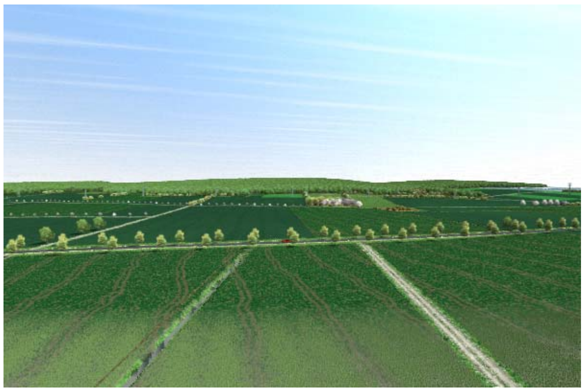
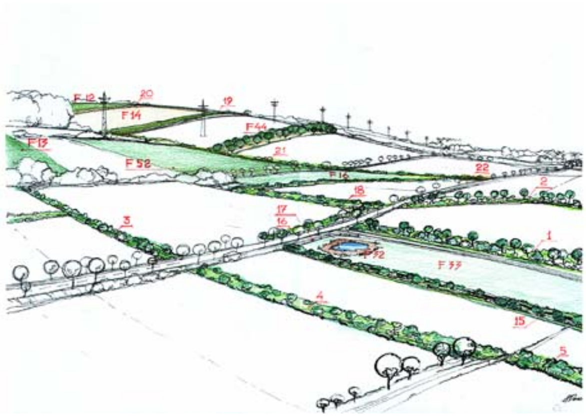
Visualization in Landscape Planning:

Choosing appropriate visualization methods for public participation





Von der Fakultät für Architektur und Landschaft der Gottfried Wilhelm Leibniz Universität Hannover zur Erlangung des akademischen Grades Doktorin der Ingenieurwissenschaften (Dr.-Ing.) genehmigte Dissertation von:

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2011

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APPENDIX B I

Acknowledgements

This dissertation grew out of work that I undertook as a research assistant in the Institute for Environmental Planning at the Leibniz University Hannover during the research and development project “Interactive Landscape Plan in Königslutter am Elm” (IALP) (see V. HAAREN et al. 2005). The dissertation expands on the findings of the IALP and places them in a wider scholarly context. For the opportunity to combine my dissertation with the IALP, I would like to thank the Federal Nature Conservation Agency that funded the project and thus my research work.

On a more personal note, I would like to mention that a dissertation is an exercise in combating self-doubt. I would like to thank all those people who believed in me, when I did not. A dissertation is also a test of tenacity, finding out what it takes not to give up. I want to thank those people who made it possible for me to keep going. First of all, my deepest thanks goes to Prof. Dr. Christina von Haaren for giving me the opportunity to re-enter professional life after a time-out for family, and for her encouragement and insightful comments that were essential along the way. I would also like to thank Professor Andrew Lovett from University of East Anglia in Norwich for his extremely helpful feedback and the hours he has spent reading this text. My thanks also go to Dr. Astrid Lipski for taking me under her wing, guiding me around the pitfalls of the process, and to Anna Maier-Pfeiffer for getting me “back on track” when I was ready to give up. Without her coaching and friendship, this thesis would never have been completed. I would also like to thank Judy McAlister-Hermann for extensive proofreading and editing, as well as Ed Warren, Karin von Schweinitz, Virginia Ballhaus and Angela Kircher.

Furthermore, I thank the visualization experts who agreed to be interviewed: Prof. Ian Bishop, Stephen Ervin, Prof. Eckart Lange, Prof. Mark Lindhult, Prof. Andrew Lovett, Prof. Jim Palmer, and Prof. Stephen Sheppard, who greatly enriched this thesis with their insights and comments. From the Anhalt University of Applied Sciences I would also like to thank Prof. Erich Buhmann for his role in bringing many of these experts to Germany and Dr. Elke Eckhardt for her helpful advice and encouragement.

My gratitude goes to the IALP team, Karl-Ingo Friese, Carolin Galler, Roland Hachmann, Jutta Meiforth, Arne Neumann, Simone Schipper, and Susanne Stabrey, for the productive and enjoyable collaboration which I experienced with them. My appreciation also goes to Prof. Bettina Opperman for her “healthy distrust” of visualization and her challenging questions. In addition, Anne Hebsaker, Sergy, Inga Koepke, and Daniela Hogrebe deserve thanks for their contributions to the preparation of the visualizations used in the dissertation.

Finally, I want to say that a dissertation is a lonely endeavor. I would like to thank all those friends who did not abandon me, despite my reclusive nature during the dissertation. My appreciation goes to a supportive circle of friends from the Südstadt Gemeinde am Döhrener Turm and the International Women's Association Hannover e.V. Prof. Dr. Hans Peter Waldhoff and Petra Engelmann I also thank them for their words of wisdom and perspective.

The reality of life is that the responsibilities of raising a family and running a household do not stop just because one is writing a dissertation. Without Viktoria-Luise Müller and Dorothea Bichler, who relieved me of many of my daily responsibilities, I would not have had the time and peace of mind to write. The list could go on. But there is one group of people who have suffered through the trials of the last years more than most: my family. I would like to thank Christian, Linda Star, Winni, Till, and Joachim for their encouraging words, "You can do it!" and their support in the end phase with statistical analysis, translation, corrections, jokes, and cooking. Each has contributed to this thesis in his/her own way. Finally, I would like to thank my husband Clemens for standing by me from beginning to end.

One last word: a thesis is also an escape. It is a luxury to be able to spend time researching a topic in depth and working in a private, intellectual bubble. I will miss having a place to go when I want to escape.

Hannover, 1. November 2010 Josephine Bartlett Warren-Kretzschmar

This thesis is dedicated to ***Josephine Warren Beach***, the wisest woman I know.

Lk. 1,37

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Abstract

Citizen participation in the planning process is a European and German political goal which is now grounded in a range of European and German legislation. For example, public involvement in environemental issues is required by the European Aarhus Convention, which calls for better information and more transparency of the decision-making processes (UNECE, 1998), as well as the European Environmental Assessment Directive (85/337/EWG) and SUP Directive (2001/42/EG). These directives are implemented into German law in the EIA and SEA Acts as well as the Environmental Appeals Act (2010) that are relevant for landscape planning. Even though the Federal Nature Conservation Act does not stipulate citizen participation, it is in practice an integral part of the landscape planning process. Increased public participation in landscape planning has the potential to improve the quality and acceptance of planning decisions through involvement of key stakeholders and citizens in the planning process. However, communicating planning information to the stakeholders in an understandable manner is a prerequisite for effective participatory planning.

The digital era has contributed computer visualization techniques that offer the possibility to simulate landscape change or visual impacts with computer-generated images and models. Software becomes more sophisticated and user-friendly, while the hardware becomes more powerful and affordable. However, research and development of these technologies is taking place faster than experience with the technologies in the planning arena can be acquired. It is tempting to embrace the new technologies because their new capabilities are so impressive; but more information is needed about how citizens actually use the different visualization methods in the participatory planning environment and what their actual needs are with respect to information and participation. Furthermore, there are few studies that examine the usefulness of the new digital technologies in comparison with conventional technologies in a real-life setting.

It was the intention of this investigation to examine how different user groups evaluate diverse visualization methods and their characteristics in order to develop recommendations about the suitability of the visualization methods in participatory landscape planning. Research questions were exploratory in nature and addressed not only the strengths and weaknesses of different visualization types but also their use in the participation process of landscape planning.

The research questions addressed visualization in terms of participants' requirements, technical characteristics, and its use in the context of the participatory planning process. The first complex of research questions focused on the suitability of visualization methods for supporting the citizens' understanding of and trust in the planning content and proposals. The suitability of the methods for successful use in participations was judged by the assessment of four criteria: spatial understanding, orientation, ability to assess change, and finally, trust in, or perceived credibility of the visualization. The second complex of research questions served to investigate the importance of different visualization characteristics – realism, dynamic navigation, and interactivity – for supporting participants' involvement in and understanding of the planning. The third set of research questions examined how the different visualization methods were used by participants in a real-life planning situation by considering the suitability and functions of the different visualizations in the participatory environment. The final set of research questions explored which visualization methods were suited to support participation in the different planning phases and what role the facilitator played in the integration of the visualization during discussion.

A mixed-method approach was used to gather and analyse both qualitative and quantitative data gathered in a visualization survey and case study: In a quasi-experimental setting, three different user groups were asked to assess visualization methods using questionnaires with closed and open-ended questions during a preliminary visualization survey. In the case study, the use of different visualization methods, ranging from traditional to high-end digital techniques, was investigated in the participatory planning environment of the project, Interactive Landscape Plan of Königslutter am Elm[1] (IALP). Multi-source evidence was gathered using participative observation and questionnaires. Finally, the findings were reviewed with experts in the field of landscape visualization in semi-structured interviews.

The investigation findings showed that two-dimensional visualization methods remained important in the discussion of planning proposals with citizens. In participation, 2D methods supported orientation, especially when 3D models were also used, and gave the citizens a necessary overview of the planning area for discussion and documentation. Furthermore, participants who were familiar with the planning area considered 2D visualization methods to be sufficient for the discussion of planning measures. This indicates that such low-end visualization methods should be used in participation to complement the newer visualization technologies.

Lay groups were found to prefer realistic visualization methods. However, the results also suggested that the viewers with more planning experience, i.e. planners, relied less on realistic images than lay groups. This underlines the necessity for planners to consider the

[1] The Interactive Landscape Plan in Königslutter am Elm is an Investigation and Development project (German: *Entwicklungs- und Erprobungsvorhaben*) that was sponsored by the Federal Agency for Nature Conservation and implemented from 2002 until 2005.

citizens' capabilities when selecting visualization methods. The findings substantiated the claim that there is no “all-in-one” visualization method. Both two- and three-dimensional images were needed to support orientation and spatial understanding. A mix of visualization methods was most successful in meeting the needs of diverse audiences and is a prerequisite for participation.

The “toggle” function that the Layer Visualization Tool (LaViTo) module provided for comparing before-and-after images helped the participants evaluate landscape change. It also emphasized the provisional character of the planning proposals and enabled the participants to focus on specific planning measures in the discussion. Furthermore, citizens actively used all the integrated features of the LaViTo module: The 2D maps and elevated views of the planning area were used for spatial orientation and understanding, while the eye-level, before-and-after images of the planning measures were used to assess landscape changes.

The findings suggest that the perceived credibility of the visualization is improved with additional information about the landscape and the visualization methods. The more participants know about the visualization and the landscape which it represents, the better they can judge how well the visualization represents reality. This was substantiated by the finding that citizens considered detailed or realistic images more credible than abstract ones.

Photorealistic images stimulated interest and made orientation and spatial understanding easier, especially for lay people. In fact, even the two-dimensional aerial photographs were found to support spatial understanding by all the surveyed groups. Although participants preferred photorealistic images, they also showed scepticism about the credibility of these images. It is questioned whether or not the landscape planner ever has sufficiently detailed information to make the decisions necessary for producing such realistic images.

Dynamic navigation was also found to stimulate interest among participants. Planning professionals considered it important because it gave the viewer more control over the visualization. Although dynamic navigation has the potential to empower participants, it was found that participants were better able to orient themselves with a still image. Furthermore, the still images were better suited for the comparison of before-and-after images. However, the 3D model with dynamic navigation was found to be better suited for the visualization of complex issues or large sites than a static image. Interestingly, the study showed that responses to dynamic navigation in the visualization survey differed from those observed in the case study. Survey respondents found static images sufficient for discussing the planning content. However, when participants in the case study experienced dynamic navigation, they were no longer satisfied with one static image. And finally, the interactivity provided by the LaViTo module was found to support collaborative discussion between citizens and planners. Citizens actively used the available

interactivity and would have liked more.

The investigation findings suggest that visualizations with movement and realism stimulate interest during the initial phases of the planning process. Furthermore, in the inventory phase, the existing landscape should be visualized with as much detail as possible. Realism was found to support orientation and identification with the landscape and to stimulate comments that reveal local knowledge. Two approaches to visualization in the concept phase were identified that deserve more exploration: geotypical visualizations, which show realistic visualizations of landscape development for similar sites not in the planning area; and georeferenced visualizations, which are schematic visualizations of the specific planning area that primarily show spatial relationships. For the discussion of planning measures, the findings as well as experts recommended that the visualization should contain as much detail as possible with the available data. Citizens requested realism, but understood the planning content with less-than-photorealistic visualizations.

Finally, facilitation played a central role in the successful use of visualization in a participatory setting. The facilitator could not force participants to use the visualization, and the facilitator's lack of familiarity with the visualization method or site reduced its effectiveness. Beyond understanding the potentials and limitations of the visualization methods, the facilitator had to fulfil additional tasks during participatory sessions: explain and demonstrate the visualization method, ensure that participants remained oriented, and document the results of the session using the visualization. The additional demands of using visualization in participation require a team of facilitators who ensure a coordinated and scripted use of the visualization.

In conclusion, the investigation confirmed that visualization is a means to understand planning and that its presence brings actors together to discuss the planning issues. A shared image – whether right or wrong – means that people discuss, exchange ideas, debate opinions, and hopefully learn from each other. In the future, facilitating the use of visualization in the discussion may be as important as the actual choice of visualization method. As the technology becomes more intuitive, new issues will arise, such as how to manage the information and to make the scenario models and methods transparent; or how much autonomy citizens should have in the decision process. Improved computer literacy and internet access, as well as the growing acceptance and use of virtual globes, hold new possibilities for presenting landscape issues and engaging citizens in planning. With the increased ability to ask "What-if?" questions of modelled scenarios, new credibility questions will most certainly arise. Can the modelled scenario visualization be made transparent enough so that citizens can evaluate its validity? Will future visualization methods such as virtual globes have similar problems, and how can the planning community address such issues? The core issues associated with visualizations will most probably remain the same: credibility, validity, comprehension.

Kurzfassung

Visualisierung in der Landschaftsplanung - Eignung unterschiedlicher Visualisierungstechniken für die Bürgerbeteiligung

Die Einbeziehung der Bürger in politische Entscheidungsprozesse ist in der europäischen und deutschen Politik ein wichtiges Ziel. Nicht zuletzt zeigt sich dieses an einer Vielzahl von Rechtsgrundlagen, in denen die Bürgerbeteiligung als Bestandteil von Planungen und Zulassungsverfahren verankert wurde. Zu nennen sind beispielsweise die Aarhus Konvention (UNECE) von 1998, die bessere Informationsvermittlung und mehr Transparenz in Entscheidungsprozessen fordert und die europäischen Richtlinien zur Umweltverträglichkeitsprüfung - UVP Richtlinie (85/337/EWG) und SUP-Richtlinie (2001/42/EG), die durch das UVP-Gesetz sowie das SUP-Gesetz in nationales Recht umgesetzt wurden. Alle diese Rechtsgrundlagen sind für die Landschaftsplanung relevant. Auch wenn im BNatSchG eine Bürgerbeteiligung nicht ausdrücklich gefordert wird, so wird sie in der Praxis doch regelmäßig durchgeführt. Mehr Bürgerbeteiligung in der Landschaftsplanung kann die Qualität und Akzeptanz von Planungsentscheidungen verbessern, wenn sowohl die Öffentlichkeit, als auch direkt Betroffene in die Entscheidungsfindungen eingebunden werden. Eine Voraussetzung dafür ist allerdings, dass Planungsinhalte in einer für die Betroffenen verständlichen Art vermittelt werden.

Im digitalen Zeitalter sind viele Visualisierungstechniken entwickelt worden, die Möglichkeiten bieten, anhand von computergenerierten Bildern und Modellen, Änderungen in der Landschaft und deren visuelle Auswirkung zu simulieren. Entsprechende Software wird zunehmend benutzerfreundlich und die Hardware leistungsstärker und kostengünstiger. Allerdings gehen Forschung und Entwicklung dieser Technologien schneller vonstatten, als damit Erfahrungen in der Planung gesammelt werden können. Es ist verlockend, die neuen Technologien anzuwenden, nur weil ihre Möglichkeiten so beeindruckend sind. Dabei wäre es wichtig zu wissen, wie die Bürger verschiedene Visualisierungsmethoden nutzen und welche Informationsbedürfnisse sie im Kontext der Beteiligung haben. Bisher gab es nur wenige Studien zu Einzelaspekten der genannten Fragen. Ein Wissensdefizit bestand vor allem bezüglich der Ansprüche der Nutzer in komplexen Planungsprozessen wie der Landschaftsplanung.

Ziel der hier vorgelegten Arbeit war es vor diesem Hintergrund zu untersuchen, welche Kriterien für die Beurteilung von Visualisierungstechniken im Kontext der Beteiligung relevant sind und wie sich verschiedene Visualisierungsmethoden für einen Einsatz in der Landschaftsplanung eignen. Im Fokus standen dabei nicht nur die Stärken und Schwächen verschiedener Visualisierungsarten mit Blick auf die Bedürfnisse der Bürger, sondern auch technische Eigenschaften sowie die Anwendung im partizipatorischen Prozess der

Landschaftsplanung.

Im Einzelnen wurde in einem explorativen Forschungsansatz den folgenden Forschungsfragen nachgegangen: Mit Blick auf die Bedürfnisse der Beteiligten, wurde untersucht, inwiefern die Visualisierungsmethoden dazu geeignet seien, den Bürgern behilflich zu sein, die Planungsinhalte und -vorschläge zu verstehen und für glaubwürdig zu halten. Die Eignung der Methoden für den erfolgreichen Einsatz in bürgerbeteiligter Planung wurde anhand von vier Kriterien bewertet: dem räumlichem Verständnis, der Orientierung, der Fähigkeit zur Beurteilung von Veränderungen sowie dem Vertrauen in die Visualisierung, d.h. deren empfundener Glaubwürdigkeit. In Hinblick auf die technischen Eigenschaften der Visualisierung – nämlich Realismus, dynamische Navigation und Interaktivität – wurde erkundet, inwieweit diese zur Förderung des Engagements der Bürger an der Planung und ihres Verständnisses der Inhalte beitrügen. Schließlich wurden zur Aufklärung des Umgangs der Beteiligten mit den verschiedenen Visualisierungsmethoden in echten Planungssituationen untersucht, welche Funktionen den Ansprüchen der Bürger besonders entgegenkamen und durch welche Visualisierungsmethoden in den verschiedenen Planungsphasen die Beteiligung besonders gefördert wurde und welche Rolle der Moderator bei der Einbindung der Visualisierung in die Diskussion spielte.

In einem gemischt-methodischen Ansatz konnten im Rahmen einer Befragung sowie in einer Fallstudie sowohl qualitative als auch quantitative Daten erhoben werden: Zunächst wurde im Rahmen einer experimentellen Situation unabhängig von der Fallstudie eine Umfrage zur Visualisierung durchgeführt. In der Fallstudie wurde die Anwendung verschiedener Visualisierungsmethoden – von traditionellen bis zu neuesten digitalen Techniken – im Rahmen eines interaktiven Planungsprojektes untersucht, dem Interaktiven Landschaftsplan Königslutter am Elm[2] (IALP). Daten verschiedener Quellen wurden aus Protokollen teilnehmender Beobachtungen und Fragebögen erfasst. Schließlich wurden die Ergebnisse der Untersuchung durch Interviews mit Experten aus dem Bereich Landschaftsvisualisierung überprüft.

Die Ergebnisse zeigten, dass zweidimensionale Visualisierungsmethoden in der Diskussion über Planungsmaßnahmen mit Bürgern durchaus noch wichtig sind. 2D-Visualisierungs-methoden wie Karten waren notwendig, um für die Darstellungen mit 3D-Modellen die Orientierung zu erleichtern und den beteiligten Bürgern einen Überblick über das Planungsgebiet zu ermöglichen. Ferner wurden 2D-Visualisierungsmethoden von Beteiligten, die mit dem Planungsgebiet schon vertraut waren, als ausreichend für die

[2] Der Interactive Landscape Plan in Königslutter am Elm ist ein vom Bundesamt für Naturschutz gefördertes Entwicklungs- und Erprobungsvorhaben, das von 2002 bis 2005 durchgeführt wurde.

Diskussion der Planungsmaßnahmen bewertet. In der Konsequenz bedeutet dies, dass vor Einsatz von Visualisierungsmethoden deshalb der Adressatenkreis erkundet werden sollte und dass neuere Visualisierungsmethoden mit konventionellen Methoden unterstützt werden sollten.

Einerseits ergab sich, dass Laien die realistischen Visualisierungsmethoden bevorzugten. Andererseits verließen sich Experten wie z.B. Planer weniger auf realistische Bilder. Somit wird deutlich, dass bei der Wahl der Visualisierungsmethoden die Fähigkeiten und Vorerfahrungen der Bürger berücksichtigt werden müssen.

Die Ergebnisse unterstreichen, dass es nicht die vielseitig einsetzbare Visualisierungsmethode schlechthin gibt. Es wurden vielmehr sowohl zwei- als auch dreidimensionale Abbildungen benötigt, um die Orientierung und das räumliche Verständnis zu erleichtern. Eine Kombination von Visualisierungsmethoden erwies sich als am besten geeignet, um den Bedürfnissen der verschiedenen Beteiligtengruppen gerecht zu werden.

Für die Beurteilung von Veränderung in der Landschaft fanden die Beteiligten die „Schalter"-Funktion eines neu entwickelten einfachen Visualisierungsmoduls des Layer Visualization Tool (LaViTo) nützlich. Damit lassen sich Vorher-Nachher-Bilder miteinander vergleichen; durch diese Funktion wird zudem die Vorläufigkeit der Planungsvorschläge betont und die Aufmerksamkeit der Teilnehmer auf spezifische Planungsmaßnahmen gelenkt. Ferner machten die Bürger aktiven Gebrauch von sämtlichen im LaViTo-Modul integrierten Eigenschaften. Die 2D-Landkarten und Höhenansichten des Planungsgebiets wurden zur räumlichen Orientierung und zum Verständnis gebraucht, während die auf Augenhöhe dargestellten Vorher-Nachher-Bilder der Planungsmaßnahmen bei der Beurteilung von Veränderungen in der Landschaft genutzt wurden.

Ein weiteres Ergebnis ist, dass die Visualisierung glaubwürdiger wird, wenn zusätzliche Informationen über die Landschaft und die Visualisierungsmethoden zur Verfügung stehen. Je mehr die Beteiligten über die Visualisierung und über die darin repräsentierte Landschaft wissen, desto besser können sie beurteilen, wie realistisch die Visualisierung ist. Dies wurde dadurch bestätigt, dass die Bürger detaillierte oder realistische Bilder für glaubwürdiger hielten als abstrakte.

Fotorealistische Abbildungen weckten vor allem bei Laien das Interesse und erleichterten ihnen die Orientierung und das räumliche Verständnis. Ferner wurden sogar die 2D-Luftaufnahmen von allen befragten Gruppen als hilfreich für das räumliche Verständnis bewertet. Obwohl die Beteiligten fotorealistische Bilder bevorzugten, hatten sie Zweifel an der Glaubwürdigkeit dieser Bilder. Der Landschaftsplaner benötigt deshalb sehr detaillierte Rauminformationen, wenn Bilder mit einem hohen Realitätsgrad erzeugt und eingesetzt werden sollen.

Das Interesse der Beteiligten an der Planung wurde besonders durch die dynamische Navigation geweckt. Auch zeigte sich, dass das 3D-Model mit dynamischer Navigation sich besser als unbewegliche Bilder für die Visualisierung komplexer Fragestellungen oder großer Vorhaben eignete. Von den Planungsexperten wurde die Möglichkeit zur dynamischen Navigation überdies für wichtig erachtet, weil sie dem Betrachter mehr Kontrolle über die Visualisierung verschafft. Dem steht gegenüber, dass die Beteiligten sich anhand unbeweglicher Bilder besser orientieren konnten. Unbewegliche Bilder waren außerdem für den Vergleich von Vorher-Nachher-Bildern geeigneter. Interessanterweise wichen die Ergebnisse bezüglich der Reaktionen auf dynamische Navigation in der Vorbefragung von denen in der Fallstudie ab. In den Fragebogenantworten wurden unbewegliche Bilder als ausreichend für die Diskussion über Planungsinhalte bewertet. In der Fallstudie waren die Beteiligten dagegen nicht mehr mit einem einzigen, unbeweglichen Bild zufrieden, nachdem sie die dynamische Navigation erlebt hatten. Schließlich wurde festgestellt, dass selbst die einfache Interaktivität des LaViTo-Moduls die kooperative Diskussion unter Bürgern und Planern zufriedenstellend unterstützt. Bürger benutzten die vorhandenen interaktiven Funktionen und hätten gern mehr davon gehabt.

Bezüglich der Eignung der Visualisierungsfunktionen für die einzelnen Planungsphasen ergab sich, dass sich in der ersten Phase des Planungsprozesses das Interesse des Bürgers durch Visualisierungen mit Bewegung und Realismus wecken ließ. Ferner sollte während der Phase der Bestandsaufnahme die vorhandene Landschaft möglichst detailliert visualisiert werden. Es zeigte sich, dass realistische Darstellungen die Orientierung in und die Identifikation mit der Landschaft unterstützen und Kommentare hervorrufen, die lokales Wissen erkennen lassen. Zwei Visualisierungsstrategien für die Konzeptphase wurden identifiziert, die weiter untersucht werden sollten: Die geotypischen Visualisierungen mit realistischen Darstellungen von Entwicklungsvorhaben für vergleichbare Landschaften, die sich nicht im Planungsgebiet befinden; und geospezifische, schematische Visualisierungen des konkreten Planungsgebietes. Für die Diskussion von Planungsmaßnahmen wurde die Empfehlung abgeleitet, dass die Visualisierung nur so viele Details enthalten sollen, wie nach Datenlage möglich sind. Obwohl die Bürger Realismus verlangten, konnten sie den Planungsinhalt auch anhand von nicht vollständig fotorealistischen Visualisierungen verstehen.

Schließlich wurde festgestellt, dass der Moderation bei erfolgreichen Visualisierungen im partizipatorischen Umfeld eine zentrale Rolle zukommt. Der Moderator konnte die Beteiligten allerdings nicht dazu zwingen, die Visualisierung zu benutzen, und deren Nutzwert wurde verringert, wenn sich der Moderator in den Visualisierungsmethoden oder in der vorgestellten Landschaft nicht genügend auskannte. Daher musste der Moderator nicht nur das Potential und die Grenzen der Visualisierungsmethoden verstehen, sondern während der Beteiligungsveranstaltungen auch noch weitere Aufgaben übernehmen: Er musste zum einen die Visualisierungsmethoden erklären und demonstrieren, zum anderen dafür sorgen, dass die Beteiligten ihre Orientierung in der Landschaft nicht verloren. Die zusätzlichen Anforderungen beim Einsatz von Visualisierungen im Kontext der Bürgerbeteiligung erfordert deshalb ein Team von Moderatoren, die die Koordination und den vorgeschriebenen Gebrauch der Visualisierung sicherstellen.

Als Fazit bestätigte die Untersuchung, dass Visualisierung ein geeignetes Werkzeug ist, um planerische Maßnahmen verständlich zu vermitteln und alle Beteiligten miteinander ins Gespräch zu bringen. Denn eine gemeinsam betrachtete Abbildung – sei sie richtig oder falsch – führt dazu, dass Menschen darüber reden, Ideen austauschen und über ihre Meinungen debattieren. In Zukunft wird der Moderation in Beteiligungsveranstaltungen auch die Rolle zukommen, die Visualisierungen auszuwählen und zu steuern. Je intuitiver die Technologie, umso mehr neue Fragen werden aufgeworfen: z.B. wie lassen sich die Informationen strukturieren und bewältigen? Wie können die Modelle und Methoden der Entwürfe transparent gemacht werden? Verbesserte Computerkenntnisse, der optimierte Zugang zum Internet, sowie die wachsende Akzeptanz und Nutzung von virtuellen Globen wie Google Earth schaffen neue Möglichkeiten, Landschaften darzustellen und Bürger in deren Planung einzubeziehen. Mit der zunehmenden Fähigkeit, die Frage nach dem "Was wäre wenn?" an Modellszenarien zu stellen, werden mit Sicherheit neue Fragen zur Glaubwürdigkeit der Visualisierungen aufkommen. Kann durch Visualisierung die Sicherheit eines Modellszenarios so transparent gemacht werden, dass Bürger dessen Glaubwürdigkeit besser einschätzen können? Werden sich solche Probleme auch für zukünftige Visualisierungsmethoden stellen und wie können Planer darauf reagieren? Auf jeden Fall ist anzunehmen, dass die Kernfragen der Visualisierung dieselben bleiben: Glaubwürdigkeit, Gültigkeit, Verständlichkeit.

Schlagwörter / Key words:

Visualisierung, Bürgerbeteiligung, Landschaftsplanung

Visualization, participation, planning

1 Introduction

1.1 Background and issues

Citizen participation in the planning process is a European political goal which is now grounded in European legislation, as for example in the Environmental Assessment Directive (85/337/EWG) (1992) or the European Aarhus Convention, both of which call for better information and more transparency in the decision-making process (UNECE Convention on Access to Information, 1998). These directives are implemented into German law in the EIA and SUP-acts as well as the Environmental Appeals Act (2010) that are relevant for landscape planning. Even though citizen participation is not stipulated in the German Nature Conservation Law, it is in practice an integral part of the landscape planning process. Increased public participation in landscape planning has the potential to improve the quality and acceptance of planning decisions through the involvement of key stakeholders and citizens in the planning process. However, effective participatory planning requires that planning information be communicated to the stakeholders in an understandable way. While traditional communication tools in planning, such as maps, diagrams, and text, remain the most common instruments for communicating information, these are limited in their ability to convey spatial information to lay audiences (LEWIS & SHEPPARD 2006; TRESS & TRESS 2003). Words and plans are important, but there is much truth in the saying, "a picture is worth a thousand words." An image not only supports spatial understanding but also helps citizens to picture landscape issues and facilitates participation (LANGENDORF 2001). In the words of AL-KODMANY (1999:39), "user participation is meaningless if participants cannot understand what is being proposed."

In the digital era, computer visualization techniques now make it possible to simulate landscape change or visual impacts with computer-generated images. Over the past two decades ingenious planners have experimented with these techniques, developing applications and looking for opportunities to use them in planning (HOWARD 1996; LANGE 1994). There has been a development from the processing of images to create realistic-looking photomontages to the generation of images from GIS data and 3D models, with increasing content accuracy of the image. The latest developments encompass 3D landscape models and virtual worlds that make it possible for viewers to experience the third and fourth dimensions of the landscape without stepping outside. Advances in technology and software have made these sophisticated landscape visualization methods affordable, and applications are now widespread in many planning-related fields (see BISHOP & LANGE 2005b). For example: the program Visulands uses 3D visualizations to simulate landscape changes for discussions of planning decisions with stakeholders (SCHROTH et al. 2006); planning support systems like CommunityViz® offer the capability to develop landscape scenarios with citizens and to visualize the resulting landscape changes (KWARTLER & BERNARD 2001); and realistic applications such as Lenné3D let members of the public virtually walk through a photorealistic, real-time visualization of planning proposals, and even view the planning at eye level (REKITTKE &PAAR 2005).

The potential to illustrate the planning situation accurately and efficiently has thus drastically improved in recent years, making computer visualization a powerful communication tool that has the potential to improve citizens' and stakeholders' understanding of environmental issues and decisions. These impressive capabilities make it tempting to embrace the new technologies unreservedly, and the "wow" effect of such technologies should not be underestimated for its potential both to activate and emotionally engage citizens as well as to stimulate interest in participatory situations (NICHOLSON-COLE 2005; SHEPPARD 2005a). But should we simply discard old technologies that satisfy participatory requirements – and are potentially less expensive? In order to identify the effective and sensible use of the different visualization methods now available, the strengths of traditional methods must be analyzed and compared with the emerging technologies.

Furthermore, research and development of visualization technologies are taking place faster than experience with the technologies can be acquired in the planning arena (ORLAND et al. 2001). Researchers such as (AL-KODMANY 2000; APPLETON & LOVETT 2003, 2005; BISHOP & LANGE 2005a, SHEPPARD 1989) and others have identified factors that influence the choice of visualization technique for use in the planning process. However, this research has focused mainly on the importance of the individual characteristics of different visualization types, for example, photorealism (APPLETON & LOVETT 2003; LANGE 2001), three-dimensional visualizations (SCHROTH ET AL. 2006; WISSEN 2007), or interactivity (SCHROTH 2008). Although different visualization methods have been investigated in which specific factors were examined, no comparison of different visualization methods has been conducted in a participatory setting. Such a comparison could not only shed light on the relative importance of different visualization characteristics in helping participants understand the planning content, but also reveal the essential strengths of the different visualization methods in participation and planning. Finally, such an investigation should substantiate or modify existing results upon which hypotheses can be made about the suitability of visualization techniques to support different planning tasks and objectives.

Current research has focused on different visualization methods, their attributes, and user response, but little attention has been given to the role of the venue, i.e. the setting and facilitation, in the effective use of the visualization. The importance of the facilitator for successful integration of the visualization in discussion has been recognized (SALTER et al. 2009), but the tasks, role, and requirements of the facilitator to actively support the discussion with the visualizations have not been well defined. Furthermore, questions remain about how visualizations are used in the participatory setting, for example, whether they are passively observed, or if participants actively incorporate them in their discussion. More clarity is thus needed about which functions visualizations fulfill in communication with citizens and how visualizations are perceived and understood by participants (APPLETON & LOVETT 2005; DRANSCH 2000).

The landscape planner now has access to an enormous range of visualization options, choices, and potential opportunities for use in the landscape planning process, and the variety and complexity of the factors which need to be considered make the selection of an appropriate visualization method very challenging (APPLETON & LOVETT 2005). Nevertheless, the choice of visualization methods must clearly be determined by the planning objectives and the participatory context. In other words, visualization remains a tool to be used in a participatory setting as an aid to achieve planning objectives. This view is supported by the literature, which also calls for more structure in the selection and implementation process in order to choose the most efficient and effective visualization method for the planning task (BISHOP & LANGE 2005a; SHEPPARD et al. 2004).

1.2 Research objectives

The purpose of this study was to improve our understanding of the use of visualization in the participation process of landscape planning to promote citizens' understanding of the planning, and to support planning tasks. The objective of the study was not only to explore the context of the use of visualization in the participation and planning process, but also to identify the participants' needs and requirements for using visualizations and to determine the suitability of different visualization methods. Finally, the investigation aimed to develop recommendations for the selection and use of visualization in the participatory setting of the planning process.

1.3 Research questions

Overall, the research objectives are addressed through the following four questions:

1. How suitable are different visualization methods for supporting participants' understanding (cognition) of the planning content during participation?
2. How important are the central visualization characteristics – realism, dynamic navigation and interactivity – for understanding planning content?
3. Which functions – engagement, communication, collaboration, education – do the different visualization methods fulfill in public participation during the planning process and what role does the facilitator play?
4. Which visualization methods and attributes are suitable to support the different planning tasks and phases?

The research questions are exploratory in nature, partly due to the fact that at the time of the investigation (2002-2005) the existing evidence and experience with visualization methods in a participatory setting was limited. The literature addressed different aspects of individual visualization methods, but little research was available about the context of visualization in a participatory setting. In an attempt to lay the groundwork for further hypotheses, the research examined visualization from several points of view. First, the focus was on requirements: a) the participants' requirements for using and understanding the visualization (i.e. the suitability of the visualizations for participant use), and b) the technical requirements, i.e., the importance of different technical attributes of the visualization methods (realism, dynamic navigation, interactivity) for participation. Second, the research examined the context of the visualization in participation and the planning process in a real-life participatory setting (see Figure 1).

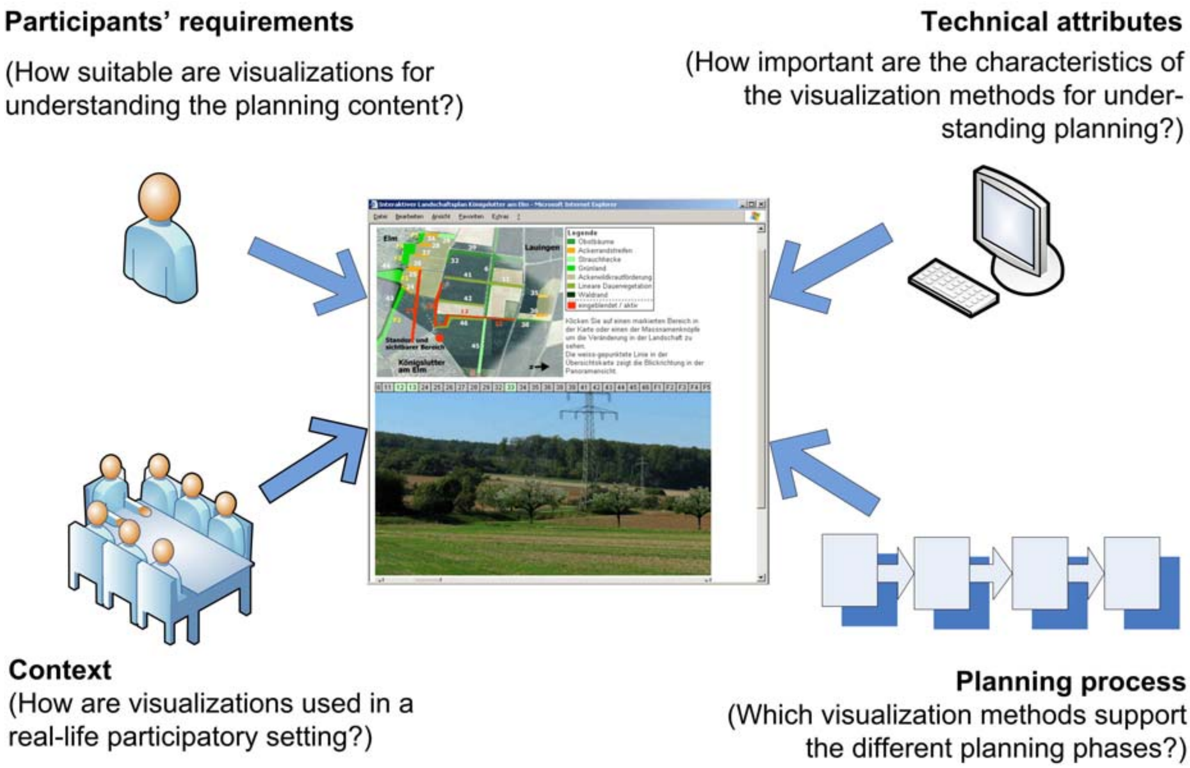

Figure 1: Overview of research questions addressed in the investigation

1.4 Visualization – a word about the term

There are various definitions for the word 'visualization', and two different ideas about this term prevail in the literature. Visualization is used to mean either a mental process or a concrete representation (a producible display). These two interpretations are reflected in the definition in the Merriam-Webster dictionary (1980), which defines the noun visualization as:

> **1:** formation of mental visual images
> **2:** the act or process of interpreting in visual terms or of putting into visible form.

BISHOP & LANGE (2005b) identify two types of visualization: the visualization of data, models, and relationships, and the visualization of landscapes and changing environments. The former represents scientific visualization, which is concerned with exploring data and information graphically in order to gain insight and understanding into data. However, for landscape and environmental planning, the focus is on the presentation of spatial information in order to illustrate the landscape and potential changes in it. Therefore in this thesis, visualization refers to the representation of landscape and spatial information, either two- or three-dimensionally, in which information about the landscape is put into a visual form, either digital or analogue.

It must be mentioned that the two current orthographic variants of this word are used by at least one author, (VISVALINGAM 1994: 19), to distinguish between visuali**s**ation as a primarily mental process that serves a variety of purposes, and visuali**z**ation as the process of transforming raw simulation data into a displayable image. More commonly, this orthographic distinction is simply made as a British (visualisation) or North American (visualization) convention, and the latter variant is used here.

In order to avoid confusion, I wish to point out that the term **visualization** is used in this text to refer to the actual product or image which is shown to the participants. The visualizations are produced using different **visualization techniques** or **methods** (and these two terms are used interchangeably here), which are made possible with different **visualization software** or **tools** (small supplementary programs). The visualizations which are produced using different techniques/methods are also referred to here as different **visualization types**, i.e. sketches, photomontage. Finally, the term **visualization technology** pertains to the hardware and software which make a particular type of visualization possible.

Furthermore, a visualization may simulate future or past landscapes in which future or past landscape conditions or proposed planning measures are displayed as a visual image. This is referred to in the following as a **simulation**, which can be either static or dynamic in nature, i.e. a rendering as opposed to an animation or an interactive 3D model. Simulations can represent not only future situations but also the landscapes of the past. While simulation of an historical landscape is difficult unless relevant historical information about vegetation and human impact is available (WANG et al. 2006), simulation of a future landscape requires information about present conditions and a model for predicting change. Computer simulation technology makes it possible to produce images of future landscape conditions and to explore alternatives or different scenarios in planning. For an in-depth explanation of the visualization of landscape simulations, see ERVIN & HASBROUCK (2001).

Ultimately in landscape planning, visualization is meant to solicit meaningful responses from the participants about the planning content: “A picture is worth a thousand words.” “Seeing is believing.” There is ample documentation of the advantages of visual information, e.g. maps or photos, over written or verbal information. It is safe to say visualizations always spark discussion, regardless of the type or participant groups. Furthermore, simulations of proposed scenarios or measures cause people to consider the planning in ways they might not otherwise have done (MEITNER et al. 2005: 203).

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2 Visualization supports landscape planning and participation

2.1 The landscape planning process in Germany

Research question: Which visualization methods and characteristics are suitable to support the different planning tasks and phases?

Landscape planning has a long tradition in Germany and is well established as a central planning instrument for proactive nature conservation. Furthermore, landscape plans are one of the standard tools used in nature conservation and spatial planning by sectoral authorities as well as local communities for making decisions about the development of nature and the landscape. Although landscape planning is a German instrument, it can also help to implement the requirements of European programs such as the Natura 2000 network, the Water Framework Directive (WFD), the Floods Directive, or Strategic Environmental Assessment (SEA). Landscape planning can be used not only to coordinate and implement individual nature conservation tasks, but also to provide the public with environmental information and support for participation in decisions about sustainable development of the local community and landscape (V. HAAREN et al. 2008).

The landscape planning process is interactive, dynamic, and need- or problem-oriented. The content of the core tasks and phases of landscape planning are closely linked:

- Inventory and evaluation

  Identification and assement of the existing condition of the landscape and development potential and the opportunities of the natural resources and landscape functions. In addition, the impacts of existing and planned uses are identified.

- Planning objectives and concepts (German: *Leitbild*) for development

  Formulation of the objectives and possible alternative objectives for the remediation, conservation, and development of nature and landscape, occasionally illustrated in scenarios and presented as models.

- Proposed planning measures

  Determination of the requirements and measures for realization of the objectives, including descriptions of alternatives that solve conflicts and information aobut their implementation. If necessary, landscape planning can be supplemented with an implementation program.

The flexibility of the landscape planning phases makes it possible to respond to current issues and requirements for an integrated approach to the protection and development of the landscape. For example, pilot planning measures can be implemented during the ongoing planning phases. The early implementation and visible progress of the planning can stimulate the public to participate in the ongoing planning. Especially at the local planning level, the public should be actively involved in the planning and in implementation of the planning results. VON HAAREN et al. (2008) identify the following opportunities for the public to become involved in landscape planning:

- Residents can contribute previously collected local knowledge, memories, experience, or existing data and information about the landscape. This can improve the quality of the landscape plan as well as reduce data acquisition costs.
- Citizens can inform themselves about environmental issues and processes in nature and the landscape by accessing background information made available to the public, e.g. via the internet. In this way citizens are better prepared to make informed decisions in the participatory planning process.
- Stakeholder groups can participate and contribute by expressing their concerns as well as ideas about the planning in a structured and organized process.
- By becoming involved in the planning process, participants have a better chance of understanding and accepting the plan contents and supporting its implementation.
- Finally, the public can share in the implementation successes, which in turn can motivate participation in the planning.

2.1.1 Deficits of the landscape planning process

The development of landscape planning over the last decades, particularly in rural areas, shows the need for stronger participation and involvement of local people (V. HAAREN & HORLITZ 2002). In reality, there are considerable deficits in the implementation of landscape planning goals, especially at the community level, where local authorities enjoy a high degree of discretionary powers in local planning issues. Implementation of environmental goals is hampered not only by strong economic interests, but also by the lack of transparency in the decision-making process and by the lack of understanding of environmental issues by both politicians and the public (OPPERMANN et al. 1997; KAULE et al. 1994). Scientific environmental information is difficult to communicate, and planners' language is not always understood by citizens, resulting in the perception that the planners are withholding information (LUZ 2000). Furthermore, lack of knowledge and understanding about environmental processes leads to a lack of awareness of existing problems, their causes, and the effects of human impacts on the landscape (BÖTTCHER & HÜRTER 1997).

The content of the landscape plan is usually presented in comprehensive reports and maps which are often dry and tedious and not easily accessible for the layperson. The presentation of the results in this form is often too abstract for the citizen (V. HAAREN 2002b). It remains a challenge to awaken the awareness and interest of the large "silent majority" of a community for the issues (PERKINS & BARNHART 2005). Therefore it is essential that the information is presented in an engaging and understandable manner (PERKINS & BARNHART 2005). The planning process must address not only the scientific or “objective” planning criteria but also the subjective and emotional issues (LUZ 2000). Furthermore, sociological research shows that there is a barrier between understanding environmental issues and actually actively engaging in pro-environmental behavior (NICHOLSON-COLE 2005).

2.1.2 Potential opportunities for using visualization to improve planning understanding

In our information-rich society, visualizations can help people to consider complex planning issues from different perspectives using a variety of information. For example, the reforms in agricultural policy and the resulting land-use developments have major consequences for landscape aesthetics. Visualization of different scenarios offers support in the political decision-making process about how the future landscape should appear (HEIßENHUBER et al. 2004). LANGE (2005) suggests that computer-based visual simulations can potentially serve as a link between the classic top-down approach, in which experts provide information to the public, and the bottom-up approach, in which the public initiates the planning and participates in the decisions.

Furthermore, the planners must communicate the environmental information and data to citizens in an understandable and meaningful form (LUZ 2000). Landscape visualizations can help planners illustrate scientific explanations and concepts to the public. Visualization tools can also translate planning jargon and issues into a common visual language which everyone can understand (BOYD & CHAN 2002). Visualizations can help to present landscape planning contents in a way that is geared to the requirements of different user groups, including young people (KUNZE et al. 2002). Moreover, visualizations can improve understanding and support collaborative communication processes that are necessary for solving complex planning issues (LANGENDORF 2001: 309; SCHROTH 2008). The image acts as a common denominator in the evaluation of personal perception with respect to the ideas and conception of others (LUZ 2000). Experience shows that a collaborative, transparent planning process that involves a variety of groups with diverse interests and ideas can reduce or avoid conflict, build trust, and improve social learning (OPPERMANN & LANGER 2003; SHEPPARD 2005b). SHEPPARD (2005c: 640) summarizes some of the key benefits offered by landscape visualization techniques for environmental awareness-building and decision-making as follows:

- The combination of scenario models with GIS and realistic simulations of the future landscape help laypersons look into the future. This may support a long-term perspective in decision-making.

- The ability to identify and locate planning information by using realistic visualizations of sites that local residents recognize, instead of using two-dimensional plans or conceptual illustrations.
- The ability to compare alternative futures side by side and pose "what-if" questions (STEINITZ et al. 2003).
- The potential usefulness of real-time models, virtual reality, and other novel visualizations in stimulating interest in the planning issues and engaging the public in the planning process (SHEPPARD & MEITNER 2005).

The literature clearly shows that visualization has the potential not only to support participation in the planning process, but also to improve the planning results by simulating interest in and understanding of the planning issues. However, the planning process is not uniform. The varied tasks and planning objectives of the planning phases place different requirements on the visualization method and its characteristics. For example, the concreteness of the planning ideas, and the corresponding visualization, is quite different in the concept phase, in which conceptual planning ideals (German: *Leitbilder*) are formulated and discussed, than in the end phase, in which specific planning measures are proposed and decided upon. This raises the question as to which visualization methods can best support the participation in the different planning phases: Are specific characteristics of the visualization – realism, dynamic navigation, interactivity – more important in one phase of the planning than in another?

Furthermore, planning discussions focus on different types of visual elements in the landscape. For example, planning questions can address the visual quality of a new wind turbine, which is a single landscape element, i.e. point information. On the other hand, they can be concerned with the best route for a new road or bicycle path, or the site for new hedgerow plantings, i.e. linear landscape elements. Questions may also consider the location and management of a nature reserve, i.e. area landscape elements. Thus, the question arises as to whether different visualization methods lend themselves better to the visualization of certain kinds of landscape features or information.

2.2 Visualization supports participation in the planning process

Research question: Which functions do the different visualization methods fulfil in public participation during the planning process, and what role does the facilitator play?

Conventional methods of public participation, such as open houses and public comment, have not been very successful in involving the public in the planning processes (SHEPPARD 2005a). Simply providing opportunities to participate in the planning process is obviously not sufficient to promote participation (BUCHECKER et al. 2003). Effective participation in landscape planning requires not only unrestricted and easy access to information that is relevant and meaningful to the planning, but it must also be presented in a form that laypersons find understandable und interesting (KUNZE et al. 2002).

Planning participation can be hindered when planning teams remain reluctant to include "ordinary people" in the process. Planners may prefer to focus on objective planning criteria rather than opening the discussion for subjective or even emotional issues which concern the public (LUZ 2000). Furthermore, expert-driven decision processes that seek technically correct solutions may not allow for public or local views and non-scientific information (SHEPPARD 2005b). Planning projects may also have a history that triggers unexpected emotional responses and attitudes among decision-makers and the public (LUZ 2000). Finally, a few decision-makers consider public involvement to be a contentious and inefficient process because it is expensive and has an unpredictable outcome (PERKINS & BARNHART 2005: 243).

The public, on the other hand, may not participate because of barriers of perception or information transmission, especially if the planning decisions are perceived as a “black box” (SHEPPARD & MEITNER 2005). Furthermore, when processes are not seen as transparent and the participants cannot follow their influence on the final decisions, participants are not motivated to become involved in the planning process (LUZ 1993). Sufficient time and resources are necessary to build public credibility or equity in the decision-making process (GREGORY 2002). During this process there is the danger that a divide will develop among participants between well-informed and uninformed groups (KAULE et al. 1994). Furthermore, individual stakeholder groups often vocalize their interests more effectively than the silent majority (KINGSTON et al. 2000). Finally, the lack of communication between different groups involved in planning, especially in the preliminary phases of a project, can lead to acceptance problems (LUZ 2000).

Visualization can play a key role in gaining public input in the planning process by focusing public discussion about planning ideas, guiding participants through the planning process, increasing environmental awareness, and improving communication (AL-KODMANY 1999a). Media, i.e. visualization, can also be used to improve communication and understanding by emphasizing important information, using multiple sensory modes, and by combining verbal and visual information (BUZIEK 2000). Ultimately, decision-making processes become clearer, more understandable, and more transparent when there is active public participation and more willingness among the public to adopt and implement decisions (V. HAAREN et al. 2008).

2.2.1 Legal framework for participation in the landscape planning process

Participation in planning is not just "nice thing to have"; it is a legal requirement which is anchored in international, European, and national legislation. The **UN Conference on**

Environment and Development in Rio de Janeiro in 1992 set the stage at a global level for a new era of environmental awareness and activism. Both Principle 10 of the Rio Declaration and Agenda 21 emphasized the importance of broad public participation in environmental decision-making.

Aarhus Convention

The Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, generally referred to as the Aarhus Convention, was adopted by the United Nations Economic Commission for Europe (UNECE). (It entered into force 2001) This laid the foundation for access to environmental information and the requirements for public participation in the decision-making process in Europe. The convention not only defines environmental information in broad terms but also stipulates the form in which environmental information should be accessible; this includes written, visual, aural, and electronic forms (Article 2). It also requires public authorities to provide information in the form specified by those requesting it. Furthermore, the promotion of environmental education and awareness among the public is one of the general provisions of the Convention (Article 3). Finally, the Convention does not specify exactly what provisions are necessary for public participation. Instead it lays down several rules which apply: authorities should provide opportunities for early participation; information is to be free of charge; and the decision makers must take “due account” of the results of the participation.

In 2006, the ‘Aarhus’ Regulation (Regulation (EC) N° 1367/2006) was implemented by the EU member states. This addresses the "three pillars" of the Aarhus Convention: access to information, public participation, and access to justice in environmental matters. The Aarhus Regulation requires European Community institutions and bodies to provide for public participation in the preparation, modification, or review of "plans and programmes relating to the environment". It also enables environmental non-governmental organizations (NGOs) that meet certain criteria to request an internal review under environmental law of acts adopted or issues not addressed by Community institutions and bodies. In Germany, the Environmental Appeals Act (German: *Umwelt-Rechtsbehelfsgesetz – UmwRG*, with the amendments which took effect on 1 March 2010) was ratified in order to incorporate into German law that part of the European Public Participation Directive 2003/35/EC of 26 May 2003 which deals with access to the courts of law.

Furthermore, the European Environmental Information Directive (2003/4/EC) and Directive Providing for Public Participation in respect of the Drawing up of Certain Environmental Plans and Programs Relating to the Environment (Directive 2003/35/EC) are implemented in German law in the Environmental Information Law (German:

Umweltinformationsgesetz) and the Environmental Impact Assessment Act (German: *Gesetz über die Umweltverträglichkeitsprüfung*). Also taken into account are the European EIA Directive (85/337/EWG) and SEA directive (2001/42/EC).

European Landscape Convention

The European Landscape Convention obliges the signatory states to establish procedures for the participation of the general public, local and regional authorities, and other parties with an interest in the definition and implementation of policies aimed at landscape protection, management, and planning (Articles 5b and 5c). The Convention defines the landscape as "an area, as perceived by people, whose character is the result of action and interaction of natural and/or human factors." This implies that the opinions of all groups should be taken into account. The active role of public consultation with regard to the perception and evaluation of landscape is also an important component of the Landscape Convention (DÉJEANT-PONS 2006).

Germany: Federal Nature Conservation Act

Article 1 of the Federal Nature Conservation Act (German: *Bundesnaturschutzgesetz*) formulates the responsibility to protect landscape and nature as a value in and of itself and as a basis for human life. The environment is to be conserved, managed, developed, and restored in order to safeguard:

- functions of ecosystems,
- the regenerative capacity of the natural resources,
- fauna and flora, and natural habitats,
- the diversity, characteristic features, and beauty of nature and landscape, as well as their intrinsic value for human recreation.

Furthermore, participation is central to ensuring that the democratic process is followed in decisions about the development of the environment. The lack of general agreement about how the landscape and nature should be ideally developed means that participation and the consideration of local knowledge, experience, and wishes about the landscapes is indispensable in a democratic society (V. HAAREN 2002b).

Article 16 of the Federal Nature Conservation Act stipulates that the states as well as the regional and local governments in Germany must produce a landscape plan. The landscape plan presents the existing condition of the environment, including information about soil, water climate, air quality, flora, fauna, and visual quality of the entire community. However, in most states the landscape plan is not legally binding. Its goals and objectives become binding only when integrated into town and country planning or when they are implemented by other means in the municipalities and districts or by citizens and NGOs.

The involvement of stakeholders and the public as well as the successful communication of planning information are essential for the plan's acceptance and success (KAULE et al.1994).

2.2.2 Definition of public participation

The term public participation has a range of definitions in the literature. In essence it means getting people involved in the decision-making process in an active and meaningful way. Public participation is a forum for communication between government, citizens, stakeholders, and interest groups, and for business about specific issues (RENN et al. 1995). For the most part, public participation in landscape planning involves intensive communication between government and community for the purpose of including citizens in the discussion about how to secure the protection, conservation, and wise management of landscape resources (HANSEN & PROSPERI 2005). The goal is to actively include the public in pending decisions in order to incorporate their wishes and opinions in the planning process (OPPERMANN & LANGER 2003). Two different motivations for participation are found in the literature: one is that participation makes the planning more effective and improves acceptance; the other considers participation a right which citizens in a democracy have in order to make their voices heard (PRETTY 1995; SANOFF 2000).

2.2.3 Forms of participation used in landscape planning

As participation is contextual in nature, it varies in type, level of intensity, extent, and frequency (SANOFF 2000). Many factors play a role in the choice of appropriate visualization methods in participatory planning. These include participation methods, group size and composition, and planning issue or phase. For example, small group situations such as workshops, round tables, and focus groups allow for more hands-on and flexible use of visualization. However, larger group situations, such as town meetings or public hearings, generally require a presentation format in which an LCD projector is used to view the computer visualization, whereby a technician translates the requests from the participants by manipulating the visualization at the computer. In this situation there is a “middle man”, or facilitator, running the visualization and interpreting the requests of the participants (BISHOP & LANGE 2005c). This situation requires a visualization that can respond quickly to the questions and flow of the discussion.

Public participation in the planning process is not new. However, its importance and methods have changed over the years. Participation has progressed from posters, brochures, and public meetings, in which citizens were minimally involved unless there was great opposition to a project, to the use of new technologies and opportunities for public involvement in decision making. Such e-participation and digital planning methods have the potential to increase transparency and involvement in the planning process. Emails, forums, and internet access to information in digital form allow citizens to give feedback and to access landscape visualizations outside of face-to-face participatory situations (V. HAAREN et al. 2005). These new technologies can complement conventional forms of face-to-face participation developed and tested in the 1980s and 1990s (BISCHOFF et al. 2005; SELLE 2000). (See CREIGHTON (2005) for an in-depth overview of participation methods and applications for planning.) Hansen and Prosperi point out three main developments which took place in the 1990s that facilitated public participation (HANSEN & PROSPERI 2005):

1. Growing awareness of the importance of the environment and the responsibility of citizens to support sustainable development
2. The emergence of the internet
3. Accessibility of Geographical Information Systems

Together with new visualization software and improvements in computer hardware, these developments have set the stage for the use of visualization methods in the participation process, both face-to-face and online.

2.2.4 Participants in the landscape planning process

In practice, landscape planning addresses a wide range of participants and interest groups with varying degrees of planning experience. Not only must governmental agencies and administrators comment on the planning measures, but political bodies must also make decisions about the content of the landscape plan. Public participation encompasses diverse groups such as environmental not-for-profit organizations, land users and property owners, citizens with an interest in the environment, as well as the general public. **Environmental groups** are an important lobby for the landscape plan, but they have relatively little political influence (BÖTTCHER & HÜRTER 1997). These groups are generally well informed about environmental issues but are often not open to compromise and are often seen in the discussion as nonconstructive (KUNZE et al. 2002). Because **land users and property owners** are often directly affected by the proposed landscape planning measures, this group often shows resistance to the landscape plan. It is therefore important that this group is involved in the process as early as possible and is well informed about compensation possibilities.

The **general public** is the largest, but not necessarily the most vocal group. Generally speaking, the public often has little interest in the landscape planning process because citizens perceive it as complicated or because they lack the knowledge and background information to understand the content and thus the relevance of the plan (KUNZE et al. 2002). In their study of participation in Swiss rural communities, BUCHECKER et al. (2003) found that, although local residents identify with their landscape, they do not feel responsible for its development and are less likely to get involved in public issues. Finally, some citizens do not communicate their ideas for fear of risking conflict.

While the general public is often reluctant to participate, citizens are nonetheless an important source of local knowledge about the landscape, and they are key in developing appropriate and acceptable solutions for local-level design and planning. Furthermore, citizens possess information about local culture and traditions which influence the use of the landscape. Finally, the subjective and emotional attitudes of this group toward the landscape and planning processes have an important influence on the success or failure of proposed planning (LUZ 2000).

2.2.5 Levels of participation

The degree of involvement of citizens depends on many factors, e.g. attitude of the stakeholders, importance of planning issues, and legislation. The scale and complexity of a project also play a role in the level of participation in which decision-makers are willing to engage. In large-scale, complex projects, for example, participation is often limited to informing the citizens, perhaps due to the large amount of information involved, and to limited resources (PERKINS & BARNHART 2005). Such projects often meet with public opposition because public participation in large-scale projects is often limited to the information level and proves to be too rigid, (SELLE 1994).

The Arnstein ladder of public participation (see Figure 2) provides a widely accepted model of the variations in government-to-citizen participation in which participation is seen as a fundamental right (ARNSTEIN 1969). The ladder describes eight levels or qualities of participation. At the bottom, no participation is possible, and at the top level, the citizens are empowered through public-authority partnerships in which the citizens are in control. Arnstein generalizes the levels of participation into three categories: at the bottom is ***nonparticipation*****,** in which governments are not genuinely interested in allowing citizens to participate. In such projects, visualizations are used to present or even “sell” final decisions to citizens or stakeholders without opportunities for input or influence on the decisions. Participation at this level is not likely to have any lasting positive effect on people’s lives (PRETTY 1995).

The middle rungs of the ladder represent ***tokenism*** in planning, in which the citizens are informed and consulted but lack power to implement their ideas. Visualizations that are intended to inform and to elicit responses fall into this category. At this level of participation, accurate and non-misleading visualization are employed (SHEPPARD 2001). Here, the use of visualization is either required or the advantages of visualization in communication have clearly been recognized.

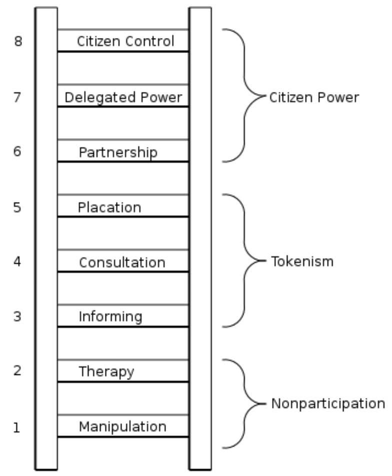


Figure 2: Arnstein ladder of public participation (ARNSTEIN 1969)

Finally, in the upper levels of the ladder there is ***citizen power*** with decision-making clout which Arnstein considers truly empowered participation. It is unrealistic to expect that visualization alone can empower citizens to this level of participation, but it can both assist in facilitating discussions and decisions, as well as mediate differing opinions, conceptions, and opposing ideas (PERKINS & BARNHART 2005).

Building on Arnstein's concept, Wiedermann and Fermers tie citizen involvement to the degree to which the authorities grant citizens rights in the decision-making process, each privilege building on the previous one. (see Figure 3) Here, informing the public is considered the initial form of participation. In a further development of the Arnstein view of participation, SMYTH (2001) added the communication technologies to this concept and identified at which level of participation various online communication technologies can be used in e-participation. Using the ladder typology for e-participation, the lowest level represents online access to information and services, and the top level is multi-directional and allows the sharing of information and interactive, co-operative discourse (HANSEN & PROSPERI 2005).

Increasing level of participation

Arnstein	Weideman & Femers	Smyth
Citizen power	Public participation in Final decisions	
	Public participation in assessing risks and recommending solutions	Online decision Support systems
Tokenism	Public participation in Defining interests, actors And determining agenda	Online opinion surveys
	Public participation in assessing risks and recommending solutions	Online discussion
Non-participation	Restricted participation	Communication barrier
	Informing the public	Online service delivery

Figure 3: Online resources support different levels of citizen participation. Source: Hansen & Prosperi (2005), based on Smyth (2001)

2.3 Evaluation criteria in participation: Functions of visualization

As the participation process offers different levels of involvement in the planning process, so can visualizations support different functions within participation which reflect the levels of participation, starting with **engaging** the public and raising interest in the planning issues. The visualization plays a central role in **communicating** planning information and ideas in the planning discussion. Furthermore, visualization can be a useful tool when citizens and planners engage in **collaborative** planning. And finally, visualizations and digital media offer many possibilities for **educating** the public about environmental and planning issues and can lead to a change in attitude or behavior.

