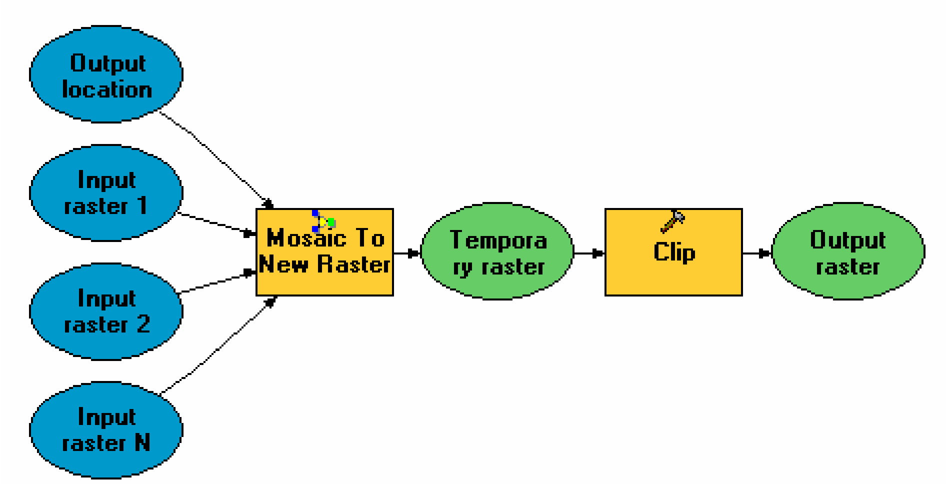

Figure C7: **Generalization of processing the elevation data and aerial photographs**

Final output data of the four geoprocessing models includes the rural development plan data (polygons, lines, lines and point), hyperlinks (points), elevation data (raster), an aerial photograph (raster), buildings (lines and polygons) and for both the current and future situation land use (polygons), roads (polygons), waterways (polygons), natural areas (point), forest (lines and polygons), linear green elements (points), undergrowth green elements (points) and landscape elements (points). These 27 datasets are used as input for the second step of the implementation process, the visualization phase.

Visualization

For the visualization of the geodata resulting from the geoprocessing phase 3D Analyst is used. 3D Analyst is the three-dimensional visualization and analysis extension of ArcGIS. The core of the 3D Analyst extension exists of the ArcScene and ArcGlobe applications. With ArcScene it is possible to make perspective view scenes in which can be navigated and interacted with geodata. ArcGlobe provides real-time pan and zoom of very large (hundreds of gigabytes) 3D raster, terrain, and vector datasets. (ESRI, 2004b). The ArcScene application is chosen as interface for the visualization of the rural development plan Zondereigen.

The visualization is created within an ArcScene document (.sxd). Geodata is added to this document as scene layers. The data sources of the geodata are stored as relative path names using the Data Source Options of the Document Properties to create a more flexible ArcScene document which can be copied to another location for easily creating a scene of another AOI. The data describing the current situation, the future situation and the rural development plan are grouped using group layers. This makes it easy to switch between different visualizations of the Zondereigen region. *Figure C8* displays the main layers of the resulting TOC (Table of Contents).

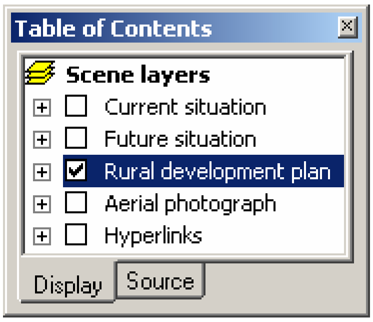

Figure C8: **Main layers of TOC**

First height is obtained for all the data layers using the elevation dataset as surface. No vertical exaggeration is applied to keep elevation differences a realistic as possible. Next step is the visualization of the data layers. For the aerial photograph only adjustment concerning the visualization is changing the quality enhancement for rendering. If the quality enhancement is set to low, this increases the performance but results in a low resolution raster image. High quality enhancement results in a high resolution image, but probably causes performance problems due to using most of the memory resources of the system. An overview of the results of different settings is shown in *figure C9*. For the Zondereigen visualization quality enhancement is set to low, to optimize performance when displaying the aerial photograph. If necessary this setting can be adjusted taking the preferred resolution and available memory capacity into account.