2.3.1 Engagement

Landscape visualizations have a strong potential to attract attention and stimulate interest in the initial phases of participation. The novelty of computer visualizations can interest, attract, and engage people in collaborative learning processes (SALTER et al. 2009; SHEPPARD & MEITNER 2005). For example, animation such as the fly-over of a 3D model can draw participants and viewers into a discussion or awaken interest in planning issues (FREIBERG et al. 2002). Furthermore, AL-KODMANY (1999b: 45) found when participants see their ideas visualized, they become more engaged in the design process: "… as we saw ideas begin to take shape before our eyes we could feel the excitement rise. The pulse begins to beat a bit faster!" However, some visualization methods are more engaging than others. The visualization attributes which emotionally involve people in the topics appear to be realism, depiction of personally relevant environments, immediacy of situation, images of people and animals, and demonstration of the future consequences of action (SHEPPARD 2005a: 646). In summary, when the visualization raises interest in or awareness of the planning issues, or stimulates citizens to participate, then it fulfills the function of engagement in the participation process.

2.3.2 Communication

Communication is by far the most extensive function of visualizations in participation. Orland points out that visualization has emerged as a "common currency" in participation that is easy for the public to understand and evaluate (ORLAND et al. 2001). Traditionally, written reports, maps, and renderings of buildings have been used to communicate planning information to the public (BISHOP & LANGE 2005b). However, plans and reports are difficult to interpret and can be misunderstood. Photorealistic images communicate proposed planning and impacts more clearly (BOYD & CHAN 2002). Furthermore, participants often have different mental images of the proposed landscape measure (DRANSCH 2000) and visualizations can supply everyone with a common visual image of the planning proposal during participation (TAHVANAINEN ET AL. 2001).

Visualization can be used to communicate with planners, citizens, and stakeholders in a variety of ways:

- Inform (planner → citizen)

Planners provide citizens with information in all phases of the planning. Visualizations and visual simulations can illustrate large amounts of information in ways that are intuitively understood by the public (KWARTLER 2006: 310). Furthermore, images convey more detailed and meaningful information than the more abstract topographic resource maps, and may therefore elicit more meaningful responses.

- Consult (citizen → planner)

Citizens can both provide planners with local knowledge about the planning area in the inventory phases as well as give their opinions or ideas about planning goals and measures later in the planning. Visualization can provide a good means for obtaining meaningful public comment (MEITNER ET AL. 2005). However, thought must be given to how the citizen responses to the visualizations can be collected and assessed (PERKINS & BARNHART 2005), and how to make the incorporation of the comments into the planning decision process transparent (SANOFF 2000).

- Discuss planning issues with citizens and stakeholders (citizen ↔ planner)

Research confirms that landscape visualization can facilitate communication between professionals and the public (LANGE et al. 2008; WISSEN et al. 2008). The discussion between the public and planner using visual images makes it possible to integrate social and cultural information that is not always accessible to planners (ORLAND et al. 2001:

140).

Visualization can support the function of communication between planners and citizens in participatory situations in the following concrete ways:

Illustrate information

It is generally accepted that images can convey more information and in a more memorable way than other forms of communication. Landscape visualizations portray actual places with varying degrees of realism and show spatial relationships, as well as spatial and temporal variations in ecosystem conditions (SHEPPARD & SALTER 2004). As visualizations can be understood without special professional knowledge, they play a key role in effective public participation (TYRVÄINEN et al. 2006). Furthermore, the successful delivery of information also depends on how the viewer interacts with the information as well as the social environment (ORLAND & UUSITALO 2001). It follows then, that face-to-face communication is also an important aspect of successful communication when using computer visualizations.

Support orientation

Visualization can enable participants to recognize specific locations or objects in the landscape which correspond to their own knowledge of the site, thus supporting the validity of the visualization (MEITNER et al. 2005). Familiar landmarks also function as reference points for orientation, for example in aerial photographs. Furthermore, it has been found (HOGREBE 2003) that orientation is best supported by a combination of both two- and three-dimensional methods that complement each other.

Improve spatial understanding

Visualizations can give viewers a three-dimensional sense of the site, so that they can construct a three-dimensional mental image of the landscape. For example, a fly-through animation of the site can help locate the different viewpoints of photos or renderings of the landscape by flying from one to another. This not only supports viewer orientation in the site, but also places the different static views in context and promotes an overall understanding of how the individual renderings fit into the site. Furthermore, this kind of visualization facilitates the spatial orientation of participants who were unfamiliar with the study area (MEITNER et al. 2005).

Gathering local knowledge and stakeholder opinion

Visualization methods such as animations or panorama photos provide the "stage" for local residents to tell their stories about the landscape. When stakeholders familiar with the landscape watched an animation of it, they made comments about specific landscape features as they virtually passed them in the animation (MEITNER et al. 2005: 201).

Visualization can also be used to elicit information about culturally based perceptions of the local landscape. Work with First Nation citizens in Canada showed that visualizations were effective in gathering comments from citizens, regardless of age, technical training, or cultural background (SHEPPARD et al. 2004: 80).

Simulate planning proposals and illustrate landscape changes

In order to evaluate landscape change, it is important to see the changes in the context of the environmental setting. Before-and-after images have been used to visualize landscape change since the early nineteenth century, when HUMPHRY REPTON (1803) showed clients before-and-after views of perspectives of site designs in his Red Books. AL-KODMANY (1999) showed proposed planning as sketches in photos. He found, the part-real, part-created images of realistic photos provided a way of reflecting back to planning suggestions the participants had requested from the artist. Today realistic renditions of potential landscape change are possible with digital photos and sophisticated visualization software (BISHOP & LANGE 2005b; LANGE 1999). Nevertheless, the concept of assessing change through the comparison of existing and simulated future conditions remains the same. However, not all visualization methods visualize change equally well. LEWIS & SHEPPARD (2006: 309), for example, found that maps generated only modest responses, while renderings of the same scenario stimulated comments about preferences or concerns, and even caused some to change their responses due to additional information gleaned from the visualizations.

Illustrate temporal and non-visible aspects of landscape change

Furthermore, visualizations can show landscape change **over a long period of time** (landscape dynamics), not just immediate impact or before-and-after situations (CAVENS 2005). Visualization can also be employed to illustrate processes that are not visible or that occur in the dark, such as the movement of bats through their habitats (HEHL-LANGE 2001a).

Bridge cultural and language communication difficulties

Visual communication with photorealistic visualization methods may bridge language and cultural boundaries. In fact, it may also bridge the communication barriers between professional planners and groups with divergent cultural backgrounds, e.g. indigenous groups. LEWIS & SHEPPARD'S (2006: 311) work with Canadian indigenous groups (First Nation communities) found that 3D perspectives helped elders and community members to visualize the landscape and identify important features. Maps alone were not sufficient for communicating planning. They suggest that visualizations should depict the landscape as it is seen through the eyes of the affected community, in combination with maps.

Focus discussion

Participants bring different backgrounds and planning interests to a participatory session. Therefore, it is sometimes necessary to direct or focus the discussion on specific issues or sites. The visualization offers the possibility to direct attention to specific locations or parts of the planning area. Animation, before-and-after images, or pre-selected viewpoints force the viewer to address specific parts of the site. In some cases, the participants may focus on areas of the image where there is disagreement on larger changes, or on areas that are unclear (APPLETON & LOVETT 2005).

Document and illustrate results of discussion

Visualization offers possibilities to document discussion results or the consensus of a meeting, for example with electronic post-its or a screenshot of accepted planning measures. Citizen suggestions can be documented in concrete images, and comments can be located in specific sites. This can make the participation process more transparent. Illustrating participants' ideas in concrete terms helps reduce misunderstanding and promote more transparency in the planning process (TYRVÄINEN et al. 2006).

2.3.3 Collaboration

Current trends in participation are moving towards particpatory modes in which information is developed jointly (ORLAND et al. 2001: 140). In collaborative planning, the planners and participants share power and there is social learning and a consensus-oriented style of communication (HEALEY 2006). The potential to make the participant into a planner can be facilitated with digital information and visualization technology (KWARTLER 2006). Visualization methods that are suitable for collaborative participation need to be highly interactive and allow real-time movement (SCHROTH 2008). They must also be able to integrate different sources of spatial data and to illustrate changes in the environment in a realistic manner (TYRVÄINEN et aL. 2006: 820). Photorealistic and virtual reality tools help to make information and issues more transparent and understandable to the various stakeholders, thus allowing a more effective discussion in a participatory setting, which is a prerequisite for successful consensus building (BOYD & CHAN 2002).

2.3.4 Education

It has been argued that the emotional responses to visualizations may help to accelerate social learning and behavioral change, especially when participants can relate the visualizations to their personal context (SHEPPARD 2005b, 2006: 85). FURNESS III et al. (1998) and SALTER et al. (2009) suggest that interactive 3D visualization can be useful in motivating viewers to change their behavior. However, LEWIS & SHEPPARD (2006) question whether participants actually learn from the visualization or are just emotionally engaged in the visualized information.

The literature clearly identifies the importance of engagement, communication, collaboration, and learning in participatory planning, and the potential of the visualizations to fulfill these different functions. However, the question remains as to how well different visualization methods support the different functions of participation. For example, are some visualization methods better suited to stimulating initial participant interest, while others provide a better basis for discussion of planning measures in a town meeting?

2.3.5 Context: Role of the facilitator in the use of visualization

The visualization **does not stand alone** in the planning process. For the most part, it is presented in a context of explanations. For example, the visualization is accompanied with a written explanation in a report or explained verbally in a town meeting. Therefore, the communication skills of the planner play a crucial role in the participation process (V. HAAREN 2002a). Nonverbal forms of communication, i.e. body language, are also used to communicate information or attitudes (LANGE & BISHOP 2005). Therefore, the contextual situation is an important factor in how well the content and context of the visualization are understood.

Furthermore, how well the visualization supports different functions in participation also depends on contextual factors such as the facilitator, venue, and audience. The facilitator plays a central role in the integration of the visualization into participation (SALTER et al. 2009; SCHROTH 2008; WISSEN et al. 2008). Participants' attitudes toward the message of the visualizations are also influenced by the perceived neutrality of the facilitator and the trust placed in this person. More information is needed about the requirements that the facilitator must fulfill in order to use visualizations successfully in a participatory planning session.

3 Suitability of visualizations for communication in the planning process

Research question: How suitable are different visualization methods for supporting participants' understanding (cognition) of the planning content?

3.1 Communication with visualizations in the participatory process

As visualization is about communication, i.e. communicating information in a visual form, the principles of communication theory should also apply to visualization. Several models of communication have developed out of different disciplines. The idea that the message sent is not always the same message that is received, was recognized by Shannon in his research about telecommunications (SHANNON 1948) at Bell Labs in the 1940s (see Figure 4). The communication medium, e.g. visualization method, and how well the signal is transmitted play an important role in how well the message is received and understood by the recipient.

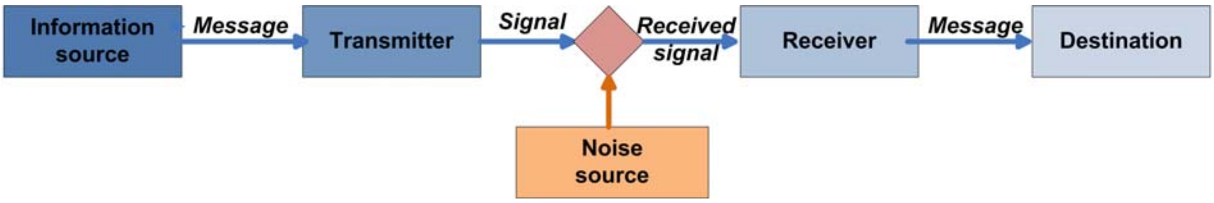


Figure 4: Communication model based on Shannon's telecommunication theory (SHANNON 1948)

In a model for communication developed by the philosopher and mathematician Norbert Wiener, he points out that the meaning of the message, how it is interpreted by the recipient, depends on cultural and social experience as well as aspects of the recipient's background knowledge (WIENER 1948) (see Figure 5). In the planning context, the information about the landscape (message) is communicated from the planner (information source) to citizens (destination), who perceive and understand it in the context of their cultural and social experience. The communication medium between the planner and citizens, whether visual or verbal, plays a key role in how clearly the message reaches the audience and what meaning it carries, i.e. how the landscape is perceived. Visual medium, however, may hold fewer linguistic and cultural barriers than a written or verbal message.

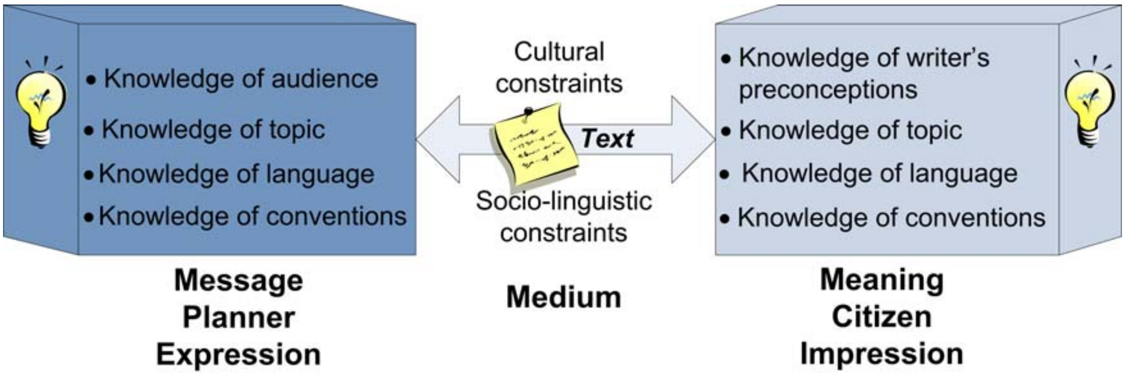


Figure 5: Communication theory model from Norbert Wiener. Adapted from STEINITZ (2010)

Visual perception accounts for over 80% of the information we perceive (BRUCE et al. 1996). Even though vision dominates, the other sensory systems also play a decisive role in communication. For example, auditory, tactile, olfactory, or gustatory senses can trigger an emotional response which can directly influence perception (WEIDENBACH 1999).

Visualization techniques are one medium for conveying information (the message) to the public. This medium is growing in importance in landscape planning, where it is proving to be one that can help solve the communication problems between experts and lay persons (see LANGE & BISHOP 2005). Furthermore, visualizations can make the participation process more accessible, improve understanding of the issues, and support decision-making (ORLAND et al. 2001). Images support understanding of the complexity of real-world situations by supplying visual information about the elements of the landscape and their interrelationships (WEIDENMANN 2002). Visualizations are generally thought to accelerate the mental processing of information, thus improving understanding by placing the information in context and making it easier to interpret the consequences of planning proposals. (SHEPPARD & SALTER 2004).

According to theories about cognitive information processing (see BUZIEK 2000), the human memory stores information in both pictorial and textural form. The separate information processing of linguistic and pictorial information is called double encoding (MANDL & LEVIN 1989; PAIVIO 1986). Double encoding improves the ability to remember the information and is supported when pictures and text, i.e. maps or images, are presented in combination with written or spoken information. Therefore, both images and words are important in developing an understanding of complex issues and storing them in the long-term memory (DRANSCH 2000). TAHVANAINEN et al. (2001: 65) used visual and verbal methods to compare visual perceptions with preconceptions of the effects of management on the landscape and found that people have different mental images when there is no visualization. Finally, repetition or elaboration of information helps people to remember information, i.e. move it to the long-term memory. A combination of media, e.g. maps, pictures, and text, increases the information about an object and emphasizes it. This suggests that important information should be presented with multiple forms of visualization.

3.2 Context of visualization influences suitability for participation

The question then arises as to what causes interference, i.e. what are the factors which influence the medium of communication “visualization” between the message and the meaning in the participatory settings?

3.2.1 Perception of visualization influences suitability

Visual perception is not only the sense that provides the most information about our environment, but it is also the sense in which we think. The other senses serve to supplement and confirm visual perception. The physical attributes of the eye and light determine what we can see. However, the cognitive process of how the brain interprets that information determines how we understand what we see (BELL 1999).

The subjective perception of the information which is communicated depends to a large degree on the experience and knowledge of the person receiving the information. An object is identified and recognized by recalling existing experience and knowledge. Depending on the available information and existing knowledge of the recipient about an object, it will be perceived differently (WEIDENBACH 1999).

We see what we want to see

Experience with visualization in transportation planning shows that people interpret the same visual image differently, depending on the viewers’ conception of the data and the display, personal background, and previous experience, as well as their cultural grounding (GARRICK et al. 2005: 7). People from different cultural backgrounds or those who live in different environments perceive the landscape differently, and respond differently to different kinds of visual presentation. Furthermore, a visual image may be constructed as much on "what an individual thinks he is going to see as on what is actually to be seen" (JAKLE 1987: 21).

Visual literacy of the audience

In the visualization of scientific information, experts (planners) and the lay public can share an understanding of visualizations only if there is a sufficient level of visual literacy. TRUMBO (1999) argues that visual literacy depends on visual learning, visual thinking, and visual communication. Participants have different experience and capabilities with visual communication or visualizations that require the ability to interpret 3D spatial qualities. When virtual reality (VR) visualization or online digital media is used, there is always the risk that part of the population is not computer-fluent and will be left out. For many viewers, a spatial understanding of the landscape requires that the viewer experience the landscape from several viewpoints (KARJALAINEN & TYRVÄINEN 2002).

3.2.2 Visualization is an interpretation

A visualization is an interpretation of the real world and thus an inaccurate portrayal of present or future landscape conditions. Sources of inaccuracy can stem from reduction in the complexity of the vegetation and landscape features in the computer model or from the uncertainty of predicting the conditions of future landscapes (LUYMES 2001). The simulation of future conditions is based on models and the translation of environmental data into images. No two individuals will produce exactly the same simulated visualization of the landscape (DANIEL 1992). Nevertheless, computer visualizations are arguably more objective than other kinds of visualizations.

No matter how accurate a simulation is, there is no guarantee that participants will interpret the visualization in the same way. The relationship between the simulation and the real-world landscape can be problematic when viewers make assumptions about the interpretation of the visualization (STEINITZ 1992). For example, photorealistic simulations carry the danger that viewers assume that it is reality because of the high level of perceived realism (LUYMES 2001).

When viewers assume that a photorealistic visualization is an accurate and transparent representation of the real landscape, then the simulation is considered authoritative, i.e. a reliable depiction of the future landscape (LUYMES 2001: 198). When authority is assumed, there is less chance that the viewer will question the assumptions or construction of the visualization. The viewer can also be blinded by the realistic image and the fascinating technology. The "wow" effect of novel visualization techniques can potentially overshadow the message and content of the visualization, or the realistic visualization can possibly raise unrealistic expectations about its accuracy (SHEPPARD & SALTER 2004). Therefore, it is important to acknowledge the potential for content and interpretation problems in the visualization, both in its production and presentation to the public (LUYMES 2001). However, thanks to their good local knowledge, stakeholders should not be underestimated in their ability to discern the potentially manipulative use of photorealistic visualization (SHEPPARD 2001). They are quick to discover inconsistencies of a visualization and have a healthy distrust of visualizations (TRESS & TRESS 2003).

3.2.3 Validity of visualization as communication medium

When the responses to the landscape visualization correlate with those made to the real-world landscape, then the visualization can be considered **valid** (DANIEL 1992). (See LANGE (2001) for a discussion of image validity.) Photographs have been found to be valid surrogates for actual landscape for judging visual quality (see BERGEN et al. 1998; STEWART et al. 1984). In addition, computer-generated images have also been found to have a high correlation to photos when visual quality is being judged (BERGEN et al. 1995). In the examination of the response validity of visualizations, the predominant belief is that the greater the realism, i.e. the level of detail and accuracy, the more valid the observer's responses to the visualizations (DANIEL & MEITNER 2001; SHEPPARD 2001; LEWIS 2006).

Validity problems can stem from inaccuracy of the visualization or from differing interpretation of the visualization (LUYMES 2001). Furthermore, because the human response to the existing landscape is not uniform, visualized landscapes will also evoke diverse responses (PERKINS 1992). In order to achieve trust in predictive scenarios, the scientific background and assumptions made in the creation of the visualization must be made transparent. Furthermore, the visualizations must be presented in a nonjudgmental manner (DOCKERTY et al. 2006).

3.3 Credibility concerns associated with visualizations

3.3.1 The process of producing a visualization

The process of producing a visualization involves different steps in which decisions must be made about the objectives, methods, and appropriate data. For example, questions must be made about what kind of data is necessary or available; and which sites, views, and locations should be visualized. All of these questions require that the parties involved in producing the visualization – planner, visualization expert, politicians, stakeholders – collaborate and communicate their ideas about the requirements for the visualization without misunderstanding. Furthermore, the decisions and assumptions made during the visualization process should be made clear to the public.

3.3.2 Visualization is not objective

Neutralilty

Ideally, the visualization is a neutral presentation of the planning situation; accuracy, objectivity, and transparency are thus important. However, visualization can be used as a rhetorical instrument to persuade, and consciously or unconsciously reflect certain institutional or societal values (LUYMES 2001; SHEPPARD 2006). Luymes calls for an "open" simulation in which the rhetorical nature of visualizations is not only openly addressed but also used to change public awareness or influence aesthetic preferences. SCHROTH (2008) also pointed out the importance of the neutrality of facilitator and of revealing the assumptions made by the visualization experts when visualizations are used in participatory situations.

Emotional response

The visualization can be used to evoke an emotional response. Sheppard makes the point that "visual imagery can be used to inform as well as to engage the emotions and influence behavior" (SHEPPARD 2005a: 638). The capability of images to reach the emotions of viewers has long been understood by the advertising industry. Furthermore, ORLAND & UUSITALO (2001) suggest that virtual environments aim to promote an emotional response by immersing the user in the illusion of the virtual reality. They also point out that this is a paradigm shift from the attempt to provide objective visualizations using GIS-based digital imagery tools. However, vivid visualizations also run the risk of upsetting people and triggering emotional reactions which could be counter-productive in participation (FURNESS III et al. 1998; NICHOLSON-COLE 2005). Nevertheless, the argument can be made for using visualizations of climate change-related sustainability issues to create an emotional response that stimulates personal identification with the landscape and promotes learning and even a behavioral change (SHEPPARD 2006).

Bias

Bias in the visualization can be a result of deliberate manipulation or unintentional inaccuracy. Furthermore, the person creating the visualization may make decisions about the appearance of the visualization which are influenced by personal ideas about the landscape. However, the greatest risk is that a realistic-looking visualization does not accurately reflect the data, i.e. the image is inaccurate but is perceived as accurate because it is photorealistic (SHEPPARD 2001; ORLAND et al. 2001). Today, technology provides very realistic, image-based representations of the landscape and vegetation, but concerns remain about how to create images that are accurate and scientifically defensible, especially when presenting changes in the landscape over time (CAVENS 2005).

When static images are used, the selection of views and viewpoints influence which areas are viewed and discussed. The choice of appropriate and unbiased view is essential to the credibility of the visualization. When the viewer has more control over the visualization, for example with VR landscape models, the risk of bias is reduced (SHEPPARD & SALTER 2004).

Finally, visualization may be worth a thousand words, but it does not tell the whole story (SHEPPARD 1989). By its nature, visualization emphasizes the visual aspects of planning over other planning issues such as biodiversity, recreational, environmental, and economic issues which must also be considered in the planning process. Furthermore, because the visual senses dominate our perception of the environment, it is important to realize that the visual image is very powerful in the communication process. It may overpower the other sensory modes – auditory, olfactory, tactile – which are also often important to consider in planning decisions.

3.3.3 Level of uncertainty

There is a strong risk that visualizations can imply greater certainty than is actually present in future predictions of landscape proposals (SHEPPARD & SALTER 2004). Participants need to understand with how much certainty future conditions can be predicted and how much editing of the information was necessary to produce the simulation (LUYMES 2001). Ways must be found to communicate the degree of uncertainty of a visualization (APPLETON et al. 2004).

3.4 Suitability criteria for using visualization in participation

The literature supports the idea that visual images or visualizations of the landscape can support planners in communicating planning proposals and landscape change to citizens in participatory situations. However, the potential “interference” that accompanies communication with visualization and the concerns raised about the credibility of visualization bring up the question of which criteria the visualization must fulfill in order for the audience to understand the message.

SHEPPARD (2001, 2005a) has formulated a general code of ethics and a guideline for visualization which specifies the standards for producing visualizations in a fair and credible manner:

- **Accuracy**: Realistic visualizations should simulate the actual or expected appearance of the landscape as closely as possible, and visualizations should be truthful to the data available at the time.
- **Representativeness**: Visualizations should represent the typical or important range of views, conditions, and time frames in the landscape that would be experienced with the actual project, and provide viewers with a range of viewing conditions.
- **Visual clarity:** The details, components, and overall content of the visualization should be clearly communicated.
- **Interest**: The visualization should be defensible by following a consistent and documented procedure, by making the simulation process and assumptions transparent to the viewer, by clearly describing the expected level of accuracy and uncertainty, and by avoiding obvious errors and omissions in the imagery.
- **Access to visual information**: Visualizations (and associated information) that are consistent with the above principles should be made readily accessible to the public in a variety of formats and communication channels.

Beyond Sheppard’s guiding principles for good visualization, which provide an important ethical framework, the question remains as to which requirements visualizations must fulfill so that participants can use them successfully when communicating about planning issues. What are the basic requirements that participants place on visualization? It is hypothesized that visualizations must fulfill basic prerequisites in order to be suitable for use in participatory situations, and the four following criteria are considered essential:

1. **Spatial understanding**: People must understand what they are seeing.

   The participants must be able to picture the landscape that is portrayed in the visualization in their "mind's eye". In other words, the visualization must provide the viewer with a spatial understanding of the visualized area.

2. **Orientation**: People must understand where they are.

   The participants must be able to orient themselves in the visualization. Being able to recognize and locate oneself in the landscape is fundamental to being able to use the visualization in the discussion and participation.

3. **Assessment of change**: People must be able to understand the proposed landscape changes.

   In order to use the visualization to assess planning proposals and landscape change, the participants must be able to recognize the landscape changes that may occur as a result of the proposed planning measures.

4. **Credibility**: People must consider the visualization to be a fair and accurate representation of the planning and landscape.

   The participants must trust the visualizations. A visualization that participants do not believe or do not consider credible is a waste of time.

Spatial understanding, orientation, the ability to assess change, and credibility are considered to be basic suitability criteria for visualizations in citizen participation. The capability of different visualization methods to fulfill these basic criteria needs to be tested in the context of the planning process.

4 Landscape visualization characteristics and techniques

Research question: How important do participants consider the different visualization characteristics – realism, dynamic navigation and interactivity – for understanding the planning content and issues?

Throughout history, man has visualized the landscape in paintings, photos, maps, and models. (For a review of the history of landscape visualization, see LANGE & BISHOP 2005.) There are numerous types of visualizations with different capabilities, characteristics, and requirements. Analogue and digital methods are available, as are non-GIS-based and GIS-based visualizations, and static or dynamic displays. Some low-end visualizations require little technical background to produce, while other, high-end visualizations require both extensive experience with visualization programs and powerful computers to produce suitable results. However, all represent the basic elements of the landscape – terrain, vegetation, water, atmosphere, built structures, animals and people – with varying degrees of realism and flexibility (ERVIN & HASBROUCK 2001). Furthermore, there is a variety of output possibilities, e.g. rendering, animation, panorama, VRML model. It should be noted that all visualization methods have one thing in common: No matter how credible they appear, they are an abstraction of the real landscape. This fact is important to remember when using visualizations in participation.

This chapter gives an overview of the different visualization options that includes both the characteristics of the visualization which are important to the viewer, such as realism and interactivity, as well as the different types of visualization that are available, while focusing on the visualization methods used in this investigation.

4.1 Characteristics of visualization methods

The variables which influence the planning process and the technical factors that determine the characteristics of the visualization present many alternatives. There is great variation in the technical requirements, for example in the output and data requirements, and in the capabilities of the visualization methods to produce realistic or interactive images. At a practical level, the scale, level of detail, perspective, and degree of interaction must be considered in the preparation of a visualization (PAAR et al. 2004). The rapid development of the technologies provides increasing options for the visualization. Despite the great variety of these options, visualization methods can be characterized by their dimensionality, level of realism, navigation possiblities, and level of interactivity.

4.1.1 Dimensionality – 2D versus 3D

Two-dimensional visualization methods such as maps, plans, and aerial photographs are traditionally used to communicate information to citizens. The third dimension, or vertical Z value (height or depth) is not portrayed in two-dimensional visualizations. The observer must interpolate or calculate the third dimension from two-dimensional information. Generally, the public finds it difficult to develop 3D mental images from 2D maps and plans. Furthermore, even when given supporting written or verbal information, individuals still have different mental images of the landscape when using two-dimensional visualizations (APPLETON & LOVETT 2005). In a three-dimensional model, the volume of space is described through a third axis, and each point has three coordinates (x, y, z). The model shows width, depth, and height. For the purposes of this study, images of the landscape such as photographs or renderings, although flat on paper or a computer screen, are also considered to provide a three-dimensional view of the landscape and thus are referred to as three-dimensional visualizations.

4.1.2 Realism

The general public can understand and recognize a realistic portrayal of the landscape most easily. Therefore such visualizations are especially effective for communicating visual change to lay audiences (BISHOP 1994; KARJALAINEN & TYRVÄINEN 2002; BISHOP & LANGE 2005b). A higher degree of realism in a visualization is associated with increased level of detail, as well as with more specific textures and geometry than those used in modeling the landscapes (DANAHY 1999). A realistic landscape visualization has the advantage of providing a great deal of information about the site in a single image. It can also give the viewers a sense of familiarity with the landscape and thereby help them to orient themselves (BISHOP 1994). Furthermore, realistic visualizations tend to evoke a more emotional response among participants and help participants to recall experiences associated with landscape change (SHEPPARD & SALTER 2004; LANGE et al. 2005).

Although a high level of realism has many advantages in landscape planning, for example in the assessment of landscape visual quality (DANIEL & MEITNER 2001), it can also be distracting in discussions by inviting the "What is wrong with this picture?" effect when participants focus on incongruent details. In fact, people's reaction to a realistic visualization may differ depending on their familiarity with the site (LANGE 2001). For example, local residents may be very aware of discrepancies in a photorealistic visualization of a familiar landscape. For this reason, it is important to make clear whether a realistic visualization portrays a specific (georeferenced) or a generic (geotypical) site. (DISCOE 2005; APPLETON & LOVETT 2005). Finally, realism requires detailed data which in turn require more time and processing power, i.e. increased cost.

The question of how much realism and detail are necessary to convey planning information has been addressed by many researchers (APPLETON & LOVETT 2003; PAAR et al. 2004). APPLETON & LOVETT (2003) found that the degree of detail in the foreground of a picture, especially of vegetation, and the texture of the ground surface have a significant effect on the degree to which the image is perceived as realistic. It is important that the realistic details of the visualization coincide with the viewers' image of the real world; otherwise, the overall visualization is placed in question. The work of HOFSCHREUDER (2004) suggests that a medium level of detail is sufficient for assessing the structure and beauty of a landscape. SALTER et al (2009) also found that a lower level of realism is sufficient for discussing design concepts.

The degree of realism and detail that can be portrayed in the visualization also depends on the resolution and accuracy of the base data. There is a danger that powerful visualization techniques can produce very realistic images, while the data is not as precise as the image (APPLETON & LOVETT 2005; LANGE 2005; WILLIAMS et al. 2007). The certainty of the simulation of future landscape conditions also plays a role in how detailed or realistic a visualization should be. The public may not be able to differentiate between high levels of realism of photorealistic simulations due to uncertainty about the level of accuracy (LUYMES 2001).

Ultimately, the necessary degree of realism or abstraction depends on the purpose of the visualization, i.e. what message is being communicated. It should convey enough information for understanding the environmental issues and planning questions and provide a visual basis for formulating an opinion and making decisions that are appropriate for the phase of planning as well as the planning question. Although the question of sufficient realism has been explored, there is little research about how important participants' perception of realism is. Knowledge about this would shed light on the necessity for realism in the participation process. This investigation therefore explored not only the question of how realistic are the different visualization methods perceived by participants, but also how important the participants consider realistic visualizations for understanding the planning content.

4.1.3 Dynamic navigation (static image versus dynamic displays)

Static images

Static images require that the person producing the visualization makes decisions about the view location, direction, and size. The choice of viewpoint for a static image can make a great difference in the perception of the landscape. The viewers' impression of the landscape can be influenced not only by what is shown but also by the choice of camera angle, position, and other parameters (WERGLES & MUHAR 2009). However, the choice of viewpoints also depends on planning issues, important landscape features, available data, and on the interest and ability of the audience to image the landscape from the different views (APPLETON & LOVETT 2005). Still images of the landscape use one of three viewpoints:

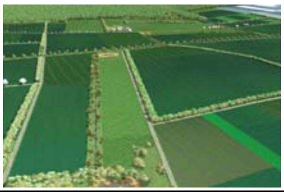
Plan view (directly overhead): The plan view provides an overview with a "detached or indifferent" perspective. The benefit is good orientation in the overall landscape. The disadvantages lie in the fact that the three-dimensionality of the landscape is lost, as it is flattened into a perspective which is seldom experienced and potentially difficult for citizens to comprehend.

Bird's-eye view (aerial oblique): This viewpoint is situated at a high angle above a 3D model or landscape. It is an unusual perspective, but it provides a three-dimensional perspective that is orthographically or dimensionally correct. The disadvantage lies in the fact that some areas of the landscape are more visible than others. This view serves as good initial image in order to show the landscape context and to explain landscape elements in the visualization (APPLETON & LOVETT 2005).

Eye-level perspective: The (adult) eye-level view evokes the most emotion and recognition of the landscape elements. However, the view of the landscape is limited by foreground elements. The fact that most of the landscape is not visible can make orientation in a larger site difficult.

The viewpoint, i.e. camera position, of the static image plays an important role in determining what kind of information the visualization can portray (DANAHY 1999). MEITNER et al. (2005) define three categories of images based on different camera positions which are used in forest management (see Table 1).

Table 1: Viewpoint determines the kind of information a visualization can convey (adapted from MEITNER et al. 2005)

	Static image type	Elevation of camera	Foreground
	Strategic overview	200 m, far from subject matter	Not displayed
	Focus on landscape patterns and spatial relationships	1 to 200 meters	Displayed but not prominent
	Sense of place	Eye level or slightly elevated	Human scale, detailed information visible

Dynamic navigation

Visualization methods can produce a static image that represents the landscape from a set viewpoint or as a real-time model in which the viewer can move freely through the landscape. In this thesis, the movement around and through a real-time model is referred to as **dynamic navigation**. The advantage of dynamic navigation over static images is that the viewer has the power to decide which areas are viewed (SCHROTH 2008). Being able to move through the visualization and to determine what is seen avoids the danger that the producer of the visualization may select beneficial views of the planning (LUYMES 2001). Furthermore, this flexibility of seeing different views would be very costly and time-consuming to reproduce with photomontages (BISHOP et al. 2001).

Dynamic navigation can involve spatial changes, for example in scale, by “zooming” in and out of a panorama or aerial photo. Navigation can also include “panning” the landscape, in which the viewer can change the direction of view from a stationary standpoint. In a virtual model the viewer can navigate freely or “jump” to defined viewpoints or positions in the model. In the case of animations, this movement is restricted to a pre-defined path. The possibility to move through the landscape provides flexibility to address the questions of the participants and help demonstrate spatial relationships (SCHROTH et al. 2005).

On the one hand, DANAHY (1999) argues that dynamic navigation reflects a person’s visual experience in the landscape, which involves moving and viewing objects of interest, using one’s peripheral vision, and picking up on spatial cues. On the other hand, people do not move in a model as they would in real life. For one thing, there is rarely free movement at ground level, and a fly-through does not reflect normal human movement. Furthermore, remaining oriented in the model while trying to understand the information it contains presents a challenge for many viewers (BISHOP et al. 2001). In addition, viewers have difficulty orienting themselves if the movement through the model is jerky because of low frame rates. For smooth movement, the frame rate should be over 15 frames per second (ERVIN & HASBROUCK 2001). Finally, when movement through the model is too fast, viewers may not have enough time to examine the landscape sufficiently in order to make planning decisions (PERRIN et al. 2001).

The self-determined exploration of the landscape provided by dynamic navigation promotes a democratic and transparent visualization of the planning. However, user disorientation in the model or the danger that the users do not "visit" important areas of the site are potential drawbacks of dynamic navigation (BISHOP et al. 2001). Furthermore, the trade-off between a realistic image, which is possible with static images, and dynamic navigation through real-time models, which have limited realism, raises the question of how important dynamic navigation is in participation. Are citizens able to understand and assess the planning issues using a single image from only one viewpoint? Or do they need images from multiple viewpoints? Or do citizens want to determine the viewpoint themselves? In an attempt to better understand the importance of dynamic navigation for participation, the investigation poses the research question: How important do participants consider dynamic navigation for understanding the planning content and proposals?

4.1.4 Interactivity

In this thesis, a distinction is made between dynamic navigation, the movement through a real-time model, and interactivity, i.e. changing the model or the underlying data and thus changing the content of the visualization. When the user navigates through a model, he or she changes the viewpoint. However, when the user changes the actual content of the visualization, e.g. "plants" trees, removes a building, adds comments, then the visualization is considered interactive.

Interactivity can range from a limited toggle function, in which prepared planning alternatives can be selected (MILLER et al. 2008), to undertaking alteration of atmospheric or seasonal conditions (BISHOP & MILLER 2007), to asking "what-if" questions of planning scenarios (SALTER et al. 2009), which constitutes an advanced level of interactivity. Software programs have become available that couple the visualized scenario with an underlying database. For example, programs such as CommunityViz® from Placeways, LLC (PLACEWAYS 2010) and What if?™ (KLOSTERMAN 2010) allow users to develop their own scenarios which are then visualized on the fly. This kind of interaction requires the computer system to redraw the images so that the users can see their suggestions or alternatives visualized immediately. For this reason, these visualizations have a lower level of realism. However, they have been proven to be sufficiently realistic for the planning discussion (STOCK et al. 2007; SALTER et al. 2009).

Interactivity is an important aspect of the visualization for discussing planning alternatives because it can support understanding and collaborative decision making (SCHROTH 2008). Ideally, citizens should have the possibility of seeing their ideas or their suggestions for changing the existing proposal visualized. This level of interactivity was yet not available at the time of the research for this thesis. The visualizations used provided a very limited level of interactivity. Participants were able to interact with the visualization by turning prepared simulations of proposed measures "on and off" in order to see before-and-after views of the planning measures.

In his research about interactivity, SCHROTH (2008) points out that, for technological reasons, the more interactive a visualization is, the less realistic it will be. For this reason, images with a very high level of realism are usually rendered as static images. If there must be a trade-off between realism and interactivity of the visualization methods, which is more important? This raises the question of how important interactivity of the visualization is in the discussion of planning options with citizens. In order to clarify this situation, the investigation pursued the question: How important is interactivity for participants to understand the planning content?

4.2 Landscape visualization techniques suited for landscape planning

A review of current visualization techniques reveals that a variety of output types is available for use in participation. These range from paper printouts of data and maps, to photographs and digital outputs which can be viewed on a computer screen or with an LCD projector. Visualizations come in different formats, such as: JPEG images; QTVR format for animations, movies, or panorama photos; and VRML format for real-time models. A brief overview of available visualization methods follows. All except immersive techniques were used in the investigation.

4.2.1 Aerial view (2D): maps and aerial photographs

Maps depict a planimetric view and show information from an aerial viewpoint. The information is presented in varying levels of abstraction, from symbols in a topographic map to photographic representations of information in aerial photos. Digital maps and aerial photographs offer an overview of the existing situation and help participants to orient themselves.

2D maps

Although maps provide a good basis for analytical work, there is great variation in how well viewers understand them. The literature suggests that lay people have difficulty understanding maps. Furthermore, maps fail to communicate landscape change to lay audiences (Appleton & Lovett 2005; Lewis & Sheppard 2006; Tress & Tress 2003; Wissen et al. 2008). Experts, on the other hand, understand maps better than lay people (Monmonier 1999). Research also suggests that experience using maps plays a role in how well viewers understand information displayed in maps and how well they can translate maps into mental images of the landscape.

Maps are important for situating and showing the direction of the viewpoints as well as for identifying landmarks in relation to the planning proposals (Appleton & Lovett 2005a). Maps also provide contextual information which helps users to orient themselves and to identify planning issues.

Lange et al. (2005) contend that cartographic representations appeal to the rational consciousness and are especially useful for discussions about rational or objective topics, such as orientation and location. On the other hand, Jorgensen (2001) found that maps supply the "visual minimum variables" that people need in order to make an aesthetic assessment of the landscape. The question then remains: What is the role of maps and aerial photographs in participation? Are these traditional methods of communicating information compatible with the newer 3D visualization methods?

Aerial photographs

Many people find aerial photographs easier to understand than maps, possibly because photographs provide more clues about the landscape. People with low map-reading skills tend to prefer photorealistic landscape visualizations (Schroth 2008). The realistic representation of landscape elements in aerial photos helps viewers to recognize landmarks and to orient themselves.

4.2.2 Artist

Sketches can be considered a “low-end”, interactive visualization method that requires little technical equipment, although drawings can also be created with an electronic sketch board and saved as electronic files. The artist can quickly transform ideas into drawings as an interactive response to impulses from the participants in “human real time”. The interaction with the artists can also help to identify critical issues, constraints, and opportunities in the planning process. Finally, sketches provide the possibility to record nonvisual comments and suggestions from the participant.

On the one hand, drawings may be more understandable than maps for laypersons. On the other hand, drawings lack georeferencing of the landscape features. This and the potential for the artist to influence the drawing, may affect the accuracy of the visualization and thus its credibility to participants. Finally, successful use of sketches in participation depends not only on the artist's talent, but also on his or her familiarity with the site and planning issues.

Because sketches are clearly abstractions of the landscape, they may be most appropriate for a geotypical visualization, one that expresses a generic image of the landscape (O'RIORDAN et al. 1993). AL-KODMANY (1999a) suggests that they are most effective during the brainstorming phase because they are flexible and abstract. Table 2 summarizes the characteristics of sketches in relation to planning use.

Table 2: Overview of the visualization characteristics of sketches

Sketches	
Characteristics	**Description**
Realism	Black-and-white sketches are an abstraction of the landscape. There is no georeferencing of the planning measures drawn.
Navigation	- Static. (different perspectives allow the possibility to view the planning area from different points of view) - Viewpoints: any viewpoint possible
Interactivity	Sketches have a high potential for interactivity. The artist can sketch the suggestions of the participants. The visualization is not limited to visualizations of planning measures that have been prepared in advance. New ideas or planning measures can be illustrated on the spot.
Illustration of invisible processes	Invisible processes can be explained with color or arrows. Comments can be captured in explanatory sketches.

4.2.3 Photos (oblique photos, panorama photos, photomontage)

Photographs

Digital photographs are useful for documenting landscape conditions because they capture a great deal of information at little expense (SHEPPARD et al. 2004). They are easy to produce, very realistic, and easy for the public to understand and recognize landscape elements. In landscape planning, photographs have been used traditionally in landscape visual preference studies (HULL & STEWART 1992; PALMER & HOFFMAN 2001). However, photographs are generally limited to views from locations where one can use a camera.

Furthermore, by the nature of the lens, photographs restrict the field of view and thus limit the contextual information associated with the view.

Panorama photos

Panorama photos extend the peripheral vision of the viewer, allowing a 360° view of the landscape from a fixed point. The ability to zoom in and out gives the feeling of movement in the landscape. Panorama photos have the advantage over photos or photomontages that the 360° view allows the viewer to select the view direction. Table 2 gives an overview of the characteristics of panorama images and their potential for use in planning.

A panorama photo is not difficult to produce. A series of overlapping photographs, taken in a 360° circle, are virtually stitched together with a special software. The resulting 360° photo can then be exported in a Quick Time Virtual Reality (QTVR) format so that the viewer can steer the direction of the view with the mouse. It is also possible to link additional information or panorama photos over “hot spots” so that the viewer can “jump” from one view point to another. (See Figure 6) Furthermore, visualization programs such as VNS offer the possibility to export the renderings in QTVR format so that the simulation can also be viewed as a panorama photo.

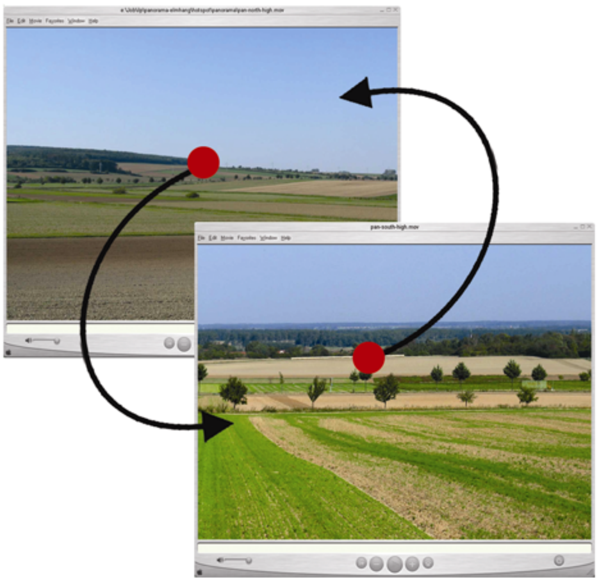


Figure 6: Panorama photos from different viewpoints are linked through “hot spots” which allows viewer to view the landscape from different viewpoints.

The panorama photo offers the possibility to present 3D content in the web inexpensively. Panorama QTVR files are easy to use and are the most frequent form of virtual reality content found in the internet (RIEDL & SCHRATT 2003). In comparison to other VR methods, it is easy and inexpensive to produce, but the viewer can observe the virtual landscape from only one viewpoint. Panorama photos also lend themselves to visual quality assessment where the visual context is important.

Table 3: Overview of the visualization characteristics of panorama photos

Panorama photo	
Characteristics	**Description**
Realism	Photorealistic image. The viewpoint of the panorama photo can be georeferenced.
Navigation	- Viewpoint remains stationary, but the direction of the view can rotate 360°. By zooming in and out of the photo, there is an impression of moving forward and backward in the picture. - Viewpoint: elevated or normal pedestrian view, depending on the possibility to make photographs.
Interactivity	No change can be made in the picture.
Illustration of visible and invisible processes	Explanatory information, i.e. text and diagrams is linked to the picture.

Photomontage

Photomontage is used extensively in the planning and design professions and has a long tradition in landscape simulations (JESSEL et al. 2003; LANGE 1990, 2002). It offers the public a realistic simulation of landscape change in the context of the existing landscape from actual viewpoints (STAMPS 1992). Photomontage is especially useful when the planning discussion focuses on specific views or landscape elements and realism is required (KARJALAINEN & TYRVÄINEN 2002; LOVETT in publication 2011; SHEPPARD 1989). See Table 4 for an overview of the visualization characteristics of photomontage.

In a photomontage, the image is altered or new elements are introduced in order to simulate landscape change using an image processing program such as Adobe Photoshop®. Photomontages can be produced inexpensively and with little technical know-how. The ease with which a simulation preparer can master photo manipulation software is a considerable advantage over more sophisticated applications (SHEPPARD et al. 2004: 75; DOCKERTY et al. 2006). However, the process cannot be animated, i.e. each view must be created separately.

Furthermore, a photomontage relies considerably on the artistry and "reasoned assumptions" of the preparer (SHEPPARD et al. 2004: 75). The realistic and convincing images are ultimately an artist's rendition of the future landscape and hold potential for misunderstandings about the difference between existing and simulated landscape features. Therefore, it is important that citizens be able to differentiate between the simulated planning measures and the existing landscape (ERVIN & HASBROUCK 2001; JESSEL et al. 2003).

Because photomontages are very realistic but not linked to the underlying data, there will always be an issue about their accuracy and credibility in participation (BERGEN et al. 1998: 289). Finally, the photomontage does not provide the analytical capabilities offered by GIS-based images (DOCKERTY et al. 2006).

Table 4: Overview of the visualization characteristics of photomontages and their capabilities for use in participation

Photomontage (with pan function and enhanced with LaViTo)	
Characteristics	**Description**
Realism	Photorealistic image. Visualized measures are not georeferenced. The image appears very realistic due to the photo image, but the location of the measures is approximate.
Navigation	- Static navigation. Fixed standpoint with approx. 180° rotation of view. Zoom possible. - Viewpoint: elevated or pedestrian perspective. Up to 360° view. (180° used here.)
Interactivity	Because of the layers of the photomontage, it is possible to select the measures individually and turn them on and off. Users can combine the measures as they like but it is not possible to visualize new ideas or measures.
Illustration of visible and invisible processes	Invisible processes such as soil erosion can be illustrated with colors or shading.

4.2.4 GIS-supported visualization types

Linking spatial information as GIS data to the visualization ensures accurate positioning of elements in the landscape and provides more flexibility in the output visualizations. A GIS-based 3D model visualization has the advantage that it can both produce georeferenced images from any viewpoint and generate new images when there are changes in the planning measures. Furthermore, GIS-based real-time models allow the viewers to move freely through the virtual landscape. The analytical possibilities of GIS systems that are linked to visualization tools help to make the planning and decision process more transparent and accessible for participants (TYRVÄINEN et al. 2006).

Renderings of 3D Computer Model (VNS)

Rendering is the process of creating images from a three dimensional model (ERVIN & HASBROUCK 2001). Both a digital elevation model (DEM), which provides information about the terrain, and GIS-data are required. Visualization software such as Visual Nature Studio (VNS) from 3DNature can apply textures to the GIS data to represent vegetation, which produces realistic-looking views of the 3D landscape model. These realistic simulations are very credible and easily understood by most participants in rural communities (APPLETON et al. 2002). (See Table 5 for an overview of the visualization characteristics associated with renderings produced with VNS.)

Table 5: Overview of the visualization characteristics of a rendering produced with VNS software and enhanced with LaViTo

VNS rendering (enhanced with LaViTo)	
Characteristics	**Description**
Realism	Close to photorealistic (depending on time and effort). The software offers the capability to represent the landscape and its structure (e.g. vegetation, streets, topography) in much detail. The use of GIS data ensures the correct location of the planning measures in the rendering.
Navigation	- Static images. (Not suitable for dynamic navigation of 3D model or on-the-fly changes of model.) Animation possible but only along pre-established path. - Viewpoint: bird's-eye or eye-level perspective. Flexible camera viewpoint possible. Rendering of any perspective possible.
Interactivity	The image of the rendering cannot be altered or interactively changed. Through the use of LaViTo the viewer can combine the different measures that have been visualized, but new content cannot be visualized.
Illustration of visible and invisible processes	Schematic illustrations (arrows, cross-hatching, etc.) are possible to illustrate on the Digital Terrain Model (DTM).
Special characteristics	High-end visualization system useful for photorealistic simulation of the landscape.

GIS-supported visualizations have the advantage over photomontage in that new renderings can be easily generated where there are changes in the planning, i.e. GIS data. Different stages of development can also be visualized by changing the textures which are linked to the GIS data. Once a model of the planning area has been produced, images from any viewpoint can be generated without additional effort (see Figure 7). Furthermore, 3D computer visualizations provide the ability to simulate landscapes which are difficult to access (WANG et al. 2006). Finally, the link to the underlying data ensures accuracy about the location of the landscape change.

However, the rendering of a realistic image requires computing time and cannot be done on the fly during a meeting. Therefore, as with the photomontage, viewpoints must be selected in advance and must be justifiable and transparent. Furthermore, the rendering is not completely without artistic license. Although the textures used in a rendering may look very real, they remain an artist's interpretation of the landscape (APPLETON & LOVETT 2005). Even though a simulation attempts to make an educated guess about the future based on expert knowledge and data, a rendering remains an estimation (ORLAND 2005). The more realistic the rendering, the more danger there is that the viewers will not recognize the uncertainty of the image (APPLETON & LOVETT 2005). Finally, software such as VNS requires extensive training, experience, and regular use to make it work efficiently (SHEPPARD et al. 2004).

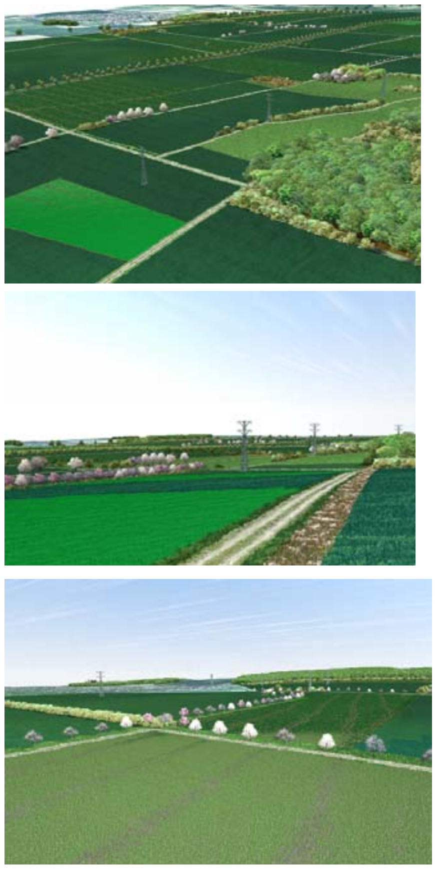


Figure 7: Different camera positions allow different views of 3D model (software VNS)[3]

VRML Model

Virtual Reality Modeling Language (VRML) is a modeling language for constructing web-based 3D models, and it provides an inexpensive and versatile technology for visualizing 3D models of landscape change (PULLAR 2002). As with the VNS rendering, a VRML model requires a DEM, GIS spatial data, and related textures. The virtual 3D model can be viewed using an internet browser with the help of a plug-in player. (See Table 6 for a description of the visualization characteristics of a VRML model.)

The viewer can move freely through the model and view the landscape from eye level or a bird's-eye view. The movement is in real time, i.e. the images or frames are produced as fast as in a film and the views are not delayed. There is a trade-off between the detailed rendering of each frame and the movement through the 3D model. Because real-time models must create imagery at up to about 30 frames per second, they are usually very simple and stylized. It is argued that the VR viewing experience increases public interest

[3] Visualizations prepared by Anne Hebsaker.

and engagement in the participation process (APPLETON & LOVETT 2009; BISHOP 2005; SCHROTH 2008). Furthermore, interactive landscape models may actually support communication about landscape-related issues by helping participants to understand the context of the issues as well as helping construct common mental models (DRANSCH 2000; WISSEN et al. 2008).

Table 6: Overview of the visualization charactistics of a VRML model produced using Scene Express software from 3D Nature

VRML Model (Scene Express from 3D Nature)	
Characteristics	**Description**
Navigation	Dynamic navigation, real-time internet use with the CosmoPlayer. Viewpoint: any part of a VNS project can be exported into a VRML file. All the camera points in VNS can be serve as predefined viewpoints in the VRML model.
Realism	Realistic, but not as detailed as a photorealistic image. (The VRML model uses less detail than the VNS project.) The planning measures are georeferenced.
Interactivity	In order to visualize changes in the planning measures, the VRML must be exported from VNS again.
Illustration of visible and invisible processes	Incorporation of additional information at "hot spots.“
Special characteristics	Dynamic navigation in real time.

Lenné3D® / LandXplorer

Lenné3D is a real-time model that provides the viewer with a highly detailed and realistic view of the landscape. Lenné3D, which was developed in cooperation with the Center for Agricultural Landscape and Land Use Research (ZALF)[4], can visualize landscapes with a realistic portrayal of vegetation and its distribution in the landscape. The 3D player makes it possible for the viewer to "take a walk" through the landscape and view a highly realistic rendering of vegetation in real time.

LandXplorer is a real-time model with interactive cartographic visualization functions for large-terrain models (PAAR 2003) that supports navigation through the large-scale model of the landscape. Lenné3D software links the real-time "walk through the landscape" of Lenné3D with the large-scale, GIS-based VR model of LandXplorer. Table 7 summarizes the visualization characteristics of both Lenné3D and LandXplorer and their capabilites for supporting participation.

[4] Lenné3D was developed by the ZALF and tested in the Königslutter case study.

Table 7: Overview of visualization characteristics of Lenné3D and LandXplorer

LandXplorer/Lenné3D	
Characteristics	**Description**
Navigation	Dynamic, real time. Viewpoint: pedestrian perspective, 360° (Lenné3D) and elevated view (LandXplorer).
Realism	From the eye-level view: photorealistic, georeferenced, and very detailed. From the bird's-eye view: photorealistic with aerial photos, georeferenced.
Interactivity	For the visual comparison the visualization of nature scenario measures with the existing situation from the same perspective. No spontaneous new ideas or measures can be visualized on the fly.
Illustration of visible and invisible processes	The land use shown in LandXplorer: GIS topic maps can be shown as well as an analysis of the site morphology.
Special characteristics	When the Lenné3D System was tested in the case study, the system was still in development. The performance of the Lennè3D module and its coordination with LandXplorer was limited.

Animations

Animations provide a dynamic experience in landscape, but movement through the model is restricted to a pre-defined path. Such a "guided tour" through the landscape can give viewers an overview of large landscapes as a fly-over or help the viewer to experience the planning area at eye level without actively steering the model (BISHOP & LANGE 2005c). Lange et al. (2004)found that citizens actually preferred animated sequences of 3D models to traditional methods for communicating landscape planning and design information in the context of a design competition. Furthermore, the animation gives the planner the possibility to ensure that the viewers see the relevant parts of the landscape where the planning issues are located.

Animations can involve not only movement through the model but also changes in the landscape. For example, temporal changes in the vegetation or movement of objects, such as vehicles, can be illustrated in animations. In order to produce smooth movement, an animation must have 15 to 30 frames per second (ERVIN & HASBROUCK 2001). Extensive computer time is required to render the number of frames and the detail of each rendered frame necessary to produce a realistic animation. However, an animation can provide a higher level of detail than real-time models because it is prepared in advance (LOVETT et al. in publication 2011).

Immersive virtual environment

Immersive visualization methods which give the viewer the feeling of being transported into the landscape are also used occasionally in participation, although they were not investigated in this thesis. The immersion experience is made possible with either head mounts, CAVE systems (CRUZ-NEIRA et al. 1992), or panorama screens. The last is the most popular in landscape planning participation because it allows multiple participants to view a visualization together, and this can lead to collaborative discussion of the planning (BISHOP & LANGE 2005b).

The immersion engages the peripheral vision outside the 60° cone of vision. It may convey the landscape situation in the most realistic manner, but it is the most expensive and most complicated of the available visualization methods. Furthermore, with all of the immersion methods, the immersion experience cannot be transported over the internet (PLEIZIER et al. 2004).

4.3 Landscape Visualization Tool (LaViTo)

LaViTo is an open source tool which was developed in the Interactive Landscape Plan (IALP). It gives a still image an interactive toggle function. This tool makes it possible to show or hide the individual simulated planning measures. In other words, LaViTo makes it possible to turn the proposed measures "on and off" in the visualization. In this way, it is possible to compare before-and-after images or alternatives of the planning, which are prepared in advance. By clicking symbols of the planning measure in an overview topographic map or aerial photo, the proposed measures appear as a montage in the panorama image.

An image of the simulated planning measures was prepared in the IALP with a visualization software (VNS and Photoshop), and images of the individual measures were saved in separate files. The tool then produced an interactive HTML version of the image, in which the measures in the overview map were linked with the planning measures in the visualization (see Figure 8). A further development of the tool also allowed a link to additional before-and-after eye-level images of the proposed planning measures. Furthermore, it was also possible to bundle the planning measures so that all measures of a type, for example, soil conservation-related, could be shown with a single mouse click.

The LaViTo is a java program that produces an HTML/JavaScript version of the photo simulation using the files produced for the montage, and it can be viewed in most browsers. The tool generates the HTML file, but it is not required for viewing and can be used with different operating systems (MS Windows, Linux, Mac OS).

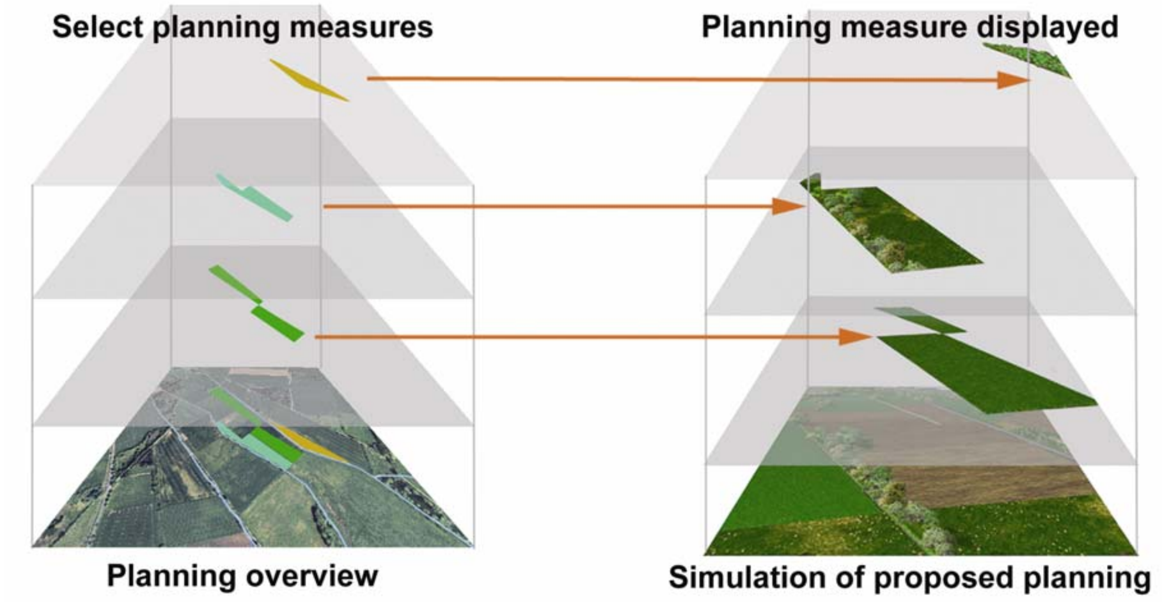


Figure 8: Still images are made interactive with LaViTo module

4.4 Combination of methods

SHEPPARD & SALTER (2004) formulate several requirements for the use of visualization in participation:

- visualization methods should be intuitive;
- visualization process should be transparent;
- there should be a choice of views, conditions, and alternatives; and
- the public should be involved in questioning, interpreting, and preparing the visualizations.

Clearly, no one visualization can fulfill all the requirements associated with planning participation (APPLETON et al. 2002). The literature suggests that combinations of visualization techniques can support participation and understanding by fulfilling different requirements of the participants (TRESS & TRESS 2003). Maps combined with real-time models can support the viewer's orientation when moving through the model. (APPLETON & LOVETT 2009). JUDE et al. (2007) suggest that the detail of complex landscapes is best visualized with renderings, for example with VNS, and that large-scale issues are better illustrated with real-time models. A combination of viewpoints, bird's-eye and ground-level views, also offers both an overview of the landscape as well as an experiential view of the landscape (DOCKERTY et al. 2005). Furthermore, SHEPPARD & SALTER (2004) have found that laypeople understand maps and plans better when realistic ground-level views are available. Finally, LEWIS & SHEPPARD's (2006) research indicates that the order in which visualizations are combined is not important.

Using a variety of visualization methods to create diverse representations at different scales and with differing levels of detail may also help to illustrate the uncertainty of the simulated landscape by showing that there is not a single correct image. Such diversity of visualization methods may also convey the complexity of the issues to participants (DANIEL 1992; GARRICK et al. 2005).

In summary, the review of visualization methods makes it clear that each visualization technique has different limitations in terms of realism, navigation, interactivity, and flexibility of use in participation. The combination of different visualization methods with different characteristics may be one answer to the question of how to address the deficits of individual methods. The following study examined the importance of the individual visualization characteristics, not only as an aid to help citizens understand the planning content, but also for their relative importance in the different planning phases. The results should be useful in making decisions about the requirements that visualizations must fulfill in the different planning phases in order to enhance citizen participation in and understanding of the planning issues.

5 Research Design

5.1 Overview of research design

A case study methodology, taken from the empirical social sciences, was deemed most suitable to study participant reactions to different visualization methods during participation (YIN 2003: 13). Concurrent mix methods were used to gather evidence and analyze participants' responses to different visualization methods. Such approaches are increasingly being used in the evaluation of complex interactions of visualization use (SALTER et al. 2009) and hold promise for triangulating evidence about participant interactions (WISSEN et al. 2008).

However, the wide range of available visualization options cannot be investigated in a single case study. In order to make a selection, visualization methods were tested prior to the case study in a preliminary visualization survey of different user groups. The survey identified suitable visualization methods and important criteria for the design and preparation of the visualizations to be tested in the case study. Finally, the findings of the investigation were discussed with visualization experts in interviews. Figure 9 gives an overview of the research design.

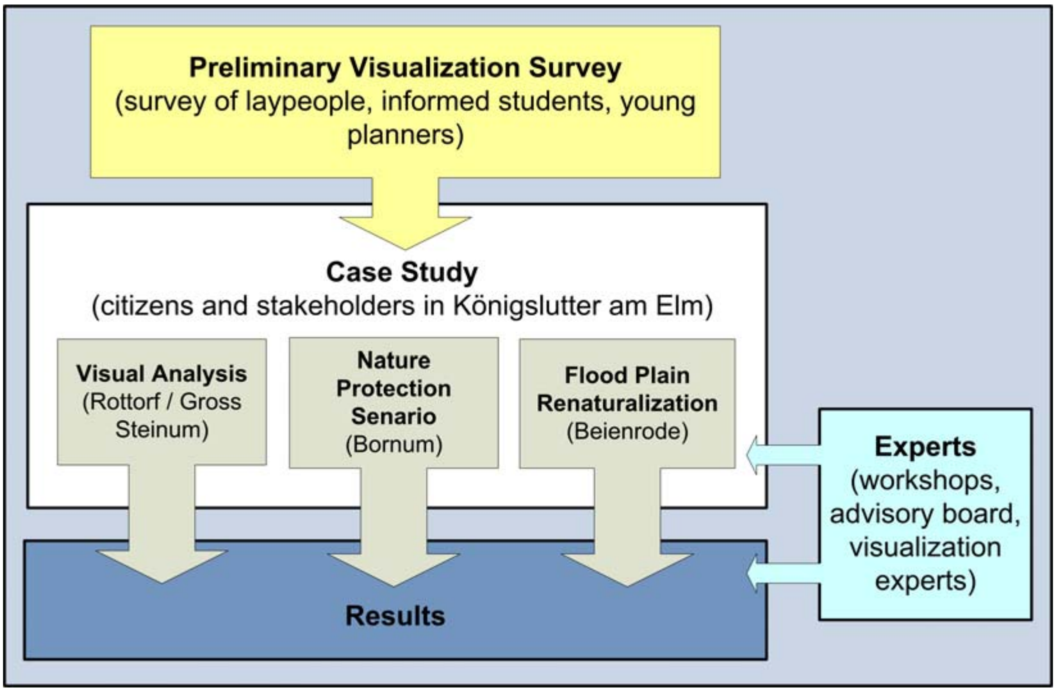


Figure 9: Overview of the research design showing the different components of the investigation

5.1.1 Preliminary visualization survey

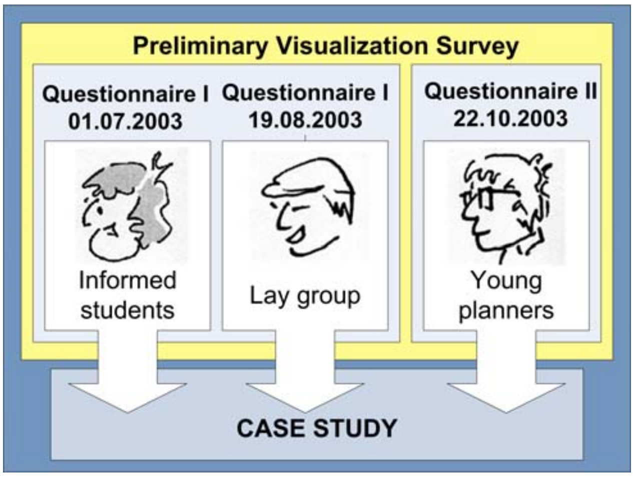


Figure 10: Design of preliminary survey of visualization methods in quasi-experimental setting

The investigation started with a **preliminary visualization survey** (see Figure 10) of different visualization methods in a quasi-experimental situation. Three different user groups – informed students, lay persons and young planners – were shown selected visualization techniques in an auditorium setting and asked to complete a questionnaire with both open-ended and closed questions. The objective of the survey was to determine the importance of visualization characteristics and the suitability of different visualization methods for supporting participants' understanding of the planning. (For an overview of the test groups, research questions, methods, and parameters of the preliminary visualization survey see Appendix A).

5.1.2 Case Study in Königslutter am Elm.

The **case study** was carried out in the context of the implementation and development project (German: *E+E-Vorhaben*), Interactive Landscape Plan Königslutter am Elm[5] (IALP), which was implemented in the Lower Saxony town of Königslutter am Elm, Germany (V. HAAREN; OPPERMANN et al. 2005). Eight visualization methods were tested over the course of three participatory investigations of the landscape planning process that focused on visual assessment, nature protection, and flood plain renaturalization issues. (For details see Section 5.6.) Different citizen groups participated in the three participatory investigations from June 2003 until February 2004. An overview of the investigations and individual participatory sessions that were undertaken during the case study is shown in Figure 11. The three participation investigations focused on planning issues on different scales and with different levels of complexity, and the objectives of the visualization also varied in the participation (see Table 8).

[5] IALP was funded by the Federal Agency for Nature Conservation and the landscape plan was executed by an independent planning office, ENTERA (http://www.koenigslutter.de)

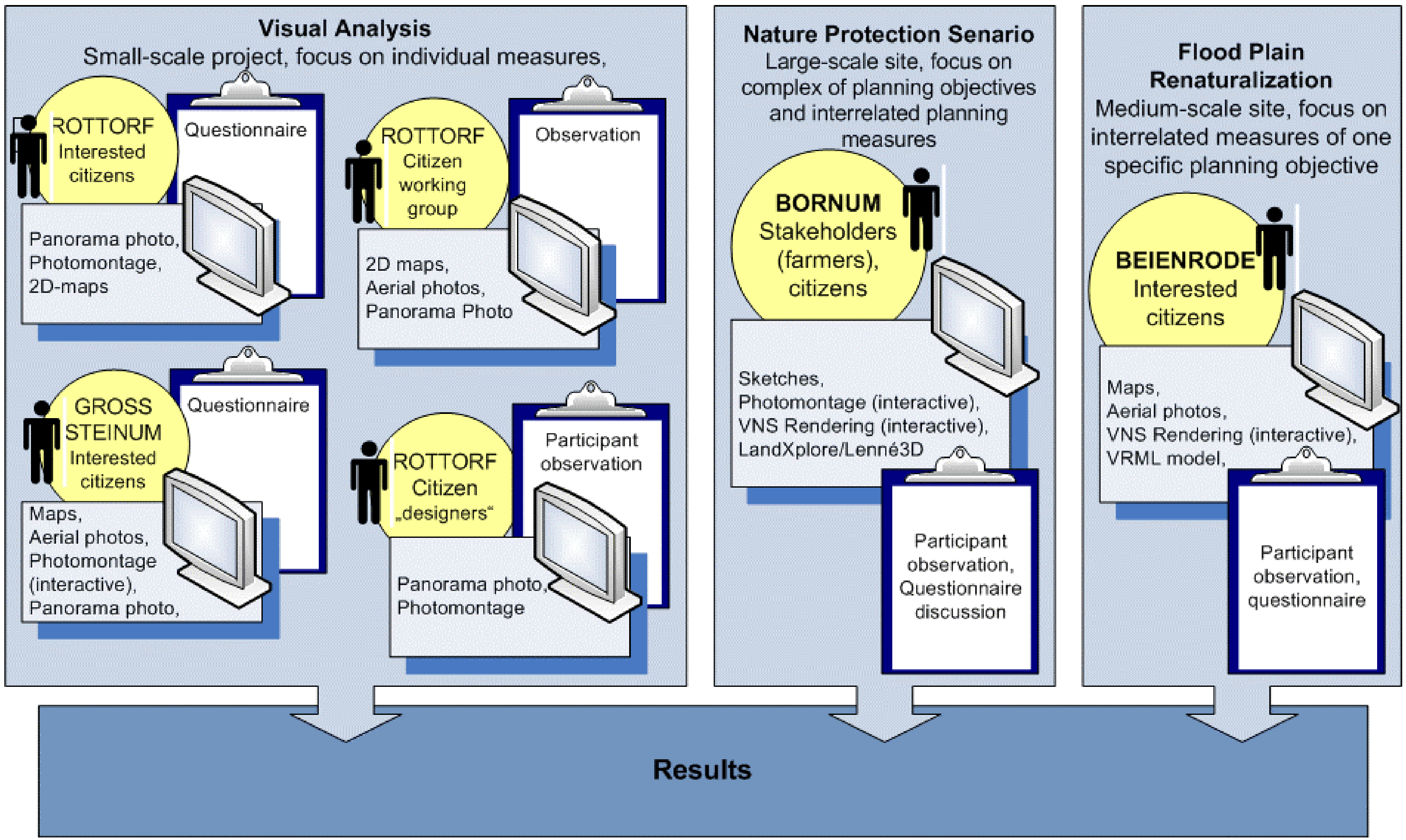


Figure 11: Overview of the different investigations and sessions of the case study in Königslutter am Elm showing the different research methods, participants, and visualization methods.

Visual assessment in Rottorf and Gross Steinum: The planning questions addressed small-scale planning measures to improve landscape visual quality. The investigation focused on photorealistic visualization methods. Data in the form of observations and questionnaires were gathered in four different participatory sessions.

Nature protection in Bornum: In a town meeting, stakeholders and citizens discussed scenarios for the future development of a large agricultural area that combined soil conservation, nature protection, and visual quality objectives. In order to assess the planning measures, citizens required a conceptual understanding of the complex interrelated planning issues. The investigation compared the use of four different visualization techniques in one setting. Participant observation methods were used to gather data in a quasi-experimental situation.

Flood plain renaturalization in Beienrode: Citizens discussed planning measures related to flood plain renaturalization on a medium-sized site along the Schunter River. The investigation examined the use of real-time 3D visualization in a participatory setting. Questionnaires and video documentation provided data for the analysis.

Table 8: Overview of case study planning and research topics and the visualization methods

Planning Issue	Objective of the visualization in the citizen participation	Topic of investigation	Visualization method		Observation	Questionnaire
BORNUM / GROSS STEINUM **Visual quality** Scale: small	Determine citizen landscape type preferences and develop planning alternatives with citizens	Photorealistic visualization methods	Panorama photos	**Maps (topo and land use) and aerial photos**	X	X
			Interactive photomontage		X	X
			"Hands-on" workshop: citizen-generated photomontage		X	
CASE STUDY: BORNUM **Soil conservation** **Nature protection** **Visual quality** Scale: medium	Visual support for the discussion of planning alternatives	Comparison of a range of visualization methods	Sketches		X	X
			Photomontage (interactive)		X	X
			VNS (interactive)		X	X
			Lenné3D		X	
CASE STUDY: BEIENRODE **Flood plain renaturaliza-tion** Scale: large	Simulate visual and spatial effects of planning proposals	3D visualization methods	VRML model (Scene Express)		X	X
			VNS Rendering		X	X

Each visualization method was tested in at least one of the participatory investigations. As testing all eight visualization methods in each of the investigations was judged to be too disruptive, it was necessary to focus the different participatory investigations on different aspects of the visualization.

The use and effectiveness of the visualization in the participatory planning setting were influenced by a large number of variables, which were difficult to isolate or control for the purpose of the investigation. Furthermore, the research investigation should not interfere with the planning process. Therefore, the visualization techniques remained the main unit of investigation, and the research questions remained focused on identifying important characteristics and functions of the visualization in communication with citizens. (For an overview of the locations, research questions, methods, and participant groups involved in the case studies see Appendix A.)

5.1.3 Expert survey and interviews

In order to validate preliminary findings, questionnaires and interviews were carried out with planning and visualization experts during and after the investigation. In the context of an IALP expert workshop on November 13, 2002, planning experts were asked to rate the importance of realism and interactivity of visualization in the different phases of the planning process. In May 2004, a survey of planning experts was again carried out at the IALP advisory board meeting. Experts were asked to rate and compare visualization characteristics and methods using keypad technology. And finally, the findings of the study were discussed in interviews with visualization experts from May 2007 until November 2008. (Table 37 in Appendix A summarizes the investigation parameters of the planning and visualization expert surveys.)

5.2 Investigation of research questions

5.2.1 Research question 1: How suitable are different visualization methods for supporting participants' understanding (cognition) of the planning content during participation?

The first complex of research questions addressed the suitability of the visualization methods for supporting the understanding of the planning proposals and content. More specifically, they examined four criteria that are considered essential for the use of visualization methods in participatory situations: spatial understanding, orientation, ability to assess change, and perceived credibility.

Spatial understanding: Which visualization methods support spatial understanding?

This question was investigated in depth because spatial understanding, i.e. the ease of "picturing" the landscape and planning proposals, is central to understanding the visualization and its usefulness in the participatory setting. Therefore, different visualization methods were compared in the preliminary visualization survey in order to deduce visualization preferences among the user groups and to identify important factors which support understanding of the planning proposals (see Figure 12).

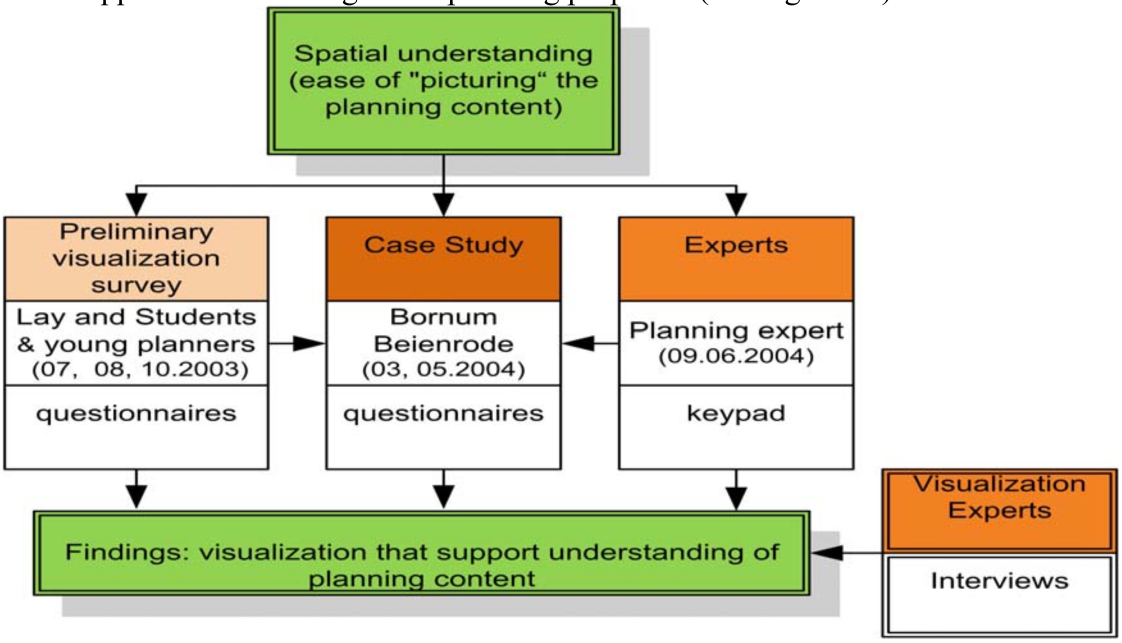


Figure 12: Overview of the investigation of spatial understanding ("picturing" the landscape)

Orientation: Which methods help participants to orient themselves in the landscape?

The approach to investigating how well the visualization methods support orientation was similar to that applied to spatial understanding. In the **preliminary visualization survey**, students and lay persons were asked to identify which visualization methods supported spatial orientation best and to comment on how the visualization helped their own orientation. Furthermore, **IALP planning experts** were also asked to select visualization methods that support good orientation in a similar experimental setting. Finally, observations of the participants' reactions to the different visualization methods in the Bornum investigation were recorded and the comments analyzed. Questionnaires with questions about the ability to orient oneself with specific visualization methods were also circulated after the Groß Steinum, Bornum, and Beienrode investigations.

Assessing change: Which visualization methods help viewers to assess landscape change?

The investigation of how well the visualization methods helped the viewer to assess change is illustrated in Figure 13. Before-and-after images, i.e. simulations, of the planning proposals, provide citizens with an example of the visual effects of planning and the possiblity to compare the changes in the landscape. In the visualization survey, participants were shown images of the existing landscape followed by simulations of landscape change made with the different visualization methods. Participants were then asked to rate how helpful the comparision was for understanding the proposed changes. Furthermore, planning experts were asked to identify the visualization methods that helped to assess landscape change.

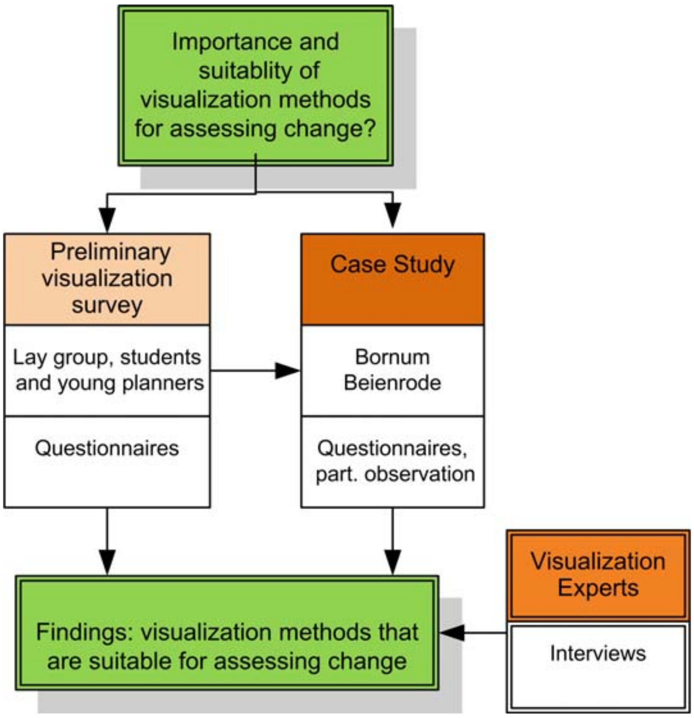


Figure 13: Overview of the investigation of the importance of assessing change

In the case study, the importance of before-and-after images for the participants in the town meeting was evaluated in Gross Steinum and Beienrode using questionnaires. In the Bornum town meeting, participatory observation was used to record how participants interacted with the before-and-after views of the visualizations prepared with LaViTo.

Credibility: What influences the credibility of a visualization?

In the preliminary visualization survey, the investigation examined the degree to which the visualization methods were perceived as credible by the young planners. Using the Likert scale (1 = low to 5 = high), participants were asked to rate the credibility of each of the visualization methods. Furthermore, to better understand which factors contribute to the perceived credibility of the visualization methods, we asked the young planners to suggest how the credibility of the visualization could be improved.

In the case study, the importance of before-and-after images for the participants in the town meeting was evaluated using questionnaires and participatory observation. Comments that showed distrust or skepticism about the visualization methods were recorded.

5.2.2 Research question 2: How important are the central visualization charateristics – realism, dynamic navigation, and interactivity – for understanding planning content?

Realism: How important is it?

The investigations addressed three aspects of realism. First, the importance of realism for understanding planning content was rated by the three participant groups in the preliminary visualization survey, and their reasons were reviewed. Second, the degree to which the visualizations were perceived of as realistic was rated by the young planners. This group was considered to have enough planning experience to judge not only how realistic the images looked but also how accurately they represented the real landscape. The IALP planning experts (09.06.2004) were also asked to choose which visualization methods they considered realistic enough for them to imagine the planning proposals. Third, planning experts (13.11.2003) were asked to consider when realism is essential in the planning process.

In the case study, the reactions of the participants in the Bornum investigation to the visualizations with different levels of realism were observed and comments that related to the realism of the visualization were recorded in writing.

Static views and dynamic navigation: How important is dynamic navigation?

The investigation first tried to establish whether a single image or multiple static images would be sufficient to support participation. All three groups in the preliminary visualization survey were asked to rate the importance of multiple views of the planning and to give their reasons. Second, the importance of dynamic navigation was examined by asking the young planners to rate and comment on the importance of dynamic navigation for understanding the planning content. It was felt that this group had more experience with the real-time 3D models and could better judge their importance for planning than the non-professional groups. Finally, the importance of being able to determine the viewpoint oneself was examined in the survey of the IALP planning experts (09.06.2004), who were asked to identify those visualization methods in which they missed the ability to determine the viewpoint themselves.

During the case study, questionnaires were used to gather information about the attitudes of participants towards the multiple views and dynamic navigation that were possible with the 3D VR models or panorama photos that were used in Rottorf (panorama photo) and Beienrode (Scene Express VRML model). In Bornum, participant observation was used to record reactions to the dynamic visualization. Furthermore, the willingness of participants to navigate through the real-time models was examined in questionnaires in Bornum and

Beienrode.

Interactivity: How helpful is it?

In this study we examined the interactivity provided by LaViTo, which, although very basic, introduces the opportunity for interaction with the content into the investigation. First, the investigation explored participant attitudes toward interactivity. In the preliminary survey, both the lay group and the young planners were asked to rate the helpfulness of the interactivity provided by the LaViTo tool for understanding the planning proposals. In Bornum, participant observation was used to record how citizens used the interactivity of the visualizations during the discussion. Finally, planning experts (13.11.2002) were asked to rate (on a scale of 1 to 3) and comment on the necessity for interactivity in different planning phases.

5.2.3 Research question 3: Which functions do the different visualization methods fulfill in public participation of the planning process, and what role does the facilitator play?

The third set of research questions looked at the application of visualization in a real-life situation and focused on how participants actually used the visualization in a discussion. The use of four different visualization methods by the citizens and stakeholders in Bornum was recorded using participative observation. The analysis of the observation looked at three questions:

Suitability and function: How do the visualization methods compare in participation?

The observation records were analysed using qualitative data analysis techniques in order to identify participant opinion and themes about the suitability of the visualizations, i.e. spatial understanding, orientation, assessing change, and credibility, as well as themes about the function of the visualization methods in the participatory setting. The participant actions or activities that were recognized as indicators of different functions are summarized in Table 9.

Table 9: Overview of the functions and indicators of visualization in participation

Function	Indicators of functions in a participatory situation
Engagement	Visualization attracts attention and motivates involvement in the discussion. Participants show interest in and awareness of planning issues.
Communication	Visualization is used to orient or locate landscape elements and viewers comments, explain planning measures, support discussion of opinions about the planning, and to document the discussion.
Collaboration	Visualization supports discussion of compromises or solutions to identified problems.
Education	Visualization can lead to changes in behavior or attitude.

Important visualization characteristics: Which characteristics are important for citizens in participation?

As previously mentioned, the preliminary survey explored the importance of visualization characteristics, i.e. realism, dynamic navigation, and interactivity, for understanding the planning content (see Section 5.2.2). However, participants may respond to visualizations differently in a real-life situation. The case study provided a situation where it was possible to compare the visualization methods, each showing different degrees of realism and interactivity. By observing which characteristics of the visualization were identified or used by participants and when, the investigator used qualitative data analysis methods to infer which characteristics were especially important or helpful.

Facilitation: What roles do the setting and the facilitator play in the use of the visualization?

The written records from the workshop facilitators, visualization facilitators, and participant observers of the Bornum investigation provided the basis for analysis of the facilitator's activities. The records were evaluated using qualitative data analysis techniques in order to identify tasks associated with the visualizations that the facilitator had to perform. Furthermore, the analysis addressed the skills and understanding of the visualization that the facilitator must have in order to use visualization in the discussions with the participants.

5.2.4 Research Question 4: Which visualization techniques support the different planning tasks and the discussion of different types of landscape features?

The fourth set of research questions considered the appropriateness of the visualization methods for use in different planning phases and for visualizing different kinds of landscape features.

Planning tasks: Which visualization methods are best suited for the different planning tasks and phases of the planning process?

Many factors influence the appropriateness of visualization throughout the planning process, e.g. objective of the planning process, planning issue, scale, context and composition of the planning audience. With this in mind, the investigation approached the topic from three different perspectives (see Table 10). First, in order to distinguish general trends or preferences, the young planners were asked in the preliminary visualization survey to choose the visualization methods that they considered suitable for the inventory, concept, and planning measure phases. The young planners were felt to be the only survey group with sufficient understanding of the planning process to make an informed judgment. Second, in an attempt to investigate the influence of different visualization characteristics, the IALP planning experts (13.11.2002) rated the importance of interactivity and realism in the different planning phases (see Section 5.2.2). Finally, because visualizations are traditionally most frequently used to illustrate planning proposals, the investigation focused on the use of visualization in the planning measure phase. Both the non-planners as well as planning experts (09.06.2004) were asked to identify the visualization methods they considered best suited to illustrate proposed planning measures.

Table 10: Overview of the investigation of the suitability of visualization methods for different planning phases

Investigation	Inventory back-ground	Concept phase	Planning measure phase
Visualization survey Young planners	X	X	X
Students			X
Lay group			X
Planning experts			X
Case study			X

Landscape features: Do different landscape features require different types of visualization for representation?

The suitability of the visualization methods to support discussion about different kinds of landscape elements – point, lineal, and area – was investigated in the preliminary survey. Non-planners (lay group and informed students) were asked to select the visualization methods that were best suited to illustrate comments about different types of landscape features.

5.3 Test groups

Informed students

Students in the second semester (German: *Vordiplom*) of the Landscape Architecture and Environmental Planning program at the Leibniz University in Hannover were selected as a group that had experience with maps and exposure to the landscape planning process, but had limited spatial planning experience. This group consisted of 17 participants, four male and 13 female, and represented informed stakeholders in Königslutter, e.g. farmers, who are accustomed to reading maps and making decisions about the landscape. However, unlike the stakeholders in Königslutter, these participants were not familiar with the study area. The majority had used a virtual model (computer game) a maximum of five times in the previous three months.

Lay group

The lay group consisted of 20 respondents, ranging in age from 12 to 64 (8 teenagers). The participants were either students or professionals who were not involved in spatial planning. The lack of experience in the planning field qualified this group as planning lay persons. This group represented potential participants in the case study in Königslutter, with the exception that they were not familiar with the planning area.

Young planners

A group of 62 students in the second half (German: *Hauptdiplom*) of the Landscape Architecture and Environmental Planning program at the Leibniz University in Hannover responded to the second questionnaire. These students (22 male and 40 female) had completed most of the planning courses as well as several practical projects. Therefore, they were considered competent to represent a planner's point of view and were asked to respond to several questions in the questionnaire as planners. The majority of this group had used a virtual model (computer game) a maximum of five times in the previous three months. Three participants were acquainted with the study area.

Citizens of Königslutter am Elm

Data were collected from 108 citizens from Königslutter am Elm. Because the three participation phases focused on three different geographic locations, there were three distinct groups of citizens who participated in each phase. Information about the composition of stakeholders in the meetings was not collected. However, it was observed that the planning issues attracted specific interest groups. For example, the discussion of the nature protection scenario for the agricultural area in Bornum attracted many farmers, whereas the discussion of visual quality in Gross Steinum and Rottorf attracted many local residents.

IALP planning experts

In order to establish external validity of the investigation, data were gathered from experts in the field of landscape planning. In the context of an IALP expert workshop on November 13, 2002, a group of 19 experts was asked to respond to a questionnaire. In a further workshop with the IALP supervisory board on June 9, 2004, 21 planning and visualization experts who attended the meeting were asked to assess the visualization methods. Both groups of experts were interested in or familiar with the visualization methods being tested in the IALP.

Visualization experts

Seven visualization experts who are internationally renowned for their publications about landscape visualization were selected on the basis of their availability and willingness to be interviewed: Prof. Ian Bishop, Stephen Ervin, Prof. Eckart Lange, Prof. Mark Lindhult, Prof. Andrew Lovett, Prof. Jim Palmer, Prof. Stephen Sheppard (see Appendix A).

5.4 Data and collection methods: Multi-source evidence gathering

5.4.1 Data collection

Data were collected on different occasions: at a total of six citizen meetings in Königslutter am Elm; in three visualization surveys carried out at the Leibniz University in Hannover; at two expert workshops of the IALP project; and from three interviews with participants and seven interviews with visualization experts. The following methods of data collection were used during the investigation in the period from June 2003 until July 2008.

Questionnaires

Questionnaires with both closed and open-ended questions were used in the preliminary visualization survey to gather evidence from lay persons, informed students, and young planners about their attitudes toward the different visualization methods and the importance of specific visualization characteristics. Furthermore, shorter questionnaires were used during the case study to gather information about citizens' opinions towards the visualization methods and their use in the meetings. These brief questionnaires were distributed after the meetings. The time required for the questionnaires ranged from 1½ hours (preliminary visualization survey) to five minutes (survey in Bornum). The questionnaires produced both quantitative and qualitative data for the analysis. In the course of the study, 162 questionnaires were completed and returned to the researcher. (Appendix B contains the questionnaires used in the investigation.)

Observation

Participant observation was an important source of evidence in the case study phase. This form of data collection has the advantage that the researcher has firsthand experience with participants and can record the information as it is revealed (CRESWELL 2003). However, the effectiveness of observatory data is limited by the skill of the observer. In the Bornum case study, data was collected by four participant-observers, who recorded their observations as written protocols. The observers were given key questions to consider in the observation. In Rottorf, an observer documented in writing which visualization methods were used during the meeting, when and for which purpose.

Interviews

Although time-consuming in the analysis, the interview is an effective instrument to gather opinions and related information (YIN 2003). Focused telephone interviews were used at the end of the Rottorf and Gross Steinum case study to gather information about participants' reactions to the visualization. Both telephone and face-to-face interviews that used a guideline of open-ended question were carried out with visualization experts at the end of the investigation to elicit expert opinion about the preliminary results. Most of the interviews were recorded on tape. For technical reasons, three of the interviews were documented with written protocols.

Documents

Minutes and reports written during the IALP Implementation and Development (I+D) project provided information for the investigation. Minutes of the research team meetings and expert workshops were reviewed, as well as reports produced by the research evaluation team. These documents have the advantage that they can be reviewed repeatedly and provide long-term coverage of the events.

5.4.2 Data analysis

Qualitative content analysis and grounded theory were used as the basis for analyzing the qualitative data gathered in the case study. In grounded theory, the inquirer hopes to discover themes of information from the participants that reoccur across different cases (STRAUSS&CORBIN 1998). The analysis of the data is an inductive process of building from the data to broad themes and ultimately generalized models and theories. The objective of qualitative content analysis is to recognize emerging themes by coding and clustering of the data (TESCH 1990). The textual data is systematically analyzed to form categories which thematically describe the uses of the visualization in the participatory setting. An attempt is made in the analysis to identify connections between participatory setting, function of the visualization, and visualization types and characteristics.

The Kruskal-Wallis test (ZAR 1998) for nonparametric analysis of variance was used to determine statistically significant distinctions in the data collected in the preliminary visualization survey. The statistical analysis of multiple tests was corrected using the Bonferroni Adjustment (ZAR 1998). JMP® 8 software was used to carry out statistical analysis.

5.4.3 Data validity

One cannot escape the personal interpretation brought to qualitative data analysis (CRESWELL 2003). However, the investigation used multiple sources of data (data triangulation) and different researchers to observe the phenomenon (investigator triangulation) as well as multiple methods to study the research questions, both quantitative and qualitative (cross-methodological triangulation). The converging lines of inquiry in a triangulation of data sources helps to substantiate emerging themes.

5.5 Preliminary visualization survey

5.5.1 Visualization survey: design and implementation

The Institute for Environmental Planning at the Leibniz University of Hannover provided the facilities to carry out the preliminary visualization survey. Two different questionnaires were developed to collect information about planner and non-planner responses to selected visualization methods. Questionnaire I was given to two different test groups (informed students and lay group) who represented the potential participants in the landscape planning process. Questionnaire II was completed by the young planners, who represented the planner's perspective (see Figure 10). All three tests took place in the same auditorium. The different visualizations were projected on a screen one after the other using an LCD projector. The participants were then asked to answer questions about the visualizations in writing. Each survey took approximately 1½ hours to complete.

5.5.2 Visualization methods tested in the visualization survey

Production of visualization

For the preliminary survey, ESRI ArcView 8 was used to create the 2D topographic map and the aerial photograph. The rendering of the 3D models, the bird's-eye and eye-level animations, and VRML model were constructed with VirtualGIS from ERDAS IMAGINE 8.6 (HOGREBE 2003). PanoramaFactory software was used to create the panorama photos, and the interactive photomontage was developed with Photoshop version 6 and LaViTo. The photographs of the site were taken in Königslutter in May 2003. The rendering of the 3D landscape model was prepared with Visual Nature Studio version 2 from 3DNature, using GIS data from ArcView 8. Table 11 and Table 12 show the visualization techniques which were tested with Questionnaire I and II: [6]

[6] The visualizations were produced by Daniela Hogrebe as part of her diploma thesis in the context of the IALP. HOGREBE 2003

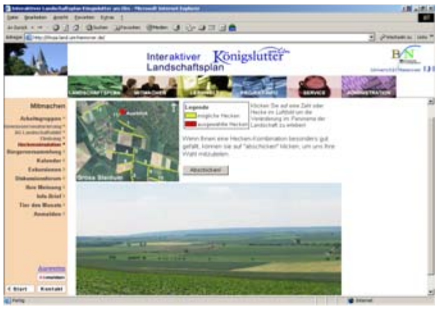
Table 11: Visualization techniques used in Questionnaire I

2D topographic maps (digital) Software: ArcView 8

Orthographic aerial photos Software: ArcView 8

Panorama photo

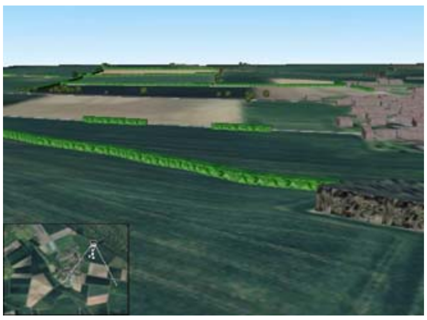
Software: PanoramaFactory



Photomontage (LaViTo interactive)

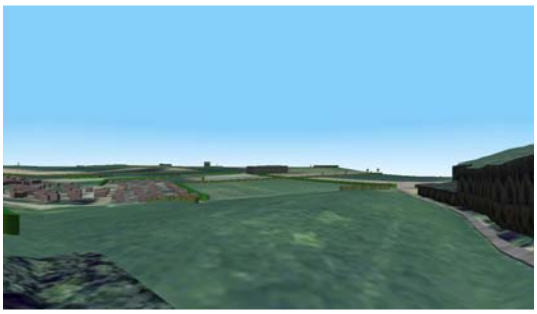
Software: Photoshop®, LaViTo

Photomontage Software: Photoshop®



Fly-over animation of 3D-model (bird's-eye view)

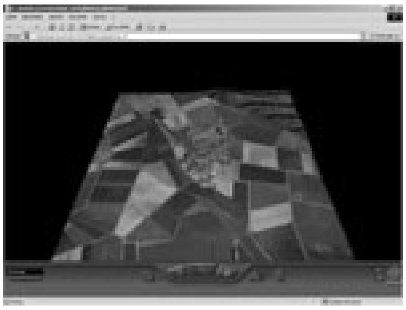
Software: VirtualGIS (ERDAS IMAGINE 8)



Walk-through animation of 3D model (eye level)

Software: VirtualGIS (ERDAS IMAGINE 8)

Rendering of 3D VR Model Software: VirtualGIS, (ERDAS IMAGINE 8)



Interactive 3D VRML model[7] Software: VirtualGIS, ERDAS IMAGINE 8.6, ArcView 8

Table 12: Supplementary visualization techniques used in Questionnaire II

Black-and-white plan of the hedgerow proposal from the Gross Steinum redevelopment plan

Orthographic perspective in black and white of the proposed measures

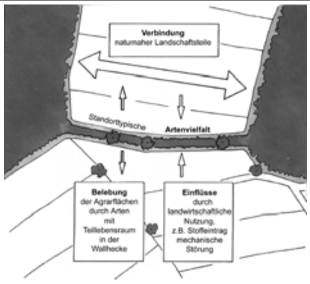
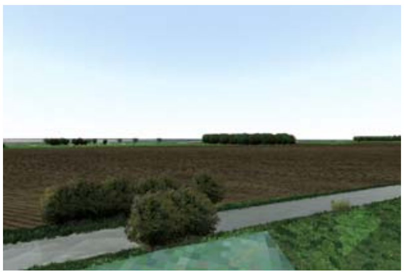


Diagram showing the function of hedgerows



VNS Rendering of 3D Landscape model[8]**–**

Software: VNS

[7]The VRML model used in the investigation was in color and it was prepared by Daniela Hogrebe.

[8] Rendering prepared by Anne Hebsaker

5.5.3 Questionnaire design

The **first section of Questionnaires I and II** contains questions pertaining to personal information (gender, age, profession) as well as questions about experience with interactive 3D models and familiarity with the planning site. (Questionnaires are located in Appendix B).

Questionnaire I

In the **second section** of Questionnaire I**,** the participants were asked to evaluate eight different visualizations (see Table 11) in terms of spatial orientation and spatial understanding, i.e. the ease with which they could picture the landscape in their "mind's eye" (German: I*nnere Auge*). A five-level Likert scale was used to rate the visualizations. In open-ended questions, respondents were asked to identify which elements in the visualization helped the orientation.

The questions in the **third and fourth sections** focused on the role of visualization in understanding planning suggestions and forming opinions about the proposals. In preparation, a proposed plan for hedgerow planting from the Gross Steinum Redevelopment Plan (German: *Dorferneuerung Gross Steinum*) was visualized using the different visualization techniques. For each visualization type, both the status quo and proposed measures were projected on the screen one after the other. Using a Likert scale, participants were requested to rate from 1 to 5 how well the visualization helped them picture the planning proposal and how helpful before-and-after images were. Further questions addressed the importance of photorealism and flexibility of the viewpoint. Finally, participants were asked to indicate their preferred visualization for viewing proposed planning and for developing their own suggestions.

Questionnaire II

The second questionnaire followed a similar structure as the first. However, in order to investigate the relationship of the new digital landscape visualization methods to traditional methods, e.g. black-and-white plan, orthographic plan, and diagram, these analogue visualization methods were included in the questionnaire (see Table 12). In addition, a VNS rendering, which was not available for the first questionnaire, was included as a further alternative for photorealistic visualization. The range of visualization methods was expanded only for the young planners for several reasons:

- This group was judged to be more able to review the larger number of visualization methods than the other groups.
- Their additional experience in the planning field made them more able to judge the analogue visualizing methods in the context of digital methods.

- Several visualizations that were developed during the project were not available when the first questionnaire was administered. Because it was important to test the newly developed visualizations before the case study, they were included only in the second questionnaire.

The objective of Questionnaire II was to gather information about a planner's perspective on visualization for additional guidance in the selection of visualization for the case study. Therefore, the focus of this questionnaire shifted from questions about basic spatial understanding and orientation to those about the characteristics and uses of the visualization.

The same presentation procedure was followed. Participants were asked to rate the credibility and realism of the visualization on a Likert scale (1 to 5) and rate how well the visualization helped them understand the planning content. In open-ended questions, participants were also asked to describe their impression of each visualization and to suggest how its credibility could be improved.

5.6 Case Study in Königslutter

5.6.1 Visualization methods tested in the case study

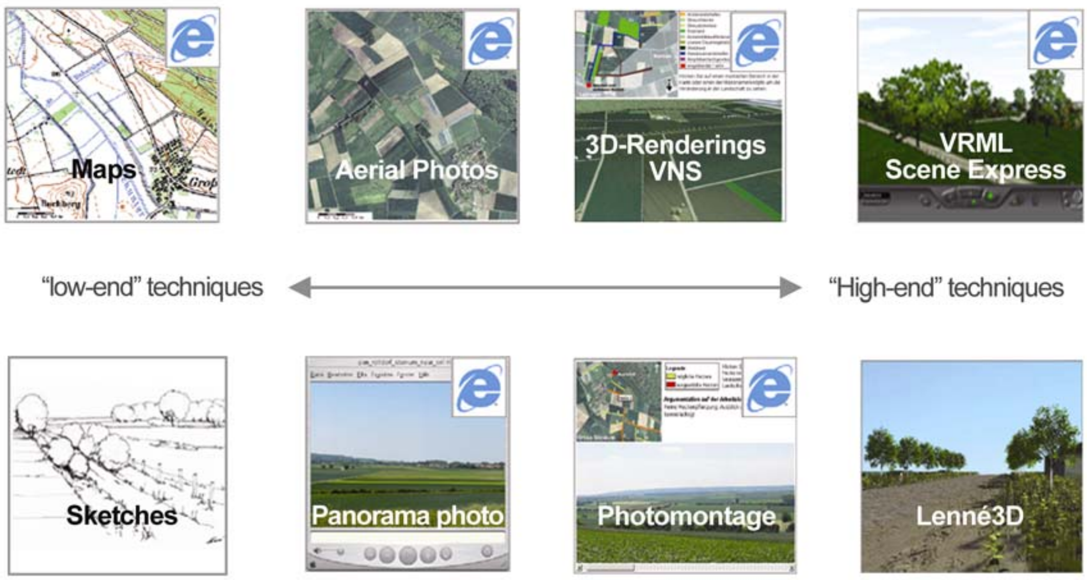


Figure 14: Overview of visualization methods used in the case study investigation

In addition to 2D topographic maps and aerial photos, six different visualization methods were tested in the case study: analogue sketches, panorama photos, photomontages, computer renderings of 3D landscape models made with VNS (3D Nature), Lenné3D/LandXplorer, and Scene Express VRML models. The interactivity of the photomontage and VNS rendering were enhanced with the tool LaViTo. An overview of the important characteristics of the visualization methods that were tested during the case study are summarized in Tables 13-18.

Sketches:

Four viewpoints were established which gave a good overview of the different planning measures. The existing landscape was illustrated with black-and-white line drawings on DIN A2 paper. The proposed planning measures were then added to the line drawings in color. During the meeting, the artist drew the participants' suggestions on transparent paper laid over the sketches.

Table 13: Technical requirements for using sketches in public participation

Sketches	
Requirements	**Description**
Required data	360° panorama photo, plan of planning measures, site photographs
Import of GIS data	Not used
Software or media	Pencil, paper, and artist
Viewpoint	Four viewpoints were selected that provided an elevated perspective of the planning measures, and four different views were prepared
Use in presentations or internet	The prepared sketches of the nature protection measures were presented on A2 paper overlaid with transparent paper on which suggestions and changes could be sketched. In the internet the sketches can be presented as short animations or films using Flash animations.

Panorama photos

Panorama photos were produced for different locations in Königslutter with the software Panorama Factory v3.1 (http://www.panoramafactory.com). Four panorama photos of the Elm slope in Bornum were made and published on the IALP internet site. Hotspots were embedded in the panorama photos so that viewers could "jump" from one panorama photo to another. In this way, users could view the landscape from different points of view. A panorama view was also taken from the Buchberg in Gross Steinum.

Table 14: Technical requirements for producing the panorama photo and its use in public participation

Panorama Photo	
Requirements	**Description**
Required data	Series of photos taken in a 360° rotation
Import of GIS data	Not used
Software or media	Panorama Stitching Software (Panorama Factory)
Viewpoint	Elevated or normal pedestrian view, depending on the possiblitiy to take photographs. 360° circular view
Use in public meetings or internet	Meetings: Overview or virtual tour of the planning area. Common picture of the site supports the discussion of the site-related issues. Internet: Virtual tour of the planning area. 360° view of the landscape for an internet questionnaire or discussion of landscape preferences.

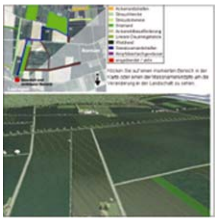
Photomontage

The photomontages used in the investigation were created with Photoshop® using photo panoramas of approximately 180° taken during the vegetation period. The individual planning measures in the photomontage were prepared with LaViTo which provided a toggle function for turning the individual measures "on and off".

Table 15: Technical requirements for producing the photomontage and its use in public participation

Photomontage (with pan function and enhanced with LaViTo)	
Requirements	**Description**
Required data	360° panorama photo, plan of planning measures, photos of existing vegetation.
Import of GIS data	Not used
Software or media	Panorama Factory, Adobe Photoshop®
Viewpoint	Elevated or pedestrian perspective. Up to 360° view (180° used in investigation)
Use in public meetings or internet	Simulation of the planning measures. Before-and-after representations of the planning.

Rendering produced with VNS and enhanced with LaViTo



Renderings of nature conservation and flood plain renaturalization measures were produced with VNS software for the participatory investigations. Ground-level before-and-after renderings of each planning measure were also linked to the LaViTo-enhanced bird's-eye rendering of the overall site in the Beienrode participatory session.

Table 16: Technical requirements for producing the rendering (VNS) and its use in public participation

VNS rendering (enhanced with LaViTo)	
Requirements	**Description**
Required data	Digital terrain model (raster 12.5 x 12.5 m), ArcView Shape files of land uses (biotope map) and planning, georeferenced orthophotos
Import of GIS data	Import of ArcView Shape files and attribute table (which can be altered in VNS)
Software or media	- Visual Nature Studio (VNS) from 3D Nature - ArcView 3.2 from ESRI - X-Frog 3.5 from Greenworks - Adobe Photoshop and Premiere - Software to create 3D objects: Archi-Sketch
Viewpoint	Bird's-eye or eye-level perspective. Flexible camera viewpoint possible. Rendering of any perspective possible.
Use in public meetings or internet	The measures can be illustrated with static views. Before-and-after pictures show the visual effects of the planning. The planning measures can be rendered from any point of view in order to improve understanding of the measures. However, in order to illustrate new planning suggestions on the fly during a meeting, VNS would need long rendering times and is therefore unsuitable.
Special characteristics	High-end visualization system useful for photorealistic simulation of the landscape.

VRML Model

The program Scene Express from 3D Nature was used to create the VRML model for the Beienrode participatory session. The software, which was an add-on to VNS 2, supported the export of all the landscape elements in a VNS project to a VRML format.

Table 17: Technical requirements for producing the VRML model and its use in public participation

VRML-Model (Scene Express from 3D Nature)	
Requirements	**Description**
Required data	An existing VNS project file
Import of GIS data	The data was prepared and imported for the VNS project.
Software or media	VNS and Scene Express from 3D Nature Player (z. B. CosmoPlayer)
Viewpoint	Any part of a VNS project can be exported into a VRML file. All the camera points in VNS can be serve as pre-defined viewpoints in the VRML model.
Use in public meetings or internet	"Guided tour" or walk-through of the planning area in real time in a meeting or on the internet.
Special characteristics	Dynamic navigation in real time.

Lenné 3D and LandXplorer

A prototype fo the Lenné3D system was tested in the Bornum investigation. The highly realistic animation of the landscape showed a 1.1 x 1.1-km² area of the nature protection scenario, and a 6 x 6-km² section of the site was visualized using LandXplorer.

Table 18: Technical requirements for producing the Lenné3D visualization and its use in public participation

LandXplorer/Lenné3D	
Requirements	**Description**
Required data	Based on: GIS data, digital terrain model, aerial photos, biotope mapping, planning measures (nature protection scenario), photo material of vegetation from the planning area, digital 3D plant models.
Import of GIS data	3D landscape model based on GIS data
Software or media	ESRI ArcView, Xfrog (3D plant models)
Viewpoint	- Pedestrian perspective and 3D map. - From the eye-level view: 360° view, but limited view of the planning area. - From the 3D map view: overview of area.
Use in public meetings or internet	Simulates planned measures and developmental scenarios as a virtual world. Supports discussion through the combination of 3D aerial photos of LandXplorer and VR eye level views of detailed, realistic landscapes with Lennè3D. Citizen comments can be located in the 3D aerial photo. A walk-through of the landscape, which gives the viewer a spatial understanding, is possible with the Lennè3D. It cannot be used in the internet.
Special characteristics	When the Lenné3D system was tested in the case study, the system was still in development. The performace of the Lennè3D module and its coordination with LandXplorer was limited.

5.6.2 Visual assessment: Rottorf and Gross Steinum

The planning discussion focused on small-scale measures, not complex in nature, that could be implemented to improve visual quality. The visualization was used to help establish citizen preferences of landscape types, illustrate proposed changes to the landscape, and develop planning alternatives with citizens. Digital 2D topographic maps, aerial photographs, and photorealistic visualization techniques (panorama photos and photomontage) were used to represent the landscape in the case study. The following aspects of visualization in the communication with the participants were addressed in the investigation:

- The role of 2D (maps and aerial photos) in the discussion
- The functions that visualization serves in the discussion with participants
- The importance of before-and-after views
- The viewpoint preferred by participants.

In Rottorf and Gross Steinum, data were gathered at four sessions using questionnaires and participant observation. Participants' comments in discussions and interviews were also included in the analysis.

Information meeting**: Interested citizens from Rottorf and Gross Steinum (04.06.2003)**

The information meeting was attended by 25 residents of Rottorf and Gross Steinum. The objective of the initial meeting was to inform citizens about the Interactive Landscape Plan and identify their concerns about the landscape. In this phase of the planning process, the visualization served not only to gather citizens' opinions about the visual quality but also to collect local knowledge about the landscape. A panorama photo and photomontage, which simulated a proposed measure, were tested. Participant observation and questionnaires were used to record citizens' reactions to visualization and to gather feedback about orientation, viewpoint, and spatial understanding.

Working group meeting **(Rottorf, 13.06.2003)**

The workshop was attended by nine concerned citizens and stakeholders, i.e. landowners and farmers that live in the Rottorf area. The participatory objective of the evening was to discuss specific visual quality issues in the Rottorf area that had been identified in the previous meeting. The visualization methods used were familiar to all of the participants, in that they had been used in the previous meeting: topographic and land use maps, aerial photos, panorama photo, These were used to discuss the issues in order to set planning priorities and talk about potential solutions. An observation record was written, noting:

- Which visualization type was used for which topic of discussion?
- When did participants switch between visualization types and for what reason?
- Which functions did the visualization have in the discussion?

Working group meeting **(Gross Steinum, 20.06.2003 and 2.07.2003)**

In a public meeting in Gross Steinum, 17 participants identified visual quality problems in the area and discussed their concerns. The majority of the participants were local farmers. A panorama photo, maps, aerial photographs, and an interactive photomontage (with LaViTo) (see Figure 15), in which different planning measures could be "turned on and off", were used to visualize a proposal for hedgerow plantings from the Town Development Plan (German: *Dorferneuerungsplan*). Data about the participants' reactions to the interactive photomontage and their opinions about which visualization techniques supported orientation and spatial understanding were gathered in questionnaires and through participant observation.

Figure 15: Interactive photomontage of hedgerow plantings in Gross Steinum

Workshop**: Rottorf designers (08.07.2003)**

In a workshop with three local residents, participants worked together with the researcher to create a photomontage of a planning proposal for improving the visual quality of the landscape (see Figure 16). A palette of images of plant species that the participants chose was prepared in advance. A static image from an eye-level view formed the background image of the photomontage. The participants instructed the researcher about which plants they wanted "planted" and where. Of interest to the researchers was the ability of citizens to develop their ideas and achieve a consensus using an interactive, photorealistic visualization technique. Participant observation and discussion with the participants formed the basis for the method evaluation.

Figure 16: Workshop participants develop their concept for improving visual quality of the landscape in a photomontage

5.6.3 Nature protection and soil conservation scenario: Bornum

On March 15, 2004, farmers and concerned citizens were invited to discuss the planning scenario for the development of an agricultural section of Bornum in a public meeting. The planning scenarios incorporated soil conservation and nature protection goals as well as visual quality considerations. The participatory objective of the town meeting was to explain to the citizens and stakeholders: the proposed scenarios, the effects of the planning measures, and the interrelationships of the environmental factors. The objective of the research investigation was to compare four visualization methods in a real-life participatory situation.

Visualization techniques tested in the Bornum investigation

The planning scenarios were simulated using four different visualization methods: sketches, photomontage (LaViTo-supported), VNS renderings (LaViTo-supported), and Lenné3D/LandXplorer (interactive). These methods were chosen because they represent a variety of navigation possibilities, interactivity, and photorealistic qualities:

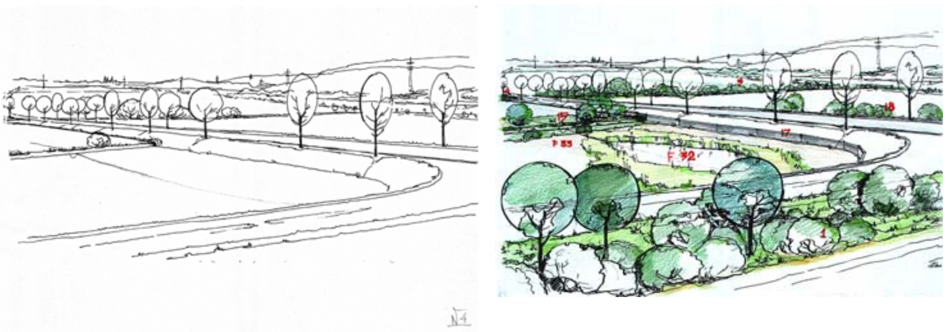


Figure 17: Before-and-after sketches of proposed measures in the planning scenario

Sketches were drawn from four viewpoints illustrating a bird’s-eye view of the planning measures as well as more detailed eye-level drawings of specific areas in the eastern half of the site (see Figure 17). The (Ukrainian) artist prepared black-and-white line drawings on DIN A2 paper of the existing site conditions and, in a second set of drawings, rendered the proposed planning measures in color. During the discussions, the artist was available to sketch the suggestions made by participants on tracing paper which was hung over the drawings (see Figure 18).

Figure 18: Artist sketches a citizen’s suggestion

A **digital photomontage,** created from a 180° panorama photo of the site, simulated the planning measures on the western half of the planning area (see Figure 19). Twenty-eight individual planning measures were illustrated and made interactive with LaViTo. This low-level interactivity allowed participants to compare existing site conditions with the simulated proposed planning measures.

The program **VNS** (from 3DNature) was used to create **renderings** of the simulated planning proposals in the western half of the site. An overview of planning measures was rendered and prepared with LaViTo, so that measures could be either viewed individually or in groups of issue-related measures (see Figure 19).

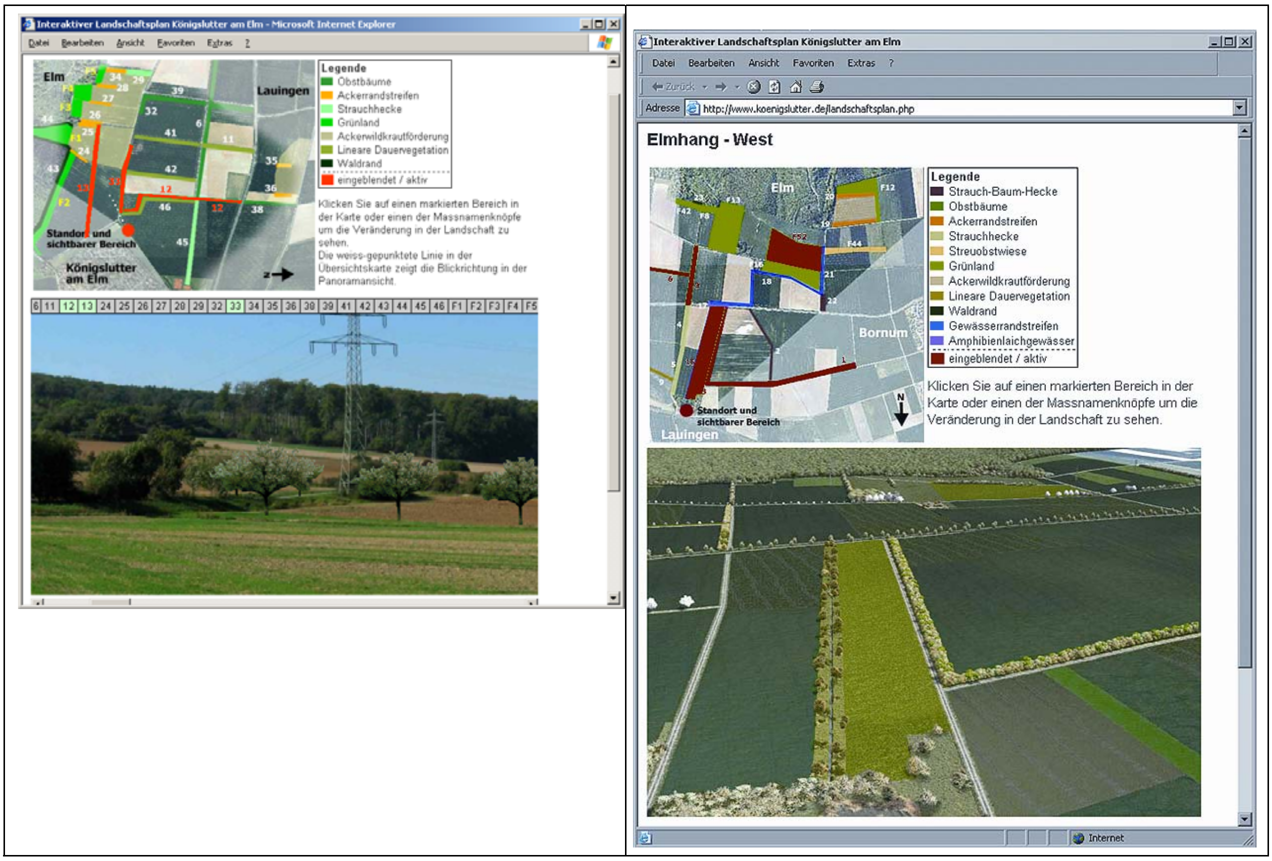


Figure 19: The photomontage enhanced with LaViTo (right) and the VNS rendering (also enhanced with LaViTo, left) visualize the nature protection scenario for the Elm slope in Bornum.

A prototype of the **Lenné3D system** visualized the eastern portion of the site with **LandXplorer,** which could display high-resolution aerial photos as well as historical land use and habitat information (see Figure 20). The citizens could interactively position their comments in the landscape model during the discussion with keywords, lines and polygons. In addition, Lenné3D's 3D player provided a virtual reality experience, in which the distribution of detailed, botanically accurate plant models was visualized in real time.

Figure 20: Lenné3D pedestrian view (left) and LandXplorer VR model (right) bird's-eye view of the planning area

Bornum investigation design

The Bornum case study provided the opportunity to compare how participants responded to the four different visualization methods in one setting. The research design was developed by the research evaluation team[9] and used participant observation techniques to investigate the use of the different visualization techniques by participants in the discussion (OPPERMANN & TIEDTKE 2004). In preparation for the meeting, the visualization techniques were set up at four stations in different corners of the meeting hall. At each station a technician familiar with that particular visualization method presented the visualization during the small group discussion.

Aerial photographs and a large analogue topographic map, which showed the location of the planning measures, were available at each station. The site was divided into east and west sections in order to make the individual planning suggestions more clearly visible during the discussion. The east section was visualized with a VNS rendering and sketches, whereas Lenne3D/LandXplorer and a photomontage were used to visualize the western portion. Although the participatory situation did not allow for a controlled test environment, the records written by the observers provided a good source of evidence as well as a triangulation of the data gathered by the four observers.

The participants were divided randomly into four groups which rotated around the stations, discussing the scenarios for 20 minutes before moving on to the next station (see Figure 21). Because the investigation took place within a "real-life" planning setting, different discussion topics were addressed at the different stations. (The discussion of the same topic using different visualization methods was not an option.) The facilitators and observers

[9] Institute for Open Space Planning, Leibniz University of Hannover, Prof. Dr. Bettina Oppermann, Simone Schipper

stayed with the groups as they moved around the stations. The observers recorded how the participants reacted to the visualization and how they used the visualization during the discussion.

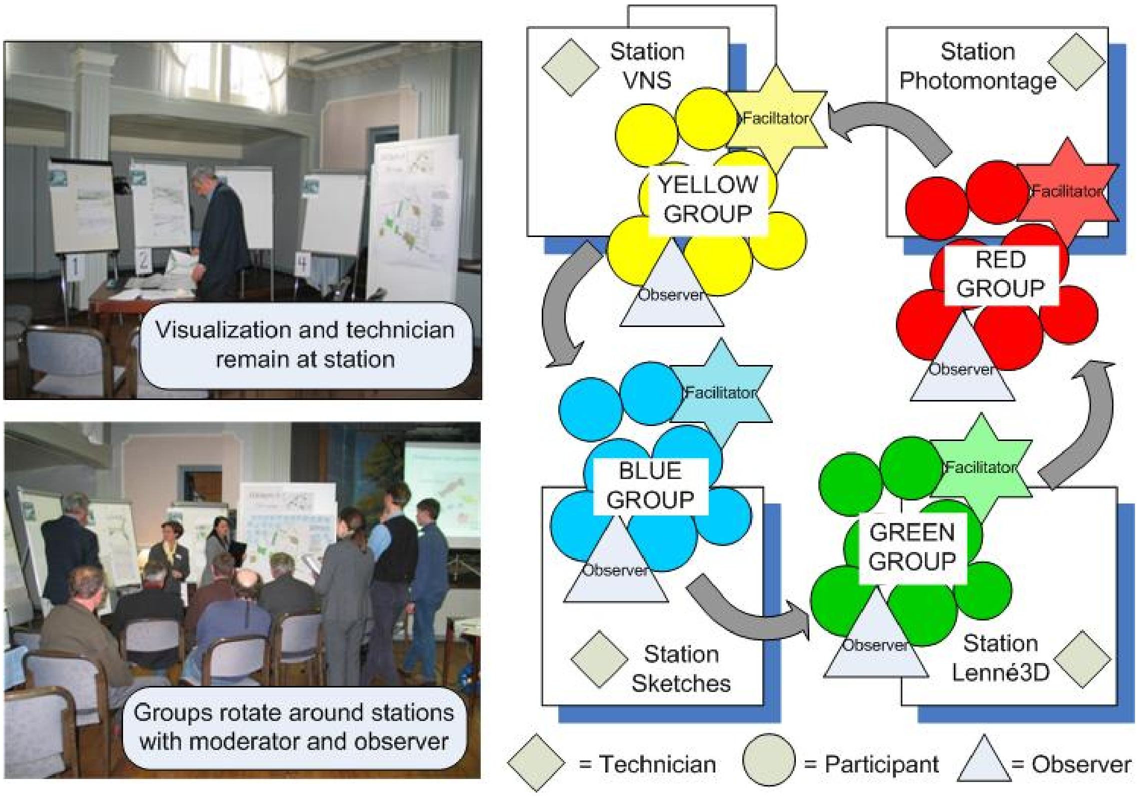


Figure 21: Research design of investigation of four visualization methods in Bornum

Data and analysis

Evidence was collected in the form of minutes taken by the visualization technicians, observers and moderators. Prior to the meeting, the observers were given an outline of important points to look for during the observation of the participants at each station. After visiting all four stations, participants had 15 minutes to discuss the different visualization methods, and their comments were recorded. In addition, participants filled out questionnaires at the end of the evening. The following data sources were produced for analysis: four reports from the moderators, four sets of observation protocols, four reports from the visualization technicians, as well as questionnaires from the participants, a photo documentation, and film.

Using methods of qualitative data analysis (TESCH 1990), the records were coded, data categorized, and reoccurring themes identified. In the investigation, data about the same phenomenon was collected from different observers, i.e. investigator triangulation was used to help validate the data. In addition, multiple sources of evidence, i.e. questionnaires and observations which addressed the same research question, were analyzed together, so that there was a convergence of information from different sources.

5.6.4 Flood plain renaturalization: Beienrode

The participatory objective of the citizen meeting was to inform and to consult with local citizens and interest groups about the objectives and planning proposals developed in the landscape plan for the renaturalization of the flood plain along the Schunter River between Beienrode and Ochsendorf. A set of planning measures were developed to address flood plain protection on publicly owned land and were simulated as follows:

- **VNS rendering** of the site from a bird's-eye view that had been prepared with LaViTo. Before-and-after renderings of each measure from eye level were also rendered and linked to the overview of planning measures (see Figure 22).