Figure C9: **Different settings for quality enhancement of the aerial photograph: low (left), middle (middle) and high (right)**

For the visualization of the other data layers, which are all vector data, assigning symbology for each unique value of the visualization category is required. The symbology for the rural development plan data is assigned using the original ArcView 3 legend files of the rural development plan (.avl). Some categories required some adjustment of their symbol for proper visualization in ArcScene. The data layers grouped in to the current and future situation group layers is symbolized using the textual visualization field the data is supplied with during the geoprocessing phase.

The polygons defining the land use, roads and waterways are visualized by 3D Texture Fill Symbols. Though it is possible to import textures, only default textures from the 3D Basic category are used. For all textures the outline width is set to 0 and in some cases the texture is adjusted using a different Fill Color for the texture. Examples of textures that are used are shown in *figure C10*.

Figure C10: **Examples of 3D Texture Fill Symbols**

The method for visualizing forest and buildings is addressed already in the previous paragraph. Instead of adding a third dimension by extruding the footprints, another method is applied to turn the polygons defining forest areas and buildings into 'blocks'. Additional line data is used to construct the sides by setting a certain width for the lines and orienting them vertically. The block is 'closed' by adding an offset to the polygons with a constant equal to the width of the lines. The lines and polygons are textured using respectively 3D Texture Line Symbols and 3D Texture Fill Symbols. 3D Texture Line Symbols are comparable to 3D Texture Fill Symbols and it is the only symbol type for lines that can be vertical oriented. Visualization of both forest and buildings using this method is shown by the middle picture of *figure C3*.

To add more realism it is possible to replace the forest layers by a more realistic visualization of the nature areas. This alternative is shown by the right picture of *figure C3*. In this visualization the point features representing forest and nature development are symbolized using default 3D Marker Symbols. Examples of default 3D Marker Symbols available in ArcScene are shown in *figure C11*. Similar to textures it is possible to import 3D objects. Due to a high number of points, and consequently 3D Marker Symbols, turning the point layer representing natural areas on will use a lot of memory when visualizing the full rural development area. This affects the performance of the scene negatively.

Figure C11: **Examples of 3D Marker Symbols**

3D Marker Symbols are also used for visualizing the other point features present in the current or future situation. These include single trees and linear green elements and the undergrowth of these linear green elements. Hyperlinks are visualized using a Character Marker Symbol, namely the Identify sign.

When height and symbology are assigned, next step is setting the priorities for displaying the data layers. In ArcMap the priority of the layers is determined by the order of the layers in the TOC. In ArcScene all data added to the scene has the same priority by default. In case of layers at the same height, this results in interfering layers as shown by the left image of *figure C12.* The land use layers as well as the roads and waterways layers all have the same default priority. The 3D Effects toolbar or the Rendering tab of the layers Properties make it possible to set displaying priorities of the layers. When the priority of the land use layer is lowered the interference vanishes. In the right image of *figure C12* the same situation is shown with different displaying priorities set for the displayed layers.

Figure C12: Layers with same priority (left) and layers with different priority (right)

Setting priorities is also important to reduce interference as a result of mismatch between data layers in case of elevation difference. This mismatch originates from the way height is assigned to the different data layers. Due to this mismatch an underlying layer may pop through the top layer, also when displayed with different priorities. This is shown in the left image of *figure C13* where an underlying raster layer (aerial photograph) pops through the top polygon layer (land use). In this example putting the priorities more apart solves the problem as shown by the right image of *figure C13.*

Figure C13: Mismatch between layers (left) and mismatch solved (right)

In case of greater elevation difference or vertical exaggeration the interference due to the mismatch of layers increases. Finally setting priorities is not enough to solve this problem. The mismatch can be further reduced by increasing the raster resolution of the surface the heights are obtained of. However the improvement is minimal. Other options are extrusion of the top layer or adding an offset to the top layer by using a constant. Although this may solve the problem, it can result in unwanted effects like for example floating roads. As the Zondereigen region is a relative flat area and no vertical exaggeration is applied in the visualization, setting priorities is sufficient to solve the problem.