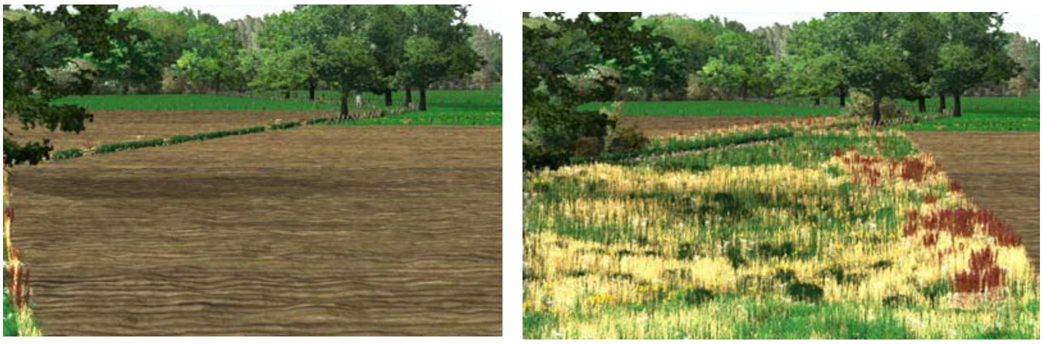


Figure 22: Before-and-after pictures of flood plain renaturalization measures for the Schunter River made with VNS[10]

- **Real-time VRML model** of the site created with **Scene Express** (see Figure 23). Five starting points for navigation were prepared in advance. The visualization technician navigated the model during the meeting, moving along the river where most of the renaturalization measures were located.

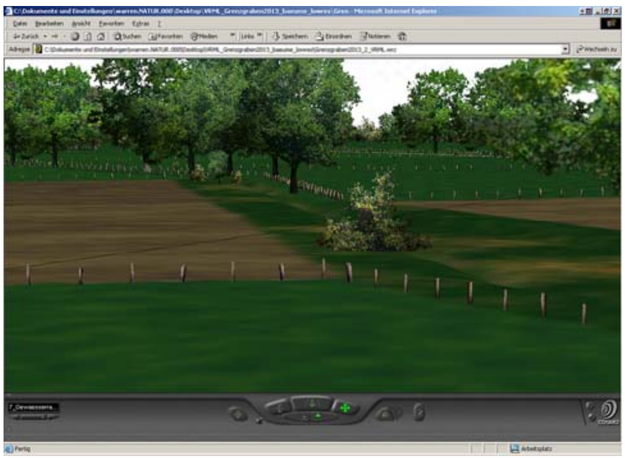


Figure 23: 3D-VRML model made with Scene Express

The investigation objective in Beienrode was to observe how participants responded to virtual worlds. For example, investigators examined how well participants could orient themselves during the dynamic navigation, or if the VRML model provided sufficient realism for them to understand the planning and comprehend the final outcome. Data about the citizens' reactions to the visualizations were collected using questionnaires and in

[10] Visualizations produced by Anne Hebsaker

conversations with participants after the meeting.

5.7 Planning expert surveys

On November 13, 2003, 19 IALP planning experts were asked to rate the importance of interactivity and realism of the visualization in different phases of the planning process. The data were evaluated and presented to the experts during the session, and their comments were recorded in writing. Planning experts at the IALP supervisory board meeting on June 9, 2004 used keypads to evaluate different visualization techniques used in the investigations in Königslutter. The keypad technology allows the participants to respond electronically. The results were visualized in Excel diagrams directly following the "voting" with the keypads. In addition to the Excel summary of the results, the experts' comments about the visualization were recorded in writing.

5.8 Interviews with visualization experts

Finally, at the end of the investigation, experts in the field of visualization were interviewed in order to discuss the preliminary findings. The researcher used a structured interview outline with open-ended questions to elicit expert opinion about the themes which had been identified in the investigation. The interviews were carried out face to face or by telephone and were transcribed and evaluated using methods of qualitative content analysis.

6 Investigation results

6.1 Suitabilitiy of the different visualization types to support participants' understanding (cognition) of the planning content

It was hypothesized here that spatial understanding, orientation, ability to assess the planning, and crediblity are basic requirements which an effective visualization must fulfill in order to be sufficiently understood and accepted by citizens. The following section discusses the capabilities of the different visualization methods to fulfull these requirements.

6.1.1 Spatial understanding (ease of picturing the planning)

Visualization survey of respondents' ratings of spatial understanding

All three surveyed groups found that spatial understanding was supported best by the photorealistic methods: photomontage and panorama photo (see Figure 24). The aerial photo was also rated higher by the young planners, who may have had more experience interpreting the 2D perspective.

The Kruskal-Wallis test (ZAR 1998) for nonparametric analysis of variance revealed no preference for any individual visualization type among the **informed students**. However, for the **lay** group, the test showed that the photomontage was more helpful than the animations, aerial photo, or real-time VirtualGIS model for spatial understanding. The **young planners** also considered the photomontage to be most helpful for picturing the planning proposals. The VRML real-time model from VirtualGIS was the least helpful. Finally, the aerial photograph and the photomontage were found to be more helpful than the topographic map, renderings, and animations produced with VirtualGIS.

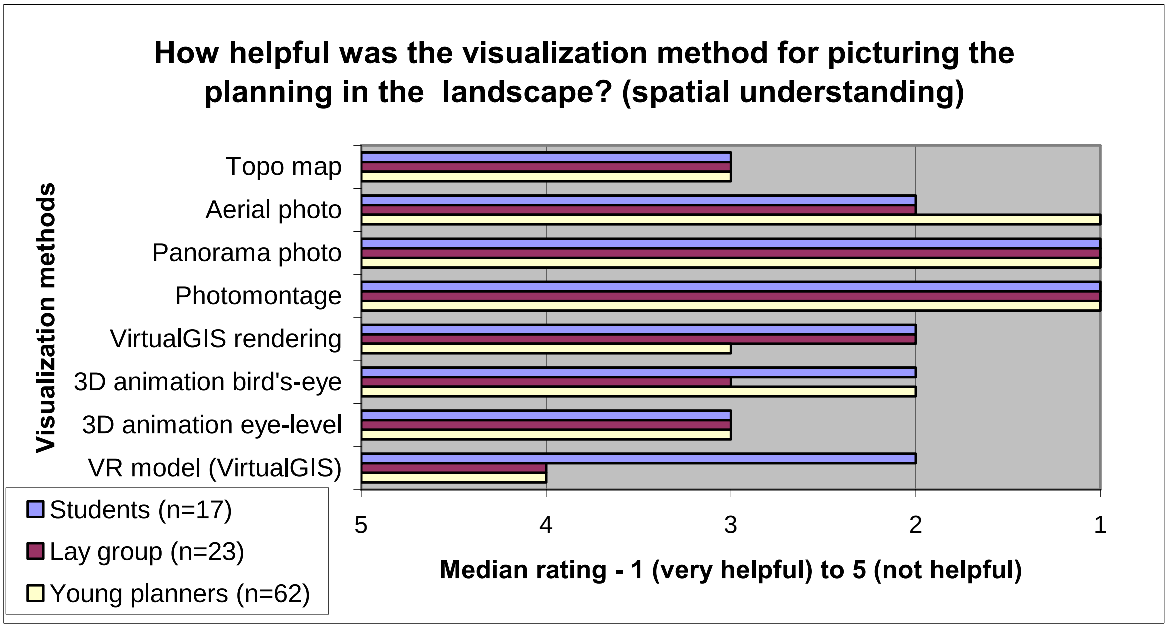


Figure 24: Overview of ratings by students, lay group, and young planners of the helpfulness of the visualization methods for picturing the landscape (Questionnaire I, questions B4 – B33, questionnaire II, questions B 13 – 55)

Young planners rated a wider range of visualization methods

The young planners rated additional visualization methods, both traditional analogue methods (diagram, black-and-white plan, and plan in perspective) and further digital methods (VNS rendering and interactive photomontage). These ratings confirmed that **photorealistic** visualization methods supported spatial understanding best. For example, the comparison of the two different computer renderings of 3D computer models showed that the photorealistic VNS rendering was rated much higher than the less detailed VirtualGIS rendering (see Figure 25). Of the traditional methods, the young planners found that the plan in perspective supported spatial understanding better than the traditional plan and topographic map. However of the 2D visualization methods, the aerial photograph provided the best spatial understanding.

The comments of the young planners about the strengths and weaknesses of the different visualization methods to support spatial understanding are reviewed below:

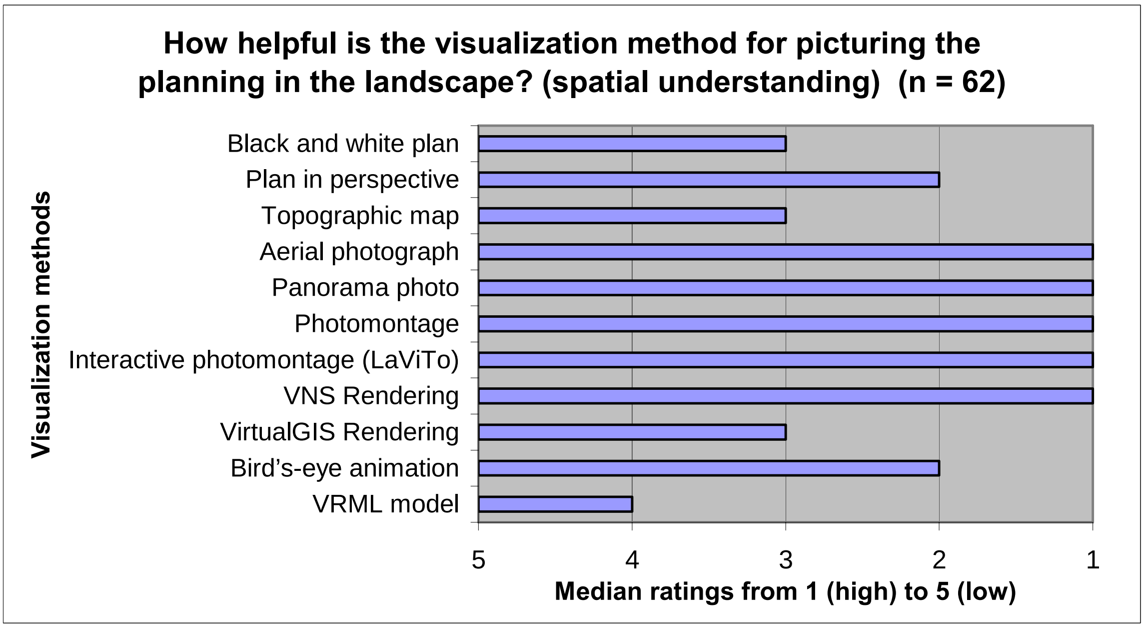


Figure 25: Overview of the young planners' ratings of the helpfulness of analogue and digital visualization methods for picturing the planning (Questionnaire II: questions B1-59)

Diagram: good for planning concepts and background information but poor for spatial understanding

The majority of the favorable comments characterized the diagram as a good instrument for clearly and efficiently understanding the planning concepts and background information. However, it did not support spatial understanding. For example one participant commented, "*explains content, but does not help to picture the landscape.*"

Black-and-white map: potentially difficult for non-professionals to understand

Approximately 60% of the comments were critical of the black-and-white plan. The most frequent criticism was that it was confusing and too complex; the young planners expressed concern that it would be difficult to understand for non-professionals. Although it provided little spatial understanding, it did offer a good overview.

Plan in perspective view: better spatial understanding than 2D plan

The comments about the plan in perspective (also in black and white) were much more positive than the responses to the black-and-white plan. The majority (70%) of the comments showed a positive reaction to the plan in perspective, citing an improved ability to imagine the spatial component of the landscape (over the black-and-white plan) because of its 3D character. For example, some comments described the plan in perspective as "*easier to imagine than a 'flat' plan*". Others found the plan in perspective to be intriguing, although some suggested that the plan in perspective might be distorted.

Topographic map: not for everyone; color helps, but still difficult to understand

The young planners' opinions were divided about the topographic map: 40% felt the topographic map was difficult to understand and inadequately designed; and approximately 60% thought it was clear or easy to understand, and they appreciated the use of color and the good overview which it provided. The use of color improved the understanding of the map. Nevertheless, even young planners, who were experienced with 2D maps, still had difficulty imagining the landscape with the topographic map.

Aerial photograph: easy to picture the landscape, even though 2D

The aerial photograph was one of the first photorealistic visualizations that the young planners viewed in the survey. Most (92%) commented that the aerial photo made it very easy to picture the planning, citing the attributes of realism and color most frequently as the reason. The comments indicate that the natural or original colors helped to make the visualization clearer. Furthermore, even though it was a 2D visualization, the respondents considered the aerial photograph better than the topographic map because the aerial photo: "*makes it enormously easier* ***to imagine*** [the planning]," and "*is more realistic and easier* ***to recognize*** [the landscape]," and "*is easier* ***to understand*** *than the others, clearer*." The comments appear to indicate that aerial photographs are better suited than topographic maps for citizen participation.

Panorama photo: realism and movement give the feeling of being in the landscape

Over 90% of the young planners' responses to the panorama photo were positive. The realism of the photomontage impressed the young planners most, with 43% of the comments specifically mentioning the realism of the visualization. The next most frequent comment was about the ease of picturing the landscape. The movement of the panorama photo introduced an emotional aspect or identification with the landscape. The respondents commented that "*The viewer feels transported into the landscape*" or "*as if one were on a walk*."

Photomontage: realism meets approval, but scepticism remains

The young planners were impressed by the photomontage and described it with adjectives like: realistic (23 x), well done/good (13 x), natural (5 x), clear/explicit (4 x), descriptive (3 x). However, a few participants considered the photomontage to be manipulative or that it portrayed a very different picture of the landscape than in reality, e.g. "*strange because the hedges appear larger than they probably are in reality*."

Interactive photomontage (LaViTo): interactivity helps understand the planning

The photomontage that had been prepared with LaViTo received overwhelmingly positive responses from the young planners. For example, "*realistic, explanatory; the ability to click the hedges on and off makes it easier to imagine the planning*." The **combination of**

visualization types in the LaViTo supported visualization was also recognized as helpful, “*works well together, one knows where one is and has a realistic image for looking at a part of the landscape.*”

VNS rendering (eye level): helps to picture the landscape even though it is not a photo

The majority of young planners considered the VNS rendering to be realistic (16 x) and that it helped to picture the landscape (13 x), e.g. “*it invites one to consider the planning and to really imagine it.*” At the same time, the participants commented on the artificial character of the visualization (13 x). Interestingly, the participants recognized that the visualization was computer generated, not a photo, but it nevertheless helped them to imagine the planning.

VirtualGIS rendering: too abstract

The majority of the young planners were critical of the rendering made with VirtualGIS®. The comments describe the visualization as artificial looking (14 x), not realistic enough, (11 x), too abstract (8 x). On the other hand, there was a handful of comments which indicated that the visualization helped to picture the landscape and supported spatial understanding (10 x), e.g. “*spatial effects are easy to understand, though abstract objects are very unrealistic*”.

Bird’s-eye animation of VR model (VirtualGIS): useful overview but poor graphic representation

Comments reflected the fact that the visualization was obviously computer generated but still understandable, e.g. “*not natural, but convincing, interesting, legible, good choice of colors*”. There was much criticism of the computer graphics (15 x) and the type of image (23 x). However, most of the positive comments praised the usefulness of the visualization (21 x), e.g. to give an overview of the planning measures. The comments indicate that the bird’s-eye animation (with VirtualGIS) is apparently good for an overview of large-scale situations but does not offer enough detail for a close-up perspective of the landscape.

Eye-level animation VR model (VirtualGIS): unrealistic graphics too distracting at eye level

The young planners’ comments about the eye-level animation were very critical (80%). The limitations of this representation of vegetation became apparent at eye level, e.g. “*the hedges are not very realistic, objects are not recognizable, too abstract.*” Although it was considered a good perspective for citizens, it was difficult for them to maintain an overview of the landscape. They had difficulty recognizing landmarks and vegetation with the abstract graphics, which made orientation more difficult. Finally, the participants were irritated by the height of the eye-level camera, which was somewhat above the normal eye-level perspective. For an eye-level animation, the camera height must be adjusted to the normal pedestrian height.

VRML model (VirtualGIS): representation of vegetation too abstract

The young planners considered the interactive VRML model to be the **least helpful visualization** method of all. The most frequently mentioned deficit was the rudimentary graphic representation of the vegetation. The complaints about the graphics were similar to the previous comments about the VirtualGIS eye-level animation: blurry and poor resolution. The poor quality of the graphics seems to have been so distracting that the participants were not able to use the model to picture the planning.

Visualization preferences found in the visualization survey: panoramas easy to understand

Both lay group and informed students preferred the panorama photo. It provided realism and a helpful 360° overview. The topographic map and aerial photograph also gave the less experienced groups a good overview. The topographic map was preferred by the informed students, possibly because they were more familiar with the 2D map symbols and appreciated the additional information that they found in the map. On the other hand, the lay group preferred the aerial photo because it was realistic but also gave a good overview. This supports the experience in the case study in which the citizens' first contact with the visualization was via interactive maps and aerial photographs. One of the first questions was, "*Where is my house*?", which could be found much more easily in the aerial photos than the topographic map. This is also supported in the findings of the case study questionnaires in Gross Steinum and Bornum. However, the citizens preferred a combination of visualizations rather than a single one.

Planning experts evaluate helpfulness of the visualization methods to picture the planning (IALP advisory board, 09.06.2004)

Figure 26 shows that about half of the planning experts selected VNS rendering (LaViTo) as a good method for picturing the planning in the landscape, with LandXplorer and photomontage (LaViTo) selected almost as frequently. The choices were made with keypads, so there are no comments which might shed light on the reasons. The same group was also asked to select visualization types that would help to convince citizens of nature protection measures. Although the diagram shows a slight preference for visualization methods that provide a good overview, i.e. maps and aerial photos as well as LandXplorer, there is no significant statistical difference between the two answers.

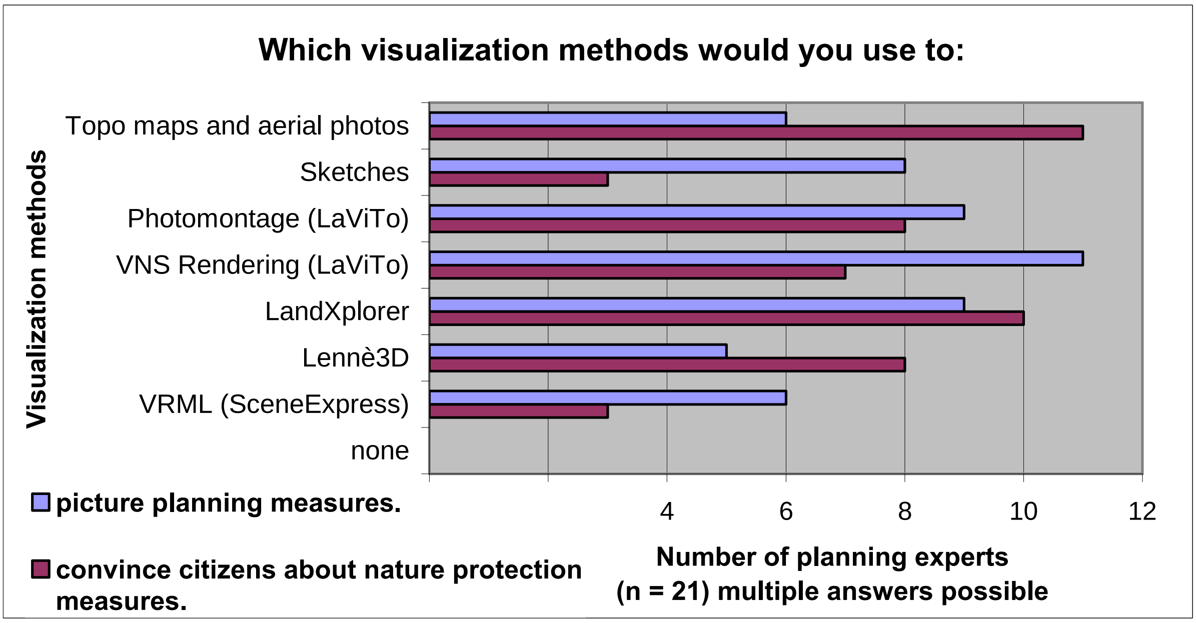


Figure 26: Planning experts (survey from 09.06.2004) identify (with keypads) visualization methods that help to picture the planning and methods that are useful to discuss nature protection issues with citizens.

Responses from Königslutter case study about the ease of picturing the landscape

Surveys during the case study consistently showed that photorealistic visualization methods helped to picture the planning: In Rottorf (4.06.2003), participants unanimously agreed that the photomontage was helpful in picturing the planning proposals that were discussed. In Beienrode (26.06.2004), 80% of the respondents found the interactive VNS renderings (LaViTo) and the Scene Express VR model sufficiently realistic to imagine the planning well. The eye-level "before-and-after" renderings also made with VNS and used during the meeting, were unanimously considered realistic and helpful in picturing the planning.

Interestingly, the questionnaires that were answered by citizens at the town meeting in Bornum on 15.03.2004 show that 75% of the participants found maps/aerial photographs, VNS rendering (LaViTo), and LandXplorer to be helpful to picture the planning (see Figure 27). The majority of the participants were farmers or land owners in the area. The familiarity of the participants with the site may be one explanation for their ability to use the 2D maps and aerial photos to picture the planning. Less than half of the respondents found the (not very realistic) sketches and, interestingly, the photomontage to be helpful in picturing the proposed planning. The reasons remain unclear, but a few participants expressed some distrust of the photomontage.

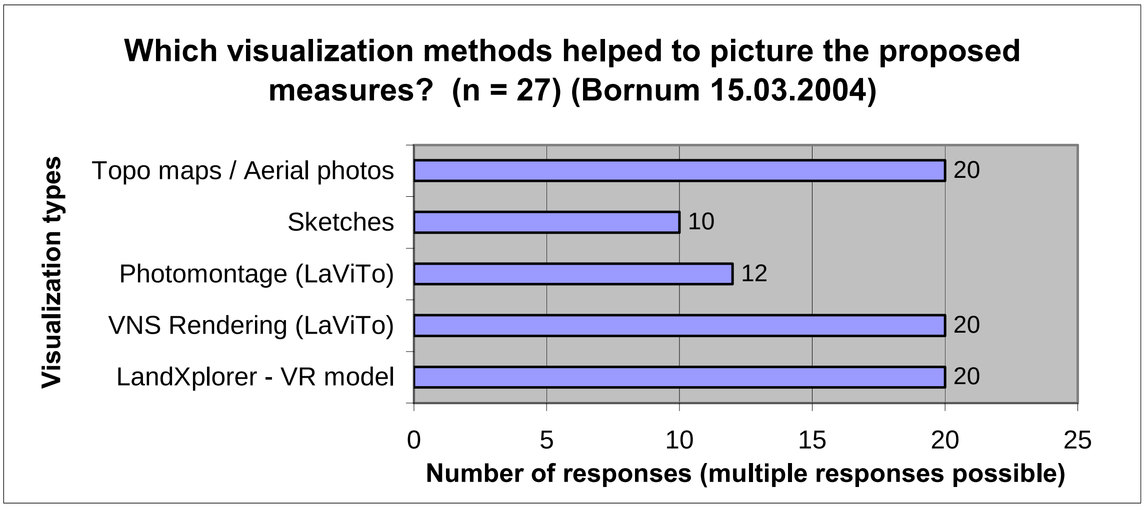


Figure 27: Participants in the town meeting in Bornum (15.03.2004) identify visualization methods that help spatial understanding.

6.1.2 Visualization methods that support orientation

Evaluation of visualization survey questionnaire: students and lay group

The survey revealed that the respondents established spatial orientation primarily through identification of landmarks, e.g. settlements, roads, landscape elements, and topography. They stated that orientation is easiest in visualizations that have realistic and detailed images and an elevated viewpoint, for example the view from a hill top or bird's-eye perspective. Also cited as helpful were dynamic navigation, i.e. zoom or pan functions, and information, e.g. labels, north arrows, and legends.

Both students and lay persons considered the panorama photo to provide good spatial orientation (see Figure 28). As one lay person commented, "*The panorama photo is realistic, one viewpoint, but 360° view*" (dynamic navigation from a static point). The students identified realism, the ability to recognize landmarks, and the experiential quality as reasons of choice: "*One has the feeling that one is standing on the site and sees it with one's own eyes.*"

In addition, the students also considered the topographic map to support orientation equally well, because it provided the most information about orientation, e.g. north arrow, legend, labels, and roads. The lay persons, on the other hand, preferred the aerial photograph because it was realistic.

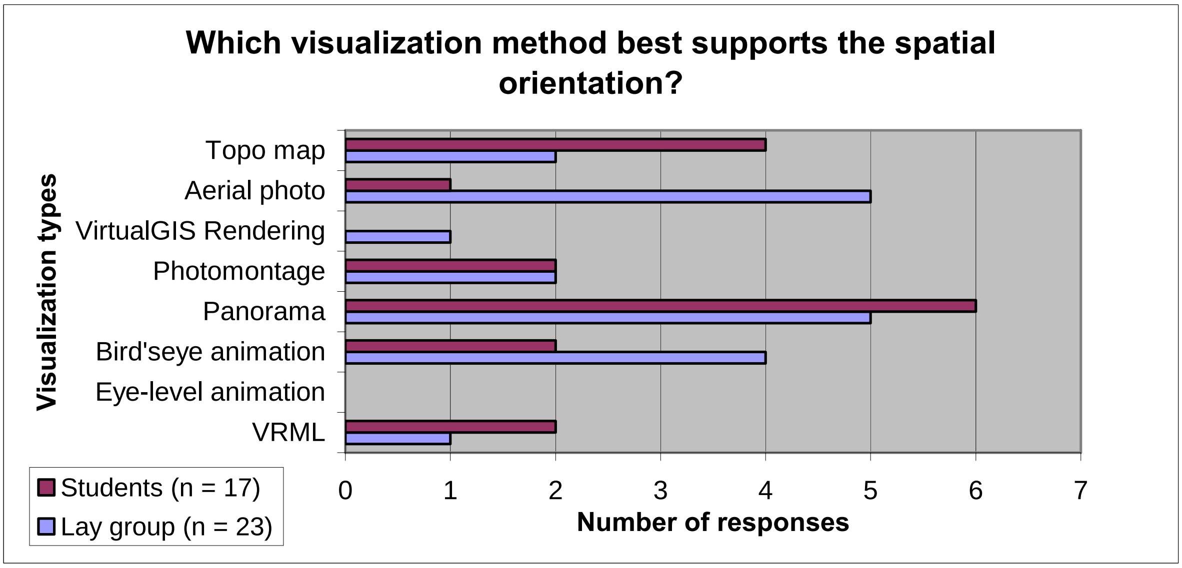


Figure 28: Overview of choice by students and lay group of visualization methods that support spatial orientation (Question B34).

The informed students and lay group considered orientation best with a combination of 2D and 3D methods: 95% of the 40 respondents of the visualization survey preferred the use of a combination of visualization methods to establish orientation. There was no clear preference for the combination of visualization methods. In fact, among the 34 responses, 22 different combinations were suggested. Approximately 60% preferred a combination of two visualization types, while the rest preferred a combination of three types of visualization. However, all but four combinations included a 2D visualization – either a topographic map or an aerial photo – with a 3D visualization image. Half of the participants suggested a combination of 2D and a 3D photorealistic visualizations (most often the panorama photo), while about one-third recommended some combination of 2D and dynamic 3D model (animation or VR model).

Planning expert survey (09.06.2004): experts orient with topo maps and aerial photos

The summary of the keypad survey in Figure 29 shows that the majority of planning experts found the spatial orientation easiest with the topographic map and aerial photo. In contrast to the lay and student groups, who could not orient themselves well in the Virtual-GIS VR model, half of the experts considered orientation to be easy with the interactive VR model from LandXplorer. Finally, over 40% of the experts judged the VNS rendering (LaViTo), which showed the landscape from a bird’s-eye view, supported spatial orientation. All the visualization methods that the planning experts preferred offered an elevated view of the landscape. Apparently for this group, the overview was an important factor for good orientation, and they appeared to be most comfortable with 2D topographic map and aerial photos.

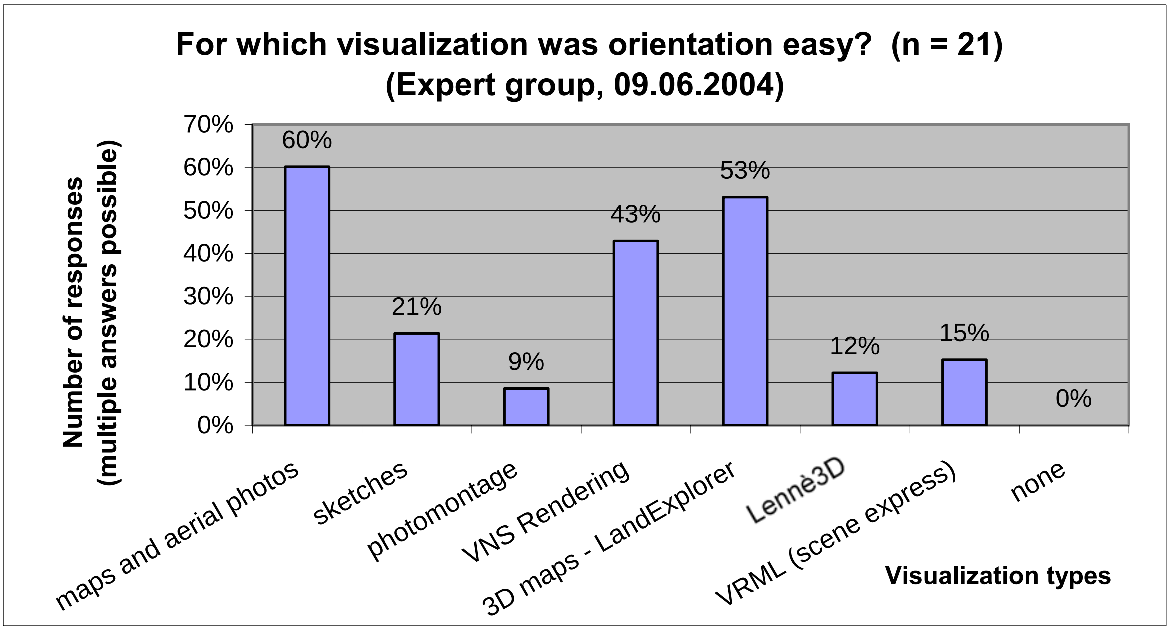


Figure 29: IALP advisory board experts select visualizations methods that support orientation (keypad survey from 09.06.2004) (Question C3).

Case study findings: citizens in Königslutter stay oriented with panorama photo

The responses from questionnaires distributed to citizens during the case study support the findings of the visualization survey. In both Rottorf (04.06.2003) and Gross Steinum (20.06.2003), respondents to questionnaires agreed unanimously that the **panorama photos** provided good orientation. The participants in Gross Steinum also considered the **topographic map** and **aerial photo** important for orientation. It should be noted that the majority of the participants were land owners and very familiar with the site. The participants used the analogue topographic map easily and often to locate landscape elements and situate their comments.

The comparison of different visualization methods by citizens in Bornum (15.03.2004) revealed once again that topographic maps and aerial photographs provided the best orientation (see Figure 30). In contrast to the planning experts, the citizens found spatial orientation most difficult with the virtual 3D maps (LandXplorer) and sketches. The comments indicate that the movement through the VR model of LandXplorer was too fast, causing viewers to lose their orientation. In the case of the sketches, the participants required several minutes to orient themselves in the drawings in order to recognize the viewpoint and direction of view for the four different sketches.

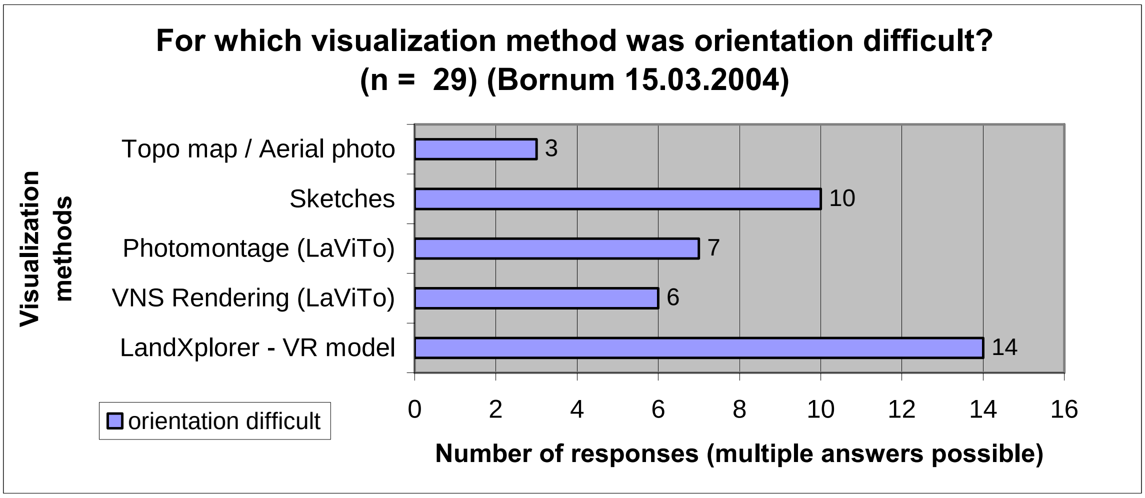


Figure 30: Participants in the Bornum investigation (15.03.2004) identify visualization methods that do not support orientation.

In Beienrode, on the other hand, the questionnaires revealed that the participants could orient themselves equally well with all the visualization methods that were used during the evening presentation: VRML model, VNS rendering, VNS before-and-after renderings, and aerial photos. In this case, however, all the different visualization methods were integrated into the presentation and discussion. The visualizations were not viewed separately. As a result, the participants received a cumulative impression of the different visualization methods. The combination of methods may have supported the overall ability to orient in the different visualizations. Therefore, this made differentiation and comparison of the individual visualization methods less clear. However, it may indicate that orientation is better in a participatory situation when several different visualization methods are used.

6.1.3 Assessing change: illustrating status quo (before) and proposed planning (after)

Visualization survey: informed students and lay group found photorealistic images best for comparison

There was agreement among the informed students and lay group (Figure 31) that the comparison of 3D photorealistic before-and-after images, i.e. rendering and photomontage, is clearly more helpful in assessing the proposed planning than with the 2D visualization methods and animations. The comments explained that the rendering and photomontage provided an image of how the planning would appear, which made the assessment of the planning easier. On the other hand, the plan showed location and gave an overview, but it did not show how the planning proposals would appear.

Of the 3D visualizations, the photorealistic visualization method – photomontage – was considered better because the representation of the vegetation in the VirtualGIS rendering was too abstract.

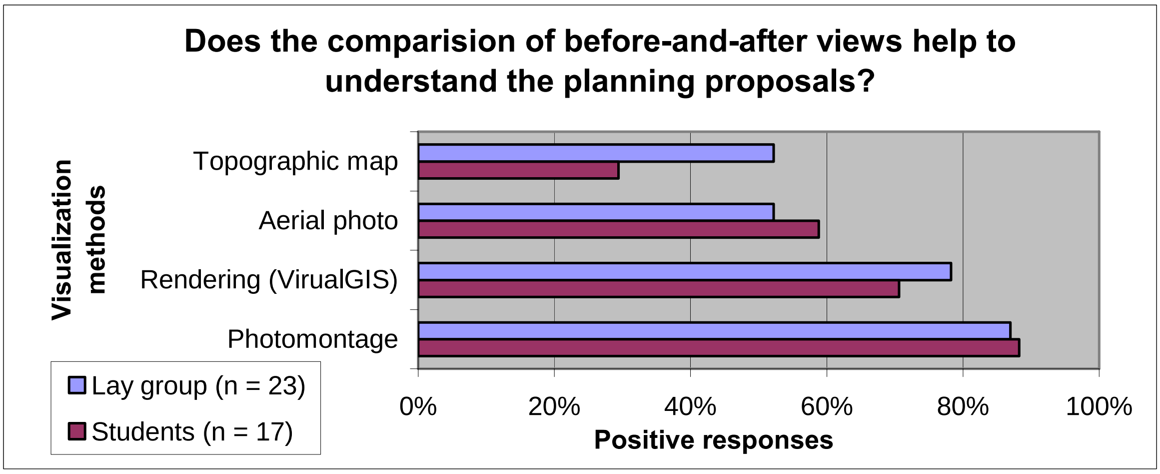


Figure 31: Student and lay groups evaluate the helpfulness of before-and-after images for understanding planning proposals (Questionnaire I: questions C2 - C8).

Visualization survey: before-and-after images helped young planners to imagine, understand, and assess the planning

The results of the survey of young planners substantiated the importance of before-and-after views for visualizing and evaluating the planning proposals. In 90% of their ratings these respondents indicated that it was either important or very important to view before-and-after images. Several important reasons are mentioned for using before-and-after images. First, it was stated that the before-and-after views help the viewer to understand the planning proposals, e.g. “O*ne has to be able to understand what has been changed in order to then eventually discover why*.” Second, the comparison also helps to explain or justify the planning, “*the changes become more visible and easier to picture ... so that the necessity of hedge planting is more understandable*.” Third, the comparison makes the changes, both good and bad, clearer so they can be evaluated better, “*it is the only way to make a realistic evaluation*.” Finally, the young planners commented that the before-and-after views also to help make a decision and promote credibility, “*speaks for transparency and credibility in the planning*.”

Case study: importance for citizens depends on personal perspective

In contrast to the visualization survey respondents, the participants in the town meeting in Gross Steinum (20.06.03) did not feel it was important to see before-and-after images or alternatives of the hedgerow plantings. This may be explained by the fact that the majority of the participants were farmers who rejected the idea of planting hedgerows. In Beienrode (26.05.04), on the other hand, the responses to the questionnaires indicate that the majority of participants, most of whom were not farmers, felt that it was very important to see planning alternatives. The attitude towards the planning issue and the composition of the audience undoubtedly affected the perceived importance of before-and-after views.

6.1.4 Credibility

Perception of credibility

The young planners rated the panorama photo as the most credible of all the visualization methods (median = 1). The next most credible visualizations were photorealistic and 2D as well as the bird's-eye animation (median = 2). The VirtualGIS rendering and VR model as well as the plan in perspective were considered least credible (median ≥ 3) (see Table 19).

Table 19: Median ratings of young planners for spatial understanding, credibility, and realism of different visualization methods (1 = high, 5 = low)

Visualization methods	Credibility	Spatial Understanding	Realism
Panorama photo	1	1	1
Photomontage	2	1	1
Interactive photomontage (LaViTo)	2	1	1
Aerial photograph	2	1	2
VNS Rendering	2	1	2
Bird's-eye animation (VirtualGIS)	2	2	3
Black-and-white plan	2	3	3
Topographic map	2	3	3
Plan in perspective	3	2	2
VirtualGIS rendering	3	3	4
VRML model (VirtualGIS)	4	4	4

Relationship of credibility to realism and spatial understanding

The results of the young planners' ratings of the different visualization methods as to their relative credibility, realism, and spatial understanding are shown in Figure 32. The young planners' comments about each of the visualization methods are discussed in the following section.

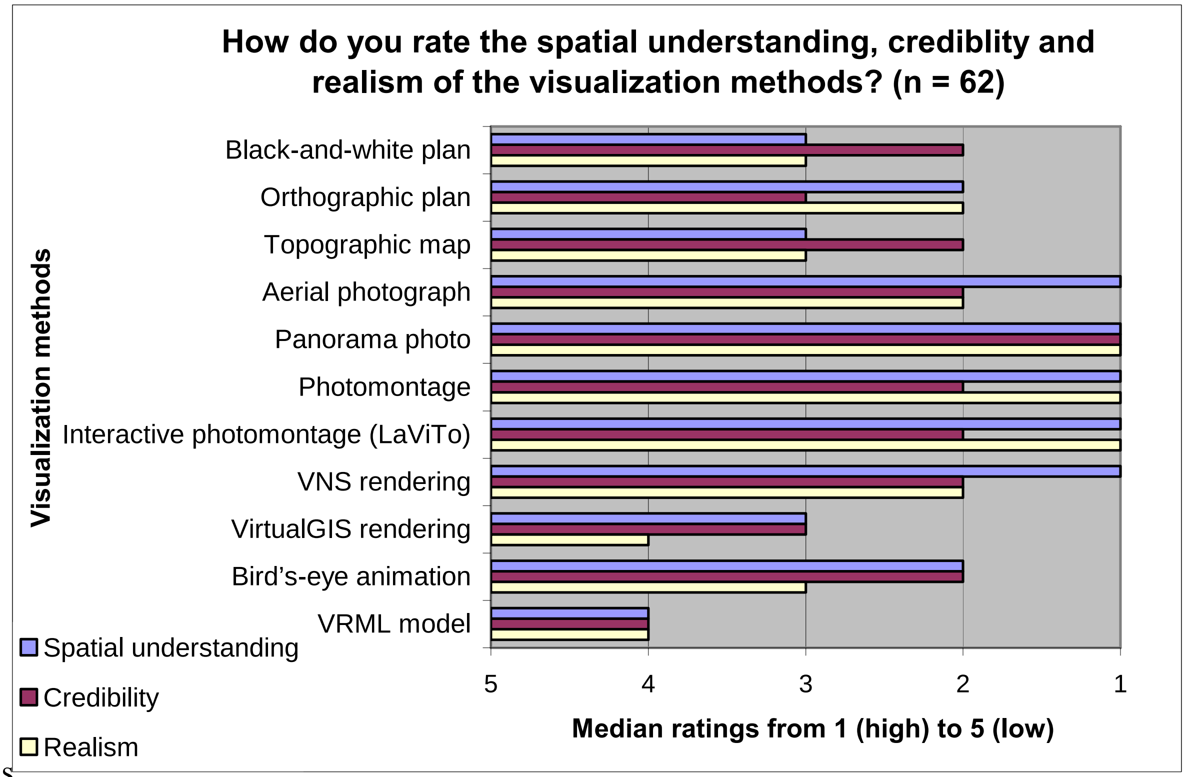


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Figure 32: Young planners compare three visualization criteria: spatial understanding (ease of picturing the landscape), credibility, and realism (Questionnaire II, Questions B1 - 59)

Panorama photo received top ratings not only for credibility, but also for realism and spatial understanding.

Figure 33 shows a high concurrence of the ratings for realism, credibility, and spatial understanding (p = 0:6218, α = 0:0020). The comments reflect an enthusiasm and sense of being a part of the landscape. About 40% of the comments specifically mention the high realism of the panorama photo. It was so real that a few participants even questioned its credibility, e.g. "*Is this real?*" and "*perhaps manipulation (too perfect)*"; however, these comments are not reflected in the credibility rating.

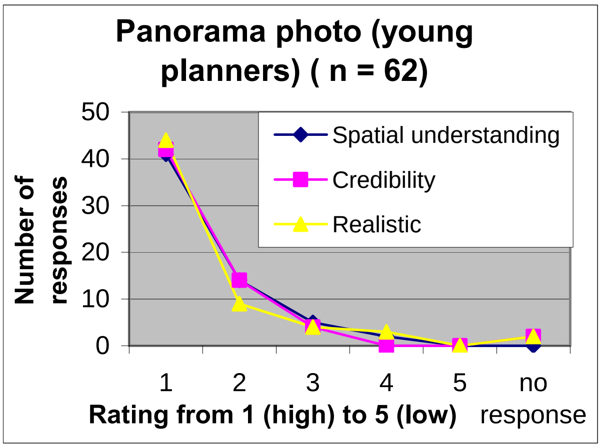

Figure 33: Young planners rate spatial understanding, credibility, and realism of the panorama photo:. (Questions B28 - 32)

The credibility of the 2D visualization methods (black-and-white plan and topographic map) was higher than their spatial understanding and realism.

There was a statistically significant difference between the rating of credibility (median = 2) and the other two factors (median = 3) ($p = 0.0002$, $\alpha = 0.0020$). The young planners commented that the black-and-white plan was serious and gave a good overview, but that it was confusing, too complex, or difficult to understand or to picture the information. The comments about the topographic map are similar. They are divided between those who felt the topographic map was difficult to understand (40%) and those who thought it was clear and easily understood, and gave a good overview (55%). Figure 34 shows the dissimilarity of the ratings of the topographic map.

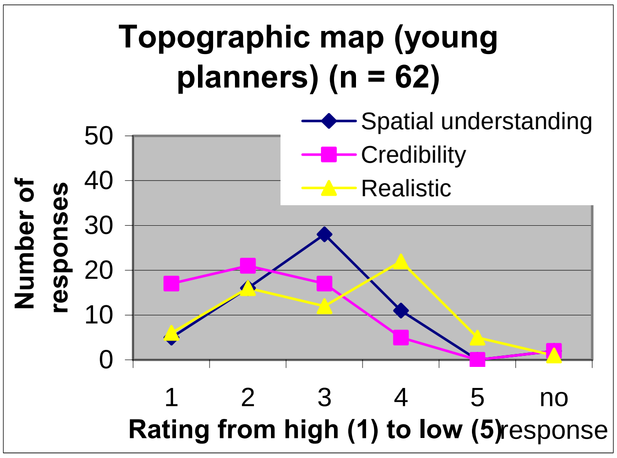

Figure 34: Young planners rate spatial understanding, credibility, and realism of the topographic map. (Questionnaire I: questions B13 - 17)

The reverse was the case for the plan in perspective view, which was easier to understand than it was considered credible.

The young planners felt that the plan in perspective was easier to picture (median = 2) and more realistic (median = 2) than the black-and-white plan, but that it was less credible (median = 3). There is a statistically significant difference in the lower rating of credibility and those of the other factors ($p = < 0.0001$, $\alpha = 0.0020$). About 30% of the comments expressed suspicion about the artistic touch: "*like a comic*", "*not scientific enough*" or "*The plan appears to be made more flattering or beautiful, perhaps use it only in connection with a topographic map.*" This may explain its lower credibility.

Photorealistic methods: criteria rated similarly

Although the median ratings of credibility were lower than those for spatial understanding and realism for some of the photorealistic methods (see Figure 32, Section 6.1.4), there is no statistically significant difference in the ratings of the three factors (photomontage: $p = 0.089$; panorama: $p = 0.6218$; interactive photomontage: $p = 0.5467$; aerial photo: $p = 0.4066$; $\alpha = 0.0020$).

Most of the comments about the **photomontage** indicated the respondents were impressed by the realism (median = 1) of the visualization which helped to picture the planning. Two participants pointed out that the photomontage can be manipulative: "*Strongly manipulated, because everything in a photomontage can be made to look good.*" This doubt is reflected in the slightly lower credibility ratings (median = 2) shown in Figure 35.

For the **VNS rendering,** the young professionals rated the spatial understanding (median = 1) slightly higher than credibility and realism (median = 2). This indicates that participants were quite able to imagine the planning with a relatively realistic, computer-generated image; they did not require a photo image. Nevertheless, as with the photomontage, there remained some uncertainty about the credibility.

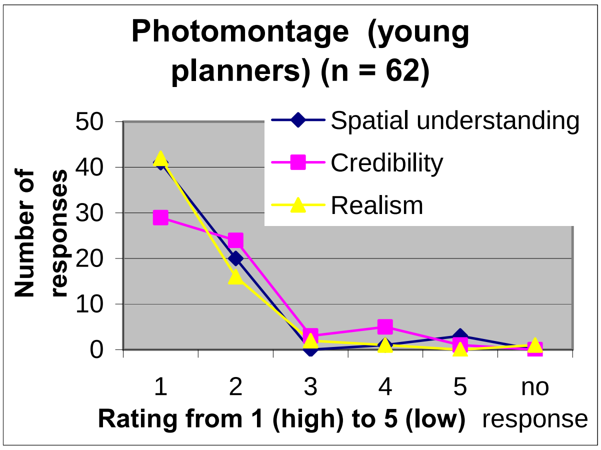

Figure 35: Young planners rate spatial understanding, credibility, and realism of the photomontage. (Questions B38 - 42)

For the **aerial photograph,** spatial understanding (median = 1) was also rated higher than credibility and realism (median = 2). The comments reflect the ratings. Over 40% of the comments pointed out the ease of picturing the planning with the aerial photograph. Realism and color were cited as strengths. Therefore it is not clear why the rating of realism was slightly lower. Although it is a standard photo taken from an airplane, its credibility remained slightly questionable.

The interactivity of the photomontage did not significantly improve its credibility rating.

As with the photomontage, the young planners rated the **interactive photomontage** as very easy to picture and realistic (median = 1), but the assessment of the credibility (median = 2) was slightly lower. The graph of the ratings (see Figure 36) is very similar to that for the non-interactive photomontage, with a dip in credibility (see Figure 35). The comments indicated that the combination of visualization types and viewpoints and the ability to click the planning on and off made it easy to picture the planning. However, this did not improve the credibility rating.

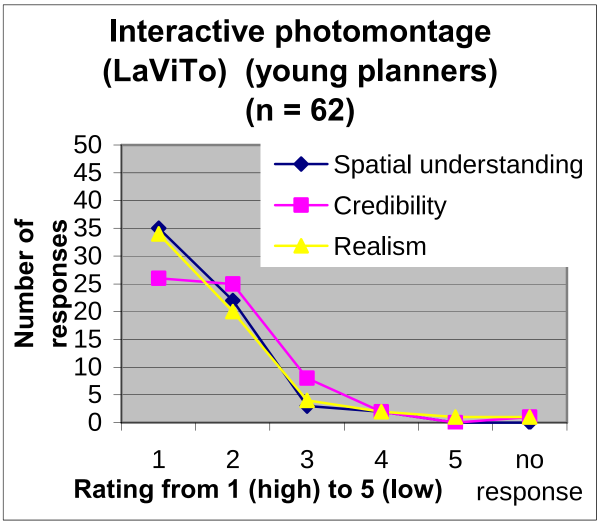

Figure 36: Young planners rate photomontage (LaViTo). (questions B55 - 59)

The strength of VNS rendering is the spatial understanding which it provides.

There is a statistically significant difference between the rating of spatial understanding (median = 1) and the other factors for VNS rendering (spatial understanding/credibility: p = < 0.0001; spatial understanding/realism: p = 0.0003; α = 0.0020). In other words, the VNS rendering provided good spatial understanding, although it was not as realistic as the photorealistic methods.

VirtualGIS visualizations lack detail

For all the visualization methods prepared with **VirtualGIS**, spatial understanding was rated significantly higher than realism. The bird's-eye animation was rated more credible than the other visualizations prepared with VirtualGIS. The VRML model was rated lowest for all the factors.

The difference in the ratings of spatial understanding and realism is statistically significant (rendering: p = < 0.0001; bird's-eye animation: p = 0.0004; and VRML model: p = 0.0017, α = 0.0020). For the bird's-eye animation, credibility was also rated significantly higher than realism (p = 0.0007). It can be hypothesized that the dynamic navigation over the site may have improved the credibility of the visualization. The VR model was rated low for all the factors.

The comments about **VirtualGIS rendering** focused on the lack of realism in the visualization, and this is reflected in the ratings. The lack of detail may have made spatial understanding more difficult than in the VNS rendering, thus affecting the credibility

The **bird's-eye animation** received mixed reviews from the young planners. On the one hand, they commented that the bird's-eye animation was unrealistic and too artificial (38 x), but on the other hand, they felt it supported spatial understanding and gave a good overview of the planning area (30 x). Interesting is the fact that both the rendering and bird's-eye animation were considered more credible than realistic. In other words, even though the animations appeared unrealistic, the young planners believed them and could understand the lay of the land.

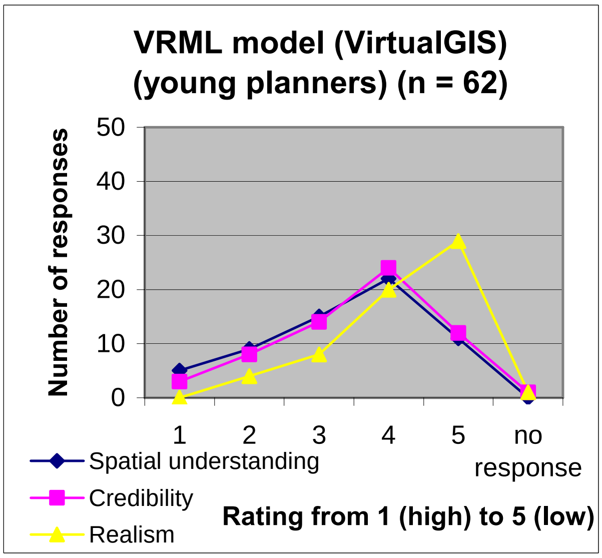

Figure 37: Young planners rate the VRML model (VirtualGIS). (Questionnaire I: questions B50 - 54)

The interactive **VRML model** received the lowest ratings in all categories. The abstract representation of the vegetation repeatedly mentioned in the comments is most probably the reason for the poor rating for realism (see Figure 37). The poor quality of the graphics may have been so distracting that it was difficult for the participants to picture the planning in the landscape, and thus it did not appear credible.

Improving credibility

The young planners made the following suggestions about how to improve the credibility of the visualization methods:

- **Panorama photo:** The young professionals suggested that the credibility could be improved by including audio, people in the foreground, labels, additional viewpoints, and different seasons. This was the first time that the other senses were mentioned.
- **Black-and-white plan:** The young planners commented that credibility could be increased with more information and metadata, e.g. date, scale, labeling, as well as more detail and color.
- **Topographic map:** There were few suggestions, but these included adding visualizations that support spatial understanding, e.g. photos, perspective, 3D or more detail and information.
- **Aerial photograph:** Suggestions for improving credibility included increasing the navigation interactivity, i.e. zooming, adding 3D visualizations and more views.
- **Plan in perspective (orthographic projection):** The young planners again suggested that credibility would be improved by color, more detail, more information, e.g. scale, or a different perspective, increased metadata and explanations.
- **Photomontage:** There were only a few suggestions for improving the credibility of the photomontage. They included visualization of the fourth dimension, i.e. growth and different time intervals of the development as well as different views from other standpoints.
- **VNS rendering:** Suggestions included improving the resolution, increasing detail, using real photos, having less abstraction in the foreground, adding people or cars to give scale, including different weather conditions. And finally, one participant raised the interesting question: "*3D-visualizations should arouse the emotions; do they really need to be credible?*"
- **VirtualGIS rendering:** In order to improve credibility, comments suggested combining different types of visualization, e.g. map, photograph, and using more

(photo)realistic graphics to represent the vegetation with increase detail.

- **Interactive photomontage (LaViTo)**: Credibility would also be increased by using a larger image in which the type of vegetation is more visible (providing more detail) and by different perspectives or viewpoints.
- **Bird's-eye view animation (VirtualGIS):** The young planners suggested that a more realistic representation of the vegetation, better resolution, and more detail would increase the credibility of visualization and that variation of the camera level would be beneficial.
- **VR model (VirtualGIS)**: There were many suggestions about how to improve credibility. It was suggested repeatedly that a more realistic and detailed representation of the vegetation would help the credibility and understanding of the visualization. Better textures and resolution, less abstraction, the use of photos, labels, and a small overview map for orientation were among the suggestions made in the comments.

In general, the comments from the young planners suggest that credibility can be improved through:

- More information – background information, legend, metadata
- Improved graphics – more detail, better resolution, color
- More realism – less abstraction in the foreground
- More context – overview maps, larger images
- Additional views of the planning – different perspectives, different viewpoints,
- Sound and 4th dimension.

Apparently, credibility of the visualization is improved through more information about the background of the visualization and the planning issues. Clearer visual representations and more background information about the planning and visualization may give viewers a better understanding of the planning so they can judge whether or not the visualization represents the real situation. This, in turn, may give them more trust in the visualization. In other words, the more participants know about what is being shown in the visualization, the better they can judge the credibility of the visualization.

6.1.5 Summary of suitability criteria for visualizations in the participation process

Spatial understanding

The **visualization survey** showed that the most helpful methods for picturing the landscape were photorealistic visualizations. Specifically, survey respondents considered photomontage, panorama photos, and even aerial photos the best visualization methods for imagining the landscape. The young planners' evaluation of the strengths and weaknesses of both traditional and digital visualization methods and their suitability as a support for spatial understanding are summarized in Table 20. Both the overview of the landscape and good spatial understanding were important. The aerial photograph that provides both was one of the favorite visualization methods, even though it is a 2D representation. This may indicate that realism is even more important than three dimensionality for spatial understanding.

Table 20: Overview of young planners' assessment of the visualization methods

Visualization method	Strengths	Weaknesses
Diagram	Helps to understand planning concepts	Poor spatial understanding
B/W maps	Good overview	Difficult to understand
Orthographic plan (perspective view)	Good spatial understanding	Distortion, unclear
Topographic map	Good overview, color improves understanding	Difficult to understand
Aerial photograph	Easy to picture landscape (photorealism and color help), good overview	
Panorama photo	Stimulates enthusiasm, photorealistic, easy to picture landscape	No overview – not everything is visible
Photomontage	Photorealistic, easy to picture landscape and planning	Potential manipulation
VNS rendering (eye level)	Realistic, helps to picture the landscape	Potential for manipulation or misinterpretation
VirtualGIS rendering	Supports spatial understanding	Too abstract
Bird's-eye animation (VirtualGIS)	Good overview	Poor graphic representation, viewer not part of the landscape
Eye-level animation (VirtualGIS)	Good perspective for citizens	Poor graphic representation – too abstract
VRML model (VirtualGIS)	Can "go to" a specific place	Graphic representation of vegetation too abstract – very distracting
Interactive photomontage (LaViTo)	Realistic, helps to picture the landscape, can "try things out", stimulates interest	Confusing

The **planning experts** considered the photorealistic VNS rendering to be the most helpful for picturing the landscape, but considered the maps, aerial photographs, and LandXplorer to be useful visualization techniques for discussing nature protection measures with citizens. Although there is no significant statistical difference in the responses, planning experts may tend to prefer to use a visualization method that shows an overview rather than one that gives spatial understanding for explaining planning measures to citizens. The citizens, however, needed photorealistic visualization methods to picture the planning in the landscape.

The **case study investigation** indicated that the citizens were able to picture the landscape not only with the realistic photomontage but also with the interactive VNS renderings and VRML model from Scene Express. Specifically, the comparison of the visualization types in Bornum showed that not only the realistic 3D visualization methods but also 2D maps and aerial photographs helped the participants to picture the landscape. However, in the case study, the participants were very familiar with the landscape. There was no clear preference for one visualization method. Instead, the citizens were able to use different methods to imagine the landscape and possibly benefited from the combination of methods.

Orientation

The **informed student and lay groups** were found to depend on landmarks for orientation. Realistic and detailed images with elevated viewpoints and pan/zoom functions helped the respondents to establish orientation, possibly making it easier to recognize landmarks. The surveyed group considered the panorama photo, which fulfils many of these criteria, the most helpful. Orientation was also supported by the overview provided by 2D visualizations as well as information such as labels, north arrow, and legends. The photorealistic aerial photograph was central for the lay group, whereas the students preferred the topographic map because it provided more information.

Furthermore, the survey of the lay and informed student groups indicates that a combination of at least two visualization methods should be available, including one 2D method, i.e. topographic map or aerial photo, and a 3D visualization method: half of the group preferred a photorealistic visualization and one-third an animation or VR model.

For the **planning experts**, on the other hand, orientation was easiest with the two 2D maps and aerial photos. Unlike the lay and student groups, the experts found orientation in the VR model easiest of all the 3D visualizations.

The **case study** showed that citizens familiar with the landscape could orient themselves well with 2D visualization methods. However, the majority of citizens had difficulty staying oriented in the VR model when the standpoint of the viewer moved. This difference between the planners and the other groups underlines the importance of considering the abilities of citizens (as opposed to planning professionals) when choosing a visualization method for use in public participation.

Assessing change

The **young planners** almost unanimously considered the before-and-after views important for evaluating the planning proposals. Two images made it easier not only to picture the landscape but also to make the effects of the planning clearer and therefore more transparent. The Königslutter citizens had various opinions about the importance of before-and-after images. In Gross Steinum, a majority of the participants were against the proposed planning measures that were visualized and therefore saw no need to view before-and-after images. However, participants in other participatory sessions considered the comparison very important. Finally, informed students and lay persons found the comparison of 3D photorealistic visualizations most helpful for recognizing the planning changes, better than 2D visualization methods.

Credibility

Relationship of credibility, realism, and spatial understanding: Based on the median responses, the following statements can be made:

- The panorama photo is the only visualization method that received top ratings not only for credibility, but also for realism and spatial understanding.
- The strength of 2D visualizations appears to be their credibility. For both the black-and-white plan and topographic map, credibility was rated higher than realism. In other words, the respondents believed it more than they could understand it. The reverse was the case for the orthographic plan in perspective view. It was easier to picture the spatial situation, but it was considered less credible.
- For all the photorealistic methods there is no statistically significant difference in the ratings, although the median rating for spatial understanding was slightly higher than for credibility. This raises the question of whether there is a basic distrust of realistic visualizations. Possibly a photorealistic image does not supply sufficient evidence to establish its validity.
- The interactivity of the photomontage did not significantly improve its credibility rating.
- The strength of VNS rendering is the spatial understanding which it provides. There is a statistically significant difference between the rating of spatial understanding and the other two factors.
- For all the visualization methods prepared with VirtualGIS, spatial understanding was rated significantly higher than realism. The bird's-eye animation was rated as more credible than the other visualizations prepared with VirtualGIS. The VRML model was rated lowest for all the factors (median = 4). The visualization method as it was used in the survey does not appear to be suitable for use in public participation.
- Median ratings of the criteria of each visualization method differed by no more than one rating point.

The relationships between credibility, spatial understanding, and realism revealed in the statistical analysis of the young planners' ratings of visualization methods is in Table 21.

Table 21: Summary of the multi-comparison tests of the credibility, spatial understanding, and realism ratings of the visualization methods by young planners which show significant statistical differences

Relationship of credibility, spatial understanding and realism	Visualization types
Credibility = Spatial Understanding = Realism	- Panorama photo - Photomontage - Interactive photomontage (LaViTo) - Aerial photograph
Credibility > Realism	- Black-and-white plan - Topographic map - Bird's-eye animation (VirtualGIS)
Spatial Understanding > Credibility	- Plan in perspective (orthographic projection) - VNS rendering
Spatial Understanding > Realism	- VNS rendering - VirtualGIS rendering - Bird's-eye animation (VirtualGIS) - VRML model (VirtualGIS)

Improving credibility: Credibility is apparently improved through more information, both visual and meta, about the planning measures, site, and visualization. The more participants know about what is being shown in the visualization, the better they can judge whether the visualization represents reality and the more they trust the visualization. Young planners' suggestions about improving the credibility of the different visualization methods are summarized in the following table:

Table 22: Overview of young planners' comments on credibility

Visualization methods	Improve credibility with:
Black-and-white plan	More information
Plan in perspective (orthographic projection)	More color, detail, information, metadata
Topographic map	3D visualizations
Aerial photograph	Additional 3D visualizations
Panorama photo	Sound
Photomontage	Visualization of 4th dimensions, additional views
VNS rendering	More detail, increased resolution, less abstraction in foreground
VirtualGIS rendering	Improved realism or detail
Bird's-eye animation (VirtualGIS)	More realistic vegetation, more detail, variation of camera level
Eye-level animation (VirtualGIS)	not applicable (n.a.)
VRML model (VirtualGIS)	More detail and realistic graphics, better resolution, less abstraction, overview map
Interactive photomontage	Larger image, different perspectives, clearer vegetation

6.2 Importance of visualization characteristics for understanding the planning content

6.2.1 Importance of realism for understanding the planning content

Importance of realism as rated by lay people, informed students, and by the young planners and planning experts

The survey responses (see Figure 38) show that a realistic representation was clearly important to all groups. However, realism was more important for the students and lay groups (median = 1), than for the young planners (median = 2). In fact, two-thirds of the lay people considered realism very important. The variation in the ratings may indicate that the more planning competence a viewer has, the less important realism is. (This says nothing about how realistic a visualization should be, only that realism is considered an important factor in understanding planning content.)

Figure 38: Informed students, the lay group, and young planners rate the importance of realism for picturing the planning proposals. (Questionnaire I: Questions C12, C14; Questionnaire II: Question C60)

The content analysis of the comments about realism produced the following categories:

- **Providing information**: These were comments in which the visualization method offered participants information about landscape elements and helped them locate the planning measures, e.g. legend, scale, etc.
- **Ease of picturing the site**: This category includes comments which pointed out that the visualization supported the spatial understanding and provided a complete picture of the planning issues. For example, "*It made it easy to imagine the landscape*". Comments about orientation or overview of the landscape and the

context of the planning measures, e.g. "*overview of the planning measures*" were also included in this category.

- **Realistic:** This category included comments about the realism of the visualization such as, "*realistic* ", even "*photo-realistic*", "*shows detail*" and is "*exact*".
- **Navigation benefits**: These are comments that addressed the kind of navigation and the kind of perspectives, size, and ability to determine the view.
- **Interest in and understanding of planning measures:** This category included comments about the ability of the visualization to activate the emotions, interest, or experiential aspect. These comments also addressed the ability of the visualization to convince or help the viewer understand the planning issues. Comments about before-and-after views and the capability to avoid mistakes were also considered in this category.

The responses shown in Figure 39 indicate that a realistic picture is most important because it helps the viewer to imagine and understand the landscape (63% of the comments). Furthermore, realism is more important for stimulating interest in planning issues than for providing information. The respondents who did not consider realism important felt it was superfluous and saw the danger of manipulation.

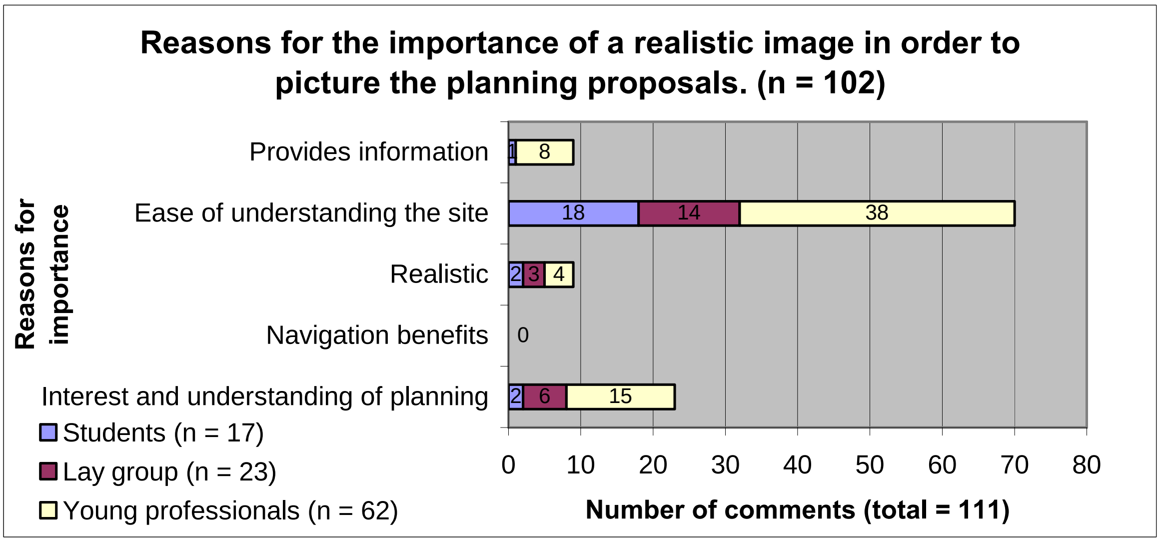

Figure 39: Overview of comments made by young planners, lay and informed student groups about the importance of realistic images for picturing the planning proposals (Questionnaire I: questions C12, 14; Questionnaire II: Question C60).

Informed students: realism helps to picture the landscape and judge proposals

All except one of the students (i.e. 94%) considered a realistic representation to be either important or very important. The most frequent reasons were the ease of picturing the planning proposals in the landscape and the ability to judge the effects of the planning proposals. That realism supported the spatial and visual understanding of the landscape is illustrated in comments such as, "*It is easier to imagine the whole situation when there is a realistic representation, otherwise one 'forgets' so much when imagining it*" or "*The more realistic the representation, the better one can picture the effects of the planning proposals on the landscape.*"

Lay group: realism also speaks to the emotions

Here again, 95% of the lay group respondents considered the realistic representation important or very important. The reasons were similar to those of the students. The majority of comments related to the ease of picturing the landscape and the helpfulness for assessing the planning measures. However, the lay group commented more often (1/4 of the comments) on the emotional impact of the realistic visualizations and their ability to stimulate interest. The following comment illustrates the importance of the emotional component of realistic images: " *[Realism] appeals to my emotions and for that reason it is important for a positive attitude towards the planning*."

Young planners: realism helps understand planning but also limits fantasy; consider combination of realistic and abstract

Compared to the other groups, a slightly smaller percentage of the young planners, 49 of the 62 respondents (80%), considered a realistic representation either important or very important. Again, the young planners' comments show the main reasons for realism was to help picture the landscape and the effects of the planning (55% of comments). For example, one young planner commented, "*When one looks at a map, one has an idea of the landscape, but one gets a real impression first with a photo.*"

Here, too, about 25% of the comments mentioned that the emotional component of realistic images stimulated interest or led to a better understanding of the planning issues, e.g. "*Based on a realistic visualization, I would probably stand up for the environment more.*"

Like the lay people, the young planners expressed concerns about the danger of manipulation ("*The photomontage should not be too realistic, in order not to mislead the citizens*") and that realistic visualizations are too specific and leave no room for interpretation: "*The more realistic, the better; however a very realistic representation does not leave any space for fantasy*."

Finally, several young planners recognized the advantages of abstract images and suggested combining realistic and abstract visualizations, e.g. "*First, realistic representation of the existing situation is important, then a topographic map with the planning. A realistic visualization of the planning proposals is a nice supplement for the untrained, certainly very useful.*"

Young planners can understand less realistic images

There was no visualization method for which the young planners rated the realism higher than the ease of spatial understanding (see Figure 32, Section 6.1.4). In other words, realism and spatial understanding are either equally good, or the spatial understanding of the visualization was rated better than its realism. This suggests that a realistic image supports spatial understanding, but the viewer is also able to think past the image and imagine more about the landscape situation than is actually represented in the image. Spatial understanding is higher than realism in the computer-generated renderings and animations and in VRML made with VirtualGIS. Some comments showed that the viewers considered these visualizations artificial (13 x), although they could still interpret the landscape. The young planners apparently were able to interpret the visualizations to develop spatial understanding even when these were not photorealistic. This would also help to explain why realism was less important for this group than the others.

Planning experts (IALP steering committee meeting, 09.06.2004)

The survey of planning experts indicated that approximately half of the experts considered all of the visualization methods except the sketches to be sufficiently realistic to picture the planning proposals. Interestingly, there was not much difference in the responses between the photorealistic photomontage and the other computer-rendered visualization methods. This agrees with the opinions of the young planners that a less than photorealistic visualization was sufficient to communicate the content of the planning. However, there may also be a minimum requirement of realism that the sketches did not fulfil.

Role of realistic visualizations in the planning process: planning experts (13.11.2003)

The survey of planning experts at the IALP expert workshop on 13.11.2002 showed that they considered realistic visualizations – aerial photographs, photo(montage)s and photorealistic visualizations – important in all of the planning phases. However, they considered them most important for the inventory of the existing natural landscape resources (see Figure 40).

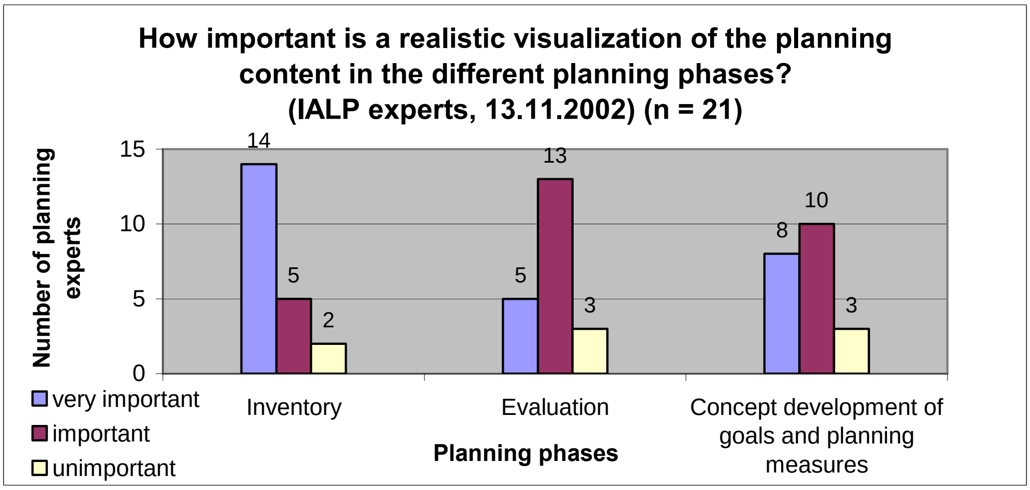

Figure 40: Survey of planners at the expert workshop of the IALP on 13.11.2002

The experts' comments showed reservations about using realistic images in the concept development phase. One expert pointed out that too much realism in this phase could raise false expectations and therefore preferred an abstract representation in the concept phase. Another expert suggested that the detail of the data and the detail of the simulation must correspond. In fact, too realistic images of planning measures could actually be a hindrance to communication because unimportant details of the visualization could dominate the discussion. A third expert suggested that the photorealistic and abstract images could complement each other and that the possibility to switch back and forth would be very worthwhile.

Other experts focussed on the factors which influence the importance of realism. Scale, content of the planning measure concept, the knowledge of the viewer, and the planning objectives determine how realistic a visualization should be. The planning topic, landscape resources, as well as the importance of visual quality also play a role in determining the appropriate amount of realism.

6.2.2 Importance of multiple views and dynamic navigation for understanding the planning context

Importance of multiple views of the planning for assessing the planning proposals

All of the surveyed groups considered multiple views of the planning to be important (median = 2). However, the young planners and students considered multiple views slightly more important than the lay group (see Figure 41). For all groups, multiple views were rated less important than realistic images. The overview of comments in Figure 42 indicates that participants who preferred multiple views did so primarily because they improved their understanding of the site and planning proposals (42% of comments). Approximately one-quarter of comments identified the benefits of seeing the planning from different perspectives, as one would view the landscape in reality. Others saw the benefits of multiple views in that they provide information about the context of the planning and give a better overall picture (20% of comments). And finally, participants recognized the importance of multiple views to make the planning more legitimate, reduce mistakes, and avoid planning bias.

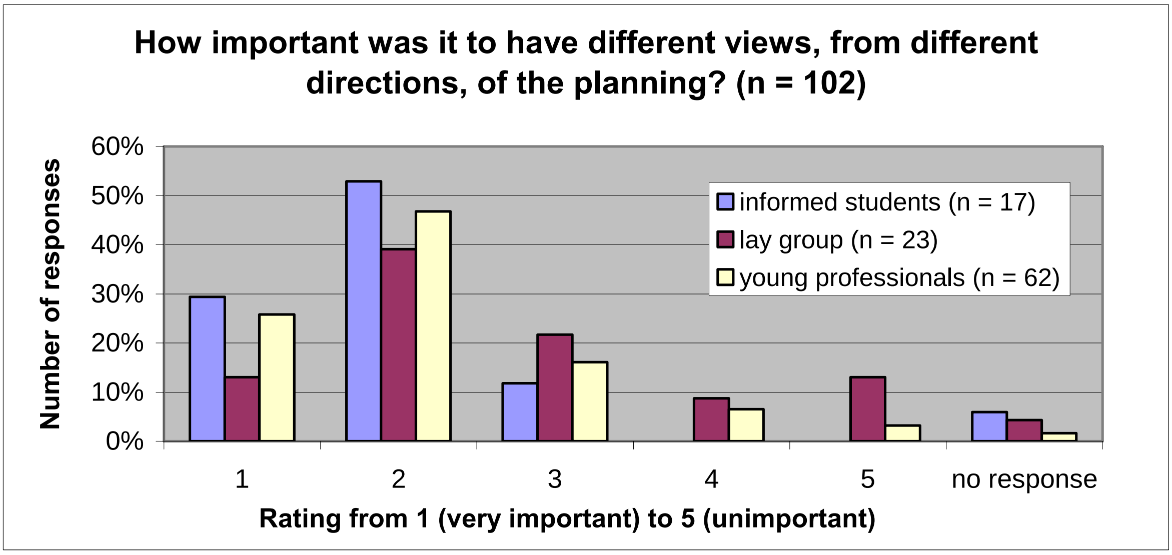

Figure 41: Young planners, lay group, and students rate the importance of multiple views. (Questionnaire I: Questions C15, C13; Questionnaire II: Question C61)

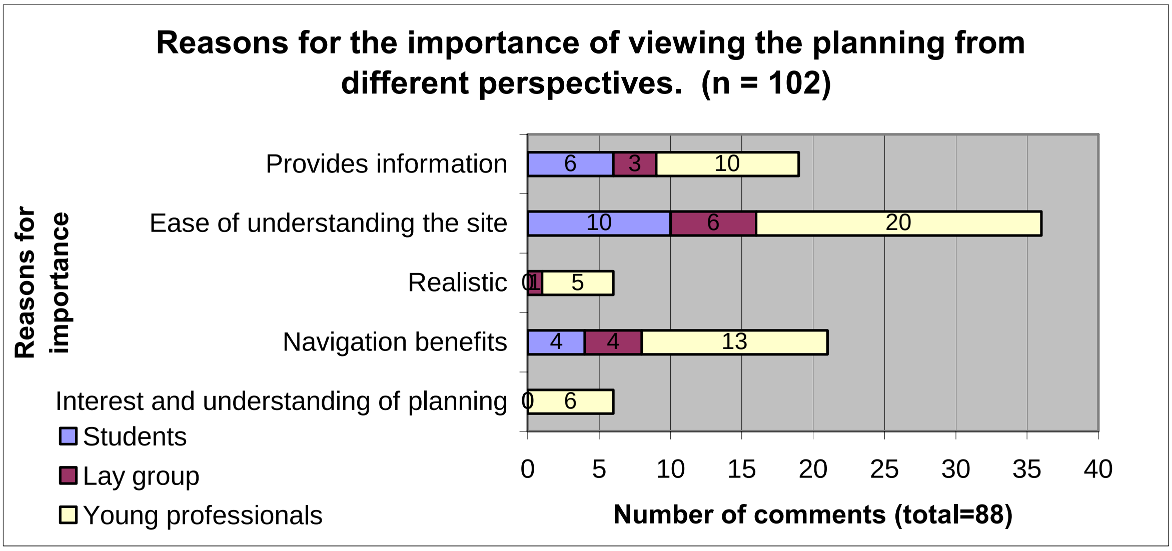

Figure 42: Overview of comments about importance of multiple views made in the visualization survey (Questionnaire I, Questions C15, C13; Questionnaire II, C61)

Informed students: multiple views support understanding of site and context

Approximately 50% of the informed students' comments mentioned that the multiple views helped to understand the landscape and supported orientation. Approximately a third of the comments indicated that multiple views provided information that helped to understand the context of the planning proposals and to give a complete impression of the site, for example, "*If one focuses on one section, then the overview is lost; the planning is for the whole site.*"

Lay group: multiple views not a must

The reasons given by this group for preferring multiple views are similar to the students': to understand the site and planning proposals and to provide an overview and contextual information. However, only 50% of the lay group felt multiple views were important or very important. The critical respondents commented that one perspective is sufficient: "*If the view from one side is good, then it is easy to picture the other side*" or "*I can imagine it from different positions.*" This raises the question of whether multiple views are confusing or an overload for some lay viewers, or whether lay viewers would be content with one good view.

Young planners: reduce planner bias

There were also some young planners who did not see the need for multiple views of the planning area. Their reasons were similar to those of the lay group: one view is sufficient to picture the planning proposals, orientation is easier with one static view. However, 70% of the participants rated multiple views as important or very important, and their reasons were similar to those of the other groups: primarily for the ease of understanding the site, spatial orientation and overview, and contextual information.

However, this group recognized the importance of multiple views to avoid mistakes in the planning assessment and to prevent planners' bias, as these comments show: "*Different perspectives can exclude planning mistakes or reduce risk.*" or "*If [there are no multiple views] then there is the danger that planners choose the 'best' view and others are not considered.*" Furthermore, the young planners saw the importance of "navigating" to different places because multiple views reveal multiple issues: "*New perspectives: different aspects become apparent*"; and different views have different functions in the communication: "*Multiple views are important: for an overview and for the details and the increased ability to picture [the landscape].*"

Importance of dynamic navigation

Young planners do not need dynamic navigation

After viewing the VirtualGIS real-time model and the panorama photo, the young planners rated the importance of dynamic navigation as neither important nor unimportant (median = 3) (see Figure 43). In fact, they considered dynamic navigation less important than multiple views and realism. In about one-third of their comments, dynamic navigation was described as either unnecessary, confusing, or a gimmick. In most of the criticism, dynamic navigation was said to be superfluous. (It is unclear what influence the abstract graphics of VirtualGIS had on the comments.)

The positive comments, on the other hand, indicated that dynamic navigation helped viewers to imagine the site and understand the planning situation (see Figure 44)**.** It also enabled the viewer to decide for herself what she wanted to see: "*One can look at certain sections longer or simply a second time, or take a break.*" or "*One can look at what is personally important.*"

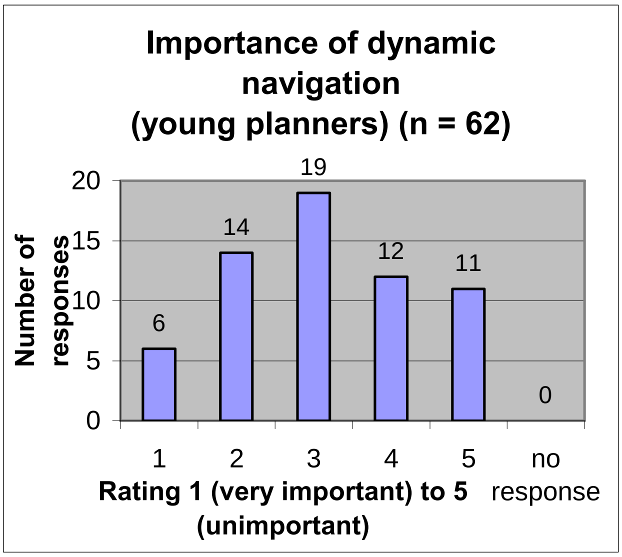

Figure 43: Young planners rate the importance of dynamic navigation for understanding the planning (Questionnaire II, Question C63)

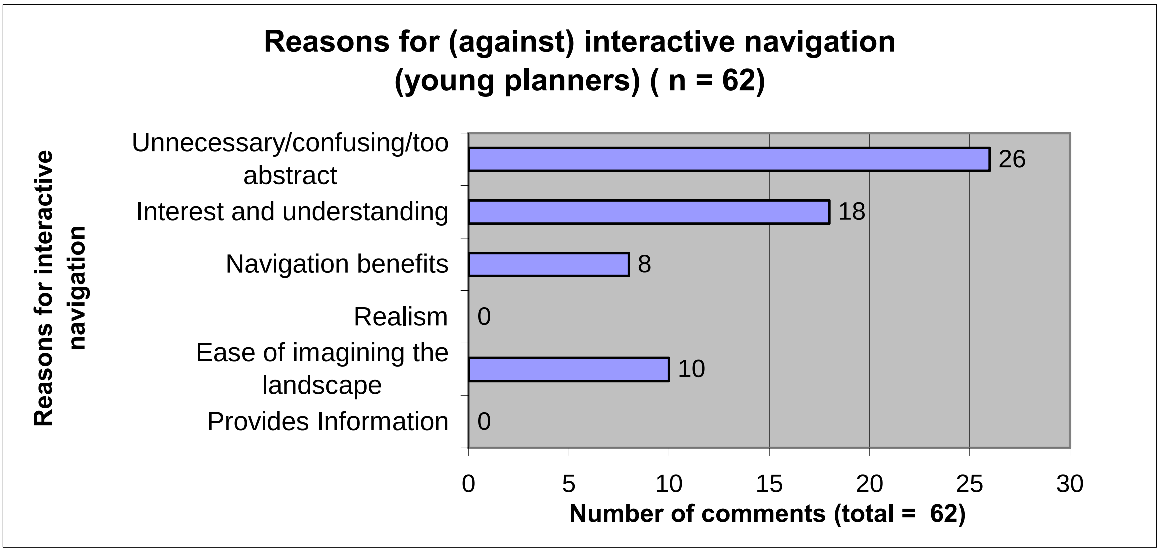

Figure 44: Overview of young planners' comments about the reasons for using interactive navigation (Questionnaire II, Question C63)

The young planners also recognized two significant qualities of the dynamic navigation that made it important for planning participation:

- **The experiential aspect**. They commented that dynamic navigation provided the opportunity to view the landscape as it is perceived from the residents' perspective: *"The landscape is probably accessible to cyclists and pedestrians and is experienced from different directions … The visual change of a familiar space is the most decisive for the residents."*

- **The potential to stimulate interest**. About half of the comments indicated that the interactivity stimulated interest in the issues, had an emotional aspect, and that it was simply fun. For example: *"One feels active and included.*" or "*It arouses interest, makes it possible to experience the planning.*" or "*It's more fun*."

Finally, the difficulty of using or following the navigation was another focus of the comments. The young planners did not have any particular desire to try out the VR model themselves, nor did any of the participants in the Beienrode or Bornum investigations.

Planning experts survey (09.06.2004): dynamic navigation gives control to viewer

The planning experts' review of the visualization methods (see Figure 45) shows that dynamic navigation and the ability to determine the viewpoint themselves were clearly important for the expert group. The experts missed the ability to determine the viewpoint themselves with the sketches and VNS rendering (LaViTo). The photomontage, on the other hand, had a fixed standpoint, but the viewer could pan the landscape 210°. This may have been sufficient to give the experts the feeling of navigating through the landscape. The experts did not have the opportunity to personally navigate the different visualization methods, but they did judge them all to be equally easy to use, with the exception of Lenné3D/LandXplorer.

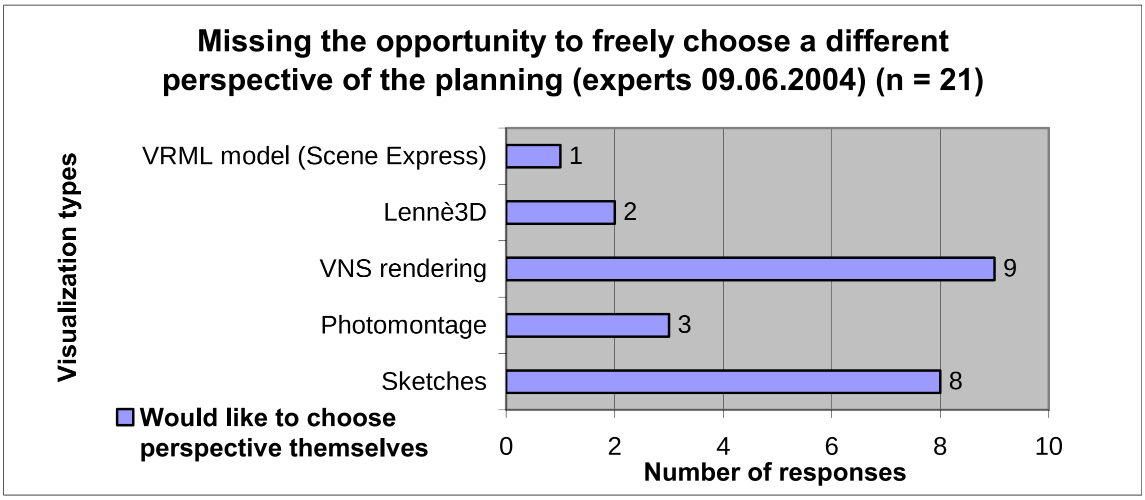

Figure 45: Planning experts identified visualization methods with navigation deficits (Survey of IALP steering committee on 09.06.2004, Question B2a) (Answers were made with keypads.)

Case study: multiple views and dynamic navigation are appreciated in real life

In the Rottorf (04.06.2003) investigation, 90% of the participants found multiple still images of the planning which showed different perspectives to be useful. Apparently, in a real-life participatory situation, the participants are not overwhelmed by multiple views. In Rottorf, the visualization focused on one planning measure with views from different sides, so that orientation easy.

In Beienrode (26.05.2004), the majority of respondents commented that the movement through the VRML model, which was made with Scene Express, helped them to understand the planning. The visualization covered a larger site that included approximately ten planning measures. Orientation was potentially difficult, but the viewers were familiar with the site and they also viewed the VNS rendering (LaViTo) and aerial photographs. In addition, the Scene Express model was more realistic than the VirtualGIS model tested in the visualization survey. Therefore, it is difficult to isolate the influence of the dynamic navigation in this case. However, the participants did not reject the model as was the case with the VirtualGIS VRML model in the visualization survey.

6.2.3 Importance of interactivity for understanding the planning content

The LaViTo tool offered the survey participants the opportunity to test different planning alternatives and produce their own ideal combination of planning measures. They could only use the prepared images, not a new idea which the user had considered. This interactivity, although limited, provided the basis for the investigation of interactivity in the visualization survey and case study.

Lay group and informed students: interactivity helps evaluate planning

The informed students found the interactive photomontage only "helpful" (median = 2) in imagining their own planning suggestions, while the lay group considered the interactive photomontage to be "very helpful" (median = 1) because it was easy to use and made it easier to picture the planning proposals (see Figure 46). Furthermore, the interactivity helped to evaluate one's own suggestions, for example “*I can try out how it looks when I plant one hedge or not, or both or none.*” and “*Then I can see what I can improve on my own suggestion.*” The comments indicate that the interactivity helped the lay group to understand the visual effects of the planning proposals and to form their own opinion about the planning proposals by testing alternatives.

Young planners tried out alternatives

The young planners did not specifically rate the interactive capabilities of the interactive photomontage, but their general comments indicate that they liked the ability "to try things out". The information not only became clearer through the interaction, but also through the ability of individuals to steer the amount and tempo of information they accessed so that they felt much more in control, e.g. "*One is not flooded with information, one can choose the tempo and view (and decide) in a differentiated way. One feels like a planner.*" Comments also underlined the fact that the interactivity also stimulates interest and emotions, e.g. „*good for trying out different possibilities*" and "*makes the viewer curious*".

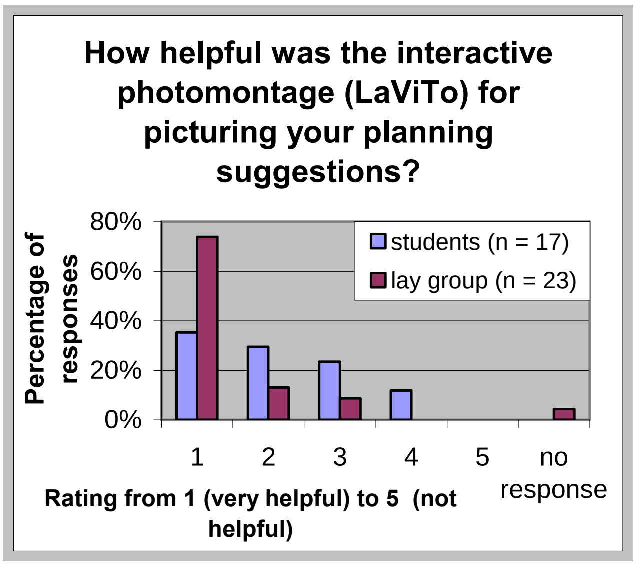

Figure 46: Lay group and students rate the helpfulness of interactive photo-montage. (Questionnaire I: ques. D2)

Planning experts want to see their own alternatives visualized

When the planning experts (IALP steering committee 09.06.2004) were asked what they missed with the visualizations – dynamic navigation, before-and-after images, planning

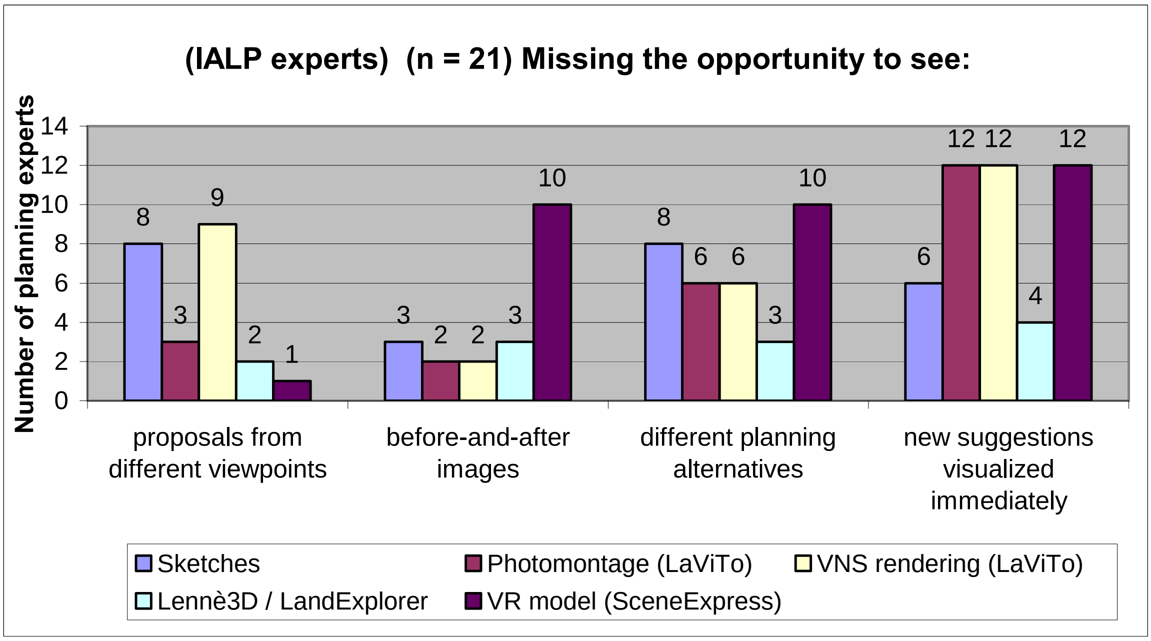

Figure 47: Planning experts evaluate the deficits of visualization methods using keypads. (Survey of IALP steering committee on 9.06.2004)

alternatives – they responded that what they missed most was the opportunity to interactively visualize their own planning ideas (see Figure 47). They did not have reservations about the technology. In fact, they appeared to want more interactivity and recognized the potential of the technology to try out ideas.

Interactivity in the planning process

The responses of the expert survey (13.11.2002) indicate that interactivity was considered most important in the assessment and development of goals and planning measures (see Figure 48). The experts did not comment about the reasons behind the rating, but the development of goals and planning measures involves the discussion and assessment of alternatives and the effects of planning. Possibly, the experts recognized the benefits of the interactive use of a model or visualization for such discussions.

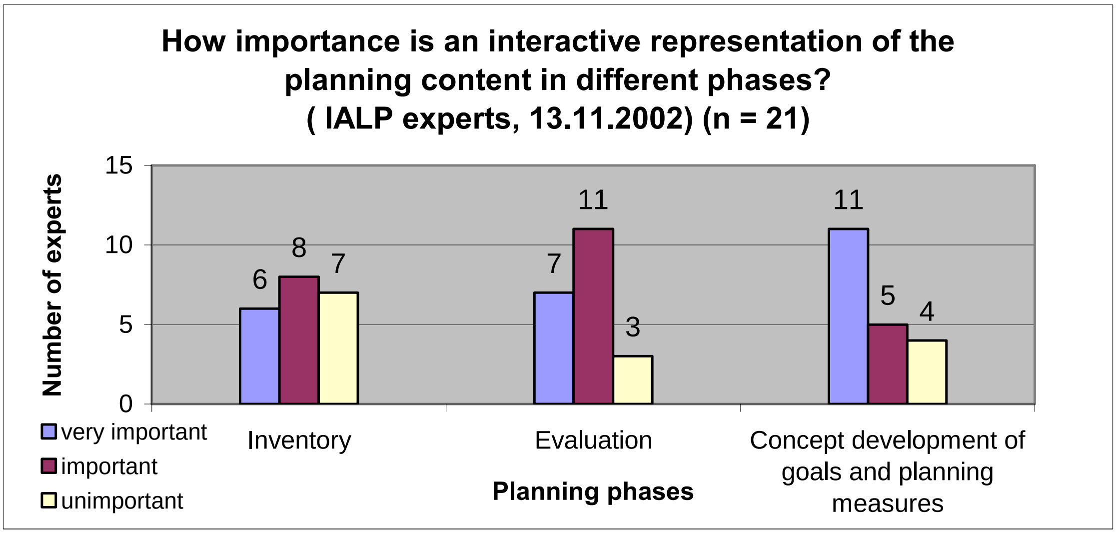

Figure 48: Planning experts rate importance of interactivity in different planning phases (Survey of experts at IALP workshop on 13.ll.2002)

6.2.4 Summary of the importance of visualization characteristics in participation

Realism

The **visualization survey** showed that the lay and student groups considered realism to be very important (mean = 1), and the young planners felt realism to be important (mean = 2). The difference in the ratings may indicate that the more planning background a viewer has, the less important realism becomes. All the surveyed groups commented that a realistic picture was important primarily because it supported spatial understanding and helped them to assess planning proposals. The lay group and young planners pointed out that realism stimulates an emotional response or connection to the planning which can promote interest in the landscape issues. However, lay people and young planners also saw the potential for manipulation in the use of realistic images.

The **planning experts** considered all visualization methods, except for the sketches, to be realistic enough to picture the landscape. This may indicate that, at least among experts, a less than photorealistic visualization is sufficient to communicate the content of the planning. This is contrary to the lay group's assessment and indicates the importance of considering the citizens' needs and abilities when choosing a visualization method.

Not surprisingly, realism and spatial understanding were found to be closely related. However, the investigation showed that the young planners rated the ease of picturing the landscape (spatial understanding) higher than the realism of the computer-generated visualization methods. Apparently, they could interpret or imagine the landscape beyond the detail of the image. This may explain why realism was less important for this group. Again, this suggests that the more planning competence a viewer has, the less important realism is to establish spatial understanding in a visualization.

In the planning process, the planning experts considered a realistic image most important in the inventory phase. Some experts were reluctant to use a very realistic visualization in the concept and planning measure development phase because the detail could be a hindrance in the discussion. This concurs with the comments of the young planners who felt realistic images were too specific and could limit the imagination. They suggested a combination of detailed, realistic images with more abstract (overview) images or conceptual visualizations. Furthermore, the level of detail of the data could be potentially insufficient for a realistic visualization. The planning experts pointed out that the degree of realism not only depends on the data, but also on scale, planning content and objectives, planning phases, and knowledge of the participants.

Dynamic navigation

The **visualization survey** results showed that 80% of the informed students, 70% of the young planners and only 50% of the lay group considered multiple views to be important or very important. Furthermore, the comments revealed that 20% of the lay group felt one view was sufficient. This raises the question of whether multiple views present lay people with a visualization overload. However, the **citizen** responses from the investigation in Rottorf indicated that multiple views were helpful for viewing site-specific measures that were limited in size.

Participants of all the groups who preferred the multiple views did so because these:

- help to understand the site (spatial understanding) and assess the planning, and
- provide contextual information (orientation, overview).

The young planners also pointed out that different views:

- can prevent mistakes and planning bias or manipulation,

- reveal different issues, and
- have different functions: overview for orientation, close-up for detail, large-scale for context.

The respondents (**young planners** only) of the visualization survey considered dynamic navigation to be neither important nor unimportant (median = 3) In half of the their comments, the young planners said they considered the dynamic navigation to be superfluous or a gimmick because it did not provide more information about the planning. In the rest, they recognized the flexibility and experiential aspect of dynamic navigation and the ability of the visualization to spark interest. However, both the young planners as well as participants from the case study had no desire to try out the dynamic navigation themselves. Perhaps the respondents considered dynamic navigation to be a good idea, but too difficult to steer oneself. The **experts**, on the other hand, recognized the advantages of dynamic navigation to give them control over the choice of the viewpoint and perspective.

The results do not give a definitive answer but point out some important aspects of multiple viewpoints and dynamic navigation. Multiple viewpoints have the advantage of letting the viewer see the planning from different perspectives with a minimum of orientation problems. Possibly a limited number of well-chosen views are sufficient for the lay group. But the question of who should choose the views remains open.

Interactivity

Interactivity was most important for the lay people because it helped them to understand the planning alternatives and to explore their own recommendations. For the young planners, the advantage of interactivity was to let them try things out and control the amount of information. Furthermore, planning experts considered interactivity important in the development of concepts and planning measures. Apparently, the planners saw interactivity as a tool with the potential to develop ideas and planning proposals.

In summary, all groups would have liked to see their ideas visualized immediately. Interactivity gave the viewer the feeling of being in control or having power in the planning discussion over the alternatives. It not only stimulated interest, but also provided the opportunity for collaboration, in which both citizens and planners could illustrate and discuss alternatives. However, the investigation also indicated that the lay group required realism for spatial understanding. At present the technology cannot generate photorealistic images quickly or “on the fly”. Visualization solutions which overcome the trade-off between realism and interactivity would greatly benefit participation.

6.3 Suitability and function of different visualization methods for participatory activities

6.3.1 Suitability of visualization methods observed in citizen participation

In the Bornum investigation, we tested the suitability of the VNS rendering, photomontage, sketches, and Lenné3D for use in participation. It was easier than expected to discover which visualization methods offered the participants good or poor orientation because participants tended to react when they were disoriented. Furthermore, the participants needed time to become comfortable with the different visualization methods before they could take full advantage of the capabilities offered. The analogue sketches in particular required a close-up inspection and more time for the participants to use them effectively in the discussion. In general, information about the data and transparency were important to the participants in order to establish the credibility of the visualizations. Participants also wanted to know how the visualizations were made, i.e. what data was used as the basis for the pictures. A healthy scepticism of the visualizations was also apparent during the sessions.

Table 23 summarizes the observations and comments gathered during the Bornum investigation that reflect how well the visualization methods fulfilled the suitability requirements of spatial understanding, orientation, ability to assess change, and credibility.

Table 23: Overview of observations about the suitability of the visualization methods for participation (Bornum investigation 15.03.04)

Visualization method	Spatial understanding	Orientation	Assessment of planning	Credibility
LandXplorer	+ Static view and bird's-eye view. Slow movement through the model	- / + Moving from point to point difficult to follow. Participants need 2D map for orientation, realism helps recognize landmarks, static bird's-eye overview provides good orientation.	n.a. (No simulation of planning)	+ Not questioned, no comment
Photo-montage (LaViTo)	+ Photorealism supports spatial recognition and understanding. Spatial understanding good enough to make concrete comments about planning measures	+ Eye-level view orientation good, photo-realism shows landmarks. (For some, orientation was difficult in wide pan.)	+ Uses "on-off" to compare planning. Photorealism shows detailed illustrations of planning measures. Stimulates concrete recommendations about individual measures.	+/- Some details questioned, distrust of photomontage
Sketch	+/- Makes it possible to recognize measures but requires active study of sketches.	+/- Orientation requires initial effort, four different views, requires time to recognize view.	-/+ Compares before-and-after sketches next to each other. More difficult than superimposed images of LaViTo images.	+/- Unclear, viewed by some as art
VNS rendering (LaViTo)	+ Used to locate comments and landmarks; graphic representations require some explanation.	+ Orientation easy with static view (after initial orientation in analogue map)	+ Before-and-after views important for assessment of planning measures. Also helps to clear up misunderstandings about planning measures.	+ Not questioned, no comment

LandXplorer provided good spatial understanding, and its credibility was not questioned by the participants. However, it was difficult to maintain orientation when the position in the VR model moved. Generally, the visualization methods with dynamic navigation were more of a challenge to incorporate into the discussion than the static visualizations. The orientation had to be re-established in the 2D map every time the position of the camera changed. But once the location of the still image was established, orientation was no longer a problem. In fact, the ability to show a bird's-eye view was very helpful to localize comments and proposed planning measures. However, the proposed planning measures were not visualized in the LandXplorer model, making it difficult to assess the landscape change.

The realistic image of the **photomontage** made spatial understanding easy. The familiarity of the participants with the site also helped them to quickly orient themselves in the image, and the "on/off" LaViTo function helped the participants to assess each planning measure. Comments indicated that the photomontage was a suitable visualization for participation, except that there appeared to be a fundamental distrust or fear of manipulation. This raises the question of whether proposed measures should be obviously different from the existing landscape, so the participants can clearly recognize what is being altered or proposed.

The **sketches** were the least suitable visualization tested in the participation. Although the sketches offered reasonable spatial understanding, so that orientation, and assessment of the planning proposals were possible, more effort was required than with the other visualization methods. Orientation as such was not difficult, but establishing orientation in four sketches with different viewpoints and view directions required the ability to mentally "jump" from one view to another. As one participant said, "*It is not clear which perspective and viewpoint is being shown.*" Finally, participants commented on the artistic quality of the sketches. It is difficult to judge how credible or valid they considered them.

The **VNS rendering** appeared to be the most suitable visualization. It was realistic enough to provide good spatial understanding, and the static, bird's-eye view made it easy for the participants to orient themselves and localize their comments in the visualization. The proposed planning measures could be assessed using the LaViTo tool, and the reliability of the GIS data base was never questioned.

Initial orientation with 2D maps, later visualization holds attention: The analogue map was used for the initial orientation. Landmarks in the map such as roads were recognized and used to establish orientation. However, once the participants became familiar with the visualization and the viewpoints, the participants no longer referred to the analogue maps. The bird's-eye view of the site provided a good overview of the planning and orientation. The visualization held the participants' attention, and even when the facilitator referred to the paper map, the discussion continued to focus on the visualization.

6.3.2 Functions of visualization methods observed in a participation setting

The comments and observations discussed in the following section indicate that the visualization methods fulfilled the functions of engagement, communication, and collaboration in the discussion to varying degrees. Neither education nor change of behavior was observed in the Bornum session. However, this was not the objective of the participation. Table 24 gives an overview of the observations made about the use of the different visualizations in the discussion of planning scenarios with citizens in Bornum.

Table 24: Observations about the functions the four different visualization methods fulfilled in the discussion with citizens during the investigation in Bornum (15.3.04)

Visualization method	Engagement	Communication	Collaboration
LandXplorer	+/- Raises interest with “wow” effect; moving from point to point difficult to follow and stay engaged.	+ Participants use bird’s-eye static view to locate, explain, and document comments with digital “post-its” – more readable than post-its on analogue map	n.a.
Photomontage	+ Participants actively direct the visualization – “on/off” stimulates active participation questions and captivates audience.	+ Enables participants to give local knowledge about specific landscape features. Detailed image prompts concrete comments and opinions about planning measures, both criticism and suggestions. Used “on/off” to compare planning. Emotional response to realistic image	+ Stimulates concrete recommendatio ns about individual measures.
Sketch	- Participants must make an effort to view sketches. Requires time to study	- Used to locate landscape elements and comments, but participants must move up close to see sketches. Not projected on screen.	-/+ Potential for collaboration not used
VNS rendering	+ Holds attention to the planning, comments not directed at each other. Participants actively turn measures “on” and “off”.	+ Participants can locate comments and landmarks, graphic representations require some explanation from planner. Before-and-after views important for discussion of planning measures and constraints; participants look at and talk to visualization.	+ Citizens formulate specific improvements

Engagement

Lenné3D/LandXplorer/Lenné3D

The “wow” effect: The moving model inspired a “wow” reaction and interest among the viewers. But when the camera moved to a new location, many participants became “lost” or disengaged in the model and focused their comments on the 2D map instead.

Photomontage

Active participation - participants direct the visualization: The participants determined which measures should be shown in the visualization and were actively engaged in directing the technical assistant. For example, they instructed the assistant to "*Turn on all the planning measures.*" All the planning measures were then turned on and the individual measures located; then they were turned on and off as directed by the participant, and discussed.

Interactivity holds attention: Even when the moderator asked the participants to locate a measure in the analogue map, they continued to discuss the measures using the photomontage. For example, one participant took control: "*I would like to return to the layers that can be turned on and off. Show the hedgerow again.*"

Sketches

Require more effort: The A3 sketchers were the only analogue visualization method. Participants who had become accustomed to seeing the visualization on a large screen had to make an effort, get out of their seats, and take time to study the sketches up close. For example, participants commented, "*One has to really study them*" and "*The sketch is complicated.* " But when the participants finished studying the sketches, then short discussions took place close to the sketches.

VNS Rendering (LaViTo)

Participants actively use visualization in the discussion: The participants used the visualization to show the group where existing planning measures were located and proceeded to explain their opinion or experience. They stood up and pointed to the projected image, "*This is where something has already been done.*" Participants used not only the image but also the interactivity of the VNS visualization actively in the discussion. For example, one participant directed the use of the visualization and instructed the technical assistant which planning measures should be " turned on" in the visualization: "*First you need to turn off all the north-south hedgerows. We have west wind here*."

Communication

The visualizations provided a common image or platform for participants to discuss their opinions about the planning measures. The group faced the visualization and directed their comments, i.e. spoke to the image. The visualization appeared to provide a "virtual space" in which the discussion took place. In situations where the stakeholders had different opinions and the visualization was used, the disagreement did not appear confrontational because the stakeholders directed their comments towards the image and not at each other.

In general, the visualization supported dialogue between experts and laypeople. It stimulated questions about the planning and helped to identify misunderstandings. The planners used the visualizations to locate measures and to explain their intentions, the necessity and priority of the planning measures, and their implementation. The advantages and disadvantages of planning measures were discussed with the participants. The citizens used the visualizations to localize their comments and questions and to illustrate their opinions. The common image provided a basis for discussing and distinguishing between what was desirable and what was possible and why.

LandXplorer

Analogue map - an important companion: The analogue 2D map was an important companion for the VR model. Initially the participants referred only to the analogue map, directing their comments there. And when a specific site was not visible in the 3D VR model or the camera changed positions, the facilitator referred to the analogue map. After some coaxing, the participants used the 3D real-time model to locate their comments, actually using the visualization to explain the direction of ploughing or showing where something should take place. Some participants went back and forth, pointing the measure out in the analogue map and then in the VR model.

Documentation - bird's-eye view is a good place to start: Participants could localize their comments best in the static bird's-eye view of the VR model. With the help of the technical assistant, the participants placed keywords that summarized their comments in the VR model. These comments were much more readable than those recorded on post-its on the analogue map.

Use of visualization is voluntary: The VR model was used primarily for discussing the location of the planning measures. When the discussion referred to a specific site, it was identified either in the analogue map or VR model. However, when the discussion revolved around non-site-specific issues, such as political policy or economic issues, then the visualization played little or no part in the discussion. The presence of the visualization did not force participants to use it. On the contrary, the facilitators had to encourage participants to incorporate the VR model into the discussion.

Photomontage

Platform to gather local knowledge: The realistic image of the photomontage raised specific questions which could be answered by the participants themselves. For example, an older local resident offered explanations about the historical development of the site which he had observed: "*A hundred years ago rows of fruit trees lined every street. Do you know why the visual landscape has changed so much? Because in the past the fruit was used.*"

Stimulates questions and supports understanding and dialogue: The photorealistic visualization raised specific questions about the content of the planning proposals and allowed the participants to make concrete, informed recommendations about the individual measures when they were made visible in the simulation. "*Where are the wildflower borders (*German: *Blühstreifen) planned? On the field margins? Wouldn't it make more sense along the streams where there has to be a protected zone anyway?*" or *"It needs to be annual species, not hardy species!"*

Visualization animated participants, prompting opinions about specific measures: The photomontage also stimulated a strong reaction to the planning measures. It prompted or provoked the participants to make very concrete comments about the planning. Many farmers voiced strong criticism about the content of the planning proposals (not the representation) and gave the planners their professional opinion. For example, one participant pointed to a specific measure (a proposed hedgerow) and declared, "*The planting is much too dense. Who is going to maintain it?"* or "*No farmer is going to give up this land, it has the best soil."*

The photomontage forced the planners to illustrate the planning measures in a detailed manner, which precipitated very concrete criticism and responses to the planning. This raises the question of whether or not the actual planning proposals were actually that specific, or if the photorealistic visualizations forced the planner to be more specific than possible on the basis of the existing information.

Sketches

Realistic enough for demonstration, but assessment more difficult: Even though the sketches were smaller than the other visualizations, the participants still used them to point out landscape elements and to locate and discuss planning measures. For example, "*This is where existing ditches should be used. The protection zone should not be placed near paths where there is a lot of traffic because there is too much disturbance."* However, the discussion of the planning proposals required that the participants compare two different sketches – one showing the existing landscape situation and one in which the planning proposals were illustrated – for each of the four viewpoints. The viewer had to switch between the drawings, mentally comparing the individual measures in order to form an opinion. In contrast, the LaViTo visualizations had superimposed before-and-after images of planning measures within the same visualization. The assessment of the planning measures with the sketches required more spatial comprehension and the ability to mentally transfer images for comparison.

VNS Rendering (LaViTo)

Visualization does not "stand alone"; it is rather a planner's tool for explanation: The graphic representation, or textures, of the VNS visualization were occasionally too schematic and needed an explanation, for example, "W*hat is that brown supposed to be?*" There were also misunderstandings about the content of the planning. For example, a participant commented about the planting of the stream bank in the visualization, "*How* *can the stream be seen with such a dense planting along the stream bank?*" A planner's explanation was necessary to make the visualized planning measures clear: "*It is not supposed to be a vegetative, green tube. Rather it is about creating vegetative structure along the stream*." Although the less than photorealistic representation required explanations from the planners, it also illustrated the conceptual quality of the measures.

Supports planning understanding; visualization reveals impact of concrete planning: The VNS rendering showed the physical effects of the planning, forming the basis for the discussion about constraints of the specific measures. For example, one farmer asked, "*Have you ever tried to maintain such a densely planted ditch? No person or tractor can work there. A tractor needs a working radius of four to five meters.*"

The rendering not only helped to reveal potential conflicts between stakeholder groups, for example the use of the path system by farmers, equestrians, and mountain bikers, but also defused the discussion between the stakeholders by focusing the comments on the visualization. The participants faced the image and pointed at specific landscape elements (instead of at each other) to make a point.

Both facilitator and participants used the visualization to localize and explain comments. The participants used the interactive "on/off" function of the visualization to support their arguments while instructing the technical assistant what to do. Furthermore, the ability to turn measures "on and off" not only helped the participants to recognize the effects of the planning, but it also helped the planner to discuss the possible combination of measures with the citizens.

Collaboration

Lenné3D/LandXplorer/Lenné3D

The fact that the planning proposals were not visualized limited the opportunity for collaboration.

Photomontage

Formulates ideas, stimulates suggestions about the proposed measures: When the participants saw the image of the planning measures, they were able to make suggestions about changes they would like to see. For example, participants commented: "*That looks artificial – a tree every five meters. A group of trees or shrubs would be better*" or "*The row of trees should have some variety, every once in a while some bushes in between.*" The viability of their suggestions was then discussed with the planners, and alterations to the plan considered.

The photorealistic simulation of the planning forced planners to be very specific about the measures, sometimes provoking emotional, concrete criticism as well as recommendations from the participants. Ultimately, the intentions of the planners and the opinions of the citizens were clearly “on the table”, making it possible to discuss concrete alternatives.

Sketches

More potential for interactivity: Participants did not take advantage of the potential to sketch planning alternatives with the artist. There are several possible explanations, but the lack of time and some communication difficulties between the artist and participants appeared to be the main reasons. The sketches offered opportunities to engage the participants and to collaborate about planning alternatives, but in the Bornum meeting, this was not observed.

VNS Rendering (LaViTo)

Participants become planners; visualization stimulates concrete, site-specific suggestions: Based on the concrete image of the visualization and the ability to turn measures “on and off”, citizens were able to recognize the shortcomings of the planning proposals and could suggest site-specific alternatives, showing where they should be located. For example, “*The trees must be separated more, preferably [planted] only on one side [of the road].”* Another participant commented, “*There the field is planted all the way around. It is impossible for a sugar beet truck to get in there. One should leave at least one side [of the field] open.*”

6.3.3 Importance of visualization characteristics for participants

The observations of the participants in the Bornum investigation and their comments, critique and preferences pertaining to the importance of the visualization **characteristics of realism, dynamic navigation, and interactivity** are summarized in Table 25.

Table 25: Overview of observations made in the Bornum investigation (15.03.2004) about the role of different visualization characteristics in participation

Visualization method	Realism	Dynamic navigation	Interactivity
LandXplorer	+ Aerial photo makes it easier to find landmarks in the landscape.	+ Like flexibility to choose view. Moving from pt. to pt. difficult to follow – "lost in space". Difficult to find right tempo – too fast, viewers lose orientation; too slow, can't keep up with the discussion.	-/+ Digital comment post-its in model helpful, more readable than analogue post-its.
Photomontage (LaViTo)	+ Provokes strong reaction. Inconsistencies in details found. Fosters recognition and familiarity with the site. Can't ignore visual quality problems. Makes planning measures clear.	-/+ Use pan, but missed flexibility to "go to" different sites. Difficult to find right pan tempo. Orientation not difficult.	+ Use "on/off" to compare alternatives. Would like to see more alternatives and growth over time (4th dimension). Use "on/off" to make a point.
Sketch	+/- Realistic enough to understand landscape, conveys abstraction.	n.a. Not available, no means to "move" the picture.	- Needs time, difficult to communicate
VNS rendering (LaViTo)	+ Considered realistic, but some textures in the visualization need explanation from planner.	n.a. Not available	+ Helps to establish opinion. Participants prescribe how "before and after" is used. Convey proposed nature of planning. Participants want more!

Realism

LandXplorer

The aerial photograph that was draped over the DEM model gave the landscape a very realistic impression from a bird's-eye view, and citizens could easily pick out landmarks.

Photomontage

Photorealism fosters familiarity and is easy to understand: Participants could easily recognize the landscape and they localized their comments in the photomontage without trouble. The realism together with the participants' familiarity with the area helped them to orient themselves easily.

Visual quality problems cannot be ignored: The photorealistic image forced the viewers to recognize problematic visual elements in the landscape that they had ignored or not been conscious of. In a sense, the photorealistic visualization forced the participants to be "honest" about the visual quality of the landscape. For example, some participants were surprised to see a high-voltage wire running through the site: "*Hey, here you can see very clearly that the high-voltage wires disturb the visual character of the landscape* (German: *Landschaftsbild*)."

Some participants were skeptical; details can distract: The realism of the visualization was questioned. Participants recognized seasonal discrepancies in the vegetation. For example, "*Fruit trees blooming and the photo is from August? How can that be?*" Participants were sensitive to the potential of the photomontage to be manipulative. Furthermore, a "What is wrong with this picture?" attitude was present in some of the groups. This carried the danger that the details of the visualization occasionally became the focus of the discussion instead of the content of the planning measures.

Sketches

Realistic but also art: The sketches were realistic enough for viewers to recognize the important features, e.g. "*What really sticks out are the high voltage wires*" and to provoke questions or critique of the planning: *"The sketch shows very many trees. What do you want to accomplish with them?*" It is not clear exactly how the participants perceived the abstraction of the sketches in the planning context. They considered them aesthetically pleasing, and several participants perceived the sketches as art, which might have lessened their credibility.

VNS rendering

Realistic enough to judge visual quality: The representation of the landscape and the planning measures was considered realistic and sufficient to depict the landscape and for viewers to make suggestions about improving the planning. However, participants did not always understand that the schematic textures were just a representation of the planning measures and not the actual detailed, concrete planning. Some textures were misleading and required explanations from the planner, for example: "*Continuous hedges and fruit trees are too stiff*" or "*The structure of hedgerow is too dense. The shrubs are too close to each other*." Although the graphic representation of the planning measures was occasionally criticized, the validity of the underlying geo-data was never questioned.

Dynamic navigation

LandXplorer

Finding the right tempo: On the one hand, the participants had difficulty orienting themselves with the rapidly moving navigation. One participant even complained of dizziness and looked away; some participants requested that a static view should be shown, "*When possible leave one view standing.*" On the other hand, the virtual camera, i.e. navigation, was at times slower than the discussion. By the time the site had been found, the discussion had moved on to a new topic in a new location. Nevertheless, the flexibility of the 3D map was admired and the static view, especially from an elevated perspective, was used by the participants to localize and explain comments.

Photomontage

Visualizations need time: In order to use the visualizations effectively, the participants needed enough time to become oriented and to study the image. Zooming in and out helped the participants get oriented and recognize where they were standing. The panning speed also needed to be at a tempo which observers could follow. For example, one participant commented, "*Don't move so fast, one needs time to really look at the picture.*" It is not clear what the ideal speed is. In general, the comments show that the participants felt 20 minutes was not enough time to orient themselves and to use the visualization effectively.

Navigation has its limits: The groups that had already experienced the interactive navigation of the real-time VR model expected the same navigation function with the photomontage. The participants of this group missed the flexibility to move the view point to the place that was being discussed or to move closer to a site in the distance: "*Over there is an old path where the vegetation has already grown together, can you show it?"* Interestingly, this deficit was recognized only by the groups who came directly from the real-time VR model.

The panning possibilities of the photomontage gave a wide view of the site. However, panning through the wide panorama view also caused some participants to lose their orientation. Fortunately, the realistic photos offered recognizable landmarks which the group searched for together, and found: *"The pig barn with the red roof!" "That is [hotel] Königshof"*, "*Is that the B1 [roadway]?"*

Sketches

No dynamic navigation: The sketch was on paper, not projected, and was static, without any means to "move" in the picture. For the last group that visited the visualization, who had seen the visualizations with interactivity and dynamic navigation, this was a disappointment. For example, "*One can't move around in it. They are static."* Interestingly, the participants had come to expect dynamic navigation by the end of the evening.

Interactivity

LandXplorer/Lenné3D

Digital post-its can be seen better: Citizens used the opportunity to document their comments with the digital post-its in the VR model. Although only keywords could be written, the comments were visibly documented and more readable than in the analogue post-its on the map.

Photomontage

Interactivity is in demand and intuitive: Participants actively used the interactive possibilities to view different combinations of planning measures*: "Leave all the trees on and turn off all the hedgerows,*" or they requested certain planning measures to be turned on and off: *"Show the hedge there.*" They also used the interactivity to make a point. For example, one participant employed the interactive function of the visualization to support his argument by proposing that all the measures be turned off and then on and said, *"Wouldn't the implementation of all the measures cause a break in the historically developed cultural landscape? Turn on all the measures. That is clearly too much."*

Fourth dimension: The simulation of the planning measures and the ability to "see the future" stimulated questions about the development of the landscape. Not only did participants want to see visual changes over time, they also had content-related questions: "*What does the long-term development of the hedgerow look like? That is something one should visualize. How should the hedgerow be maintained?"* Another participant commented, "*One could simulate the development of the hedgerow. For example, let it grow in 10-year increments."*

Sketches

Interactivity needs time: In the 20 minutes that a group visited the station, it was not possible to document the results of the discussion with the sketches. This was due, in part, to a communication problem between the participants and the artist and the artist's unfamiliarity with the site. As a result, the citizens themselves tried to sketch. Although they had difficulty to make their ideas clear in the sketch, some participants and the artist made sketches of details which were helpful for explaining ideas.

VNS rendering

Participants interact using before-and-after views in discussion: Participants instructed the technical assistant to turn on certain measures, showing before-and-after views while they stood and explained their ideas on the screen. The interactivity was used intuitively and frequently by the participants and stimulated discussion and provoked opinions.

Interactivity underlines proposed nature of planning: When the before-and-after views showed specific landscape changes, some participants reacted with disapproval, for example by shaking their heads. However, it did not come to confrontation. Possibly, clicking the measures on and off underlined the proposed quality of the planning. The fact that the measures could be "eliminated" supported the openness to discuss planning measures as suggestions and not as the final decision of the planners.

Limits to interactivity – waking expectations: After participants realized that they could show different combinations of planning measures, they wanted to adjust the existing planning measures to show their ideas or concepts. For example, one participant wanted to see how it would look with the hedgerows in the other direction. The interactivity raised the expectation to see their ideas visualized "on the fly", and the viewers expected more interactivity. For example, one participant criticized the fact that some elements in the picture blocked other features: "*They should have been make interactive, i.e. tuned off, as well.*"

6.3.4 Role of facilitators in the use of visualizations

New tasks for the facilitators when using visualization

Observations about how the visualization affected the role and tasks of the facilitator were gathered primarily in the Bornum investigation but also during the whole case study. The use of visualization in a participatory setting presented the facilitator with additional challenges. The facilitator was not only responsible for directing and documenting the discussion, but also for integrating and coordinating the visualization in the discussion, which involved juggling several visual aids during the session (see Figure 49).

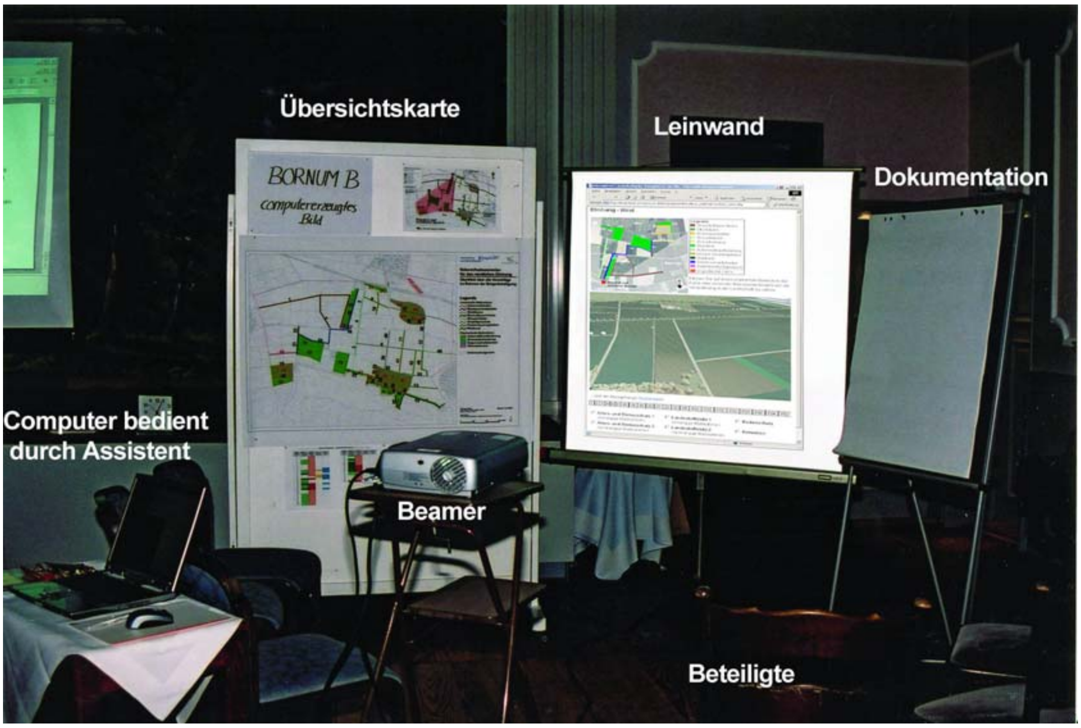

Figure 49: Set-up of presentation situation in Bornum investigation

In preparation

The technical assistant, who was familiar with the software, was responsible for running the visualization. This was essential in order to free the facilitator to concentrate on the dynamics and content of the discussion. However, the coordination between facilitator and technical assistant was not optimal. The facilitators suggested that a dress rehearsal would have helped to become familiar with the visualization methods and would have improved the coordination with the technical assistant. Their comments and observations suggest that a practice session and an introduction to the visualization methods should include the following:

- **Capabilities of the visualization**: The facilitator must understand the capabilities of the visualization and **what it can do**. In other words, the facilitator must be acquainted with the interactive and navigational capabilities of the visualization; know where the best views of the planning measures are located; which additional images are available, for example, before-and-after images; how close one can zoom in before the resolution or level of detail becomes problematic.
- **Limitations of the visualization**: The moderator also needs to understand **what the visualization can NOT do**. In order not to raise false expectations, the facilitator must avoid making suggestions about what can be visualized which the visualization cannot fulfil. The observations show that the citizens often expected more from the visualization than it could produce, for example the immediate

visualization of new suggestions "on the fly". The facilitator must understand what is not possible, and why, in order to avoid disappointment and the loss of credibility.