Another problem related to elevation difference is the occurrence of gaps between polygons when heights for a polygon layer are obtained from a surface. This problem is visualized in *figure C14.* When no elevation is specified for the land use layer, the polygons join up perfectly (left image). As soon as height is obtained from a surface gaps occur at the borders of the different polygons (right image). The greater the elevation difference is, the bigger the gaps are. A solution for this problem is converting the DEM from raster to TIN, but in that case the elevation is too coarse. Due to the relative flatness of the Zondereigen region and the absence of vertical exaggeration the problem occurs to a limited extent. In *figure C14*, elevation is exaggerated for the purpose of illustrating the problem.

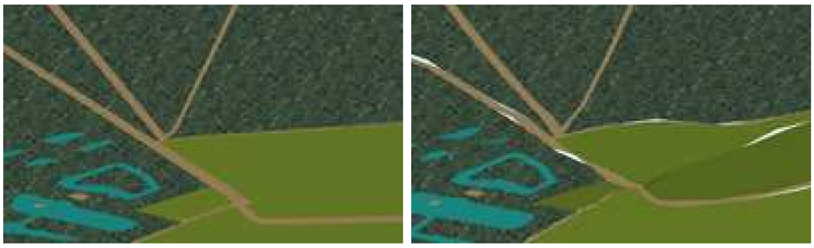

Figure C14: **Problem when assigning elevation to polygons: land use without height (left) and land use with height (right)**

Besides this problem it proved not possible to implement a multi-resolution approach for the visualization in ArcScene. Although it is possible to specify a range of scales at which a layer will be shown, scale dependent drawing is not supported in ArcScene. It is possible to make these setting in ArcScene so that they are available if the layer is used in ArcMap. Also concerning different views of the visualization and further functionality of these views to support orientation, ArcScene is limited. This issue will be addressed in the next paragraph.

Interaction functionality

For interaction with the visualization created during the visualization phase an interface is required. It is possible to export the 3D scene into a VRML file (.wrl). VRML (Virtual Reality Modeling Language) is a standard file format for representing 3D interactive vector graphics, designed particularly with the World Wide Web in mind. This makes it possible to use a web browser in combination with a VRML plugin as an interface. But although it is possible to export the 3D scene into a VRML file (.wrl), the resulting VRML file is not satisfying due to bugs in ArcGIS 9.0. 3D objects as well as textures fail to export. Even when for example exporting the scene two-dimensional to JPEG format, 3D objects do not show up in the exported image. Furthermore no freely distributable software is available yet, allowing users to view and interact with 3D scenes. The current versions of ESRI's freely distributable products ArcReader and ArcExplorer support only 2D maps and data. Therefore the default interface offered by ArcScene is chosen to function as the basic interface which is adjusted where necessary and possible.

In ArcScene default navigation functionality is available on the Tools toolbar. The Navigate button allows users to rotate the data in 3D, zoom in and out, and pan the data. With the fly tool it is possible to fly through the scene in any direction and move forward or backward at different speeds. These tools are the most important tools for navigating through the virtual environment. In ArcGlobe there is besides a Fly tool also a Walk tool available on the Tools toolbar. This tool can be used to explore the data from the ground. Although it would be useful for providing the user with a world view of the scene, it is not possible to have this option available in ArcScene. In ArcScene the 'work area' is just empty space, there is no ground or surface which can be altered like in ArcGlobe. In ArcScene it is possible to display multiple surfaces at the same location with differing elevations.

Another tool available in ArcGlobe (and ArcMap), but absent in ArcScene is the Hyperlink tool. This tool can be very useful for giving the actor(s) viewing the 3D scene the possibility to give feedback or to get additional information. Therefore the default ArcScene interaction functionality is expanded with the ArcScene Hyperlink Command (see *Appendix D* for information on how to add this tool). Difference with the Hyperlink tool in ArcMap and ArcGlobe is that the ArcScene Hyperlink command is limited to field-based hyperlinks. This means that the target that will be launched needs to be specified for each feature in a field in the attribute table of the layer. It is not possible to specify hyperlinks directly without having to use a field to supply the targets (dynamic hyperlinks). With the Hyperlink tool it is possible to access documents or web pages related to features, which can contain additional information or the possibility to give comments. The development of these documents or web pages has not been part of the implementation and therefore these interaction functionalities are only partly implemented.