- **Application of the visualization:** Furthermore, the facilitator must know **what the visualization is good for**, i.e. how it can be used in the discussion or its suitability for different kinds of planning questions; documentation capabilities; showing the existing situation from different perspectives such as an overview for large-scale measures and an eye-level view for discussing the visual impact of measures.
- **Teamwork with technical assistant:** In addition, the facilitator must be able to use the visualization in **coordination with the technical assistant**. The two must be able to work as a team. The assistant must understand the facilitator's instructions and the facilitator must understand the constraints of the program in order not to expect the impossible from the technical assistant. Finally, a familiarity with the site is also essential for both the facilitator and assistant in order to respond to the instructions of the participants to view different areas. Both must become familiar with landmarks in the landscape which can support orientation.

It becomes clear that the effective use of the visualization places many demands on the knowledge and experience of the facilitator. Ideally, the facilitator is involved in or familiar with the production of the visualization. When this is not the case, then preparation and practice with the visualization is essential.

Tasks of the facilitator during the participation session

The use of visualization during the meeting required the facilitator to assume additional tasks in order to effectively integrate the visualization into the discussion. The following tasks associated with the visualization were identified during the observation of meetings. The facilitator did not always perform the following tasks herself, but it was her responsibility that the explanations were provided by the appropriate expert.

Orientation: This is a prerequisite for the use of the visualization. In Bornum the facilitators needed to explain where the visualized area was situated in the context of the site and to point out the viewpoints, direction of views, and the boundaries of the visualization in the topographic map. The facilitator also tried to identify landmarks within the visualization. With the static presentations, a moment was needed for orientation at the beginning, but then it remained clear.

For the visualization methods which used dynamic navigation, the facilitator needed to help the participants reorient themselves throughout the meeting. For this, the facilitators relied heavily on the 2D maps and needed a good knowledge of the site, which was not always the case. In fact, one facilitator felt the discussion of the different planning scenarios took place mostly on the analogue map, which offered the facilitator a good overview in which participants could help locate the measures.

Demonstration of the visualization method: In order for the participants to use the visualization, they needed to know what it could do. A short demonstration of the visualization method which showed interactive and navigation capabilities, i.e. the ability to zoom, pan, and move through the model, was important at the beginning of the participatory sessions. Furthermore, supporting visualization material was introduced at the beginning of the meeting, so that participants were aware of its availability. For example, the before-and-after renderings of planning measures from different viewpoints prepared with VNS were introduced at the beginning, but then minimized or closed during the discussion of the overall scenario. Although these would have helped clarify certain questions, they were used very little during the discussion. Apparently what is not visible is easily overlooked and more difficult to integrate into the discussion.

Explanation of the visualization: Some of the participants were curious about the visualization methods and wanted to know how they were produced and what kind of data was used, i.e. photos or GIS and DEM data. A brief explanation helped the participants judge the reliability of the visualizations and understand the visualization technology and its limitation. Participants were interested in information about the origin, actuality, and exactness of the data, as well. An explanation was given of the level of detail that could be shown and the reason for the limitation, e.g. detail of data or capabilities of the visualization program. Finally, the participants needed to know the location of the planning measures and to have an explanation of their representation, e.g. textures, colors, type of trees.

Coordination of the visualization in the discussion: The visualization methods with dynamic navigation were more difficult for the facilitators to coordinate than those with a static view. When the discussion focused on a specific planning measure, then the visualization needed to move to that site in the VR model or photomontage. This required a good site knowledge by both the facilitator and the technical assistant. Furthermore, the discussion often changed locations faster than the visualization could follow and the participants could become oriented. The coordination of the visualization depended to a large extent on how well the technical assistant could follow the discussion and her familiarity with the site. It was the role of the facilitator to ensure that everyone was oriented before the discussion could continue.

Documentation: The digital visualizations had the potential to document the consensus of the planning discussion with a screen shot. But this was found insufficient or impractical because it did not document the citizens' stipulations about the measures, e.g. "*Fallow grassland will be accepted only with an exchange of land 1:1*." LandXplorer also offered the possibility to document comments with keywords, but most of the documentation took place on the analogue maps with post-its. Further investigations should address the question of how documentation can be integrated into the visualization in order to improve transparency.

Visualization in the discussion process: constraints and opportunities

In general, the reactions of the participants to the use of the visualization in the discussion ranged from enthusiasm to rejection. The majority of the participants were open to the visualization, even when they disagreed with the proposed planning measures. However, some participants showed skepticism throughout the meeting. Others overcame their reservations and used the visualizations when commenting about the site. Observation of the participants during the Bornum investigation suggested the following general statements about the use of visualization during the discussion process.

Participants need time to feel comfortable with the visualization

Understanding the visualizations needed time; in other words, the facilitator needed to invest time at the beginning of the session to make sure the participants were comfortable or familiar enough with the visualization in order to use it. Comfortable means, in this case, being able to orient oneself in the image and to recognize and understand the representation of the planning measures as well as the interactive and navigation capabilities of the visualization. Participants did not jump right in and start using the visualization. They first watched and discussed without the visualization. For the most part the participants needed encouragement to use the visualization in the discussion.

The time needed to acclimatize was different for the various visualization methods. For the photomontage and VNS rendering, it was relatively short. Once orientation was established in the photomontage and it was clear where the planning measures were located, the participants could readily use it. Viewers easily understood the “before and after” or “on/off” function of the LaViTo visualization types.

The sketches required more time than the other visualization methods for orientation in the four different view points. But once established, the viewers used them without problem. For the LandXplorer VR model, participants needed first to establish their orientation and understand how moving through the model worked. Furthermore, every time the position in the model moved, time was needed for reorientation and to locate the new position in a 2D map.

Focus on site-related discussion

The facilitator could only suggest or encourage the use of the visualization. The dynamics of the group often led the discussion. When general issues, i.e. non-site-related issues, were pressing, then the visualization played a subordinate role. In other words, the visualization was important only when site-related issues were discussed. This may seem obvious, but it was not always easy to predict which issues would dominate the discussion. If the facilitator was not able to focus the discussion on site-related issues, then the visualization was irrelevant.

On the other hand, the facilitator observed that the participants used the visualization primarily to locate and discuss landscape elements which were visible in the visualization. In a sense, by choosing to visualize specific areas, the planner focussed the discussion on these areas of the site and the related issues. This raises the question of who decides which areas should be visualized: planners, politicians, stakeholders, residents?

In the questionnaire at the end of the Bornum session (see Figure 50), citizens said they thought that the maps, aerial photos, and VR model helped to focus the discussion on the planning measures more than the photomontage and sketches did. This may indicate the importance of 2D methods or maps for keeping the participants oriented and for identifying measures which kept the discussion focused on the planning measures.

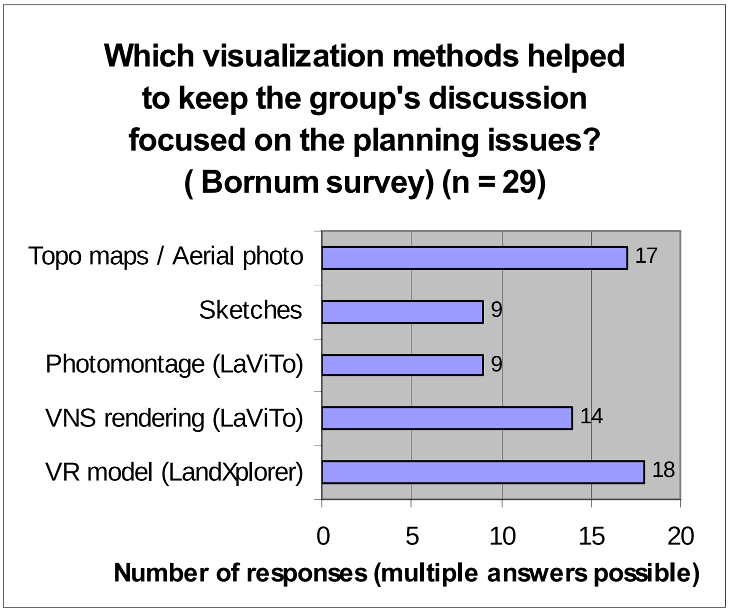

Figure 50: Citizens in Königslutter identify visualization methods that helped focus discussion. (Survey from Bornum 15.03.2004, Question 3)

6.3.5 Summary

Suitability of visualization methods for use in participation

The suitability requirements for participation were fulfilled to varying degrees by the four visualization methods. (See summary in Table 23.) All four visualization methods provided the participants with sufficient spatial understanding. However, the ease of orientation, assessment of the planning proposals, and credibility were perceived differently. The **VNS rendering** with LaViTo best fulfilled all of the requirements. The **photomontage** also fulfilled all the suitability requirements except that its credibility was questioned by some participants. Although the **LandXplorer** VR model provided good spatial understanding and credibility, participants found orientation in the moving model to be difficult. Furthermore, assessment of the planning proposals was not possible because they were not simulated. Finally, although the **sketches** fulfilled the suitability prerequisites, they required more time and effort to use. For this reason they appear to be the least suited of all the visualization methods for participation, at least in this kind of setting.

In general, the assessment of the planning measures was most effective with the visualization methods that had been prepared with LaViTo (VNS rendering and photomontage). The comparison of before-and-after simulations of the planning measures was actively used by the participants to discuss their opinions about the planning measures. Furthermore, orientation was more difficult with the 3D VR model and sketches than with the photomontage and static VNS rendering. The movement through the VR model was at times too fast, and the four different viewpoints of the sketches required more time and effort for orientation in the image. The credibility of the GIS-supported visualization methods (LandXplorer and VNS rendering) was not questioned. However, the credibility of the photomontage was questioned, and the sketches, although understandable, were seen as artistic representations of the site.

Function of visualization in the participation process

The four visualization methods were observed to fulfill three participation functions to varying degrees during the investigation in Bornum: **engagement, communication, and, to some extent, collaboration** (see Table 24). A change in the behavior of the participants could not be observed during the investigation. **VNS rendering and photomontage** prepared with the LaViTo tool supported the three functions best. The interactivity provided by the LaViTo tool appeared to engage the audience, supported the discussion, and provided a basis for collaborating about the planning measures.

The movement of the **LandXplorer** model stimulated initial interest and fascination, but it also caused viewers to lose their orientation, and thus interest, in the model. Nevertheless, a static bird’s-eye view of the model provided a good basis for communicating the location and documentation of participants' comments. Unfortunately, the planning measures were not simulated, which made collaboration difficult.

The panning movement and interactivity of the **photomontage** (LaViTo) engaged the participants and supported communication and the beginning of collaboration. Participants were also actively engaged in steering the visualization and choosing which measures were turned “on and off”. The participants' familiarity with the site supported spatial understanding and orientation and made it possible for them to focus on communicating about the planning measures. Some participants voiced concerns about manipulation with the photomontage. Possibly where artistic license was suspected, viewers were more suspicious.

The **sketches** were used to communicate opinions about the planning measures, but the analogue pictures did not engage the audience or animate interest; instead, participants had to make an effort to stand and study them up close. Participants could recognize and locate planning measures in the sketches, but they required more time than with the other visualization methods. In the meeting situation with 20-minute discussion periods, it was not possible to take advantage of their potential for interactive and collaborative work.

The bird's-eye view of the **VNS Rendering (LaViTo)** provided good orientation and acted as the basis for a discussion of the proposed measures. The less photorealistic representation of the landscape, which occasionally required explanations from the planner, illustrated the proposed nature of the measures. The citizens used the visualization to make concrete suggestions about improvements to the planning proposals and the preferred combination or priority of measures.

Table 26 gives an overview of the strengths and weakness of these visualization methods in the support of the different functions in the participation process.

Table 26: Review of strengths and weaknesses of the visualization methods for use in participation

	Sketches
+	Realistic enough to use in discussion
-/+	Potential for interactive/collaborative work with artist (not taken advantage of in investigation)
-	Required more effort for orientation
-	Format not conducive to group discussion, difficult to compare planning measures
	Photomontage (LaViTo)
+	Pan function and photorealism engaged participants' interest: interactivity easily and often used by participants to support communication
+	Good orientation (bird's-eye view helpful)
+	Photorealistic image stimulated concrete criticism and recommendations
-	Emotional responses, focus on detail and correctness of image
-	Credibility questioned
	VNS Rendering (LaViTo)
+	Engaged participants, who used it easily and often to support communication
+	Good orientation (bird's-eye view helpful)
-/+	Textures not always clear and required explanation; stimulated discussion, supported conceptual quality of planning discussion
-	Static, no navigation or additional perspectives
	LandXplorer
+	Movement of model fascinated and engaged viewers
+	Located, communicated, documented participants' ideas
-	Movement through model made orientation difficult

Importance of visualization characteristics in the participation process

Table 25 contains a summary of the observations and comments made during the Bornum investigation about the importance of realism, dynamic navigation, and interactivity of the different visualization methods.

Realism: The photorealism of LandXplorer and the photomontage made it easy for the participants to picture the existing landscape and to pick out landmarks which supported orientation. The less photorealistic visualizations depended more on the 2D map for orientation. Interestingly, the photorealistic photomontage also forced the participants to see existing visual problems which they ignored in reality, e.g. high-voltage wires.

The photorealistic simulation of the planning measures in the **photomontage** raised several issues. First, because the planning measures were illustrated in detail, the planners had to be very specific about these. Second, the concrete representation of the planning measures evoked a strong emotional reaction from some participants. And finally, the photorealistic representation also elicited the "What is wrong with this picture?" phenomenon, in which incorrect details of the photomontage distracted from the content of the planning discussion. These observations raise the question of how realistic the visualization of simulated planning measures should be. Should proposed planning measures be intentionally and recognizably different from the existing landscape so the viewers recognize which measures are simulated, or should they blend into the landscape in a realistic manner?

On the other hand, the **VNS rendering** was realistic enough that participants could recognize the planning measures and orient themselves in the landscape, but the textures used to represent the planning measures were less detailed than in the photomontage. It was evident to the participants that the VNS rendering was a simulation. Some unclear graphic representations required the planner to explain the textures and the planning measures. This opened the discussion up to concrete suggestions from the participants about how the planning measures should actually be implemented. There were no comments or concerns about manipulation, as was the case with the photomontage.

Although the **sketches** were not photorealistic, they were realistic enough for the participants to locate landmarks, to understand the planning, and to make comments and suggestions. It is not clear how the abstraction was perceived, or whether it had an influence on the credibility of the images.

Dynamic navigation: The LandXplorer VR model offered the most flexible dynamic navigation. Once participants had experienced the VR model, they expected the same navigation possibilities with the other visualization. However, the participants also recognized the orientation benefits of the static views and the necessity to have 2D maps for orientation with the VR model.

Finding the right speed of navigation within a visualization, no matter which method, was a challenge during the meeting. The movement needed to be fast enough to synchronize with the discussion, but not faster than the viewers could follow and stay oriented. In Bornum, participants lost their orientation frequently in the navigation of the LandXplorer VR model, and the movement actually gave some viewers motion sickness. Part of the difficulty lay in the size of the site. In order to move from one planning measure to the next in the model, the viewers had to “fly” from one place to another, and lost their orientation in the model. The experience in Beienrode with the VR model showed that participants could stay oriented better when changing locations within the model if the camera started each time from a bird’s-eye view and zoomed in to discussion “hot spots”, which had been prepared in advance.

Panning the landscape from a fixed point was possible with the photomontage. The participants missed not being able to “go to” a landscape feature, but they could orient themselves much better when the pan rotated at “pedestrian” speed. The participants‘ familiarity with the site, their ability to recognize photorealistic landmarks, and the stationary viewpoint made the orientation during panning much easier than in the VR model.

Interactivity: When interactivity was available in the visualization, it was used intuitively and welcomed. The participants quickly understood how to use the interactivity, whether it was with the digital "post-its" in the VR model, which the participants used to mark their comments, or the ability to turn measures "off and on" in the photomontage and VNS rendering. The interactivity supported the participants to become active members of the discussion. Moreover, the planners used the interactivity provided by LaViTo to illustrate the priority and combinations of different planning measures. Considering how quickly the participants picked up on the interactive opportunities of the visualization, it was not surprising that they wanted more interactive possibilities, e.g. visualizing their own planning suggestions “on the fly”. Although the sketches had the potential to develop and illustrate the participants' ideas with an artist during the session, the amount of time available, communication difficulties, and the analogue medium and size of the sketches made it difficult to use the potential to interactively develop ideas with the participants in the town meeting setting.

Role of the facilitator

In order to effectively use the visualizations in participatory situations, the facilitator must be familiar with both the planning issues and the visualization technology. Preferably, the facilitator should be involved in the production of the visualization. However, when this is not the case, a dress rehearsal with the visualization and technical assistant prior to the participatory session is crucial so that the facilitator understands what the visualization can and cannot do; how it can be used in the participation, and how to coordinate it with the technical assistant. Furthermore, the facilitator must accomplish the following tasks when using visualizations during a meeting:

- Ensure that the participants can orient themselves in the visualizations.
- Introduce and demonstrate the capabilities of the available visualization methods, i.e. navigation possibilities and interactivity.
- Explain background information about the visualizations, i.e. how it was produced and what kind of data were used, so that participants can understand the validity and limitations of the visualization.
- Coordinate the visualization with the discussion, e.g. ensure that the visualization shows the areas being discussed.
- Document the results of the discussion with the visualization. This is an aspect of the visualization which requires further solutions.

Observations showed that participants needed time to become comfortable with and warm up to the visualization. The time required for acclimatization was different for the various visualization methods. The participants embraced the photomontage and VNS rendering more quickly than the VR model and sketches, which required more effort for orientation. The amount of time viewers needed to become oriented and to understand the situation and visualization should not be underestimated by the facilitator and deserves more investigation.

Finally, the visualizations were used primarily when site-related issues were discussed. However, the group dynamics were often more powerful than the facilitator in directing the discussion topics. When general issues were pressing or needed to be discussed, the facilitator was powerless to redirect the discussion to site-related issues, and the visualizations were irrelevant. This emphasizes the importance of being aware of the citizens' issues when developing the meeting agenda and visualizations. The citizens felt that the methods which provided an overview helped most to focus the visualization on the planning measures, indicating that orientation is central to keeping the participants "on track".

6.4 Suitability of visualization methods for different planning tasks and phases

6.4.1 Visualization methods that are suitable for the planning phases

Suitability for background information and inventory: young planners considered 2D important

For the young planners, 2D visualizations were central to conveying information in the inventory phase. The photorealistic 3D visualizations, which convey spatial understanding, were of secondary importance. Figure 51 shows that the young planners chose the aerial photograph (53%) and topographic map (45%) most frequently to illustrate background information about the planning. A 2D representation appeared sufficient to convey inventory data, for which location and content are more important than the visual appearance.

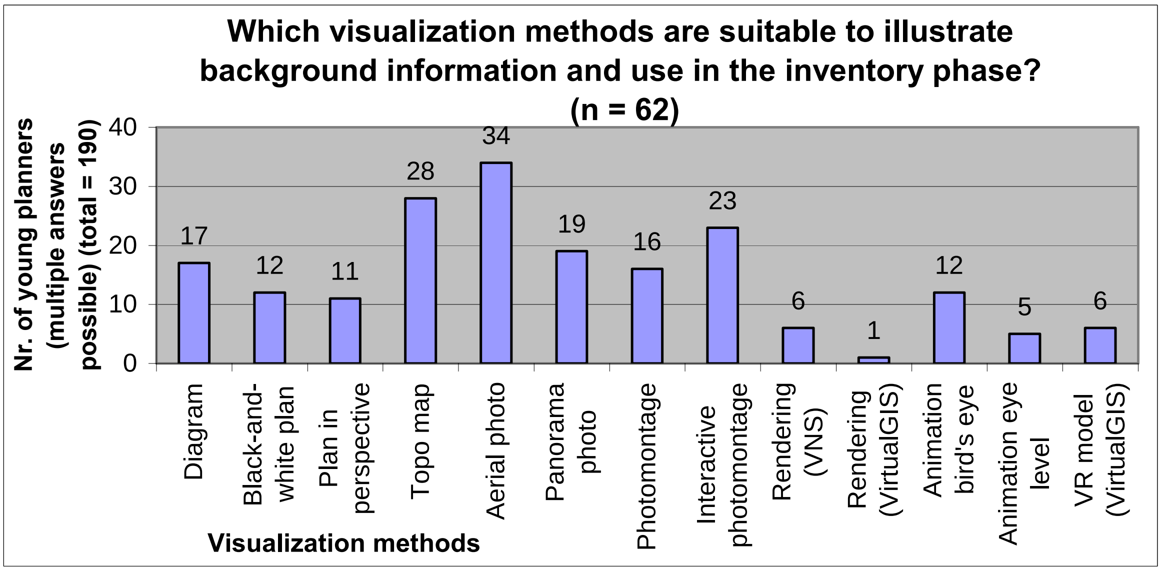

Figure 51: Young planners select visualization methods that are suitable for illustrating background information and inventory. (Questionnaire II, Question C65)

Suitablity for the concept phase: young planners preferred photorealistic visualization

Spatial understanding becomes more important in the concept phase. Young planners selected the photomontage (43.5%), interactive photomontage (LaViTo) (42%), and aerial photograph (40%) most frequently for use in this phase (see Figure 52). The topographic map was selected by 35% of the respondents, and the panorama photo somewhat less frequently (27.5%). A realistic representation appears to be an important characteristic of the visualization in developing planning concepts. The importance of the topographic map could lie in that it provided additional information and a good overview for orientation.

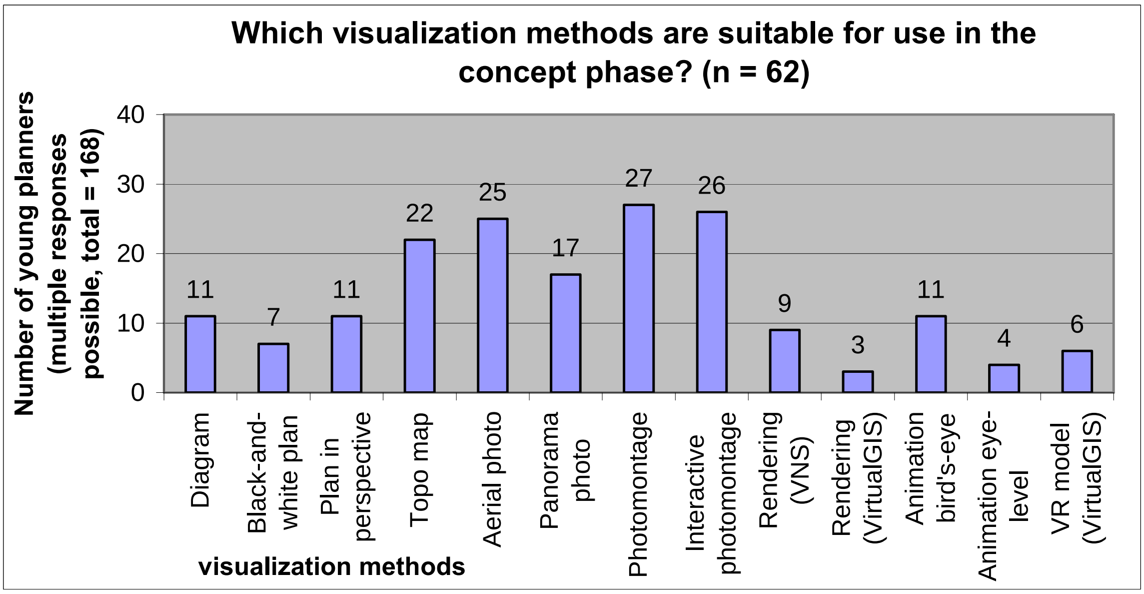

Figure 52: Young planners selected visualization methods suited for use in the concept phase of planning. (Question C66)

Suitability for the planning measure phase

Visualization survey: young planners

The young planners consistently gave two reasons for their preference of the visualization methods in this phase: ease of picturing the site (spatial understanding) and providing overview and information. The majority of the young planners preferred the aerial photograph and the interactive photomontage (LaViTo) (both 58%) for illustrating proposed planning (see Figure 53). The photomontage (43%) and the panorama photo (35.5%) were also frequently chosen. All are photorealistic visualizations which support spatial understanding. This underlines the importance of a realistic image for the discussion of concrete planning measures. However, it was not clear which other factors influenced these preferences, for example, the interactivity incorporated into the LaViTo photomontage. More investigation is needed to determine exactly which attributes of the visualization other than realism influence the users' ability to assess the planning proposals.

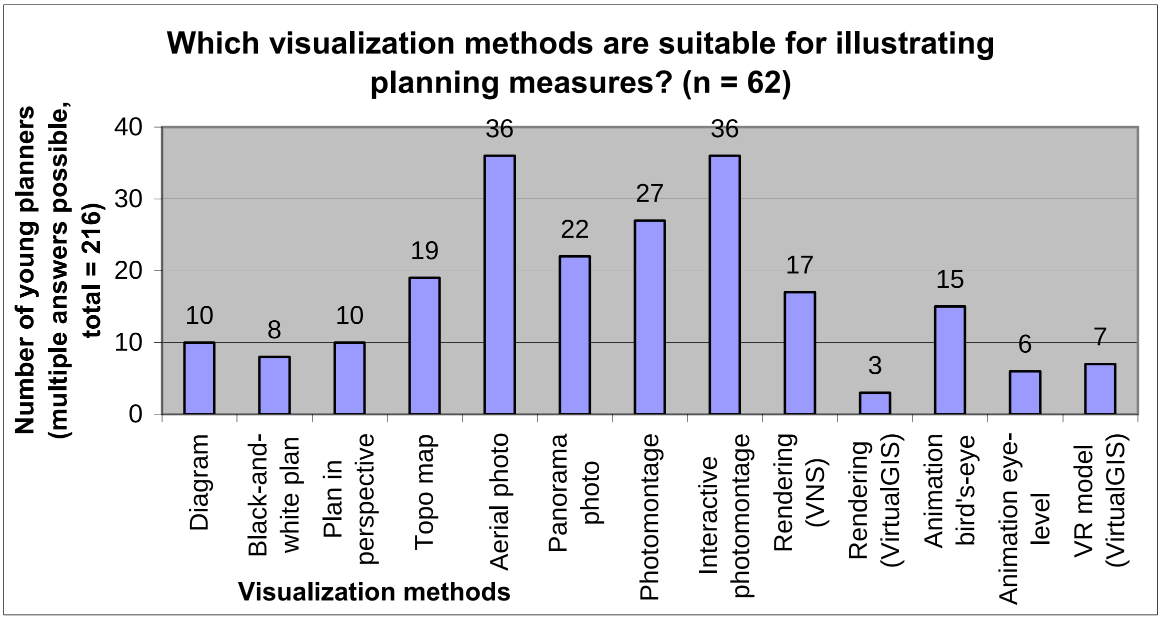

Figure 53: Survey of young planners' selection of visualizations suitable for illustrating planning measures (Questionnaire II, Question C67)

Very few people selected the rendering made with VirtualGIS. Based on comments made about the other visualization methods produced with VirtualGIS, it is hypothesized that the representation of the vegetation and landscape in the rendering was not realistic enough. None of the traditional visualization or VirtualGIS methods were considered particularly suitable for use in this phase.

Students and lay group preferred a combination of 2D and 3D images

The **lay group** selected only three of the visualizations. The majority (65%) preferred the photomontage, 17% of the group chose the 3D bird's-eye animation, and 13%, the aerial photos. The students' choices also reflected these preferences: photomontage (47%) and bird's-eye 3D animation (30%), but not with the same unanimity (see Figure 54). Interestingly, both groups preferred the photomontage together with a visualization method that offered an overview, i.e. either a 2D or 3D bird's-eye view: aerial photo or bird's-eye animation.

For the l**ay group**, realism was the main reason for preference in all of the visualizations. Furthermore, their comments showed that the animation and aerial photograph provided information and navigation benefits, while the photomontage made it easy to picture the site. For the group of i**nformed students**, spatial understanding was the most frequent reason for preferences. Again, realism was an important prerequisite for spatial understanding (see section 7.1.1). The capability of the visualization to provide an overview and information was the second most frequent reason.

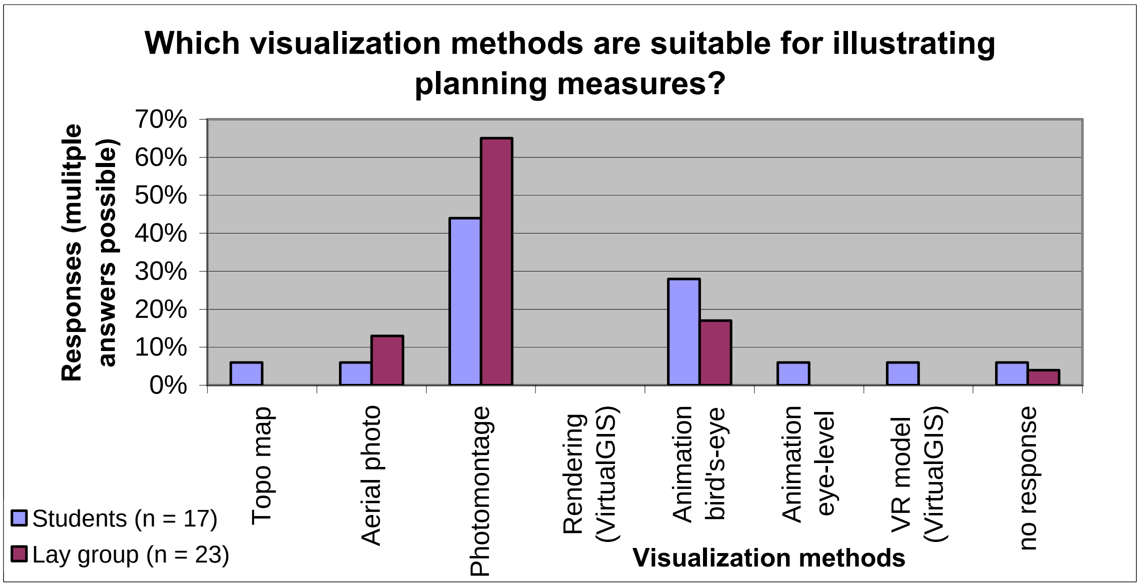

Figure 54: Survey of informed students' (Question C14) and lay group's (Question C16) selection of visualization methods suitable for illustrating planning measures.

A comparison of the comments made by the informed students, lay group, and young planners about the individual visualization methods may help provide insight into the reasons why these groups preferred different visualization methods. Their responses are summarized in Table 27. Only the young planners preferred the topographic map in this phase. The aerial photograph supported the lay people's spatial understanding of the planning and provided the young planners with information. All groups agreed that the photomontage helped picture the planning. The bird's-eye animation provided a good overview of the planning, but the VirtualGIS rendering and real-time model were too abstract to be useful in this phase.

Table 27: Summary of reasons for preference of visualization methods for showing the planning measures (lay group, informed students, young planners)

Visualization method	Lay group	Informed students	Young planners
Topographic map	-	-	Provides information Easy to picture site
Aerial photograph	Easy to picture the site	-	Provide information, Helped understand planning
Photomontage	Realistic, easy to picture the site, stimulates interest and understanding of planning	Realistic, easy to picture the site, stimulates interest and understanding of planning	Realistic, easy to picture the site, stimulates interest and understanding of planning
Bird's-eye view 3D animation (VirtualGIS)	Good overview, navigation benefits	Good overview, easy to picture the site	Good overview
VirtualGIS rendering and VRML model	-	-	-
Interactive photomontage	Does not apply	Does not apply	Easy to picture the site, realistic, provides. information, stimulates interest and understanding of planning.

Survey of planning experts (09.06.2004)

The planning experts on the IALP supervisory board rated (with keypads) a smaller and, in part, different selection of visualization methods than the other groups. Therefore, the comparison is limited. Although the number of responses was relatively low, which may have been due to their initial inexperience with the keypads, the experts considered the VNS rendering to be most helpful for picturing the planning proposals, followed by the photomontage (LaViTo), LandXplorer VR model, and the sketches (see Figure 55). In contrast to the other groups, the experts considered the aerial photo among the least helpful visualizations. Possibly, the experts felt a 3D image of the planning was needed in this phase of planning.

In a further question, the experts assessed the helpfulness of the visualization methods to evaluate the planning, i.e. form an opinion about it (see Figure 55). Across the board, the visualization methods were considered more helpful for picturing the planning than for forming an opinion. In fact, the 2D methods played almost no role in their assessment of the planning proposals. One possible explanation is that the visualization emphasized the visual aspect of the planning and may not have provided the experts with sufficient background information to form a planning opinion.

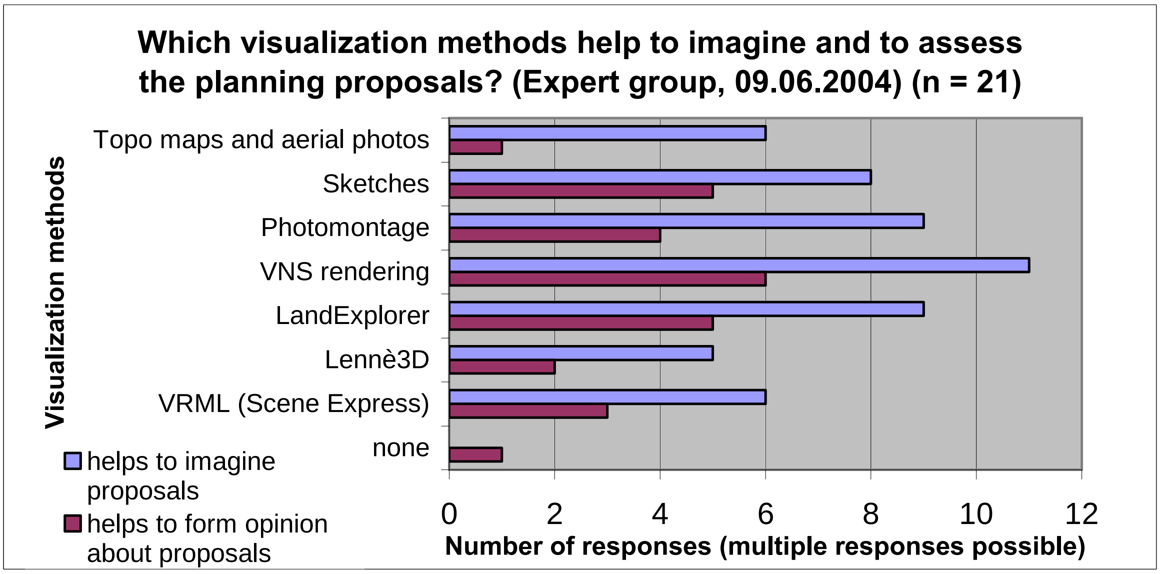

Figure 55: Planning experts from the IALP advisory board rate helpfulness of visualization method to visualize and evaluate planning proposals (Questions C1 and C2, expert survey on 09.06.2004)

Case study: citizens in Königslutter

In the Bornum investigation, the participants considered VNS rendering (LaViTo), VR model (LandXplorer), topographic maps and aerial photos most helpful to picture the planning (see Figure 56). Except for the 2D methods, this agrees with the results of the expert survey. Furthermore, like the experts, this group considered these visualization methods more useful to picture the planning measures than to assess them. Possibly the citizens also recognized the need for more than visual information to evaluate the planning.

It is noteworthy that 22% of the participants in Bornum felt the maps alone were sufficient to judge the effects of the planning. This question was asked after the participants had seen all the visualizations, so it is difficult to judge its validity. Nevertheless it would indicate that land owners and residents familiar with the site could use 2D maps successfully.

The participants in Bornum did not consider the photomontage to be particularly helpful to picture the planning. However, the survey of citizens in the Rottorf investigation showed that a static photomontage of the planning proposal with before-and-after images helped all of the participants to judge the effects of the planning. The photomontage used in Rottorf simulated a single, small-scale planning measure (removal of a row of trees), while the photomontage in Bornum showed more than a dozen planning measures on a large site. One could hypothesize that a photomontage is sufficient for simulating small-scale, individual planning measures, but is less suitable for large-scale planning scenarios.

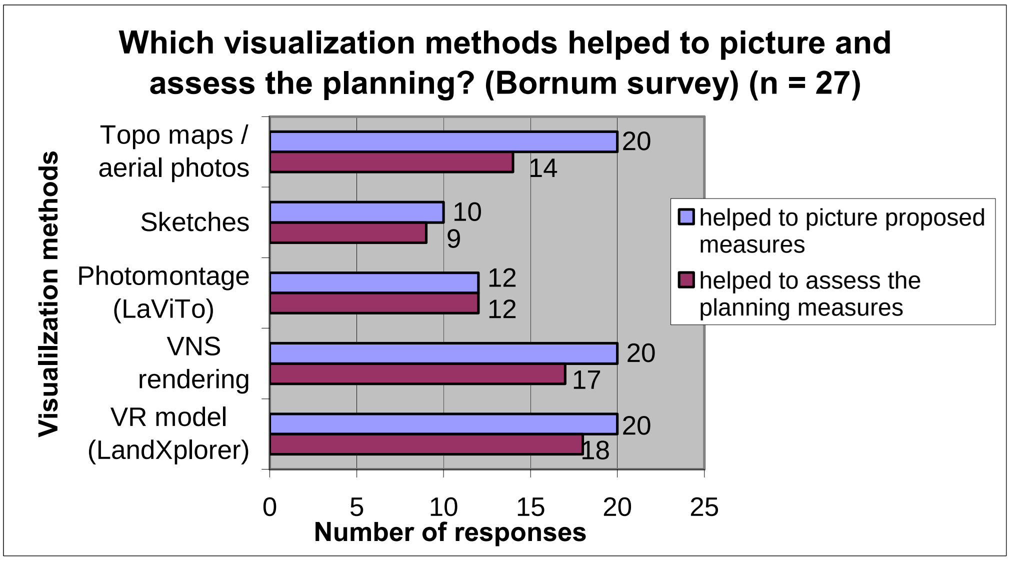

Figure 56: Citizens in Bornum rate the helpfulness of visualization methods to picture and assess the planning measures (survey of 15.03.2004, Questions 1 and 2).

The survey of participants in the Beienrode investigation found all of the visualization methods to be very helpful: 2D maps and aerial photos, interactive VNS renderings (LaViTo), before-and-after images made with VNS, and the VR model (Scene Express). In contrast to the Bornum investigation, where the participants experienced the individual visualization methods in separate discussion groups, in Beienrode the citizens experienced all the visualization methods during a single discussion. They were asked to evaluate the visualization methods at the end of the meeting, after they had seen all the visualization methods. The unanimity of the responses could possibly be explained by the fact that it was difficult for the participants to differentiate between or clearly determine which of the specific visualization methods helped most to judge the effects of the planning. In other words, the combination of the visualization methods in one meeting may have had a synergetic effect that made the visualizations more effective or helpful.

Young planners compared suitability of visualization in different planning phases

In the visualization survey, the young planners were the only group which evaluated the suitability of the visualization methods for the three different planning phases. Their assessment of the suitability of the individual visualization types for the different planning phases is summarized in Table 28. The results suggest the following:

- In the **inventory phase** and for communicating **background information,** 2D methods (topographic map and aerial photographs) were most important, while photorealism and the diagram were of secondary importance. The overview provided by a 2D visualization was sufficient, and spatial understanding was less important.
- In the **concept phase,** both 3D photorealistic and 2D methods were important, with preference given to the photomontage (both with and without LaViTo) and aerial photograph. Apparently, the spatial understanding that realism supports was more important in this phase than in the previous planning phase.
- In the **planning measure phase** as well, photorealism – both 2D and 3D – was important. For the most part, the young planners preferred the same visualization methods as they did in the concept phase, but to an even greater degree. Interestingly, the interactive photomontage was much preferred over the static photomontage. This would indicate that interactivity is an important characteristic of the visualization in this phase. This agrees with the opinion of the planning experts about the role of interactivity in the planning phases. (See section 7.2.3) Furthermore, the young planners also considered visualization methods that provided an overview to be helpful in this phase.
- Throughout the planning phases, the **aerial photograph** was one of the most often selected visualization methods. It would appear that planning participation should always have an aerial photograph available.
- Overall, the **VirtualGIS** rendering, eye-level animation, and VR model were not

considered very suitable for use in the planning. The abstract representation of vegetation with VirtualGIS made it difficult for the young planners to picture the planning. Only in the bird's-eye animation, which showed the landscape at a larger scale, was the lack of detail not distracting.

- **Traditional visualization methods** – diagram, black-and-white plan, and plan in perspective – were most useful in the inventory phase but were otherwise of little significance.

Table 28: Survey of young planners' selection of visualization methods suitable for different planning phases

	Background information	Concept development	Planning measures
Diagram	27%	18%	16%
Black-and-white plan	19%	11%	13%
Plan in perspective	18%	18%	16 %
Topographic map	48%	35%	30%
Aerial photograph	53%	40%	58%
Panorama photo	30%	27%	32%
Photomontage	25%	43%	43%
Interactive photomontage	37%	42%	58%
VNS rendering	10%	14%	27%
VirtualGIS rendering	1.6%	5%	5%
Bird's-eye animation	19%	18%	24%
Eye-level animation	8%	6%	10%
VirtualGIS VR model	10%	10%	11%

☐ 0-20% ☐ 20-40% ■ 40-60% of responses

6.4.2 Visualizing different types of landscape features (point, lineal, and area information)

Visually significant point landscape features

Figure 57 shows the specific preferences of the informed students and lay group for visualization methods that illustrate visually important point landscape features, such as a specimen tree or geological feature. The panorama photo was the method chosen most often (by 35% of the respondents) because it provided realism, the ability to assess the visual aspect, and showed the context of the landscape element.

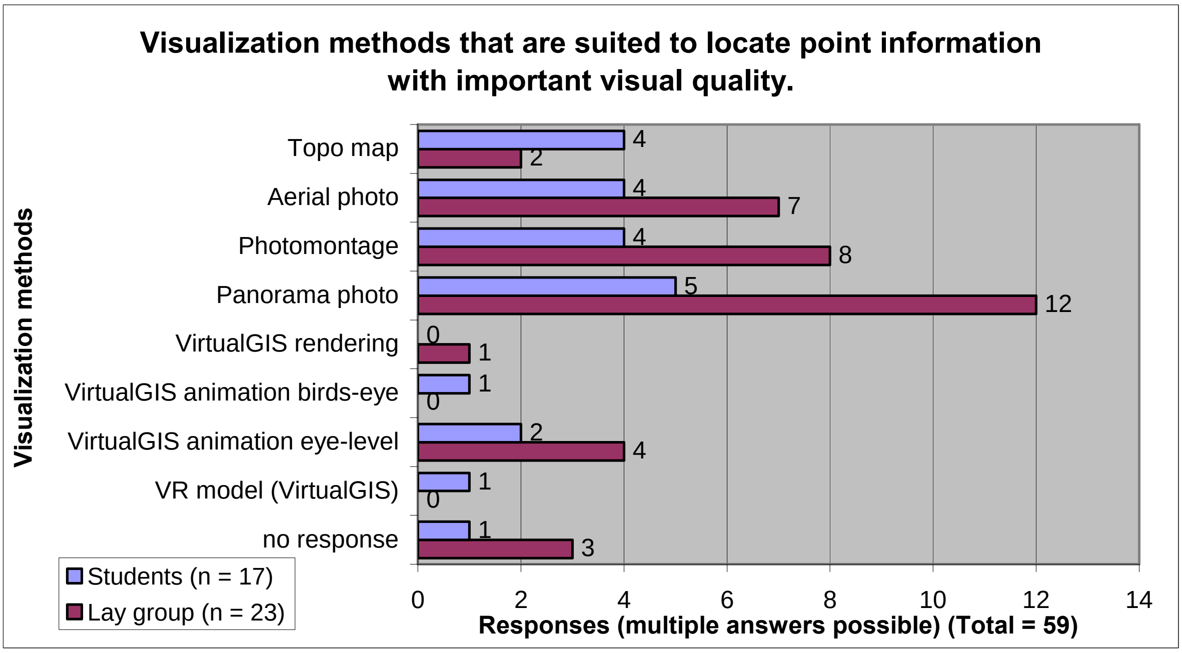

Figure 57: Overview of survey responses about the suitability of visualization methods to show point information with significant visual quality (Questionnaire I, B36)

The lay group clearly preferred realistic visualization methods, whereas the informed students showed no clear preference. In order to better understand the characteristics of the visualization that were important, the visualization methods have been grouped into three different categories of (see Table 29):

- **2D** (topographic map and aerial photo),
- **3D photorealistic** (panorama photo, photomontage, VirtualGIS rendering), and
- **3D VR** (bird's-eye and eye-level animations, VirtualGIS VR model).

Categories that were preferred in 40%-60% of the responses are highlighted in green, 20%-40%, yellow, and 0%-20%, white.

Table 29: Informed students and lay group assess the suitability of visualization methods to illustrate point landscape features with important visual quality.

Visualization methods	Students responses	Lay group responses
2D visualization (topographic map, aerial photo)	**40%** Overview, ease of locating info, recognition	**25%** Overview, ease of locating and picturing info, recognition, spatial orientation
3D photorealistic visualization (panorama photo, photomontage, VirtualGIS rendering)	**40%** Context, realism, detail	**60%** Context, realism (35% chose panorama photo)
3D VR visualization (bird's-eye animation, eye-level animation, VirtualGIS VR model)	**20%** Overview, spatial understanding	**10%**
☐ 0-20% ☐ 20-40% ☐ 40-60% of responses		

The **informed students** considered the following visualization methods suitable for illustrating visually important point landscape elements:

- 40% of the students chose 2D visualizations because of its good overview and ease of locating or recognizing landscape elements.
- 3D photorealistic methods were also chosen by 40% because they showed the context as well as realism and detail. For example, one participant commented, "*especially for subjective things (particularly beautiful trees), it depends not just on the location itself, but also on the surroundings*."
- 3D-VR visualization methods were selected by 20% because these supported spatial understanding of the site, e.g. "*One has a good view of the whole area, but individual elements can be seen in their surroundings, so that one can orient oneself in the surroundings*" and because they provided familiar or flexible views of the site.

Of the **lay group,** 60% preferred 3D photorealistic visualization methods for the same reasons as the students. Furthermore, 25% chose a 2D visualization method, citing the reasons the students gave as well as better spatial orientation and ease of imagining the landscape. Interestingly, among the lay people, the aerial photograph (photorealistic 2D) was preferred three to one over the topographic map to show location. (This was equally divided among the students.) The 3D VR eye-level animation appealed to only 10% of the respondents.

General point landscape features (no aesthetic importance)

The student group - real-time experience plays a bigger role:

The informed students evaluated the visualization methods similarly for locating both general and visually important features (see Table 30). However, different reasons were given in the comments for these choices. The experiential aspect of the 3D real-time visualizations played a larger role for general point landscape features. Movement through the landscape was important because it gave a good overview and showed the surroundings.

Lay group - eye-level view and experience become important:

The choice of visualization methods was more evenly spread than in the previous question (see Table 30). Photorealism was less important, whereas the real-time visualizations was significantly more important. When showing the location of general point information or landscape elements, the 3D real-time visualization method was preferred, especially the eye-level animation. It can be hypothesized, when the visual impact is not the issue, photorealism becomes less important and the ability to show location from a familiar point of view becomes more important. Interestingly, the eye-level animation was chosen in combination with other visualization methods two-thirds of the time.

Table 30: Informed students and lay group assess the suitability of visualization methods to illustrate point landscape features with no visual significance.

Visualization Methods	Student responses	Lay group responses
2D visualization (topographic map, aerial photo)	**30%** Overview: Aerial photo: recognition of the landscape	**32.5%** Overview, orientation. Aerial photo: picture the landscape
3D Photorealistic visualization (panorama photo, photomontage, rendering)	**40%** Recognition of the landscape	**32.5%** Realism, ease of picturing and recognizing the landscape
3D real-time visualization (bird's-eye animation, eye-level animation, VRML)	**25%** Overview, context, experiential quality	**35%** Pedestrian view (in combination with other visualization methods)
☐ 0-20% ☐ 20-40% of responses		

Linear landscape features

The lay and informed student groups assessed the suitability of the visualization methods to show linear landscape features, such as roads and paths, very differently from the previous point landscape features. First, none of the informed students and only a few of the lay group chose 3D photorealistic visualization methods, i.e. photos or panorama photo (see Figure 58). Second, the lay group chose the topographic map and bird's-eye animation

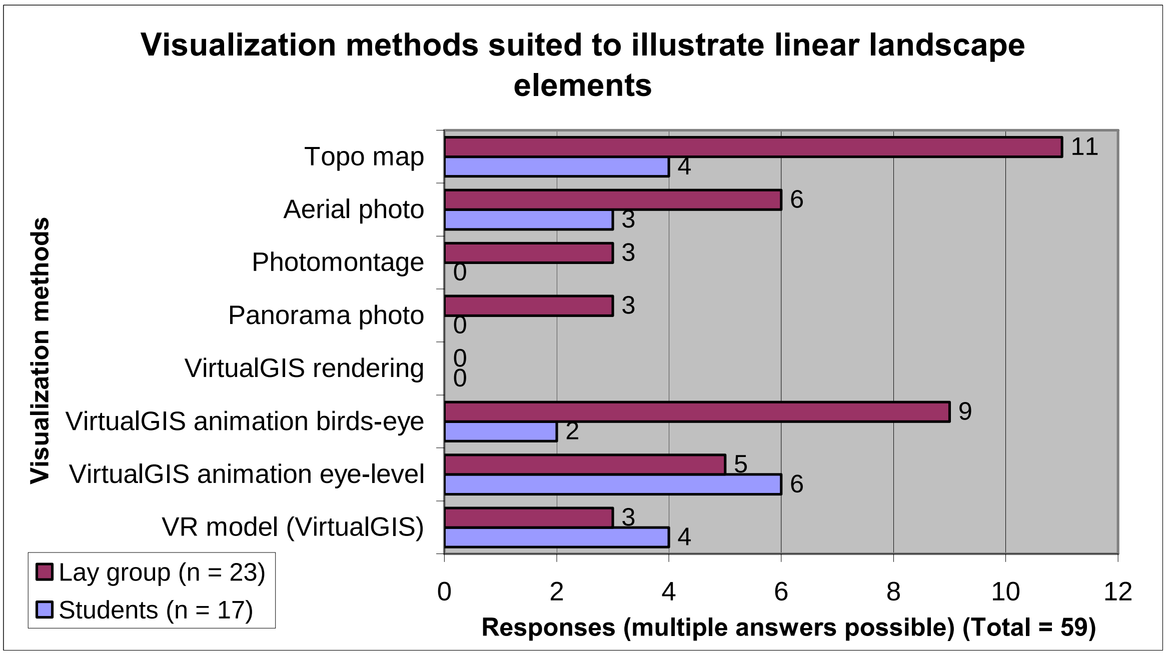

Figure 58: Summary of students' and lay group's assessment of suitability of visualization methods to illustrate lineal information (Questionnaire I, question B37)

most frequently to illustrate linear landscape elements. This is in strong contrast to their assessment of point landscape elements.

The **informed students** found eye-level movement important (see Table 31). More than half (60%) of the students selected 3D real-time visualization methods. The most important reasons given were dynamic navigation and the ability to see the landscape from a familiar point of view (eye level). The 2D visualizations were chosen by approximately 40% of the students because they provided a better overview and spatial orientation. Students who chose both 2D and 3D methods used the 2D for orientation and the 3D to picture the landscape. One student commented, "*The map provides orientation, or helps to make the route of the path clear; an animation would be useful in order to have a better picture of the landscape (a bicycle path is foremost functional).*"

Table 31: Suitability of visualization methods to illustrate linear landscape features was assessed by the informed student and lay groups.

Visualization methods	Student responses	Lay group responses
2D visualization (topographic map, aerial photo)	**40%** Overview, locate info, spatial orientation, recognition	**42.5%** Overview, orientation
3D Photorealistic visualization (panorama photo, photomontage, rendering)	**0%**	**15%**
3D real-time visualization (bird's-eye animation, eye-level animation, VRML)	**60%** Dynamic navigation, familiar points of view, context, experiential	**42.5%** Bird's-eye view: dynamic navigation
☐ 0-20% ☐ 20-40% ☐ 40-60% of responses		

The l**ay group** found the 2D and 3D VR visualizations equally suitable for visualizing linear information (42.5%). They selected combinations of 2D and real-time visualization methods. The 20 respondents suggested 16 different combinations of visualizations, 11 of which include both 2D and 3D real-time visualization methods.

Interestingly, the photorealistic methods were not important for either group, and 3D real-time visualization with dynamic navigation was considered more suitable for linear landscape elements than for point information. Possibly, the functional aspect of the information influenced the choice of visualization. Linear elements such as roads and paths imply a function that involves movement. Therefore, it follows that the ability to move through the landscape becomes more important than in the discussion of static information. On the other hand, when there is movement 2D visualization methods, i.e. the topographic map, may be needed to identify the linear elements and to support orientation.

One participant brought up another interesting aspect of the use of visualization in the planning: "*The topographic map is for me the basis for legal planning decisions. Therefore the path should be recorded on it. With the interactive (3D) model, the path becomes clearer for the viewer, equally with the bird's-eye view.*" Apparently for this participant, the 3D visualization had only a demonstrative quality, not an official or formal character.

Area landscape features

In order to show area landscape features, e.g. nature protection areas, the student group preferred methods that provided an overview and good orientation, i.e. 2D methods and the bird's eye animation. Photorealistic methods played no role (see Figure 59). On the other hand, the lay group considered the aerial photograph to be the most suitable for illustrating area information, more so than for any of the other types of landscape features.

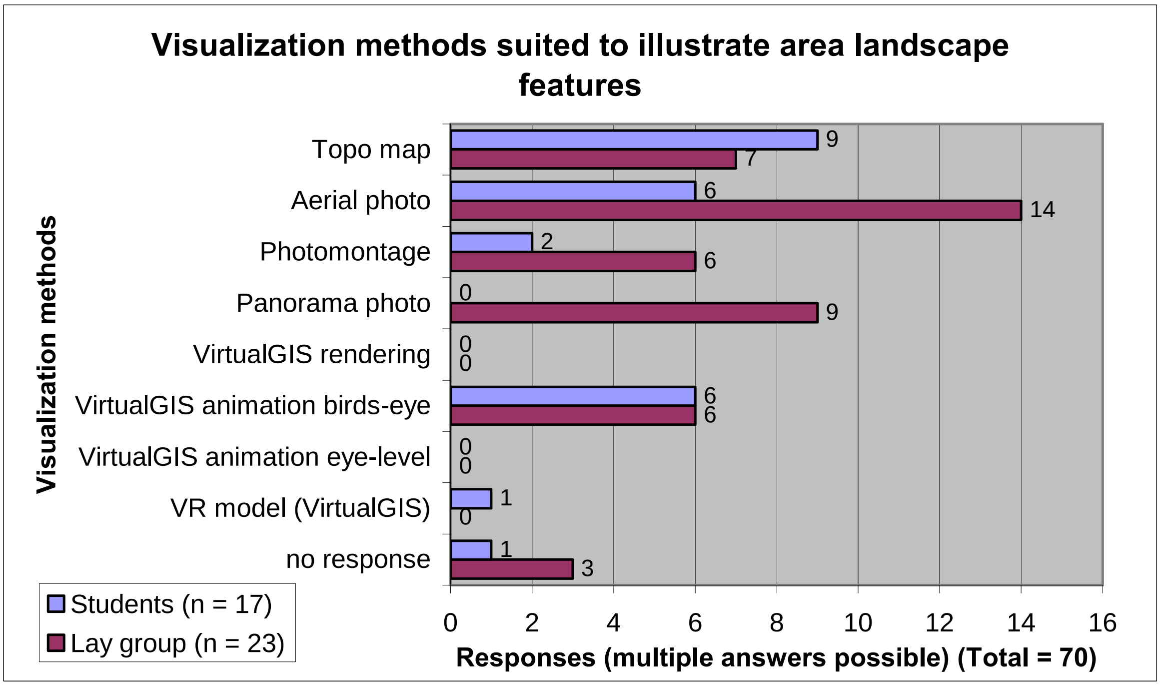

Figure 59: Overview of student and lay group ratings of suitability of visualization methods to illustrate area information (Questionnaire I, question B39)

Table 32 shows that 65% of the student responses preferred either a topographic map or aerial photograph because these provided a good overview and the ability to locate as well as provide information about the structure of the landscape, i.e. land use, boundaries, and spatial orientation. A further 25% of the student responses preferred the bird's-eye animation of the site for similar reasons.

The lay group also relied on 2D methods, but 3D photorealistic visualization played a supporting role instead of VR methods (see Table 32): 50% of the lay group chose 2D visualization. Both the aerial photos and the 3D photorealistic (35%) methods were chosen because they provide a good overview, spatial orientation, and supported recognition of the landscape. Similar to the students, the lay group considered the visualization important for overview and orientation of the area landscape features, but possibly they required more photorealism to achieve this.

Table 32: Suitability of visualization methods to illustrate area landscape features as assessed by the informed student and lay groups

Visualization methods	Student responses	Lay group responses
2D visualization (topographic map, aerial photo)	**65%** Overview, locate info; topographic map: additional info, orientation. Aerial photo: shows context, ease of recognition	**50%** Aerial photo: overview, spatial orientation, recognition
3D photorealistic visualization (panorama photo, photomontage, rendering)	**10%**	**35%** Overview, recognition
3D real-time visualization (bird's-eye animation, eye-level animation, VRML)	**25%** Bird's-eye view: overview, shows surroundings	**15%**
☐ 0-20% ☐ 20-40% ☐ 40-60% of responses		

6.4.3 Summary of the suitability of visualization methods for planning phases and visualizing landscape features

Inventory phase

In the inventory phase and for communicating background information, the **young planners** considered the most important methods to be 2D topographic map and aerial photographs. In this phase, photorealism was of secondary importance. It is hypothesized that the overview provided by a 2D visualization was sufficient, and spatial understanding was less important. **Planning experts** (13.11.02) emphasized the importance of realism in this phase to illustrate the existing landscape resources.

Concept phase

In the concept phase, the **young planners** considered both 3D photorealistic and 2D methods to be important, with preference given to the photomontage (both with LaViTo and without) and the aerial photograph. Apparently, the spatial understanding that realism supports became more important in this phase than in the previous planning phase. The **planning experts** (13.11.02) considered interactivity to be important in this phase in order to explore alternatives, but they were reserved about using photorealistic methods for fear that the detail would hinder the discussion or that the data were not detailed enough.

Planning measure phase

The **lay group** and the **informed students** preferred the photorealistic methods, such as the photomontage, to picture the planning proposals. Visualization methods that provided an overview – bird's-eye animation and aerial photo – were the next most frequently selected methods. It appears that the ideal combination is comprised of both a 3D photorealistic method which gives spatial understanding and a method that offers an overview, i.e. either a 2D aerial photo or 3D bird's-eye animation. This reflects the ratings of the **young professionals**, with the exception that they also considered interactivity important. **Planning experts** (IALP meeting 13.11.2002) also found interactivity most important in this phase.

The analysis of the comments showed that the **lay group** considered realism the most significant reason for preferring a visualization method in this phase, and for the **informed students** it was the ease of picturing the landscape (spatial understanding). Furthermore, the young planners considered both the ease of picturing the site and providing information important reasons for selecting a visualization technique for the planning measure phase.

The **young planner**s found both 2D and 3D visualization methods to be important. For the most part, the young planners preferred the same visualization methods in this phase as they did in the concept phase. Moreover, the interactive photomontage was much preferred over the static photomontage. This would indicate that interactivity is an important characteristic of the visualization in this phase. This in agreement with the **planning experts**' (13.11.2002) opinion about the role of interactivity in the planning phases.

The **planning experts** (09.06.04) found the 3D photorealistic methods – VNS (LaViTo) and 3D aerial photos (LandXplorer), photomontage (LaViTo) – more suitable for picturing the planning proposals than the 2D methods. This may indicate that the 2D methods are important for orientation and overview, but that spatial understanding, which is supported best by 3D visualizations, is of central importance in the understanding of planning measures. (Practically no planning expert considered the 2D methods helpful for the assessment of the planning proposals.) However, planning experts also expressed caution about too much realism in this phase.

In the **case study in Bornum**, the participants also considered VNS rendering (LaViTo) and 3D real-time model (LandXplorer) to be the most helpful to picture the planning proposals, but not the photomontage. In fact, the 2D maps and aerial photographs were judged more helpful than the photomontage by the citizens in Bornum. It is difficult to compare all of these results because the lay and informed student groups did not view VNS rendering and LandXplorer. Furthermore, it is unclear what role the citizens' familiarity with the site played. However, both are photorealistic visualization methods that offer an overview, either as an integrated aerial photograph (VNS rendering, LaViTo) or as a model draped with an aerial photograph (LandXplorer). Therefore, one could infer that the citizens and planning experts also considered it necessary to have a combination of 3D realistic visualizations, which provided spatial understanding, and visualizations that gave an overview, either in 2D or as elevated perspective, in the discussion of planning measures. Findings from the **investigation in Beienrode** also suggest that a combination of visualization methods may have a synergetic effect.

In general, the aerial photograph was one of the most often selected visualization methods throughout the planning phases. It would appear that planning participation should always have an aerial photograph available. Overall, the VirtualGIS rendering, eye-level animation, and VR model were not considered very suitable for use in the planning. The abstract representation of vegetation with VirtualGIS made it difficult to picture the planning. Only in the bird's-eye animation, which showed the landscape on a larger scale, was the lack of detail not distracting.

Finally, both **planning experts** and **citizens** alike found the visualization methods more suitable for picturing the planning proposals than for evaluating them. This indicates that visualizations can provide an image of the planning, however more information is needed in order to assess the planning.

Landscape features

The results of the visualization survey show that lay and student groups preferred different types of visualization methods to illustrate different kinds of landscape features. Figure 33 summarizes the preferences of the respondents for **2D** (topographic map and aerial photos), **photorealistic** (panorama, photomontage, VirtualGIS rendering), and **3D VR** (bird's-eye and eye-level animations and VirtualGIS VR model) visualization methods to illustrate different types of landscape features.

Table 33: Summary of preferred visualization methods for illustrating landscape features

Landscape feature type	Student responses	Lay group responses
Point information with visual significance	2D or 3D photorealistic visualization	3D photorealistic visualization (2D visualization)
General point information (not visually important)	No clear preference	No clear preference
Lineal information	VR visualization or 2D visualization	2D visualization or VR visualization
Area information	2D visualization or VR visualization	2D or 3D photorealistic visualization

Visually important point landscape features: The lay and informed student groups found both 3D photorealistic visualization methods in combination with 2D visualizations suitable to illustrate visually significant point landscape features for similar reasons. The lay group preferred the realistic 3D photo visualization methods, while the 2D visualizations were more important for the students. In combination, the 2D visualization provided an overview, and the 3D photorealistic methods helped participants to picture the situation. (The panorama photo was the most frequently chosen 3D photorealistic method.)

General point landscape features (not visually important): The lay and informed student groups showed no clear preference of visualization method for illustrating point information without visual significance. For the lay group, the 3D VR visualizations increased in importance. Especially the eye-level experiential aspect of the VR animation was helpful when discussing general point information.

Linear landscape features: Both groups chose a combination of 2D and 3D VR visualization methods to illustrate linear landscape features. Photorealism played little or no role in illustrating linear information, rather the movement, i.e. dynamic navigation, was important. More specifically, the students preferred the animation that showed movement at eye level because it provided a familiar point of view, and the lay group preferred the bird's-eye animation because it offered a good overview. Lineal information often involves movement, e.g. roads and paths, which makes the navigation through the landscape more important. The 2D methods helped to locate the landscape elements, and the VR methods provided a "drive-through".

Area landscape features: 2D visualizations were found to be best suited for showing area landscape features, giving a good overview and the ability to locate information. The informed students also considered the bird's-eye animation to be suitable because it provided a good overview and helped to identify landscape structures. The lay group, on the other hand, once again preferred to support the 2D visualization with a 3D photorealistic visualization. Possibly the lay group required more photorealism than the students to locate landmarks as an aid to orientation and to identify landscape elements.