As already stated in the previous paragraph ArcScene is limited when it comes to different views and further functionality of these views to support orientation. Without programming it is not possible to support the main view of the visualization with a plan view showing both the location and view direction of the user. Only possibility is to add a viewer to the main viewer and set the Viewing characteristics of this additional viewer to Orthographic (2D view) in the View Settings. The added window showing the plan view can be dragged and resized according to the preferences for showing two views simultaneously. It is also possible to hide the viewer. *Figure C15* shows how the viewer is added to the Zondereigen visualization. Comparing both images makes clear that any link between both views is lacking with this way of implementing a plan view to support orientation. As indicated there is no symbol showing both the location and view direction of the user and at the same time both viewers are not linked when navigating in a viewer. The left image shows the scene with the full extent. The main viewer as well as the additional viewer shows the whole Zondereigen region. When the view of the main viewer is changed by navigating as shown in the right image, nothing happens to the additional viewer. Therefore this method of implementing a plan view to support orientation in ArcScene is restrictive, but more advanced orientation support is not available by default within ArcScene.

***Figure C15:* Perspective view supported by an orthographic view**

On the contrary concerning the interaction functionality interaction of the 3D scene, the ArcScene interface is very effective. Using the TOC the user is able to choose which scene layers are displayed and if necessary how the layers are displayed. With the TOC as created for the Zondereigen visualization (*figure C8, figure C15*) it is easy for the user to switch between the rural development plan, the current situation or a future situation or to display the aerial photograph or hyperlink layer. If necessary it is possible at a lower level of the TOC to for example replace the abstract visualization of forest with a layer showing 3D trees instead, turn off objects which are not of interest or even change the visualization of certain objects.

For the virtual tour the possibility to navigate through the 3D Viewer by predefined viewpoints is also required to guide actors to hotspots in the virtual environment. This can be implemented in ArcScene through bookmarks. A bookmark can be created in ArcScene by navigating the scene to the location and perspective a bookmark needs to be created of followed by the Create command (View, Bookmarks) and entering a name for the bookmark. For the Zondereigen region bookmarks are created for all villages in the region and the location of the hyperlinks. These bookmarks can be viewed by clicking the name of the bookmark under the Bookmarks option in the View menu.

Besides predefined viewpoints, restricting navigation to a predefined path can be very useful for the traffic and recreation themes of the virtual tour, for instance to show different tracks. Predefined navigation can be realized in ArcScene by creating animations. With the tools offered by the Animation toolbar it is possible to record navigation, capture perspective views, save and export tracks, create video files, make group animations, create tracks from paths, and manage and preview animations. For the Zondereigen case animation is applied to the traffic safety and accessibility theme. The objective of this application is to show the different tracks for bicycle traffic and agricultural traffic from a certain point to another. For this purpose creating tracks from paths proved to be useful.

For creating the animations two additional shapefiles were used: one defining the track for bicycle traffic and one defining the track for agricultural traffic. By selecting the line feature defining the track followed by executing the option Camera Flyby from path of the Animation toolbar it is easy to create an animation of the camera along the track. Despite trying all different options available when creating a camera flyby from a path, the result was not satisfactory. Also in case of an extremely low simplification factor, the process resulted in a bouncy flyby. This is probably caused by a bug in ArcScene whereby the observer and the target can not turn simultaneously. Exclusively when the path is just a straight line, the observer as well as the target follow the path as intended. With this in mind, a more time consuming method was applied for the creation of satisfying animations because animations in ArcScene are really powerful especially when the different layers are switched on and off during the animations.

Principle of the applied method is the creation of an animation track for each segment of the path. With the animation manager the timing of these tracks is arranged to create an animation of the path which strictly follows the track defined for bicycle or agricultural traffic. First step of this method is splitting the line feature that defines the track into multiple line features using the Split Line At Vertices tool from the ArcToolbox. Then for every line features, in the right order from start to end of the track, an animation track has to be created without overwriting the previous animation track. This is done by selecting the line feature in the layer’s attribute table and then importing a camera flyby for this path using the Animation toolbar, with a vertical offset of 5, the lowest possible simplification factor and the Overwrite last imported track box unchecked. When this procedure is finished for each line feature, the timing of the imported tracks needs to be arranged for creating the animation.