7 Discussion of Results

7.1 Which visualization methods best support the understanding of the planning content?

7.1.1 Spatial understanding (picturing the landscape) and overview or orientation are prerequisites for participation

Photorealism is especially important for lay group; supports 3D feeling

The visualization survey showed that photorealistic visualizations were especially important for lay people and helpful for the students and young planners. This substantiates the findings from APPLETON & LOVETT'S (2005) interviews with planning professionals which found that realism is important for lay groups. Furthermore, the difficulty of creating a mental image of the landscape using 2D maps is documented in the literature (LEWIS & SHEPPARD 2006). This would explain the young planners' difficulty to visualize the landscape with the 2D black-and-white and topographic plan. The comments suggested the lack of clues in the visualization made the spatial understanding of the landscape difficult. Interestingly, the young planners considered the aerial photograph to be one of the best methods for showing spatial understanding, even though this is a 2D representation. This may suggest that realism plays an equally important role in spatial understanding as three dimensionality.

Site familiarity requires less realism for spatial understanding

Familiarity with the site also influenced how well participants could picture the landscape and orient themselves in the visualizations. For example, in the visualization survey, the lay people who were not familiar with the visualized landscapes commented that 2D did not support spatial understanding. However, a quarter of the Bornum citizens, who were familiar with the visualized landscape, felt the 2D map alone would have been sufficient. WILLIAMS et al. (2007) also found that familiarity with the site has an effect on the amount of realism that is necessary. In addition, LANGE's (2001) investigation of viewer responses to visualizations showed that local residents tended to perceive more realism in the images than the average viewer.

Planners prefer 2D for public meetings

The planning experts (09.06.2004) preferred 3D photorealistic visualization methods for picturing the landscape. However, when asked to choose the visualization methods that would be useful to communicate with citizens, they selected maps, aerial photos, and LandXplorer. Even though the planning professionals recognized that lay people have difficulty creating mental images and orienting themselves in 2D maps (APPLETON & LOVETT 2005), the planning experts apparently preferred visualization methods that provide an overview when explaining measures to citizens. The citizens' need for photorealistic visualization methods to support spatial understanding may not be met when planners use only 2D visualization methods to explain planning proposals.

Young planners need less realism for spatial understanding

Not surprisingly, the survey of young planners showed that realism and spatial understanding are closely related. However, the comparison also revealed an important aspect of less realistic visualizations. The young planners rated the spatial understanding of the compute-generated visualization methods higher than the realism of the images. This might indicate that young planners were able to extrapolate or interpret the visualizations in order to form a clearer picture of the landscape in their mind's eye than was actually presented in the visualization, so that realism was less important for this group. It remains unclear exactly which factors contribute to better spatial understanding. It may depend on the ability of the viewer, or on other attributes of the visualization. Less realism may leave more room for personal interpretation of the visualization, making it seem easier to imagine. The research of SCOTT & CANTER (1997) indicates that people conceptualize the *content* of a photograph differently than they conceptualize the *places* represented in the same photographs. This is an area for further study and an important consideration in the discussion of how much realism is necessary for communicating landscape change.

7.1.2 Orientation is fundamental to the use of visualization

Realism supports orientation

Realism was considered important for orientation and overview in both the visualization survey and the case study. The less photorealistic visualizations required the 2D map to support orientation. These findings agree with those of MEITNER et al. (2005), who not only found that realistic visualization methods helped participants to recognize specific locations and features, but that they were also important for establishing the viewers' relationship to their own knowledge of the site.

Landmarks and overview needed

The visualization survey revealed that landmarks as well as 2D maps and aerial photos supported orientation, especially for the students and lay group. The case study also showed that the overview provided by 2D visualizations remains basic to establishing initial orientation. This agrees with the findings of APPLETON & LOVETT (2005) that a map is important to establish the location and direction of viewpoints and landmarks familiar to the viewer. Furthermore, they found that it is useful to show users overview images initially that portray a large portion of the planning proposal, perhaps from an elevated or even aerial viewpoint, because they show context and landscape elements. Similarly in the visualization survey, it was also found that realistic and detailed images with elevated viewpoints and pan/zoom functions helped the respondents to establish orientation by giving an overview and possibly making it easier to recognize landmarks. The student and lay groups considered the panorama photo, which fulfils many of these criteria, the most helpful for orientation. The aerial photo, which offers both an overview of a 2D visualization and photorealism, also appears to be an ideal and essential visualization method for participatory sessions.

The interviewed visualization experts agreed that maps should be available, but their reasons varied. **Lindhult** agreed that some form of contextual information is important in order to orient oneself in an image, but it need not be a map, depending on the audience. He suggested that landmarks may be sufficient for people intimately familiar with a site. **Bishop** pointed out that the usefulness of maps depends on the planning topic. For example, maps are important in discussions of projects because people need to know where they are. However, maps are unimportant for a survey of attitudes. **Lovett** emphasised that a contextual 2D map is especially important in a real-time environment, where it is easy to become disoriented. A map view in the corner of the real-time display, as is possible with Scene Express, can be very helpful.

Ease of orientation in VR models depends on experience

In the Bornum investigation, the movement in the real-time model was difficult for the citizens to follow and maintain their orientation. In contrast, the visualization survey showed that the more experienced young planners and planning experts could orient themselves well in the real-time models and actually preferred VR methods, i.e. animations, which offered a good overview. These results indicated that viewers with more planning experience could orient themselves in 3D VR models better than the lay group and citizens. SCHROTH (2008) found that familiarity and map reading skills were related to the ability to orient oneself in VR models. Since planning experience would imply better plan-reading skills, these results appear to substantiate Schroth’s findings. In any case, planners and the public have different abilities to understand and use the VR models, and this should be reflected in the choice of visualization methods used in public participation.

Combination of 2D and 3D methods supports orientation and spatial understanding

The overwhelming majority (90%) of the respondents to the visualization survey felt a combination of visualization methods was necessary for good orientation and spatial understanding. This was also found to be true in the case study. For example, all the methods provided sufficient spatial understanding to locate and discuss specific planning measures; however, orientation, especially with the VR model, required support from 2D maps. The literature also contains recommendations for using a combination of different visualization techniques (AL-KODMANY 1999b; BISHOP et al. 2001). KARJALAINEN & TYRVÄINEN (2002) found that a mix of visualization methods offers possibilities to visualize the planning accurately with detailed (small-scale) views and to provide large-scale context with VR methods. APPLETON & LOVETT (2005) also point out that the public audience has very different backgrounds and opinions so that a variety of visualisations may be needed for public meetings. However, the choice of which 3D visualization methods should accompany the 2D method in planning participation is more complex and depends on more than just how well the visualization methods support spatial understanding and orientation. Consideration must be given to the purpose of the planning, the type of change being represented, scale, and the final users/viewers of the simulation (GHADIRIAN & BISHOP 2008; KARJALAINEN & TYRVÄINEN 2002).

The lay and student groups requested a combination of at least two visualization methods including a 2D (i.e. topographic map or aerial photo) and a 3D method. This supports the findings of LEWIS & SHEPPARD (2006) in their work with First Nation groups that it is important to visualize the landscape in a manner that the community can understand in combination with maps. SHEPPARD & SALTER (2004) also agreed that realistic ground-level views are often necessary for lay people to completely understand maps and plans and that more realistic visualizations tend to evoke more affective reactions from the viewers. On the other hand, SALTER et al. (2009) found that semi-realistic visualizations accompanied with 2D plans were sufficient to discuss revisions of spatially specific proposals for design concepts. This suggests that the level of realism can vary, but that it is necessary to have a 3D image of the proposals.

The interviewed experts agreed that a combination of 2D and 3D methods was helpful, but did not always consider this absolutely necessary. **Lovett** pointed out in interview that the type of visualization depends on the context of the particular planning decision. For example, a real-time model attracts attention at a public meeting, but still images may be suitable to get people to think about change, or an animation may be helpful to show a road. Furthermore, **Ervin** pointed out that the combination of 2D and 3D visualizations is not enough; a mix of plans, pictures, and words is necessary. Not only are written and verbal explanations of the visualization important, but also the visualization method must suit the question.

7.1.3 Assessing change with visualization methods

Before-and-after images support assessment and increase transparency

In the visualization survey, the young planners considered the before-and-after views essential for evaluating the planning proposals because these views made the effects of the planning clearer, helped avoid mistakes or false assumptions in the planning, and added transparency to the planning process. In the case study, the citizens used before-and-after images frequently to view the landscape change, and they considered them essential for evaluating the proposals. Furthermore, the level of interest and engagement was high with the visualizations that had been prepared with the LaViTo tool that allowed the comparison of superimposed before-and-after images. MEITNER et al. (2005) also found that before-and-after images increased the level of interest and engagement in the planning discussion and even reduced the stress or time demands on participants. Furthermore, they found that the side-by-side digital images gave viewers a quick impression of the differences. However, the side-by-side, before-and-after sketches, which were used in Bornum, were more difficult to compare than the superimposed digital images. This may indicate that either sketches are not be as easy to compare as photorealistic images, or that the superimposed images are easier to comprehend and compare than side-by-side images.

The interviewed experts varied in the degree to which they felt before-and-after images were important: from “a must” (**Sheppard**) to useful, but not crucial (**Lindhult**). **Lovett** also considered the before-and-after comparison important, but felt it depended on the purpose of the visualization. For example, he pointed out that the discussion of general strategies may not require before-and-after images; but that a specific planning proposal may need a baseline image for comparison. **Bishop** also judged before-and-after images to be essential if citizens are to reach an informed opinion. However, he also pointed out that there is the danger that before-and-after images place too much emphasis on the aesthetics or imagery compared to other key factors in the planning process. He made the point that before-and-after images are not the whole story, especially when the main results of a project are ecological and the threat is not visible in the imagery. **Ervin** also supported this idea and expressed the importance of including annotative information, such as charts and explanations, to accompany the before-and-after images. Planning professionals interviewed by APPLETON & LOVETT (2005) also emphasized that visualizations should not stand alone and that additional information should be presented alongside the visualization.

Comparison of photorealistic images is most helpful

For both the students and lay group, the before-and-after images made with 3D photorealistic visualization techniques, e.g. rendering and photomontage, were more helpful than the animations and 2D visualizations for assessing landscape change. TRESS & TRESS (2003) also found that the use of static photorealistic simulations of different planning scenarios effectively helped stakeholders to assess the effects of the different scenarios. In his interview, **Lovett** pointed out that some visualization methods lend themselves better to comparing before-and-after images than others. He agreed that comparing two situations with side-by-side sets of stills may be just as effective and possibly easier than trying to go back and forth between two real-time models. Furthermore, it is very difficult to show before-and-after changes in real time.

Which “after”? Who decides?

Although the interviewed experts agreed that before-and-after images were important, they placed different requirements on the production of the “after” images. **Sheppard** pointed out that “*Just an ‘after’ is dead wrong*.” He felt one should be suspicious of limited before-and-after simulations. The “after” images should not only show different time intervals, but also alternative future developments that are potentially influenced by maintenance, climate change, or other factors. He also recognized the value of the historical “before” in the planning discussion. **Lindhult** suggested that the choice of visualization method and viewpoint should be discussed with the public at the very beginning of the planning process. Finally, **Lovett** made the point that both before and after should be visualized with the same technique so that the content is compared and not the level of realism.

7.1.4 Establishing credibility of the visualization methods

Photorealism supports credibility

Of all the methods tested in the visualization survey, the photorealistic methods were considered most credible. In their responses, the young planners repeatedly commented that credibility is improved with increased realism or detail. They felt realism gives the viewer the capability to recognize the landscape and to compare it to his own picture of the real landscape. This explanation is supported by findings of MEITNER et al. (2005) that the ability of participants to locate or recognize familiar locations or features in the visualizations enhanced the credibility of the visualization. Based on the findings of the visualization survey, one could hypothesize that realism plays a central role for credibility. However, it is not the only factor.

Information supports credibility

Although there was no statistically significant difference in the young planners’ ratings of the credibility, spatial understanding, and realism of the photorealistic methods, their median ratings of credibility were slightly lower than those of the other criteria. Possibly the participants were uncertain about a simulated image that looked very real. This would explain the “What is wrong with this picture?” responses as an expression of the participants’ attempt to determine how honest the picture was. Moreover, this would agree with the findings of the visualization survey that, in addition to the realistic image, the viewers need additional information to judge how well a picture corresponds to reality.

The young planners also felt that credibility would be improved by:

- additional background information about the visualization, e.g. metadata, visualization method,
- contextual information, e.g. overview maps, larger images, legend

- and the ability to view the planning from different perspectives, either in movement or additional static views.

The literature supports these findings. BISHOP et al. (2001) also found that auxiliary information such as full field of view, but also non-visual information such as sound and haptic experience increase the validity of the visualization. APPLETON & LOVETT'S (2003) investigation of realism showed that even detailed images lacked in information for many viewers. Motion and sound were also found to influence viewers' judgements of the scenic beauty of a landscape with dynamic landscape elements such as a waterfall. (HETHERINGTON et al. 1993)

It is suggested in the literature that credibility of landscape visualizations can be further supported by additional non-visual information, for example via interactive links to statistical data (HEHL-LANGE 2001b) or by landscape indicators (WISSEN 2007). APPLETON & LOVETT'S (2005) interviews with planning professionals also confirm that visualizations require auxiliary information and should not stand alone. Furthermore, communicating the intent and limits of the visualization, i.e. uncertainty, to the public is also central to the credibility of the visualization. It must be made clear whether the images form a definite proposal or merely indicate how it might be. The more information people have about the visualization, planning, and site, and the more transparency there is about the data and how the visualizations were constructed, the more people will understand the visualization, and credibility is thus increased.

Do people question visualizations?

In the Bornum investigation, at least one participant in each group mentioned the possibility of manipulation of the visualization in the photomontage, mostly with respect to the representation of the vegetation or landscape. In the visualization survey, as well, the lay people and young planners saw the potential for manipulation in the use of realistic images. Although the differences were not statistically significant, it is interesting that almost all visualization methods were judged by the visualization survey respondents to be slightly better suited to illustrate the existing landscape than the future landscape. This may indicate a general uncertainty about simulations. In his interview, **Lange** pointed out that manipulation is possible with all media and presentations. What is shown or not shown in a plan or what is said (or not) in a presentation can influence the assessment of a proposal. In fact, he considered visualization to be potentially less manipulative than other forms of communication if the method used is transparent. In his experience, people had questions about how a visualization was produced, but more from a curious or informative standpoint than a critical one. He felt that people recognize where the visualization differs from reality and acknowledge that it cannot be perfect, but do not fundamentally question its credibility.

Artistic license: the weak link between detail and data

In the visualization survey, the credibility of the visualization methods in which artistic license could be suspected (plan in perspective, photomontage) was rated lower than their realism and spatial understanding. For these visualization methods, the viewers apparently had an innate sense that the representation might not be completely accurate. It is not clear how credible the participants in the Bornum investigation considered the sketches. The line drawings conveyed the conceptual nature of the planning; the credibility of the details was thus not an issue. Similarly, APPLETON & LOVETT'S (2005) interviews with planning professionals indicate that the uncertainty of the planning is better understood in visualizations on a landscape scale than in those with ground-level detail. For the latter, sketches can better show small-scale design in a less realistic manner.

However, ORLAND (1994) warns that as detail increases the link with the underlying data becomes progressively weaker. Interestingly, this connection was not recognized or mentioned by any of the participants of the visualization survey or case study. However, lay people and young planners did see the potential for manipulation in the use of realistic images. This would support SCHROTH's (2008) findings that, although most people agree that any image could be manipulated, it is not the technical nature of the visualizations, but the trust in the data and institutions or persons that is crucial for credibility. SHEPPARD et al. (2004) also found that the perceived credibility depends on the transparency of the visualization, i.e. data, and how reliable the producer is judged to be.

Interestingly, in both the visualization survey and case study, the credibility of the GIS-supported visualizations was not questioned. The young planners criticized the representation of the textures of the GIS-based visualizations, but the authenticity of the simulation was not questioned. APPLETON & LOVETT (2005) also found that the presence of artistic license in the representation of vegetation is far less apparent in computer renderings generated from GIS data. This is a latent danger in GIS-based visualizations. The ability of the producer and the decisions made about what and how to visualize the planning proposals will also bias the visualization (MACFARLANE et al. 2005). Realism or detail implies accuracy. When the detail is inferred and not drawn from the underlying GIS data, then the visualization can be misleading and wrong (SHEPPARD 2001).

Influence of interactivity and dynamic navigation

The interactivity of the photomontage did not significantly improve its credibility rating in the visualization survey. However, the minimal interactivity used in the investigation provided only pre-determined views of proposed measures; participants could not explore there own alternatives in a scenario or incorporate new information. The findings of WISSEN et al. (2008) indicate that interactivity with additional data or information would improve not only the understanding but also the credibility of the visualization. Others

(DANAHY 2001; ORLAND & UUSITALO 2001; BISHOP & LANGE 2005a) also argue that visualizations with dynamic navigation, in which participants can choose the viewpoint themselves, are potentially more credible and transparent than prepared static visualizations. Although not specifically tested in the investigation, this would agree with the comments of the young planners and planning experts that more views of the planning and self-determined views would improve the credibility of the visualization. However, WISSEN et al. (2008) suggest that 3D VR models have a strong impact on participants that may make viewers feel slightly manipulated.

Finally, **Bishop** pointed out in his interview that, when pre-determined views in a VR model are necessary to effectively focus discussion on specific sites, people must agree that the selection is a fair representation of the situation. If a few question the validity, this may cause others to wonder about the representation as well.

People trust 2D visualizations

The 2D methods appeared to be intrinsically trustworthy. The young planners considered the black-and-white plan and topographic map to be more credible than understandable. In other words, they found the 2D methods to be true or credible, although they had difficulty picturing the landscape with them. Comments from the visualization survey also indicated that respondents felt the 2D visualization represented an official or binding representation of the situation.

The survey of planning experts showed that they preferred to use the 2D map and aerial photographs for communicating planning proposals to citizens. APPLETON & LOVETT (2005) also found that, of all the visualization methods, planning professionals generally have the most experience with maps. They also considered maps a requirement for public participation, and this was confirmed by our findings. Although the lay persons had more difficulty than planning professionals to develop spatial understanding with 2D maps, they use maps in daily life to navigate and establish orientation when driving or hiking. Perhaps the 2D maps, therefore, are assumed to have high credibility, even though they may be more difficult to understand. Finally, of the 2D visualization methods, the aerial photograph was considered the easiest for picturing the landscape situation. It invariably stimulated the “Where is my house?” question among participants. The aerial photo was never questioned and therefore provided a credible basis for discussion with citizens.

Improving credibility by conveying uncertainty

This investigation confirmed findings in the literature that the more participants know about the visualization and what it is being shown, the better they can judge whether or not the visualization represents reality, and the more they trust the visualization, i.e. the more credible it is. However, the question remains as to how to make the uncertainty of the photorealistic simulations or GIS-based visualizations clear to citizens. **Sheppard** suggested in his interview that rendering alternative simulations could help show the uncertainty of the simulation. For example, simulations which show how the landscape will be in one year can be made with relative certainty. A prediction of the situation in fifteen years is far less clear. The uncertainty of the development could be illustrated by simulating three possible alternative developments. However, **Sheppard** also pointed out that the public generally prefers a simple, definite answer. Unfortunately, this is not possible because a simulation is based on scientific data, and data comes with uncertainty, e.g. 20% probability or a statistical range, which is difficult to represent in a visualization.

Sheppard also suggested that when realism is required, for example to determine views, a precise image is appropriate. However, it is also important to frame the visualization with the recognition of other possibilities that are explained or visualized. Furthermore, no simulation is without some creative bias, and it is generally acknowledged that there is no such thing as a completely objective visualization (APPLETON & LOVETT 2005). **Bishop** pointed out that when a few viewers question the validity, it causes the other participants to wonder about the representation as well. Perhaps SCHROTH'S (2008) suggestion of interviewing the participants is the only certain way to establish how credible the they consider the visualizations, and it offers the opportunity to discuss the uncertainty of the simulations. WILLIAMS et al. (2007) also recommends discussing the representation of the landscape in the visualization with participants in a test phase.

7.2 How important are different visualization characteristics for understanding the planning content?

7.2.1 Realism

Importance of realism depends on the experience of participants

Our findings that realism is important in order to help the public imagine and understand visual landscape changes is supported by other investigators (APPLETON & LOVETT 2003, 2005; DANIEL & MEITNER 2001; LANGE 2001; SHEPPARD 2005). For instance, TRESS & TRESS (2003) found that photorealistic images of landscape changes are powerful and persuasive for communicating future scenarios to the public and politicians. LANGE & BISHOP (2005: 29) have summarized the situation: "*The easiest form of visualization for the public to associate with and understand is realistic portrayal of visual landscape change.*"

However, the visualization survey also showed that the importance of realistic images varied among the different surveyed groups. For the lay group, photorealistic visualization methods were very important for recognizing landmarks, establishing orientation, and picturing the landscape. This is in agreement with APPLETON & LOVETT'S (2005) findings that planning professionals considered realistic visualizations important for the lay audience. LEWIS & SHEPPARD'S (2006) work with First Nation communities also showed that photorealistic images were more effective than abstract images or topographic maps for communicating landscape change. In contrast, the young planners and planning experts required less realism to understand the planning content than the informed students and lay group. The difference in the ratings may indicate that a viewer's experience with spatial planning is one factor that influences the importance of realism. This relationship is not definitive and needs more investigation.

Furthermore, in the visualization survey, planning experts considered all visualization methods to be realistic enough to picture the landscape, with the exception of the sketches. This may indicate there is a minimum requirement of realism that the sketches do not fulfil. This minimum level of realism appears to be higher for lay groups. It is generally agreed in the literature that the more realistic or detailed the visualization, the more valid it is as a visual surrogate for the landscape (BERGEN et al. 1995; DANIEL & MEITNER 2001; LANGE 2001; WILLIAMS et al. 2007). However, there is still no consensus about how much realism is appropriate for visualizations in different planning situations (APPLETON & LOVETT 2003; LANGE 2001; SHEPPARD 1989). The results of this investigation suggest that the sufficient level of realism also appears to be dependent on the experience of the viewer.

Realistic images give an honest view of the existing landscape and a concrete view of the proposed landscape

In the Bornum investigation, the realistic photomontage forced the participants to see existing visual problems which they ignored in reality, and it provided a shared image of the existing landscape. For example, many of the participants were surprised to see the high-voltage wires on the hillside. In effect, they no longer saw the wires when driving past the site. In his interview**, Bishop** agreed that the main role of visualization in the discussion process is to give the viewers a common mental image that allows them to focus on the real differences they see and not the differences they perceive.

In the case study, the concrete images of the photomontage made the planning intentions very clear and prompted specific comments and suggestions from the citizens which led to concrete discussion of the measures. This experience supports the findings in the literature that participants can communicate more specifically about the landscape with realistic images (APPLETON & LOVETT 2003; BERGEN et al. 1995).

Realism promotes emotional identification with the landscape

Participants in the visualization survey commented repeatedly that realistic images promoted identification with the landscape. Both the lay group and young planners recognized the emotional component of the realistic image, which inspired a positive attitude toward or motivation to protect the environment. The participants were able to recognize "their" landscape and, as one participant said, "*It functions as a motivator in participation and can promote interest in the landscape issues.*" Sheppard's research about visualizing climate change also substantiates the power of realism to activate participant interest, to maintain a high level of engagement among the public participants, and to support personal identification with the issue (SHEPPARD 2006).

This raises the question of when a strong emotional response is useful and when it should be avoided. The emotional effect of realistic visualizations should not be underestimated but used wisely and responsibly. SHEPPARD (2001, 2005b) lays down guidelines for ethically sound and fair visualization but also points out the power of visualization to emotionally convey the consequences of climate change in order to influence behavior (SHEPPARD 2005a). The participation objectives are an important factor in the decision about how realistic the visualization should be.

Detailed data must back up a photorealistic image

In the Bornum investigation, the photorealistic visualizations of the planning required the planners to be very specific about planning measures. This raises the question of whether the planners could make such site specific recommendations based on landscape scale data. Did the photorealistic representation force the planner to be more specific than the data would allow? Interestingly, the citizens did not question the relationship between the visualization and the source data. Nor did they differentiate between how the photomontage and the GIS-supported visualizations were generated. This reveals the potential to mislead or improperly represent planning measures without being questioned by participants. The literature also contains warnings against representing proposed planning in greater detail than can be supported by the data or planning decisions (APPLETON & LOVETT 2005; ORLAND 1994). In his interview, **Lange** also pointed out the dangers of photorealism to misrepresent the planning measures, suggesting that the results will never look exactly like the visualization, especially for complex projects. He also recognized the inherent danger of simulations of future landscapes that look realistic, although the data required to generate the image is missing or incomplete. Furthermore, **Lovett** noted that not only must the appropriate data be available, but the technology must also be able to process it.

Photorealism appears final: a promise for the future

In the investigation the photorealistic visualizations conveyed the impression of finality. They evoked an emotional response and concern among the citizens that the planning decisions had already been finalized, leaving no room for new ideas or discussion. This reflects the findings of WERGLES & MUHAR (2009) that, although visualizations are not considered reality, they are regarded by participants as design commitments that will be compared to the results. When there is too much discrepancy, citizens will feel betrayed. APPLETON & LOVETT (2005) also found that realism invites attention to detail and implies finality and an expected result. **Lindhult** also warned in his interview that the power of visual memory is not to be underestimated. A realistic visualization promises something specific, and participants do not forget what they have seen. In fact, SHAW et al. (2009) deliberately reduced the amount of realism in visualizations of climate change scenarios in order to avoid negative reactions and personal distress among participants or even legal repercussions.

In his interview, **Sheppard** mentioned a further danger. He recognized that there is risk not only in being too specific, but also in the fact that the design can be changed after it has been rendered. The people who present the visualizations are the messengers. If the administration and planners change their minds after the message is delivered, the messenger is still held responsible. Sheppard also identified the risk of simply getting it wrong, making the wrong assumptions. He suggested that the best defense is to emphasize that the visualization is a "best guess". There is also the difficulty of bridging the gap between what you show and what people see and their inability to deliver an equivalent response. Finally, he pointed out that there are many factors over which we have no control that influence future development. The risks are higher with photorealistic visualizations that a promise is made which cannot be kept.

Happy medium between photorealism and abstraction

On the one hand, the VirtualGIS renderings and VRML model with rudimentary representation of the vegetation and ground textures received much criticism and were found unsuitable for participatory planning. ORLAND et al. (2001) also found that abstract, rudimentary images were criticized more than detailed, realistic ones. Furthermore, SHEPPARD (1989) also warns that abstraction can both mislead and confuse, and even lead to suspicions of bias. On the other hand, the details of photorealistic methods were also criticized. It is also pointed out in the literature that criticism of detailed images can distract the public and lead them to focus on trivial aspects of the planning (APPLETON & LOVETT 2005).

The VNS rendering appears to provide a satisfactory compromise between photorealistic and abstract images. The responses from the case study indicated that it was realistic enough so that participants could recognize the planning measures and orient themselves in the landscape. However, the textures used to represent the planning measures were more conceptual and abstract than in the photomontage. Although some graphic representations of the planning measures were misleading and required explanations from the planner, such questions provided the opportunity to clear up misunderstandings and make the planner’s intention clear. Furthermore, the questions opened the discussion to concrete suggestions from the participants about how the planning measures should actually be implemented. Interestingly, there were no comments or concerns about manipulation of the image with the VNS rendering, as was the case with the photomontage. The VNS computer renderings appeared to have a useful level of detail and realism to promote discussion with less emotional reaction among the participants than with the photomontage. Apparently, the visualization was understood as a proposal and not as a final landscape.

It appears that, even though participants demanded realism, less realistic images also served their purpose in participation well. This is supported in the literature and was confirmed by our visualization experts. In his interview, **Lindhult** pointed out that "*abstraction is the key*" to visualization. The objective is to communicate quickly, not to simulate reality. He felt visualizations should illustrate a space as opposed to definite objects. In their research on the visualization of climate change, WISSEN et al. (2008) also found that a high degree of abstraction helped to convey the main message and motivate participants to contribute their own view of the issue as well as their local knowledge. REKITTKE & PAAR (2005) suggest that a flexible level of abstraction through interactive control of the level of realism can respond to the requirements of planning issues and indicate the certainty of the image.

On the other hand, **Lovett** pointed out in his interview that realism is very important when discussing matters of detail such as small scale design features, e.g. windows on a building. Furthermore, he suggested that elements of photorealism may be important for people to regard the visualization as credible. APPLETON & LOVETT (2005) have found that planning professionals also see a need for sufficient realism in order to avoid confusion, misinterpretation and to establish authenticity. The challenge remains to weigh the importance of having a detailed image against the danger of the details sidetracking the discussion. HULL & STEWART (1992) recognize this discrepancy and recommend that a public consensus about the appropriate level of realism should be reached before a proposal is discussed.

Factors that determine the level of realism

The results of the investigation indicated that not only the experience of the audience plays a role in the amount of realism that is appropriate, but also the project scale, planning issues, objectives of the participation, and availability of data. The interviewed visualization experts suggested similar criteria. **Lovett** agreed that the amount of realism depends among other things on the audience and the planning question. **Lange** tied the level of realism to the requirements of the projects. For example, large-scale landscape planning requires less detail. He also emphasized the importance of the data for determining how realistic an image can be. He felt sufficient data are often not available to support a realistic visualization. In such a case, the visualization should be abstract in order to show that planners can know for sure because they do not have enough information or data. SHAW et al. (2009) substantiate the importance of data availability, adding that the constraints of time and budget also factor into the amount of realism. Finally, the factors that influence the level of realism in a visualization must be made clear to the politicians, citizens, and stakeholders.

Combining levels of realism

The young planners and planning experts (13.11.2002) suggested that a combination of visualization methods with different levels of detail can complement each other, for example, realistic images with more abstract (overview) images or conceptual visualizations. They also recognized the benefit of switching back and forth between photorealistic and abstract images. Similarly, it is suggested in the literature that combinations of visualization methods are useful to address different scales and planning objectives. For example, KARJALAINEN & TYRVÄINEN (2002) used photorealistic photomontage techniques for close-up views where detail was important and 3D models for long-distance views. Also GHADIRIAN & BISHOP (2008) combined more abstract VR models with pre-located panorama photos, and REKITTKE & PAAR (2005) experimented with visualization methods that can render different levels of realism.

Combining different levels of realism can respond to the different requirements of the project, audience, and budget while avoiding the impression of finality in the planning. In his interview, **Lange** posed the question: "*Realism is nice to have, but is it helpful?*" For lay people it would appear that realism is helpful and desirable. However the planner must recognize and communicate the limitation of the realistic visualization to citizens.

7.2.2 Dynamic navigation versus still images

Still images and multiple views satisfy lay audiences

The demand for multiple views differed among the respondent groups. The young planners considered multiple views important in order to avoid mistakes or planner bias, while the lay group was content with a single, well-chosen view which provided an overview and sufficient detail. This raises the question of whether multiple views are necessary or whether they present lay people with a visualization overload. Although the number of views which participants considered useful was not addressed in this investigation, it deserves further exploration.

Furthermore, the results of the Bornum investigation indicated that multiple static views from different viewpoints required more time and effort for the participants to establish orientation and spatial understanding than in the panorama or single, elevated views. It is not clear which factors played a role in the difficulty. Potentially, the large site and the need for site familiarity in order to recognize landmarks for orientation, the lack of detail in the sketch, or the number of different views may all have been contributing factors.

In contrast, the Rottorf investigation showed that the citizens had little difficulty orienting themselves or understanding the multiple views of a single, well-defined planning measure. It would appear that multiple, static views are suitable for small-scale projects, but not for large-scale projects. **Lange** substantiated this in his interview. He pointed out that, when a project is so large that the still images do not show the complete extent of the planning proposals or the connection between different areas, then a real-time model is necessary in order to move from one position to another on the site. If the project is small enough that all the alternatives or issues can be seen from one spot, then static images may be sufficient.

Who decides on the view?

The viewpoint and perspective of the visualization influence what the participant sees and which planning proposals are visible. Thus, the selection of views and viewpoints has a fundamental influence on the discussion of the planning issues. The literature reflects this concern that the selection of viewpoint can cause the still images to be manipulative (HETHERINGTON et al. 1993; BISHOP & ROHRMANN 2003).

This raises the question of how to determine which views and perspectives are to be illustrated with static images and who decides. Should citizens be involved in the choice of viewpoints in order to focus the discussion on sites and issues that concern them, thus improving acceptance and credibility? On the other hand, the planner must ensure that important planning issues are represented, even when the stakeholders have other interests. APPLETON & LOVETT (2005) recommend public involvement in the choice of viewpoints and transparency in the selection. WILLIAMS et al. (2007) also suggest that a pre-test would be helpful to establish whether the image reflects the issues important for the citizens. The viewpoint, i.e. camera position, also determines the level of detail of the image and thus the usefulness of the visualization for different types of planning questions. MEITNER et al. (2005) suggest three distinct types of viewpoints that have very different functions: those that offer a strategic overview, show spatial patterns, or convey a sense of place.

In their interviews, the visualization experts suggested combining approaches. **Lovett** recommended a pre-test with local officials to determine views before developing the visualization. He considered the decision about viewpoints to be a product of professional knowledge, identification of important landscape features, and the available data. **Bishop** felt that planners must make the decision. He pointed out that it is sometimes necessary to direct the viewer to the important viewpoints in different parts of the study area, especially for large sites. In such cases, the planner must select the view, and in so doing effectively focuses the discussion on the issues that are represented. However, **Bishop** also pointed out that people must agree that it is a fair representation of the situation.

Dynamic navigation is not for everyone

In the visualization survey, the **young planners** were ambivalent about dynamic navigation, indicating that it is "nice to have" but not absolutely necessary. The strong interest in VR models cited in the literature (BISHOP et al. 2001; BISHOP & LANGE 2005a; SALTER et al. 2009) was not clearly reflected in the responses of the visualization survey. This could be due to the newness of the technology and the unfamiliarity of the participants with VR models at the time of the investigation.

Lovett, on the other hand, has found that movement in a model attracts interest and is useful when trying to capture the attention of the public. The experiential aspect of dynamic navigation has also been discussed in the literature. SCHROTH (2008) also found that movement through a VR model had a strong engaging effect in stakeholder workshops. Furthermore, WERGLES & MUHAR (2009) point out that there is a fundamental difference in how the viewer observes the landscape between passively viewing it with still images and actively exploring the it with a 3D VR model. However, PERRIN et al. (2001) suggest that the still image is better for participation because it gives the viewer more time to study the landscape scene and to consider the details, and thus provides a better basis for decision making. Their findings indicate that the movement which was initially helpful may later be detrimental to the actual discussion. This was observed in the Bornum investigation. The actual discussion about planning measures took place when the real-time LandXplorer model stopped and a static image of the landscape was displayed.

Dynamic navigation empowers viewer

The young planners' comments speak for the importance of dynamic navigation. They indicated that dynamic navigation gave control to the viewer to determine the speed of movement through the landscape and to choose the views of personal interest or preference. Furthermore, the self-determined movement through the landscape helped to picture the landscape.

Likewise, the majority of planning experts considered dynamic navigation important for similar reasons. It offered them control over the choice of the viewpoint and perspective. SALTER et al. (2009) recorded similar responses about the usefulness of VR models in participation. They found that participants not only considered the ability to move and see different viewpoints very helpful, but they also actively took control of the visualization by instructing the facilitator to show certain views. This was also the experience in the Rottorf and Gross Steinum investigations; the citizens directed the facilitator to specific views in the VR panorama photo. It appears that the citizens had no difficulty orienting themselves in a VR scene with a stationary standpoint.

Generally, there was a more favorable response to the VR models in the case study than in the visualization survey. This could be due in part to the fact that the VR models used in the case study were more realistic than those in the visualization survey. Moreover, it was observed in the Bornum investigation that once participants had experienced the VR model, they expected the same navigation possibilities with the other visualization. This would indicate that, if only still images are shown, they may be satisfactory. However, once viewers have experienced the VR model with dynamic navigation, they recognize the flexibility, and find the still images no longer sufficient. MEITNER et al. (2005) also found that once people had seen an animation, they actually questioned the selection of the views and wanted to view the proposed measures from different angles. However, BISHOP et al. (2001) point out that the kind of movement the viewer has in a real-time model does not resemble real-life experience, either at the ground level or in a fly-over.

Viewers reluctant to navigate: interface important

Despite their enthusiasm about the technology, neither the young planners nor case study participants had any ambition to try the dynamic navigation themselves. Perhaps the respondents considered dynamic navigation to be a good idea, but too difficult to steer oneself. Certainly, the participants' reluctance was partly due to the fact that VR models were not used as frequently at the time of the investigation as they are today.

The interviewed visualization experts had mixed experiences with participant use of VR models. **Lovett** found participants reluctant to navigate through models themselves, with the exception of children, and they required encouragement. **Lindhult**, on the other hand, felt that as people become accustomed to 3D real-time models they will lose their initial fear and accept the technology. **Lange**'s experience with planning experts (with an average age of 50) in a workshop setting is that the participants were not at all reluctant to navigate through VR models using the computer system that they had developed. This would support the findings that the experts were more comfortable with VR models than the lay group. **Lange** contended in his interview that the interface is decisive. The software must be intuitive and resemble a game. He found the participants were not reluctant to use the system and they "*wandered happily through the forest*". The intuitiveness of the interface and familiarity of the participants with VR models undoubtedly plays an important role in the acceptance and use of real-time visualization methods.

Orientation in VR models can be challenging

Although VR models offered spatial understanding, experience, and flexibility, orientation was difficult. In the Bornum investigation, when participants moved from one view to the next within the model, they often became "lost" and needed a 2D map to re-establish orientation.

The majority of the interviewed visualization experts agreed that interactive 3D VR models improve spatial understanding but orientation presents a challenge. **Bishop** considered an accompanying map to be an important part of helping people orient. He suggested using a map which shows the location of the viewer and the scope and direction of the view, for example with a compass or north needle. He pointed out the possibility of losing orientation also exists in the real world, but it is greater in 3D models.

In his interview, **Sheppard** considered still images to have the advantage that they are anchored and can be located in a map. However, the 3D model offers the opportunity to travel. He suggested that, when someone interactively moves through the model and chooses a path, this may even improve the level of orientation beyond that of static images. However, like Bishop, he recognized the danger that the user will get lost or even not navigate to the important places. This risk depends on the facility of the user, nature of the data, and ease of use of the interface. **Sheppard** felt the question of ease or difficulty of orientation was not clear and agreed that this is a complex issue with a range of variables that need further exploration.

Tempo: finding the right speed through the model

Finding the right speed of navigation through a visualization during the public meetings was a challenge with all the VR methods. The movement needed to be fast enough to synchronize with the discussion, but not faster than the viewers could follow and stay oriented. In Bornum, participants lost their orientation frequently in the navigation of the LandXplorer VR model. In fact, the movement actually gave some viewers motion sickness. Part of the difficulty lay in the size of the site. In order to move from one planning measure to the next in the model, the viewers had to "fly" from one place to another and frequently lost their orientation within the model. This substantiates SCHROTH'S (2008) observation in stakeholder workshops that the tempo must permit orientation but must stay with the scenes that are being discussed.

The interviewed visualization experts suggested solutions to the challenge of orientation in VR models. **Ervin** found that the tempo at which one moves through a 3D model is wrong for spatial understanding. It does not provide a feel for the space. He suggested staying in the bird's-eye view, which gives a good overview, and then selecting different viewpoints where the viewer can then "descend" to in the model. This idea was supported by our experience in Beienrode with the Scene Express VR model. It was observed that participants could stay oriented better when changing locations within the model if the camera started each time from a bird's-eye view and zoomed in to discussion "hotspots", which had been prepared in advance. **Lovett** had also found that embedded viewpoints, which provide people with defined locations within the model, have helped to solve orientation problems. One problem that he has also recognized, is that people need to acquire a feel for the sensitivity of the computer system, especially when they are learning to navigate or use the VR model. The user may move the mouse or joystick too quickly, causing the system to jump after a pause, which is disorienting.

Combination of 3D models and still images

All the interviewed visualization experts considered VR models helpful in public participation, but they also recognized the potential for combining them with other visualization methods. They consider the participants' familiarity with the site and experience with VR models, as well as the size and scope of the planning measures and the planning intentions to influence the combination of methods. In the investigation the following levels of navigation capabilities as well as realism were identified.

Viewer freedom: self-guided movement

The participant has the most freedom and control over what he sees in a 3D VR model, which allows self-determined movement or navigation. This holds the danger that important sites may not be visited, however it avoids planner bias and thus has greater credibility.

In interview, **Lovett** pointed out that VR models offer the advantage that people are able to choose their own vantage points, making it possible to view the landscape from far away and close up. Furthermore, some issues are difficult to address with animations or sets of stills. However, he recognized that comparing change is difficult with a VR model. Although it is now possible to switch back and forth between models, in his opinion the ability to make and compare "what-if" changes "on the fly" is still a long way in the future.

Movement with pre-set viewpoints

A VR model with pre-set viewpoints allows the viewer to start his own navigation or movement through the model from important sites. In his interview, **Bishop** pointed out that limited navigation and interactivity may be a good compromise to keep viewers on track on a large site, especially when specific views are important. He attempted to gather citizens opinions about scenarios that had been developed for a large site. In order to compare opinions, viewers had to view the same sites, which meant limiting the interactive navigation possibilities. A 3D model was combined with predetermined viewpoints and realistic panoramas were embedded at the viewpoints. On the one hand, this combination ensured that viewers "went" to the important views. On the other hand, the participants had the opportunity to look at what interested them with the embedded panoramas. We made comparable observations in our the case study investigation. The participants had little difficulty with orientation in the panorama photos, except when the rotation movement was too quick to follow. Furthermore, orientation with the pan function was easier for participants than navigation through the VR model, especially when panning at "pedestrian" speed.

The integration of interactive models with other visualization methods, either static images, animations, or panorama, offers many opportunities to use visualizations in ways that fit the needs of individual projects while giving the viewer freedom to explore the site. In a coastal management study, JUDE et al. (2007) also employed a combination of a virtual environment from ArcGIS 3D Analyst (ESRI), which could be converted into VRML files for viewing on the internet, and static images made with VNS (3D Nature). The dynamic, interactive visualizations allowed planners and participants to navigate through the model as well as to query the data on screen, whereas the more realistic static images were well suited for detailed discussion.

Animation and pre-set images

A third possibility is the combination of animation or visualization methods that have a pre-determined path with panorama or still images at predetermined viewpoints. MEITNER et al. (2005) found that a fly-over animation which showed the location of respective still images helped to anchor the images in the landscape and supported the contextual planning aspects of the images as well as spatial orientation. Such animations stimulated local stakeholders to express their local knowledge about specific and meaningful features of the landscape that they viewed in the animation and stimulated interest in seeing additional views. However, WERGLES & MUHAR (2009) point out the limitation that an animation has pre-determined tempo and views in the same way the viewpoint of static images are pre-selected.

The question remains when stills or real-time models are preferable. **Bishop** pointed out in his interview that the problem of static images is that one must decide the vantage point from which they should be taken. He felt that people liked some movement, depending on the proposed planning measure. If the issue concerns a spatially contained planning measure, then static images can be sufficient. There is also the question of how many viewpoints or static images people want to see. For larger planning situations, where people are interested in the view from "their front door", then it is difficult to cover their requests with still images. On the other hand, **Lindhult** felt that people understand still images better and real-time models. In addition, they can go back to a specific scene or image in the discussion. Furthermore, PERRIN et al. (2001) suggest that still images are better suited for decision making because the viewer can decide how much time he needs to study the landscape and consider details. Finally, **Lange** also pointed out in his interview that an interactive real-time model could include multiple static images (when the model is not moving), but that multiple static images will never be interactive, and interactivity is preferable.

7.2.3 Participants want interactivity

Although the interactivity tested in the investigation was very limited, it can safely be said that participants wanted as much interactivity as possible, i.e. the ability to manipulate the content of the visualization. The results of the visualization survey indicated that interactivity was most important for the lay group because it helped them to understand the planning alternatives and to explore their own suggestions. By actively toggling features and trying out alternative combinations, they increased their understanding of the planning. Similarly, MILLER et al. (2008) found that participants particularly liked the ability to turn features on and off. This capability gave the participants control over the information and changes to the visualization, which in turn led to increased interest in the planning. The Bornum participants quickly understood how to use the interactivity, and they employed it in the discussion to support the presentation of their ideas. In fact, they would have liked more interactive capabilities, e.g. to be able to see development over time. This supports SHEPPARD's (2001; 2005c) findings that both spatial as well as temporal interactivity may enhance the transparency and credibility of landscape visualizations by transferring additional control to the user. SCHROTH (2008) also found that temporal interactivity increased not only the perception of the landscape and understanding of long-term landscape changes but emotional interest, as well.

The planning experts (survey of 13.11.2002) considered interactivity most important in the development of concepts and planning measures. The planners and facilitators in the Bornum investigation used the interactivity to illustrate the priority and combinations of different planning measures in a collaborative discussion of planning issues. Apparently, planners recognized the potential of interactive visualization to develop ideas and planning proposals, whereas the citizens used the interactivity to understand the proposals and alternatives, which in turn stimulated interest in creating their own alternatives. This supports SCHROTH's (2008) findings that temporal navigation supported the dialogue during the discussion of scenario alternatives. He also identified context factors which affect the impact of the visualizations in a workshop environment: individual user, planning topic, visual variable, virtuality, participation process, and presentation.

Possibly, the sketches had the greatest potential for interactivity and collaborative discussion of the planning measures. However, the participants did not take advantage of this potential or the opportunity to let the artist sketch their ideas, as demonstrated by AL-KODMANY (1999b). Apparently, the setting, amount of time available, communication problems with the artist, and his lack of familiarity with the site were not conducive to a collaborative use of the medium.

The interviewed visualization experts attempted to put the euphoria about interactivity and the high expectations of the participants in perspective. **Lindhult** agreed that participants would prefer to have real-time interactivity. However, he also warned that clients with the so-called "dial-it-in" attitude ("Just dial it into the computer and show it to me.") often have unrealistic expectations of a program's interactive capabilities. Furthermore, the experts pointed out that interactivity and its use in participation have the potential to influence the planning decisions in unconscious ways. **Ervin**, although not against such a development, pointed out that real-time interactivity can visualize ideas, but warned that the technology should not influence the questions which are asked.

Sheppard recognized that interactivity is a goal of technological development, but suggested that there are other, equally important goals. Although it would be interesting to be able to test different proposals, he warned that there can be a danger of jumping to conclusions with such technology: "*You try something, take a look and make a decision, and move on*." In this case, there may be too little reflection or analytic process. Such technology can be useful in the preliminary phases to generate ideas and preliminary responses that can be presented to the public later in the planning process following sufficient reflection. He considered interactivity to be a reasonable goal for the software industry, but also felt there are other things such as labelling or transparency that are probably just as important.

Lovett foresaw the technological development going in a similar direction, although considerable linking of modelling, GIS databases, and visualization capabilities are needed to make it possible. He agreed that there will always be people who would like to pose the "what if" question and see the answer right away. However, there are many technical challenges when realism is added.

7.2.4 Trade-offs: realism, dynamic navigation, interactivity

In summary, there is no clear-cut answer to the research question, "When are realism, dynamic navigation, and interactivity important?" In consideration of the different user groups, the following can be said:

Realism was important first and foremost for the lay audiences, but the amount of realism must be considered in light of the available data and the concreteness of the planning. Realism was of much less importance for the planners and experts. Dynamic navigation, on the other hand, was important for planners but only "nice to have" for the citizens. Planning experts also found it more important than lay audiences, while lay people had more difficulty than the experts orienting themselves in VR 3D models. Finally, everyone wanted interactivity**:** the more the better.

When considering the functions of realism, dynamic navigation, and interactivity in the planning discussion, one can say the following:

- The movement, i.e. dynamic navigation through a model, activated interest and helped provide credibility and spatial understanding, but discussion with citizens took place with a still image.

- The flexibility of dynamic navigation was “nice to have”, but it was not as crucial to the planning discussion as realism or interactivity.
- The importance of dynamic navigation must be weighed against realism. The scale of the project and the amount of detail necessary must be considered, as well as the intention of the visualization. For example, realistic models stimulate emotional reaction, whereas more abstract models support cognitive responses (SCHROTH 2008; WISSEN 2007).
- The more the participants can interact with the visualization, the more they trust it and feel a part of the planning. Interactivity gives the viewer the feeling of being in control or empowered in the planning discussion about the alternatives.

Interactivity was an important step towards collaboration, in which the planner can illustrate alternatives and citizens can formulate, i.e. visualize their alternatives in discussions with one another. However, the investigation also indicated that lay people require realism for spatial understanding. Here lies the dilemma: in order to accommodate these requirements, the technology must be able to generate photorealistic images quickly or “on the fly”. In his interview **Lange** also addressed the interdependence of interactivity and realism, i.e. detail. He pointed out that the more detail there is, the more difficult it is to make the system interactive: Realism and detail exclude interactivity. Less detail and more abstraction means more interactivity. For example, when detail is required on the landscape scale, then there can be little or no interactivity. For **Lange**, the important question about realism and interactivity depended on when or at what stage of the planning process the visualization should be included. However, in the discussion of interactivity in participation, it should be noted that SCHROTH (2008) found that a high level of participation does not necessarily require a high level of interactivity.

A reasonable approach for using visualization in the participation process appears to be the combination of methods that provide different levels of realism, navigation, and interactivity that address the needs of the audience, planning situation, questions, and resources, i.e. data, time, and money. For example, a VR model can be used to stimulate citizen interest or to provide an overview of large sites when the detail of the planning proposal is not the issue. On the other hand, a realistic still image is better suited for discussions that focus on the specifics of planning measures of limited size or the comparison of alternative planning proposals.

7.3 How do different visualization methods compare in the participatory setting?

7.3.1 Which functions did the visualization methods serve in the participation process?

Visualization supports participant engagement

The investigation found that movement through the VR models and animations attracted participants' attention and that photorealism supported their identification with the landscape by helping them to recognize their personal landmarks. Both the experts and the literature support these findings. In his interview **Lovett** agreed that visualization offers a great opportunity to engage people's interest and to better inform them about the planning and communicating options. SHEPPARD (2006) also found in the context of developing climate change scenarios for citizen participation, that realistic landscape visualisations can engage the emotions and compel interest in local and personal issues. Furthermore, WISSEN et al. (2008) found that a high degree of virtuality or realism of 3D VR visualizations triggered the attention and emotional reaction to the information much more than the same information in written or verbal form or a more abstract model.

The movement in the LandXplorer VR model stimulated initial interest and fascination, but the movement also caused viewers to lose orientation, and thus interest, in the model. This agrees with SCHROTH's (2008) findings that the VR model sparked initial interest in the workshop situation, but that the "wow" effect did not last and diminished over time. However, GHADIRIAN & BISHOP'S (2008) work indicates that a low-detail, real-time model not only engages people in the initial exploration of the site, but also stimulates questions about the site and planning.

Participants use visualization to communicate

Visualization methods support the discussion

All the visualization methods tested in the Bornum investigation were actively used by participants to localize and explain comments about the planning and to show spatial relationships in the landscape during the discussion. It was found that establishing orientation was the first step to using the visualizations for communication. Furthermore, the image became the starting point for discussion, regardless of the participants' opinions about the planning proposals. MEITNER et al. (2005: 203) also found that visualizations of management scenarios always stimulated discussion as well as a thoughtful critique of the visualizations and summarize, "*Simply creating a picture of a proposed management alternative causes people to question and think about these proposals in ways that they might typically not do otherwise.*"

The interviewed visualization experts also agreed that visualizations supported communication in various ways. In his work with First Nation communities, **Sheppard** found that visualization helped to contextualize the planning in reality better than any other tool. By placing the data in the real-world context, the participants could better recognize and understand, and bond with the process. For example, he found that participants directed the visualization in order to see the view from their own house. The familiar perspective helped the participants to orient themselves and identify with the landscape situation.

Sheppard agreed that visualization can be a tool to test different solutions. He also found that it helped people to talk about the alternatives, not just choose one or another alternative, and to discuss why. It is an easy information format which people understand quickly. He also found that a visualization can stimulate much more dialogue than GIS maps.

The visualization experts all agreed that if a visualization is present, it will be used in the discussion. In **Sheppard**'s experience in meetings with First Nation people, they were constantly pointing to, referring to, or touching the images. If the imagery is there, then there is a tendency to use it. **Bishop** also found that participants use the visualization actively to the extent possible and that people clearly pointed to things and asked questions.

The experts also suggested that visualization helps to structure thought process. **Lange** pointed out that the visualization can make the situation clearer for people who had not yet thought about the issue. Seeing helps to make the issues clearer. A visualization is immediate and generally easier to understand than a written text describing the situation. However, **Lange** also pointed out that a visualization can only provide visual information. Nevertheless, the visual representation or illustration of the planning effects are very powerful. **Lovett** also regarded visualization as a mechanism for presenting information to help people think about a certain aspect of choices in a structured way. **Lindhult** saw visualizations as enhancing thought process, and considered visualization to be an essential component of the presentation that also helps guide it. However, he disagreed that the visualization helps to keep the discussion focused on the planning issues, rather it is the level of realism that influences the level of discussion: "*Keep it abstract so people can focus on what you are saying.*" On the other hand, **Sheppard** has found that the visualization helps to keep the participants generally more focused, but it is the facilitators who focus the discussion on specific planning issues. Finally, the visualization also provides the opportunity to pick up on issues which one has not considered or has overlooked in the planning.

Less conflict

It was observed that the participants directed their attention and comments towards the visualization instead of at each other. It is hypothesized that, when participants direct their comments at a projected image of the planning, the discussion may be less confrontational. However, according to **Lange**, if there is a hostile environment because of animosities among the participants, then the visualization cannot overcome such conflicts.

Time to understand the visualization

Observations from the case study showed that participants needed time to become comfortable with and warm up to the presentation. The time required to acclimatize differed for the various visualization methods. SCHROTH (2008) found that participants needed approximately five minutes to become acquainted with the visualization before using it. The amount of time needed to orient and to understand the situation and visualization should not be underestimated and requires more investigation.

Suitable for discussion: spatially related issues

The visualizations were used primarily when site-related issues were discussed. However, the group dynamics were often more powerful than the facilitator in directing the discussion topics. When general issues were pressing or needed to be discussed, the facilitator was powerless to redirect the discussion to site related issues, then the visualizations became irrelevant. This emphasizes the importance of being aware of the citizens' issues when developing the meeting agenda and visualizations. The citizens felt that the methods which provided an overview helped most to focus the visualization on the planning measures, indicating that orientation is central to keeping the participants "on track".

For questions that are less spatially oriented, **Bishop** felt that people do not really mind where something is going to happen unless it might occur in their own neighborhood. For questions that are not spatially related, the question is "how much", and not necessarily "where". **Lovett** has also found that details in the visualization can skew the discussion in a certain direction. He emphasized that the visualization must be linked to the planning issue which people need to discuss and comment on. On one hand, **Bishop** pointed out the risk that visualization can focus the attention too much on the aesthetic component, so that the other serious issues can become lost. On the other hand, he recognized the opportunity of visualization to create a common mental model which can play a role in removing preconceptions about the landscape.

Collaboration requires flexibility

In both the Bornum and the Gross Steinum investigations, the interactive photomontage initially appeared to discourage collaboration. The photorealistic representation of the proposed measures may have given the participants the impression that the planning decisions were finished, and initially stimulated protest or no comment. The interactive comparison of before-and-after images then opened the discussion of alternatives. The ability to interactively turn measures on and off provided the possibility to discuss specific and bundled planning measures and thus supported discussion between planners and citizen. Interactivity appears to be an essential characteristic of the visualization methods to promote collaborative planning. SCHROTH'S (2008) findings also support the need for interactive content of the visualization in collaborative planning.

Furthermore, the less specific or more abstract illustration of the planning measures in the VNS rendering required explanation. Questions about the textures used in the visualization stimulated more discussion about how the measures could be implemented in detail and left room for the ideas and suggestions of the participants.

Finally, the potential of the sketches for collaboration between planner and participants was not taken advantage of in the Bornum investigation. This contradicts the experience of AL-KODMANY (2002). As has been noted (see 7.2.3), the setting and number of participants, amount of time available, and communication problems with the artist may have hindered the collaboration using the sketches. SCHROTH (2008) also observed that the size of the group influences how collaborative the discussion can be.

The interviewed visualization experts expressed reservations about the successfulness of visualization to actually support collaboration between planner and citizen. In **Lange's** opinion, visualizations are used for the most part to point out location and discuss details, and less for exploration of planning issues. He felt visualizations could be used in a more exploratory way, for example to test different planning questions or to solve or discuss planning problems. He emphasized that visualizations are still used primarily to affirm or reject planning suggestions.

Finally, **Ervin** pointed out that having a person mediate between image and participants interferes with the collaborative discussion. He considered the visioning process, in which hands-on designs are developed with the citizens, using a variety of methods (collage, photocopying, slide tracing) to be more direct than computer visualizations. He felt that visioning with no mediation is simple and that visualized results can give as good an answer as a visualization. He also questioned whether the technology defines the questions that are asked or the answers one can give. He emphasized that it is important to use the method that suits the question.

7.3.2 The strengths and weaknesses of visualizations methods in practice

Maps and aerial photos

The investigation indicated that the strength of maps was to provide orientation and an overview in the planning discussions. Although it is contended in the literature that citizens and lay audiences may have difficulty understanding maps (LEWIS & SHEPPARD 2006; MACEACHREN 1994), maps and aerial photos proved to be essential for orientation in our participation sessions. This supports APPLETON & LOVETT's (2005) findings that maps are important to establish the location and direction of viewpoints of the visualizations. Our investigation also indicated that 2D methods should always be available in participation, not only to provide a good overview for orientation but also because they are important for documentation. Furthermore, the aerial photos proved to be especially easy to understand and useful in the discussion, particularly for participants familiar with the site.

Sketches

The sketches were realistic enough to be used in the discussion of concrete planning measures with citizens. However, the experience from the Bornum investigation indicated that several factors are important in order to take advantage of the potential collaboration between artist and participants. First, the artist must be familiar with the site and planning issues. Next, the group must be small enough that people can gather around the sketch, or it must be projected with an electronic tablet. And finally, it must be recognized that sketches require time to draw and discuss. This is a method that appears to be more suitable for a workshop environment than for a presentation or discussion in a large group (AL-KODMANY 2002). In the meeting situation with 20-minute discussion periods, as in the Bornum investigation, it was not possible to take advantage of the potential for interactive and collaborative work using the sketches.

Panorama photo

The panorama photos presented an easy-to-produce alternative to static images in the discussion of views or aspects of the landscape beyond the normal angle of vision. The disadvantage lay in the need to find an elevated viewpoint for photographing that ensured an overview of the landscape. (This was not a problem when produced from a VR model.)

The investigation indicated that panoramas were useful for discussing the existing situation and gave the viewer the feeling of being in the landscape without orientation difficulties. The ability to directly jump from one viewpoint to another or to zoom in and out was used in the IALP to provide a VR experience to citizens who could not access VRML models over the internet. However, this method is only suitable for open landscape situations. Furthermore, it is not suitable for the comparison of before-and-after or scenario alternatives.

The literature reflects similar experience with the panorama photo. It can be used in combination with other methods, or as an alternative to static images (BISHOP & HULSE 1994) and offers a semi-controlled, real-time view of the landscape. Furthermore, the panorama has a more dramatic effect than a single photograph (PALMER & HOFFMAN 2001) and is more effective in evaluating scenic beauty than single slides (MEITNER 2004). The peripheral vision provided by panorama photos supports spatial awareness and gives the audience a feeling of realism or of "being in the landscape" (DANAHY 2001). Furthermore, the panorama does not focus the attention of the discussion on one specific part of the landscape, as is the case with a static image (WERGLES & MUHAR 2009).

Photomontage

The realism of the photomontage engaged participants' interest and promoted recognition of landmarks and orientation. The photomontage made it possible for participants to compare before-and-after images of the concrete planning measures and to discuss details of the planning proposals. STAMPS (1992) also points out the advantages of the photomontage to show planning changes in the context of the actual setting; this also supports recognition of the real landscape. The realism of the photomontage also elicited a strong emotional reaction from the participants which could be considered either as an advantage to stimulate identification with the landscape or a disadvantage to elevate emotions about the proposed planning measures. In interview, **Sheppard** recognized the power of visualization to engage the audience but felt it should be used carefully because there is a discrepancy between the awareness and action which visualizations can bring about. He recommended that the viewers be informed about the uncertainties and assumptions that were made in the preparation of a visualization (SHEPPARD 2001; SHEPPARD et al. 2004). Furthermore, APPLETON & LOVETT (2005) emphasize that participants should understand whether the photomontage represents a typical landscape or whether it is an image of a specific planning proposal.

The interviewed experts considered the photomontage to be a legitimate visualization method in specific situations. **Lovett** has found on some occasions that the photomontage was quicker and less expensive to produce than a GIS-based visualization. He pointed out that photomontages can be effective when the frame of the existing landscape can be used to scale the landscape changes, for example, when showing a certain type of change from one viewpoint or when illustrating a change in vegetation within a defined area such as a field. **Lange** also considered the photomontage suitable for a straightforward situation that is not too complex, but that the GIS-based visualization, or some sort of transparent methodology, certainly involves less risk of manipulation. **Sheppard** suggested that when the site data is not available or a generic site is discussed, then a photomontage informed by GIS data is good a mix.

Renderings VirtualGIS/ VNS

The two rendering programs tested in the investigation provide different levels of realism. Clearly, the lack of detail in the VirtualGIS rendering made it difficult for the viewers to understand the image. On the other hand, the VNS rendering was realistic enough that participants used it frequently in the discussion to localize and explain their comments. However, the schematic textures sometime required explanations, which opened discussion about the participants' opinions and suggestions for the planning measures. The less-than-photorealistic image appeared to be advantageous for discussing planning measures on the landscape scale, where the details are less important. Nevertheless, the images were realistic enough so that orientation was not difficult and participants could make concrete suggestions about improvements to the planning proposals.

The flexibility of the GIS-based software to illustrate any view and viewpoint requested by the planners was an essential capability of VNS. However, the quality or realism of the rendering depended in part on the experience and expertise of the author/artist. Although the credibility rating varied, the participants considered the visualizations more credible than realistic. Perhaps the knowledge that the visualizations were prepared with GIS data imparted a sense of credibility. This would support APPLETON & LOVETT'S (2005) findings that planners consider visualizations based on GIS data to be more defensible.

Animations: VirtualGIS

The responses to the visualization survey indicated that all groups considered an eye-level animation an important visualization method for illustrating lineal planning measures such as roads, bike paths, and other corridors of movement because it simulated the human experience. Interestingly, there is no confirmation in the literature that animations are perceived as a surrogate for a walk-through of a real site (BISHOP & ROHRMANN 2003). In fact, WERGLES & MUHAR (2009) found that animations are not substantially better than realistic still images for illustrating (urban) landscapes. In his interview, **Lindhult** pointed out that the use of animation is also a question of cost and whether it is part of the project budget.

The fly-over animation gives a useful overview of the planning area. However, it should be noted that a fly-over animation of the planning proposals in the Bornum investigation was prepared but not shown during the meeting for fear that it might anger the participants by giving them the impression that the issues had already been decided.

VR models LandXplorer/SceneExpress

In the investigation, the LandXplorer VR model appeared to be well suited for large-scale projects or for use in the early phases of planning, when spatial relationships instead of detail are important. It has also been pointed out in the literature that the VR model can be useful for determining important views with participants which could then be rendered in more detail (JUDE et al. 2007). In principle, the VR model can support a more democratic or transparent approach to determining what is viewed, thus lending more credibility to the visualization process. The VR model has been found not only to support public participation but to help build public confidence in planning decisions (KWARTLER 2005).

Both the Scene Express and LandXplorer VR models were more realistic than the VirtualGIS model. This may have been the key factor to the different reactions of the participants to the various VR models in the visualization survey and in the case study. WISSEN (2007) found that the level of realism of the VR model can either enrich the emotional experience of the visual landscape or support understanding of the spatial relationships in a more rational way. More realistic models inspire more emotional responses. Therefore it is important to consider carefully how the VR model is used in participation (SCHROTH 2008). The VirtualGIS may have been too abstract for participants to recognize or identify with the landscape and would have been better suited for discussions of general large-scale developments from a bird's-eye view.