For arranging the timing of the imported tracks it is necessary to divide the timeline of the animation, which start at 0 and ends at 1, according to the length of the line features. Therefore the length of the line features needs to be calculated. This is done by adding a field Length with field type DOUBLE to the shapefile’s attribute table using the Add Field tool from the ArcToolbox. The values of this field have to be calculated using the Advanced option of the Field Calculator together with following VBA statement and the variable dblLength as Length:

```
Dim dblLength as double
Dim pCurve as ICurve
Set pCurve = [shape]
dblLength = pCurve.Length
```

The values of the added field can be exported into a .dbf file, which can be imported into Microsoft Excel. The imported values are used to calculate the total length of the path. With this total length the length of each line feature relative to the total path length is calculated based on a scale from 0 to 1. With these results the Begin Time and End Time of each track can be calculated in Excel. When these values are entered correctly with three decimals for each track under the Tracks tab of the Animation Manager, the animation is finished.

The animation can be run by opening the Animation Controls from the Animation toolbar. When the Options are expanded, it is possible to adjust the duration of the animation. For both the bicycle and agricultural variant this is set to twice the length of the path divided by hundred (92.7 seconds for the bicycle traffic animation and 102.0 seconds for the agricultural traffic animation). By pressing the Play button of the Animation Controls the animation starts running. The animation is saved as a ArcScene Animation file (.asa) using the Save Animation File option of the Animation Toolbar. Same procedure applies to loading an ArcScene Animation file, but then the Load Animation File option has to be used.

There is one major problem with running animations. As soon as the scene comprises a lot of data (especially 3D marker symbols) performance problems caused by the rendering time originate. This makes it impossible to show nice animations of the scene. This can be solved by exporting the animation to a videofile (.avi or .mov) using the Export to Video option of the Animation toolbar. When exporting to a video file it is recommended to enable off-screen recording under the Options button. If off-screen recording is disabled all screen activity is shown in the exported video.

Although this solution goes beyond what is considered Virtual Reality, it can be of value for the Zondereigen case. Therefore as an example, the animations of the bicycle as well as the agricultural situation were exported into .avi-files for the future situation. To illustrate what is possible, these videos are worked out with Windows Moviemaker into one video file showing both animations at the same time together with maps showing the location and view direction. For creating these animated maps almost the same procedure was followed as for the creation of the animations. Only difference is the use of the Move Layer along path option instead of a camera flyby. The moving layer is a graphics layer with an arrow showing both location and view direction. This is where it proved to be possible to implement orientation support although. A screenshot of the video is shown in *chapter 4* (*figure 4.6).* Also a video is created using the same principles showing the current as well as the future situation for one and the same track.

Appendix D Adding tools in ArcGIS

Hawth's Analysis Tools

1. Download Hawth's Tools for ArcGIS 9 from http://www.spatialecology.com/htools/ using following link:

   http://www.spatialecology.com/download/Hawths_Analysis_Tools_for_ArcGIS9.zip

2. Save the WinZip file to your hard drive (anywhere), and unzip it (if you do not have a copy of WinZip, you can download it from http://www.winzip.com)

3. Run the program called htools_setup.exe (note that this program can also be used to uninstall the software)

4. In ArcMap, Add the Hawth's Tools toolbar by selecting Hawth's Tools under the Toolbars option of the View menu.

5. The Convert Paths to Points (lines to points) tool can be found under the Animal Movements tools of the Analysis Tools.

ArcScene Hyperlink Command

1. Download the ArcScene Hyperlink Command from http://support.esri.com using following link:

   http://arcscripts.esri.com/details.asp?dbid=12615

2. Save the WinZip file to your hard drive (anywhere), and unzip it (if you do not have a copy of WinZip, you can download it from http://www.winzip.com)

3. Run the program called ArcScene Hyperlink Command.msi (note that this program can also be used to uninstall the software)

4. In ArcScene, open the Customize dialog box using the Customize option of the Tools menu

5. Select the Viewer category under the Commands tab

6. Drag the Hyperlink command to any location on the target toolbar and drop it