The strength of LandXplorer was to engage participants' initial interest through the movement of the model and to communicate and document the location and explanation of participants' comments. In the Bornum investigation, the movement of the VR model attracted initial interest and proved to be a good way of "picking up" viewers. However, disorientation in the model was a substantial problem when the viewer had to "fly" from one location to another. In that case, the 2D dimensional analogue maps helped to re-establish orientation. Experience with the Scene Express VRML model in the Beienrode investigation showed that participants could follow the movement through the VR model at eye level when moving at pedestrian speed. Orientation also appeared to be less of a problem with the VR model when the navigation started from the same bird's-eye view and zoomed in to pre-established navigation starting points each time the model moved from one site to another. However, this meant that specific sites had to have previously been identified for discussion.

The interviewed visualization experts considered 3D models to be an essential visualization method for landscape planning, despite orientation problems. **Lovett** also considered the VR models to be important because they provide more information which helps the participants make better decisions about planning proposals. **Bishop** focused on the importance of the objective basis of a VR model generated from GIS data. He recognized that there are situations when photomontage or augmented reality techniques are suitable, for example, when there are unchanging parts of the scene that is represented with a photograph. However, it the best when the changing part of the scene can be driven by objective data.

7.3.3 Role and requirements of facilitators in the effective use of visualization

Prerequisites for effective facilitators

The observations of the case study clearly showed that the facilitator played an important role in how effectively the visualization was used in participatory situations. The importance of the facilitator in the participatory process is also documented in the literature (SALTER et al. 2009; SHEPPARD & MEITNER 2005). Furthermore, how the visualization is used is determined by the way the facilitator refers to it, where he is positioned, and what priority he gives the visualization (SCHROTH 2008).

Observations from the Bornum investigation showed that the facilitator must not only be familiar with the planning issues but also understand the capabilities of the visualization technology. The facilitator must know how to use it in a participatory situation, and how to coordinate it with the technical assistant. Ideally, the facilitator should be involved in the production of the visualization or have had experience with it prior to the participatory session. However, when this is not the case, a dress rehearsal with the technical assistant is essential.

The interviewed experts reinforced the importance of a well-informed facilitator and the involvement of the facilitator in the production of the visualization. **Bishop** has found that facilitators must have a clear sense of the capabilities of the visualization and the goals of the session and understand how the visualization can help achieve those goals. However, in his experience it is hardly possible to brief a facilitator who is not familiar with the visualization for all the possible contingencies.

Sheppard also regarded the facilitator's role as extremely important – "*he can make or break an identical presentation*" – and also felt this is understudied. He noted that not only the facilitator's familiarity with the visualization process and the project is important in the participatory setting, but also the whole situation: the relationship of the facilitator to the audience, the process of people coming to vote on a final project, or discussion of alternatives. He has referred to this in the code of ethics as "framing the presentation" (SHEPPARD 2005c). Furthermore, Sheppard has identified parameters for a successful facilitator: likeability, neutrality, need to be informed, and understanding of the process by which the visualization is created. He considered the facilitator a kind of integrator or an "all rounder" in the planning situation. If this is not the case, a team is necessary to which the facilitator can divert questions.

Furthermore, **Lange** pointed out that the success of visualization also depends on whether it is central to the meeting or rather an "add-on". In other words: Is the visualization used to support the issues and discussion? Was the visualization team included in the planning of the meetings? Are the moderators familiar with the visualization technique and its limitations and possibilities? The situation is different when the planners have created the visualizations and organized the meeting. Both **Lindhult** und **Lange** felt the workshop or meeting should be scripted. The facilitator must understand the objectives of the meeting. Furthermore, the facilitator must also anticipate what kinds of questions can be answered with the visualization and be flexible and informed enough to manipulate the visualization in order to respond to participants' concerns.

The interviewed visualization experts stressed the importance of multiple facilitators in the participatory processes that use real-time models, and this is substantiated in the literature (SALTER et al. 2009; SIEBENHÜNER & BARTH 2005). **Lovett** recognized the difficulty of running a real-time visualization and speaking sensibly about it to the audience while considering the next remarks or steps in the workshop. He has used computer assistants when making presentations to a large group. The assistant is responsible for running the real-time model, while the other facilitator does most of the talking. **Lovett** also pointed out that the facilitator must know what the computer assistant can change or show in the real-time visualization and how easy it is to do.

Visualizations create new tasks for the facilitator

The investigation showed the use of visualization in a participatory setting means additional work for the facilitators because they must ensure that the audience or participants can follow the visualization. To this end, the facilitator must first be sure that the participants can orient themselves in the visualizations. It was found in the investigation that the facilitator needed 2D method to keep participants oriented and "on track" with the VR visualization methods. APPLETON & LOVETT (2005) also found that professionals are aware of the importance of 2D maps and images for recognizable landmarks which the audience uses for orientation.

Next, the facilitator must introduce and demonstrate the capabilities of the available visualization methods, i.e. navigation possibilities and interactivity, and explain background information about the visualization, i.e. how it was produced and what kind of data were used, so that participants can understand the validity and limitations of the visualization. However, APPLETON & LOVETT (2005) found that professionals are divided about how much technical information is useful to explain to viewers: on the one hand, explaining the real-world basis of the data supports credibility; on the other hand, this may cause confusion.

Furthermore, facilitators are responsible for coordinating the visualization with the discussion, i.e. ensuring that the visualization shows the areas being discussed. The literature suggests the facilitator should share these with a computer assistant (SALTER et al. 2009) as well as script the use of the visualization in the workshop environment. (SCHROTH 2008). Finally, the facilitator should document the results of the discussion with the visualization when possible. This is an aspect of the visualization in the participatory process which is apparently assumed to take place but has not been addressed specifically in the literature and requires further solutions.

Finally, it became clear throughout the investigation that citizens require time to understand and to explore the visualization. Not only do the introduction and explanation of the visualization method require time, but participants also need enough time to become comfortable with and warm up to the presentation. SALTER et al. (2009) also found that, especially with interactive scenarios, time was a limiting factor in the participatory setting.

7.4 Which visualization methods and characteristics are suited for different planning tasks and phases?

7.4.1 Suitability for demonstrating or illustrating point, line, area information

The results of the visualization survey showed that not all the visualization methods were suitable for the discussing different kinds of landscape elements or information. In both the lay group and informed students, all the visualization methods were considered equally suitable to illustrate point information, but to illustrate aesthetically important point information the lay group preferred photorealistic visualization methods. For linear landscape features, animations or VR models were considered most suitable. The lay persons preferred an overview (bird's-eye animation), and the students liked the experience (eye-level animation). Linear landscape features possibly imply movement along a path. Both the overview and experiential understanding of the planning provided by the real-time visualization methods were important. Most of the respondents considered 2D methods most suitable for illustrating area information or landscape features, and an overview was the most important requirement. The lay group preferred the 2D view of area features with photorealistic methods, while the students preferred the bird's eye-view animation.

There is little discussion in the literature of how to best visualize different landscape features and this needs further exploration in a participatory setting. MEITNER et al. (2005) examined different scales of static visualizations and found that they show different characteristics of the landscape and support different issues of planning discussions: strategic overview, spatial patterns, sense of place. More study should be devoted to the suitability of the different visualization methods to portray different qualities of the landscape.

7.4.2 Suitability of visualization methods for different planning phases

Initial contact: stimulating interest and emotion

The investigation indicated that movement and realism appear to be significant attributes that trigger or attract participants' interest, but the perspective of the view also seems to influence the emotional involvement of participants. For example, in the visualization survey the young planners considered the black-and-white plan "boring", but when drawn in perspective, i.e. given a 3D quality, it stimulated interest, and respondents felt more "a part of the landscape". On the other hand, the bird's-eye animation stimulated interest through the movement, but evoked no emotional response. Some viewers commented that they did not feel a part of the landscape because it was too far away. On the other hand, the eye-level view of the panorama photo made viewers feel "transported into the landscape", as if they were there. The realism and recognition of the landscape provided by the panorama photo certainly played a role as well as the movement. MEITNER et al. (2005) also found that fly-through animations helped local citizens recognize specific locations or features and connect them to their own understanding of the landscape.

In the Bornum investigation, the VR model was a "show-stopper". In the beginning, the audience watched intently as the camera "flew" over the site. However, later, as specific sites were discussed, movement through the model became distracting. GHADIRIAN & BISHOP (2008) confirm that low-detail, real-time models help to engage people in their initial exploration of the site. SCHROTH (2008) also encountered the "wow" effect of 3D models, but also found that it wears off when participants have become used to the models.

The interviewed visualization experts agreed that VR models raises curiosity and interest in lay audiences. **Lovett** has found when a VR model is shown, people are much more likely to approach the visualization and ask questions. He has found that it draws people in, much more than a set of stills in a PowerPoint presentation. On the other hand, **Ervin** felt that placing tangible 3D models and posters in public places is a simple and effective way of raising public interest which should not be overlooked.

Background information

The young professionals considered 2D visualization methods – topographic maps or aerial photographs – most effective for conveying background information in the inventory phase. Experience from the case study in Königslutter indicated that multimedia such as film and educational computer programs, although more costly, are a good medium for communicating background information. While **Lindhult** supported the importance of using multimedia in order to reach everyone in the audience; **Bishop** warned that a sleek multimedia presentation may give the impression of a "done deal".

All the interviewed experts stressed that visualizations are just one of many methods for conveying information. Both **Lovett** and **Ervin** emphasized the importance of written and verbal information as a means of communicating background information. They pointed out that audience and presentation situation also determine how the information is presented, e.g. meeting, stand, poster, as well as the amount of time available to inform. Furthermore, **Sheppard** suggested that there are more ways to build context than maps, for example, aerial photographs, writing on the board, verbal introductions, or presence of a local expert who can set the scene. Sheppard also recognized that providing background information often happens by default and that there should be a full range of content and vision packaging relevant to the question at hand such as charts, maps, data, photographs, and precedents for other areas.

Consideration must also be given to how citizens are prepared for participation in the planning decision process. More investigation is needed about effective ways to inform and help citizens acquire knowledge about the planning content and issues before they are presented with planning proposals and alternatives.

Inventory phase

The investigation results do not give a conclusive answer about which visualization methods best support this planning phase. For example, the young planners preferred the use of 2D topographic maps and aerial photos in the inventory phase, while the planning experts and participants in the case study preferred photorealistic visualization methods to gather local knowledge about the landscape.

The interviewed visualization experts had a wide range of experience and suggestions about suitable visualization methods for the inventory phase. Most agreed that 2D and photorealistic representations of the landscape are helpful if the issues focus on aesthetic aspects of the landscape. **Bishop** agreed that a combination of 2D and photorealistic images is good for showing the status quo, although this also depends on the viewers' knowledge of the site. **Ervin** also agreed that realistic images and maps provide a good basis for informing citizens but that written information must also be included.

Sheppard, on the other hand, felt that aerial photos, satellite images, Google Earth, etc. could convey more information than maps or ground photos. Furthermore, **Lindhult** pointed out that the issues should determine how realistic the visualization must be. For example, a photo is suitable for scenic issues, but not for information about soil. Finally, **Lovett** felt that information about land use can be illustrated with simple textures in the inventory phase. However, when a change in the visual quality is the issue, then it becomes important to show realistic baseline data. Furthermore, he suggested that photorealism may be important for showing biodiversity features of the landscape in order to distinguish habitats associated with certain types of land cover.

Concept phase

There are many opinions about what kind of visualization is suitable for the concept phase. The young planners in the visualization survey considered both photorealistic and 2D methods important for discussions in the concept phase, for which they preferred the photomontage (both with LaViTo and without) and aerial photographs. Apparently, the spatial understanding, which realism supports, became more important than in the previous planning phase. On the other hand, the planning experts (13.1.2002) considered realism less important than in the inventory phase. Their comments expressed reservations about the use of realistic visualizations in this phase because they felt the detail could hinder the discussion and that too much realism in the concept phase could raise false expectations. This is in accordance with the opinions of the planning professionals interviewed by APPLETON & LOVETT (2005) that too much detail too early in the process could stand in the way of communicating the concepts. Furthermore, these planners felt the details were unlikely to be finalized in the early stages of the planning process and could therefore not be visualized. Once again, the detail of the data must match that of the visualization, which makes it difficult to produce detailed, site-specific visualizations in the concept phase. AL-KODMANY (1999b) found the combination of freehand sketching and GIS maps to be effective for identifying issues and brainstorming about possible solutions.

The interviewed visualization experts had diverse opinions about how to use visualization in the concept phase. One approach that the experts proposed was the use of abstract images or information that communicate the spatial relationships of the site. **Lovett** suggested a stylized visualization, one that is clear and helpful for orientation. He felt the visualization needs to concentrate on the key strategic features or major policy issues and can be portrayed with a symbol or simple text. Other experts suggested that the more vague the concept is, the more vague the medium should be, e.g. fuzzy rendering, high-level aerial photos. Finally, **Ervin** considered words to be the medium of choice in the concept phase.

Another approach which **Sheppard** suggested is the use of photorealistic images of generic landscapes that show examples of potential development. He suggested that realistic, precise representations of a similar planning situation located somewhere else, similar but not the same, can give the required realism and preciseness needed to understand the issues. SHAW et al. (2009) visualized climate change scenarios at a scale that “matters to people” but used iconic places to illustrate the effects in order to reduce personal identification with the visualizations. Both **Bishop** and **Lindhult** relied on 2D methods in this phase of planning. **Lindhult** considered 2D plans more useful for determining program and form when deciding which design element should be included. Finally, **Lange** proposed a computer tool that could generate simple 3D visualizations quickly, without providing too much input. Such a tool would help generate alternatives quickly.

The experts' suggestions ranged from abstract images and 3D models to 2D maps and written information to photorealistic images, which give citizens a clear picture of what could be. There were no conclusive recommendations for this planning phase. Clearly, this is an area which deserves more investigation.

Planning measure phase

Opinions varied among the surveyed groups about the suitability of different visualization methods for the discussion of planning measures. For the lay group and informed students, a photorealistic image which supports spatial understanding and a method that offers an overview, i.e. either a 2D aerial photo or 3D bird's-eye animation, were an ideal combination. In contrast, the young planners considered the LaViTo interactivity which allowed the comparison of before-and-after images to be essential for the evaluation of planning proposals in this phase. This is in agreement with the planning experts (13.11.02), who considered interactivity most important in this phase. Although the planning experts (09.06.2004) also found the interactive photorealistic and VR methods more suitable to picture the planning proposals than the 2D methods, they also expressed caution about too much realism in this phase.

Unlike the planning experts, the visualization experts considered realism important in the visualization of planning measures. **Sheppard** supported the importance of realism in every stage, although he felt people expect realism more towards the end of the planning process. The amount of realism also depends, among other things, on the planning question. **Bishop** also considered photorealism important throughout the planning process and said one should try to be as realistic as possible whenever possible.

Mix of visualization methods important

The investigations substantiated the assertion that there is no perfect or "all-in-one" visualization method (APPLETON & LOVETT 2003). The findings indicated that a mix of visualization methods was needed in order to support spatial understanding and orientation and that few methods provided both. It appears that in the discussion of planning measures, 2D visualization methods are important for an overview and orientation. Photorealistic images provide a "picture" of the planning, and interactivity provides experience and exploration. Realism, to the extent it is possible, helps less experienced viewers picture the landscape, whereas the participants that have more experience with planning require less realism. The work of LEWIS & SHEPPARD (2006) with First Nation communities reinforces the importance of visualizing the landscape from the point of view of the affected community in combination with maps. SALTER et al. (2009) also found that using both semi-realistic visualizations and plans were a good combination for supporting the discussion of spatially specific proposals.

Furthermore, the respondents recognized interactivity as useful for understanding the proposals and developing ideas. They found the toggle interactivity provided by LaViTo tool helpful to “try out” different combinations of planning measures, and the dynamic navigation of the VR model helped to experience the landscape. SCHROTH (2008) also found that even a low level of interactivity was sufficient to communicate landscape change in agricultural settings. He also observed in his case study that spatial or dynamic navigation can support the use of landscape visualizing as a tool in the discussion of planning issues.

The observations of the investigation in Beienrode suggested that a combination of visualization methods had a synergetic effect which helped participants to understand the planning measures. The experts agreed in principle that a mix of visualization methods is advantageous, but warned about the expense of producing visualizations, the time involved, and the data needed to back them up. **Bishop** considered the combination of maps with other visualization methods a good idea, but felt that mixing still images, animations, and real time may amount to information "overkill", and is not useful. However, when realism and interactivity are important, a combination of methods could be complementary.

Visualizations should not stand alone

The survey of the citizens and planning experts (09.06.2004) indicated that the visualizations helped more to picture the planning measures than to evaluate them. This suggests that the assessment of the planning measures may require more than a visual image in order to make a qualified judgement. MEITNER et al. (2005) also found that a combination of visualization methods helps to communicate the complexity of the planning measure, but that both additional explanations or interpretations and answers to questions are necessary. Furthermore, the interviewed experts all made the point that visualizations must be accompanied by written and verbal explanations. The contextualization or use of additional non-visual information was not a focus of this investigation, but the importance of such supporting information cannot be overlooked. Interestingly, SCHROTH (2008) found that the importance of including non-visual information for the participants was linked to their map-reading abilities. Contextual information must be accessible, either in written, oral, or graphic form to support the evaluation of different landscape planning scenarios. Further investigation should be devoted to what kind, how much, which form of and when contextual information should be integrated into participation in order to support citizens' understanding of the issues.

7.5 Limitations of investigation

7.5.1 Survey design and case study approach

Visualization survey

Small sample sizes of the lay (n = 17) and informed student (n = 21) groups meant that the results of the quantitative analysis could not be generalized to the larger population. However, the analysis of the quantitative data in combination with the results of the young planners' (n = 62) survey indicated clear trends that were useful in the preparation of the case study visualizations.

The survey of the young planners focused on slightly different aspects of visualization than the previous two surveys; this limited the comparison of some of the topics. The young planner survey addressed the question of credibility of the visualization methods, which was deemed important for the development of the visualization methods for the case study, as well as traditional visualization methods in order to explore the relationship of the digital visualization methods to traditional analogue methods. These themes were not tested in the lay group and student surveys.

Finally, the respondents in the visualization survey were asked to evaluate the visualizations as if they were in a participatory situation. However, in a real consultation situation, they may have responded differently. The influence of the setting on the results of the visualization surveys should not be underestimated.

Case study in Königslutter am Elm

The challenge of case study research is to fit the research into the process. This challenge manifested itself in the limited influence possible on the design of the individual sessions to observe or question the participants in order to gather data. Because the public meetings took place in different communities, with different participants and different visualization methods, it was difficult to do a cross-case analysis. As a result, the multiple-source evidence took on a patchwork character with little control over the number or background of the participants. The small sample size of much of the multiple-source evidence meant that the results of the individual samples could not be considered representative or comparable. Furthermore, video documentation of the sessions, which might have made the cross-case analysis more valid, was rejected because of the danger that this would have disturbed the participants and interfered with or disrupted the planning discussions.

Despite these methodological and practical limitations, the results of this work reflect opinions collected from over 210 people during the individual investigations of the dissertation. Furthermore, thanks to triangulation of the data sources, the themes identified in a qualitative analysis of the data from questionnaires, interviews, and documented observations have a wider applicability and potentially stronger validity than would have been the case with individual investigations. Finally, interviewing visualization experts was an important instrument to substantiate the findings of the investigation and to give them broader validity among planners.

Bornum investigation

The Bornum investigation was the single participatory session which provided the opportunity to test several visualization methods in the context of the town meeting. In the other town meetings, visualizations were used, but the agenda of the meeting did not include the visualization. In other words, the visualization played a supporting role in the meeting, but was not addressed as a topic on that evening's agenda.

Limitations of venue

The four visualization demonstrations, i.e. discussion groups, were held in different corners of a large hall. This meant that, at times, when the four groups were vehemently discussing the issues simultaneously, the sound level was extremely high, requiring a great deal of concentration. It was noticeable that the evening was very strenuous, not only for the organizers, but also for the participants.

It is not clear what effect the seating arrangement of rows of chairs in front of the screen had on the discussion and use of the visualization. However, the arrangement was flexible and participants moved the chairs around to suit themselves.

Time limitations

Finally, the time limit of 20 minutes at each station was too short for those visualizations that required more time for orientation and interactive use, i.e. the sketches and LandXplorer. The time frame of the investigation made it difficult to explore the potential of these visualization methods. Furthermore, the limited amount of time for discussion at each station did not always allow the participants to become comfortable with the visualization. The time participants apparently needed to adjust to the visualization technology left only about 15 minutes for actual use of the visualization in the discussion. The facilitator of LandXplorer pointed out that the fast navigation through the model was in part due to the time pressure during the evening.

Group phenomenon

At the first visualization station, regardless of which one, the participants “let off steam”, voicing their general complaints or opinions about the general situation in Bornum, and it was difficult to focus the discussion on site-specific topics. Furthermore, the participants visited the stations in a different order. It is not clear how the order of viewing affected how the participants perceived the visualizations, but it was observed that participants expected dynamic navigation after viewing the VR model.

When general non-site-specific issues – dogs in the area, refuse/trash, conflicts with tourists, youths, or general economic problems of the farmers – became the topic of discussion, it was difficult to redirect the conversation to site-specific issues. Participants looked at the visualization but continued to discuss general issues that were not site related and did not refer to the visualization. Even though the technical assistant tried to focus the discussion on the concrete planning measures by clicking the measures off, the participants continued to discuss their complaints. In this situation, despite repeated attempts to use the visualization, the facilitator felt that the visualization played a relatively small role in the discussion.

Group dynamics also played a role in the discussion. In some of the groups there were one or two members or a group of stakeholders who dominated the discussion. For example, when farmers were in the majority, then the discussion focused naturally on issues that concerned them, and they led the discussion. In such cases, general or non-site-related issues often dominated the conversation; the visualization was of little use, and it was difficult for the facilitator to incorporate the visualization in the discussion.

Observation method

Video analysis of each station would have been the ideal method for observing the interactions with different visualization methods. But due to the sensitivity of the planning issues and stakeholders, it was decided against videotaping the session. Although there were multiple observers, the resulting observations and protocols may not have captured all the important evidence. Without a video record, there was no possibility to go back and observe and assess the sessions again.

7.5.2 Limitations of the data

The data in this investigation was collected in the period from 2002 to 2005. In the meantime, the general public has had more exposure to 3D models such as Google Earth, and viewing computer-generated images, and acceptance and use of the internet are considerably higher. It is very possible that the responses of the lay group and citizens would be different or more favorable to the VR models today than they were in the survey. Nevertheless, the investigation revealed the basic requirements of the participants and how the visualizations were used in the participation setting.

It should also be noted that the investigation was carried out in German and that the questionnaires and comments made by participants have been translated into English here in order to make the results available to an English-speaking audience. The translation of data into another language adds to the risk of error in the interpretation of the data. However, a concerted effort was made to translate the comments as true to meaning as possible.

7.5.3 Limitations of visualizations

Partly due to the time needed to become acquainted with the software and to produce the visualizations, most of the visualizations were tested towards the end of the landscape planning process in the planning measure phase. The application of visualization in the discussion of goals and objectives with citizens was limited. Furthermore, several methods tested at the end of the project were not available in the initial visualization survey, which limited the wider comparison of the visualization methods.

VRML models: VirtualGIS vs. Scene Express

There was a rapid development of visualization software during the course of the investigation, especially for virtual model programs. In other words, the real-time visualization methods available and tested in 2002, when the preliminary visualization survey was carried out, were far more rudimentary in the portrayal of vegetation than techniques used in the case study in 2004. Specifically, in the initial phases of the investigation, Scene Express was not available, and VirtualGIS VRML model was the only VRML model tested in the visualization survey. However, the lack of detail or realism in the VirtualGIS (ERDAS) VRML model and renderings made it difficult to compare the usefulness of the VR model to the more realistic Scene Express VRML model or VNS (3D Nature) renderings due to the clear discrepancy in the perception of realism of the two VR models. Therefore, one should be careful not to generalize the responses about the VirtualGIS models to the other VRML models.

Sketches

In order to achieve more comparability to the other visualization methods in the Bornum investigation, the sketches should also have been presented to the audience digitally. The paper format and size, among other things, may require a different setting and group size. Furthermore, the language problems between the (Ukrainian) artist and (German) audience hindered the communication and thus the test of the medium in the participatory setting. Finally, the comparison of before-and-after sketches was possible, but the four different sets of images were too many for the investigation situation. It would have been more effective to focus on one or two different views, which would have reduced the time needed for orientation in the sketch.

LandXplorer/Lennè3D

At the time of the Bornum investigation, the Lennè3D program was still in the developmental phase. An animation of the area of investigation was possible, but coordination of the Lennè3D player with the LandXplorer VR model presented some technical difficulties. Therefore, LandXplorer was used most during the workshop, and the results primarily reflect the experience with LandXplorer.

7.5.4 Limitation of analysis

Because qualitative research is fundamentally interpretive, the analysis of the data to form themes or categories and ultimately to interpret and draw conclusions means the researcher filters the data through a personal lens. The triangulation of data, investigator, and methodology in the investigation was an attempt to overcome the personal bias.

The analysis of multiple-source evidence presents the challenge to compare different visualization types with different populations in different settings. The analysis attempted to address all of the data collected and assess them in context of the existing evidence and expert opinion. In general, the qualitative content analysis, although interpretive, gave more insight into the motivation or needs of the participants than the quantitative data analysis, which was based on evidence from the visualization survey of small sample size (n = 17, 21, 62). However the quantitative analysis of the distribution of the responses did provide an indication of possible preferences or attitudes about the visualizations, which was valuable information for the design of the case study. Moreover, the visualization survey results are strengthened by the case study findings.

8 Conclusion: Lessons learned

8.1 Recommendations for visualization in public participation

No "all-in-one" visualization: combination of methods important

In order to meet the diverse needs of the participants, visualization methods must provide a range of features, which is difficult with a single method. These findings clearly agree with APPLETON et al. (2002: 160), who argue that "*there is no universal landscape visualization solution.*" Although it can be debated that different visualization methods are better in different situations and for different audiences, one point is certain: no single visualization methods could fulfil all the wishes of the participants.

Furthermore, a combination of methods is not only important to meet different user needs; it also appears that a combination of visualization methods has a synergetic effect and improves the overall understanding of the planning. This is not to say there should be a visualization "free-for-all". Rather, within a reasonable framework of expense and time, a combination of visualization methods, e.g. 2D maps and 3D visualizations with varying degrees of realism and interactivity, can be a fruitful approach to meeting the needs of diverse groups of people and planning questions.

2D visualization remains basic to participation

Topographic maps and aerial photos are the prerequisites for good orientation. A bird's-eye view gives a good overview of the planning area, but our findings showed that most participants used maps and aerial photos to orient themselves on the site. For that reason, the tried-and-true 2D maps and aerial photos, either digital or analogue, should be a standard component of the presentation with visualizations when working with citizens.

Although the results show that lay persons have difficulty creating 3D mental images of the planning proposals from 2D maps, many participants who were familiar with the site used maps not only to orient themselves but also to localize their comments in the planning area. The analogue 2D maps offered an important overview of the planning area and provided a basis for the documentation of written comments. Due to their photorealistic attributes, the aerial photos made it even easier for the participants to locate the planning area or landscape features on the site and frequently aided the discussion.

Combination of 2D and 3D realistic images is satisfactory for orientation and spatial understanding

Good orientation and spatial understanding are two prerequisites that visualization should fulfil in order to be used in participation. The findings showed it is necessary to have both an overview of the planning for orientation and eye-level visualizations for spatial understanding. Both 2D maps and bird's-eye views or movement provided the necessary overview for good orientation, whereas photorealistic eye-level images or movement were the necessary basis for picturing the landscape, i.e. spatial understanding. Observation made during the case study showed that all the features of the LaViTo VNS rendering were actively used by the participants: the combination of 2D maps and an elevated view of the planning area, for orientation, and the eye-level before-and-after images, for understanding the planning measures.

Before-and-after views help to assess change

The ability to assess visual landscape changes is essential for the discussion of planning proposals. Before-and-after images fulfil a minimum requirement for assessing change. The low-level interactivity offered by the LaViTo tool to turn proposed measures "on and off" was actively used in the discussion of visual effects of the planning. Not only did it allow citizens to evaluate the change, but it also supported the recommendation character of the visualization and made the effects of the planning decisions more transparent. Furthermore, the interactive comparison supported collaborative discussion between planners and participants about the necessity of individual measures for the success of the scenario and allowed citizens to test out their ideas.

A static image was found to lend itself better than moving images to the comparison of before-and-after conditions. It is important that the existing and simulated landscape images are produced with the same level of realism. The ability to compare not just one "after", but rather alterative planning proposals can give the participants even more ability to assess the possible landscape changes and an understanding of the reliability of the simulation. Ideally, different stages of the "after" image should be illustrated, either over time or with different developmental scenarios. Finally, the assumptions made in the simulation of the future landscape change, for example about the time span and influencing factors and the reliability of the simulation, must be made transparent.

Information, control, and involvement support credibility

The evidence suggests that the more participants know about the visualization and what it is showing, the better they can judge how closely the visualization represents reality, and the more likely they are to trust it, i.e. the more credible they consider it. In the investigation, the most frequent suggestion for improving credibility of the visualization was to improve its realism. Citizens can more easily compare how well the visualization agrees with their own mental image of the site when the visualization shows details of the landscape. In addition, more information about the data, the production of the visualization, and the uncertainty of the image helps viewers to judge the limitations of the visualization. Finally, viewers are more able to assess the credibility of the visualization in a comprehensive context when the visualization is linked to non-visual information, e.g.

ecological or economic data.

Second, the more control the viewers have over the visualization, the less likely it is that they will feel manipulated by the visualization. Such control ranges from being able to select the view in a real-time model to regulating the factors under consideration in a scenario model. Although the latter was not possible with the visualization methods tested in the investigation, the development of software such as CommunityViz (http://www.communityviz.com/) now makes it possible to investigate how control over the scenario affects the credibility of the resulting visualization.

Third, the more intensively citizens are involved in the preparation of the visualization, the more likely they are to trust the resulting image. Transparency in the visualization process is enhanced by citizen input into the selection of issues, sites, and viewpoints, or even the level of detail to be included. Moreover, alternative simulations which show the potential discrepancy of future predications also add transparency to the simulation.

Movement, realism, interactivity stimulate interest and involvement

The investigation showed that one strength of visualizations was their ability to reach viewers emotionally, to make them feel a part of the landscape, to stir association with personal landscape images, and to catch people’s interest. Three factors of the visualization that stimulated interest and made participation enjoyable ("fun") were found to be movement, e.g. of an animation or navigation through a model, photorealism, and interactivity. SHEPPARD (2001,2005c) formulated ethical standards for producing objective visualizations. The question arises as to whether visualizations remain credible when they involve the participants' emotions. Our findings indicate that visualizations can be used to stimulate interest, to make people feel emotionally involved, or to help them identify with the planning issues and that credibility is not compromised in this attempt to activate. Therefore, one of the most valuable functions of visualizations for participation may be their capacity to draw participants into the discussion, activate their interest in the issues, and help citizens recognize and identify with the landscape.

8.2 Visualization characteristics: weighing the alternatives

Realism supports orientation and spatial understanding among lay people

The visualization survey provided strong evidence that a realistic representation of the landscape is especially important for lay people. Realism is important for this group because it supports orientation, i.e. recognition of landmarks, and spatial understanding. However, the case study evidence also indicated that, although photorealism clearly helped citizens to orient themselves and to imagine how the landscape would look, participants were also able to use less-than-photorealistic visualizations to discuss the landscape changes when they were familiar with the site. In both the case study and the visualization survey, the realistic aerial photo provided both good orientation and spatial understanding, despite its 2D character. The photorealistic 2D method proved to be a valuable and understandable visualization method in the discussion with lay groups.

Communicate the factors that limit realism

The investigation showed that realism is important to the participants; they want it and, to some extent, expect it. In the case study the realistic images portrayed concrete planning measures and helped the planner explain and address specific aspects of the planning measures. However, realism sometimes led to the "What is wrong with this picture?" attitude, in which viewers look for inconsistencies in the realistic images, getting distracted from the discussion of the planning content. Viewers' awareness that realistic photos can be manipulated indicated that they understood that visualizations are simulations.

This healthy distrust of the photorealistic methods observed both in the case study and in the visualization survey showed that the citizens understood that a photomontage is an artistic renditions of the future landscape, although it looks like a real photo. However, this may not be as clear with less realistic images made with GIS-based visualization software. The limits of realism must be made transparent, not only in photorealistic visualizations, but also in computer-generated ones.

Finally, in order to produce a realistic representation of the proposed planning, the planner is required to make concrete decisions about the planning measures on a site scale, for which the information may not be available. Our observations indicate that very realistic concrete images of the landscape may push the planner to be more specific than is possible at the landscape scale. This problem has been identified by APPLETON & Lovett (2005); the question remains how to represent proposed landscape elements in a photorealistic image so that the uncertainty of the representation can be clearly communicated to the citizen. The planner must weigh the wishes of the audience to see the planning in detail against the detail of the data and the reliability of the prognosis. It is important to communicate the limiting factors of the visualization.

When to use 3D models: still images versus dynamic navigation

The evidence from both the case study and the visualization survey indicates that still images made it easier for lay people to stay oriented and understand the planning proposals than a moving image. Furthermore, a static, bird's-eye view of the planning area was found to be a good starting point for the discussion of overall measures and spatial relationships. In addition, still images were well suited for the comparison of before-and-after images of defined planning situations. However, the pre-selection of viewpoints necessary for static images raises the issue of who decides which view is selected. The planner must weigh the importance of showing views of specific planning measures against the credibility gained when citizens are given the opportunity to decide themselves which views they consider important. In either case, the static images focus the discussion on the issues that are visualized; the choice of views must therefore be made transparent.

Dynamic navigation enables the viewer to choose his own viewpoint and ensures a more democratic view of the planning. Furthermore, dynamic navigation and multiple views were shown to increase the perceived credibility of the visualization. However, this flexibility and freedom of movement also carries the danger that the important sites may not be visited.

Both in the case study and in the survey, the real-time models with dynamic navigation offered a "fun factor" and stimulated interest and curiosty among the viewers. Although the moving images appeared to increase interest in the visualization, when the movement became faster than the speed of a pedestrian, the viewers became disorientated and at worst felt uncomfortable. Orientation in the real-time model was difficult for many participants when they "flew" from one site to the next in the model. It was found that viewers could orient themselves better when they started from the same bird's-eye view each time they changed position. Prescribed viewpoints, from which the viewer could choose and move to directly, also helped viewers to orient themselves in the model and ensured that important sites were visited.

Both static images and dynamic navigation in real-time models have their place in citizen participation. However, it should be noted that the participants wanted to choose the view themselves after they had experienced the flexiblity of the VR model. Nevertheless, the discussion always took place using a still image of a location which the participants and planners agreed upon.

Never enough interactivity

The "toggle" interactivity of LaViTo helped lay persons control the amount of information they viewed and assess the visual consequences of the proposals. The interactivity was quickly understood and actively used. However, citizens would have liked to see their own proposals interactively visualized. New technology which makes it possible to ask "What-if?" questions of scenarios (CommunityViz^{TM}, PLACE^{3}S) and to visualize the answers is beginning to make it possible to fulfil requests such as those encountered in the case study.

Interactivity not only stimulated interest and gave the participants the feeling of being in control of the information, it was also an important step towards collaboration between planner and citizen. While the planning experts considered interactivity most important in the development of concepts and planning proposals, the visualization experts were more reserved about the importance of interactively producing visualizations. The experts recognized the danger of "jumping to conclusions" or of insufficient reflection about the visualization. At least one expert suggested that other technological developments may be more important, such as intuitive interfaces that participants can comfortably use themselves.

Many factors influence the choice of visualization method

As pointed out earlier, no single visualization method can satisfy all the expectations and requirements that accompany participation. Table 34 summarizes the strengths and weaknesses of the visualization methods that were tested in the investigation. Although the technology is developing rapidly, a photorealistic real-time model that can be altered "on the fly" is not yet a reality. A trade-off between interactivity and the level of detail remains. Many factors influence the choice of visualization method, such as availability and quality of data, planning issues, audience, and familiarty with the site, and size of planning area. Furthermore, the choice also depend on how the visualizations are used in participation and planning process.

Selecting the appropriate visualization for planning participation remains a complex question that may have a different answer for each specific situation in the participatory planning process. The choice involves the consideration of many above mentioned factors that are dependent on the situation. Figure 60 gives an overview of the different considerations that flow into the decision about the choice of appropriate visualization methods.

Table 34: Overview of strengths and weaknesses of the visualization methods tested in the case study.

Visualization method	Use in planning process	Strengths and weaknesses						
		GIS-based	Photorealism	Dynamic navigation	Interactive	Internet	Production effort	Requirements
Panorama photo	Virtual tour and overview of the planning area. Supports discussion.	-	++	(+)	-	+	++	Stitching-Program, 360° overlapping photos
Photomontage	Photorealistic view of the landscape from one viewpoint, before-and-after images, e.g. effects of planning measures.	-	++	-	(+) (Prepared with LaViTo)	+	+	Digital processing program, photos (analog or digital)
Renderings from 3D-Model (VNS)	Visualizations of the landscape from any view point, overviews as well as close up views of planning measures, detailed simulations of the proposed measures, before-and–after images, animations.	+	++ (Dependent on experience of producer)	-	(+) (Prepared with LaViTo)	+	+ (Long learning curve)	DEM, GIS-Data, visualization and digital processing programs, powerful PC.
Real-time 3D-Model (VRML) (Scene Express)	View landscape from all directions. Walk or fly through the planning area in real time. Support spatial understanding in citizen participation. Begehung des	+ (exported from VNS)	+	++	-	+ (Requires a fast internet connection)	++	VNS-Project (GIS-Data, DEM) Scene Express Program
Lenné3D / LandXplorer	Detailed, realistic visualization of landscape in real-time. / visualization of 3D model in real-time.	++	++	+	+	-	+	DEM, GIS-Data, photo material, Lenné3D-System, powerful PC. GIS experience

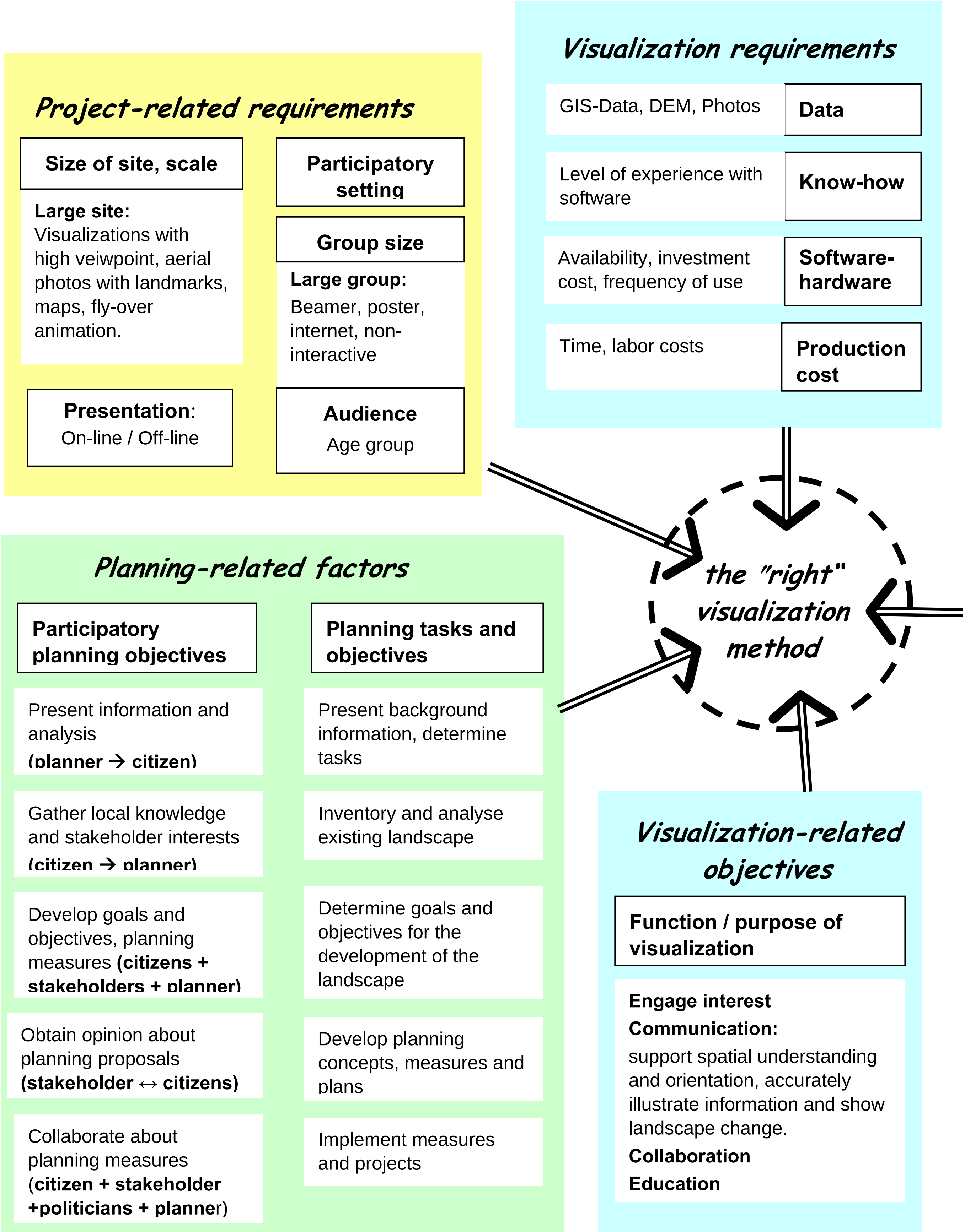

Figure 60: Considerations when choosing the appropriate visualization method for participation

Panorama photo

+ VR feeling of being in the landscape
+ Considered very credible and very supportive of spatial understanding
+ Single standpoint makes orientation easier than in VR model
- Elevated viewpoint important for overview, not effective when field of view is restricted
- Rotation speed should not be too fast

Photomontage (LaViTo)

+ Pan and photorealism engaged participants' interest, interactivity easily and often used by participants to support communication
+ Good orientation (bird's-eye view helpful)
+ Good for still images when detail is required

+/- Suitable for framed landscape views

-/+ Photorealistic image stimulates concrete criticism and recommendations

+/- Emotional responses

- Focus on detail and correctness of image
- Not suitable for projects where many views are required
- Credibility questioned

Strengths and weaknesses of techniques

Orientation: Maps, aerial photos, birds-eye view

Engage interest: panorama photos, 3D Model(photorealistic, dynamic navigation), animation, film

Support spatial understanding: photorealistish, real-time model,

Accurately illustrate information: GIS-based→VNS

Maps and aerial photos

+ Good orientation, support other methods
+ Good overview for documentation
+ Aerial photos easy to understand, engaging
- Little or no spatial understanding

Sketches

+ Realistic enough to use in discussion
+ Potential for interactive/collaborative work with artist
+ Annotation of non-visual comments
- Requires more effort for orientation than realistic images
- Format not conducive to group discussion, requires time to identify effects of planning measures

VNS Rendering (LaViTo)

+ Engages participants, easily and often used by participants to support communication
+ Appears less final, good discussion basis
+ Good orientation (bird's-eye view helpful)

GIS-supported data increase defensibility

-/+ Textures not always clear and require explanation, stimulates discussion, supports conceptual quality of planning

- Static, no navigation or additional perspectives

LandXplorer

+ Movement of model fascinated and engaged viewers
+ Flexibility to locate, communicate, document participants' ideas
+ Participant determines what he wants to see
- Orientation in model potentially problematic
- Comparison of alternatives difficult

Visualization in the planning process: different phases place different requirements on visualization

8.3.1 Where does visualization fit into the planning process?

Getting started: movement and recognition stimulate interest

Awakening citizens' interest in the planning issues is the first step in participation. Our findings substantiated the statement that "Things that move attract attention." Movement and the possibility to interact with the model capture peoples' attention. For example, the VR model not only offer movement, but also allow people to become actively involved with the virtual landscape. However, the investigation also supported SCHROTH'S (2008) findings that the initial fascination of a moving model wears off when the viewers become familiar with it.

Realism and the perspective of the image also play a role in attracting viewers' interest. The findings indicate that recognition of the personal landscape in a realistic image influences the emotional involvement of the participants. Furthermore, the eye-level view provides the viewer with a familiar perspective that promotes identification with and interest in the landscape. The panorama photo, which showed a panable, realistic, eye-level view of the landscape, was especially successful in attracting the citizens' interest and stimulating discussion about the landscape in the case study.

Inventory phase: realism helps elicit local knowledge

Presenting and communicating information about the existing site is central to the inventory phase. The importance of realism and accurate visualizations in the site inventory to introduce base-line data and planning issues was substantiated by the visualization survey and the planning experts. A realistic visualization not only draws participants into the planning issues, it also draws out their local knowledge. For the participants, a realistic portrayal of the existing landscape was important to help them recognize their landscape, which in turn, promoted identification and orientation.

Photorealistic visualization methods such as aerial, panoramas, and photomontages gave the citizens a sense of familiarity and credibility, and helped to elicit comments about the landscape. In the case study, the aerial photos proved to be a good starting point to draw citizens into the initial phase of the landscape plan, e.g. by locating their own houses on the aerial photos. The movement, overview, and realism of the panorama photos provided a good basis for residents to contribute their local knowledge about the landscape.

Concept phase: geotypical or georeferenced visualizations

The evidence in the investigation and the literature suggests two different approaches to visualization in the concept phase. The debate focuses on the amount of realism that should be used in this phase:

- **Georeferenced** –Site-specific abstract visualizations: Because the planning ideas are not yet concrete in the concept phase, the visualization should be abstract or stylized. This approach suggests that schematic images such as sketches (AL-KODMANY 2002) or abstract versions of possible planning proposals (COCONU et al. 2005) can be used to show spatial relationships without including detail.
- **Geotypical -** Realistic visualizations of generic sites: Another approach is using realistic images of similar planning situations to discuss potential future development possibilities. Realistic images that do not show the actual site, but rather a comparable site, give a clearer picture than a abstract image of how the development of different goals and objectives could look. However, the viewers must mentally transfer the concepts to the actual site.

In the case study, the visualization was tested for the most part in later planning phases. More investigation is needed to determine which kinds of visualization best support the concept phase of the planning process. The suitability of these two approaches for discussing concept development with citizens should be compared in a real-life situation in order to examine participants' reactions and requirements.

The experts regarded interactivity important in the development of concept and ideas. Although interactivity means less realism or detail, the experts considered interactivity more important than detail when contemplating different alternatives in this phase.

Planning measures: a mix is needed

The evidence clearly speaks for a combination of visualization methods in the planning measure phase. Two-dimensional methods such as maps and aerial photos are important for overview and orientation. Photorealistic methods help to picture the landscape change. Real-time models empower the participants to explore the site themselves and support credibility. The interactive comparison of before-and-after images played a central role in the discussion, either to explain measures, to illustrate an opinion, or even to support decisions about alternatives. The point at which the viewers perceive the combination of visualization methods to be an “overload” instead of helpful is not clear and needs further investigation.

Furthermore, the planning experts were cautious about using too much realism in the visualization of planning measures. Although they felt realism is expected most at the end of the process, they warned that sufficient, detailed data must be available. The dilemma remains of providing realism in the visualization of the simulated planning proposals, while at the same time indicating the uncertainty of the actual planning measures.

VR models show lineal landscape elements best

It was hypothesized that the physical form of the landscape elements that are discussed may influence the choice of visualization methods. The findings of the survey indicate that there is no clear preference for point information. However, the discussion of lineal landscape elements, such as roads or bicycle paths, are best portrayed with VR models or animations. For area information a visualization that presents an overview – either 2D or bird's-eye view – was more important than photorealism.

Visualization methods do not stand alone; they are a planner's tool

The visualization is embedded in a larger presentation context. The investigation showed that the images are an important instrument in the discussion of planning issues with participants, but that images can only support the discussion with planners, not replace it. Repeatedly, the visualization experts emphasized the importance of additional information. The planner's contextual information, e.g. an explanation of the visualized planning measures or additional background information, was essential to help citizens understand and interpret the visualization. In the case study, the visualization appeared to function as a communication tool in the discussion between the planner and the citizens. By explaining the visualizations, the planner had the opportunity to discuss misunderstandings and conflicts about the planning measure with citizens.

8.3.2 The facilitator is central to successful use of visualizations

Facilitators play an important role in integrating the visualization into the participatory setting. However, the facilitator cannot force participants to use the visualization in the discussion. Ideally, the facilitator should be involved in the production of the visualization, so that she has experience using the visualization method and is familiar with its capabilities and limitations. However, the responsibility for actually operating the visualization should be borne by an additional facilitator. The use of visualization in the participatory session requires careful planning and scripting and when possible, a trial run of the session in order to ensure a smooth presentation and good teamwork. Furthermore, the meeting facilitator and the visualization facilitator also need to be familiar with the planning area in order to localize participants' comments.

The using visualizations in participation also presents new tasks for the facilitator. Beyond acquiring experience with the visualization methods and making the necessary preparations for using the visualizations in discussions, the facilitator must ensure that the participants understand and can follow the visualizations during participatory sessions. The facilitator must allow enough time for the following:

- **Orientation:** Ensure that the participants are well oriented in the visualization throughout the session.

- **Demonstration:** Introduce and demonstrate the capabilities of the available visualization methods, i.e. navigation possibilities and interactivity, so that viewers understand what it can (and cannot) do.
- **Explanation:** Explain background information about the visualization, i.e. how it was produced and what kind of data was used, so that participants can understand the validity and limitations of the visualization.
- **Coordination:** Coordinate the visualization with the discussion, e.g. ensure that the visualization shows the areas being discussed.
- **Documentation:** Document comments and results of the discussion using the visualization.

8.4 Reflection

8.4.1 If a rerun of the investigation were possible

Pilot project was ahead of its time

Like so many researchers, I wish I could repeat the investigation, knowing what I know today. At the time the study was carried out, it was exploratory in nature, investigating broad hypotheses about the usefulness of different visualization methods because little experience had been gathered with the technologies in a participatory setting. The investigation is useful because it provides a broad comparison of visualization techniques in a real-life setting, and it tests a method for their observation. However, knowing what we know today from investigations about different aspects of visualization, e.g. interactivity or realism, the questions could now focus more on how the visualizations are used and less on which characteristics of the visualization are important.

In a sense, the pilot project was ahead of its time, which is the intrinsic problem of pilot projects. DSL internet connection was unavailable, computer literacy among citizens was lower than today, and the majority of households did not have access to the internet. In 2002, 43% of German households had an internet connection as compared to 69% in 2008. None of the households had broadband connections in 2002, which was important for downloading visualization files, whereas 73% of the households with internet connection in 2008 had broadband connections (CZAJKA & MOHR 2009). In part, the pilot project was meant to introduce citizens to the new technology. Therefore, the handling of the computer to view the visualizations was more of an issue in 2004 than it would be today. Today, the investigation could focus more on the visualization methods and less on familiarizing citizens to the new technology.

Videotaping captures everything

The comparison of the quasi-experiment and the case study showed that people actually behave differently in a real-life situation than they “think” they would react, i.e. what was recorded in the survey. The participants' reactions to the visualization in a real planning situation were sometimes unexpected and revealed the importance of testing the methods in a participatory environment. It was not always possible to predict which aspect of the participation or visualization would be important to observe. Videotaping the participants’ reactions to the visualization would have provided more evidence and reduced the risk of missing an important reaction. Furthermore, videos offer the possibility to check and re-evaluate the evidence, which helps to prevent investigator bias. However, in the investigation, the planners discouraged the taping of the session for fear the presence of video equipment might intimidate or disturb participants. Since the time of the investigation, video technology has become smaller and the cameras less imposing. and this technology has been used successfully in the investigation of participant behavior in workshops that use visualization (SALTER et al. 2009; SCHROTH 2008).

Contextual factors need more consideration

In the case study, it was not possible to control the multitude of factors which influenced how the visualization was used or the factors which influence the reaction of the participants (APPLETON& LOVETT 2005). The wide variety of visualization methods, which were tested under the uncontrolled conditions of the case study, supplied a patchwork of evidence that made it difficult to produce conclusive results about the different methods. Instead, the investigation gave an overall picture of the advantages and disadvantages of the methods in participation. If the investigation were to be undertaken again, an attempt would be made to keep the contextual factors more comparable, as far as possible in a case study, and to investigate fewer methods, but also to test them in all the investigations in order to achieve more direct comparability of the methods.

VRML model software

The visualizations were developed over a three-year period during the research project. New developments in the visualization techniques were incorporated and tested as the project progressed. For this reason, different developments in visualization methods were tested during different phases of the investigation. For example, the VirtualGIS VRML model was tested in the initial visualization surveys, whereas the Scene Express VRML model was used in the last participation investigation in the case study. The VRML models improved greatly during the period of the investigation. The Scene Express VRML model was considerably more realistic than the VirtualGIS model. Therefore, it was difficult to compare the two VRML models because the quality of the graphics was so drastically different. Ideally, the Scene Express VRML model should have been used from the beginning, but it was not available at the time.

8.4.2 Surprises of the investigation

In retrospect, two main aspects of the investigation were surprising. First of all, the importance of "getting the stakeholders on board" prior to the participation sessions was unexpectedly significant. Understanding the issues that concerned the citizens and stakeholders was key to the development and the successful use of the visualization in the participation process. When citizens needed to clarify fundamental or non-site-related issues, the visualization was of little use in the discussion. Planners need to be aware of the issues which are important to the citizens, and these issues need to guide the decisions about the appropriate visualization method. It is hypothesized that the more the participants are involved in the planning and determination of which issues should be discussed, the more likely it is that the visualization will be used by the participants.

Furthermore, the group dynamics and discussion leaders can play a surprisingly large role in how the visualization is perceived. The same visualization can be perceived to be an acceptable basis for group discussion of planning issues, or it can be seen as a biased simulation which can divide and upset the viewers. Especially a realistic image has the potential to trigger strong emotional reactions to the planning proposal (NICHOLSON-COLE 2005). Finally, the importance of scripting the participation session for the successful integration of the visualization into the participation session became very clear by the end of the case study.

Second of all, both the number of decisions involved in developing visualizations for citizen participation as well as the number of people who must partake in the decisions – from planners to stakeholders – was surprisingly high. The coordination of the planner's objectives, the needs and interests of the stakeholders, and the technical requirements necessitated numerous discussions and decisions for which nearly as much time was needed as for the actual production of the visualization.

8.5 Unanswered research questions for future investigation

8.5.1 How is the production of the visualization integrated into the process?

Questions remain, such as "Who produces the visualization?" Is it the planner, who has background information about the landscape and is involved in the planning decisions but may not be versed in the visualization software; or should an external visualization specialist be hired to create the visualizations, who must be briefed on the landscape and planning issues? What role does the person creating the visualization have in planning decisions? APPLETON & LOVETT (2005) point out that the person creating the visualization makes decisions about many factors – content, style, viewpoint, etc. – which affect the outcome of the visualization. What effect do these decisions have on the resulting visualization and its use in the participation? An investigation of this decision process would shed light on how the person producing the visualization influences the outcome of the visualization.

Furthermore, the question remains of when and how often visualizations should be made during the planning process. What does this depend upon? The production of a visualization requires time and money. Therefore, it is necessary to consider at what point in the process the planner should invest in a visualization. Finally, how is the time needed to produce the visualization reflected in the planning process? Can planning decisions be made early enough to allow sufficient time to produce the visualization for the participation sessions, or does the visualization force the planner to make decisions too early in the process?

8.5.2 Which visualization should be integrated into the early phases of the planning process?

In the case study, the visualization was tested primarily in the inventory phase or the final planning phases, in which the existing landscape and concrete planning measures were discussed with citizens. The suitability and use of visualization were explored minimally in the concept phase because there was less public participation than in the other phases. Two approaches to visualizations for the concept phase were identified in this investigation which deserve comparison: geotypical and georeferenced images. In the conceptual or visioning phase of planning, the visual simulations serve as grounded metaphors in reality for the participants (KWARTLER 2005). More study should be devoted to examining which visualizations serve as the best metaphor for concept development and visioning.

In addition to studying the integration of the visualization in earlier planning phases, ways to link the visualization more directly to decision making need exploration, so that it is more than just “nice to have”, as Lange expressed it in his interview. He suggested that the visualization comes too late in the planning process, when most people have already made up their mind about the planning proposals. The actual capacity of the visualization to change peoples opinions or attitudes was not explored in this investigation. The significance of visualization to influence attitudes or behaviour has been recognized in the context of climate change scenarios (NICHOLSON-COLE 2005; SHAW et al. 2009; SHEPPARD 2006) and deserves further investigation in the landscape planning context.

8.5.3 What is the planners’ perspective on visualization?

This investigation focused on the citizens’ ability to understand and use the visualization in the participatory setting and not on the planners' perspective. However, the planners’ insight into the process would have been an interesting addition. Understanding the planners’ attitudes about how the visualization affects the planning process, either supporting or hindering their planning tasks and decisions, could provide additional insight into how useful planners consider the visualization to be and how willing they are to use it. In his interview, Lange suggested that incorporating public participation and visualization into the planning process requires planners to adjust to new time and financial demands. This change in the planning system may not come easily.

8.5.4 What consequences does enhanced interactivity have for participation?

At the time of the investigation, a very limited kind of interactivity was available to the participants. With the visualization methods tested here, it was not possible to visualize interactive changes to the landscape scenario in order to ask “what-if” questions “on the fly”. The responses to the limited visualization clearly showed that citizens want and use interactivity when it is available. However, new visualization methods that allow users to test different scenarios, such as CommunityViz, have been tested by SALTER et al. (2009) and STOCK et al. (2007) Those investigators have found that this kind of interactivity also increased time and information requirements for effective use in participation.

Furthermore, the participants in the case study did not have the opportunity to actually interact with the visualization themselves during the participatory events. A facilitator always ran the visualization, thus the investigation did not explore the usability of the visualization by the citizens. Moreover, the lack of high-speed internet connections in Königslutter made it difficult for participants to use the VRML models over the internet. Therefore, the investigation did not determine how easily citizens could use the interactive methods or how willing they were to do so.

How much information can participants manage?

The increased availability of information and improved interactivity of the visualization may result in both increased public interest and involvement, as well as more empowerment of citizens in the planning process. The question arises as to whether or not this will improve the planning results. Increased public input or control by participants may not necessarily lead to better planning decisions. Therefore, more study should be devoted to the implications of better informed and more empowered citizens in the participation process of landscape planning.

The possibilities to integrate more non-visual information into the visualization through a scenario model which attempts to reflect the complexity of the planning decisions requires the citizen to assimilate an increasing amount of information and to understand the complex relationships of scenario factors. At which point is the citizen overwhelmed by the information? In other words, the amount and kind of information participants can manage and the limiting factors need investigation.

How much is left up to the citizen?

The new possibilities to interact with scenario models and to visualize different alternatives present new opportunities for collaborative discussion of the planning proposals. But how should collaborative discussion be organized and how much autonomy should the citizens have in developing scenarios? Can citizens develop their own scenarios under expert supervision? In such cases, the facilitation and expert input become key. While the participants determine the questions and criteria for analysis, does the visualization remain the tool for understanding the results?

Will the increased ability of the citizens to independently explore the visualization and determine the questions improve the quality of the planning process? Are planners prepared to give the citizen more space to develop their own ideas, in a sense giving the citizen more power to make suggestions? Does visualization help citizen involvement in planning decisions move up the Arnstein ladder of participation? SHEPPARD & SALTER (2004) point out that "*It is not clear whether the increasing choice and control by the viewer necessarily improves the decision making and validity*." These question remain unanswered.

Is the technology influencing the planning question?

The answer to the larger question of whether the technology used in the case study influenced the planning questions is not conclusive. To some extent, sites or situations were chosen for the participation sessions that could be visualized well with the visualization methods that were to be tested. For example, the planners in Rottorf first suggested that a proposal for residential development be visualized with the photomontage method. This was rejected by the visualization team on the grounds that the plan was not concrete enough and there was too little information about the proposed architecture to illustrate it in detail. Instead, a concrete planning measure – the removal of a row of trees along a country road – was visualized in a photomontage. Thus, there was a certain selection of sites and issues based, in part, on their suitability to test the visualization methods. This reflects the findings throughout the investigation as well as in the literature, that the suitability of the visualization depends not only on the audience, the planning questions, the data, and other contextual factors; but also on the potential influence of the technology in the selection of planning issues.

It is remains unclear exactly how the visualization impacts the planning questions that we ask, or whether the technology affects the planning process, and how decisions are made. It is clear, however, that the visualization emphasizes the visual aspect of the planning question and that planners need to provide contextual information about the image for participants, such as background or additional information that helps them to judge the credibility of and interpret what they are seeing in an ecological context.

Does the visualization influence the group dynamics?

It was observed that the group dynamics affected how the visualization was accepted by the participants. This raises the question about the inverse. How does the visualization affect the group dynamics? Can it defuse conflicts in participation or does the realistic image fuel existing conflicts? In the case study, the visualization offered a common image, a quasi-virtual space in which the participants could communicate and discuss aspects of the planning. The concept of shared virtual space as seen, for example, in the phenomenon of Second Life shows how well people can imagine and "live" in a virtual space. Research about how people behave in virtual spaces shows that people communicate differently in a common virtual space than in a face-to-face conversation (FRIEDMAN ET AL. 2007). Can the visualization offer a shared virtual space, in which there is less confrontation? Can the concept of planning in virtual spaces lead to more cooperative planning?

8.6 Visualization methods with potential for the future

Since the IALP was carried out, visualization technologies have grown more sophisticated, hardware has become more powerful, and new technologies have been developed that have new potential for use in public participation.

Virtual globes: Google Earth

Virtual globes such as Google Earth have rapidly gained in popularity since their introduction in 2005. The public has embraced its interactivity and realistic satellite images as well as the ability to see a landscape from a 3D perspective. Google Earth makes 2D maps into 3D representations, which users can view and navigate on their own. In a sense, Google Earth has brought 3D models to the public. Google Earth makes interactivity, movement, and realism possible, and this attracts and fascinates the public.

Social scientists argue that Google Earth supports an enhanced spatial and social experience and that the internet is not a space radically distinct from that of the real world (JENSEN 2010). Moreover, the scientific community recognizes opportunities to use virtual globes (e.g. ESRI Virtual Globe Web) to access spatial information (BUTLER 2006). The combination of Google Earth, GIS data, sketch-up models and GPS information opens a new era of interactivity and access to information. Furthermore, Google Earth offers a spatially based approach to organizing information which can be personalized and continually updated (JENSEN 2010).

The technology is inclusive and communicative, but is it reliable and valid? Can one always believe what one sees in Google Earth? It remains unclear how virtual globes can be integrated into the public participation process, and what role they will play in official decision-making processes, and what codes of practice should be followed with virtual globes (SHEPPARD & CIZEK 2009). The use of virtual globes in planning participation raises many questions but also many opportunities and deserves future investigation.

YouTube

YouTube movies are a new way of disseminating information to the public that provides high accessibility and the ease and immediacy of the movie media. YouTube provides opportunities to inform citizens about landscape planning issues and to educate wider audiences. For example in the case study, a film about the renaturalization of the Schunter River was produced at considerable expense and shown once to citizens at a town meeting in Beienrode. YouTube provides a perfect platform to disseminate such information to a larger audience, so that citizens can easily inform themselves before attending a meeting. A more informed public can lead to a more meaningful participation.

YouTube not only offers improved accessibility to information, but also the opportunity to document meetings for citizens who could not attend. In a sense, it offers a live record. YouTube also allows one to broadcast a message quickly, passionately, and inexpensively.

Landscape visualization with scenario modelling: more interactivity and answers to “what-if” questions

The capability to visualize modelled information and to work interactively with the model has improved significantly since the case study in Königslutter was carried out. Integrated modelling and visualization systems such as Place3S, What If?, and CommunityViz allow participants to ask “what-if” questions about landscape scenarios. These interactive GIS-based scenario analysis tools integrate real-time modes and visualization capabilities; they also have the potential to change citizen participation into a much more active and collaborative process (NIEMANN & LIMP 2004). These programs can manage and represent information in a manner that helps communities understand the complexities of the planning issues, and they enable citizens to interact with the information and each other (SALTER et al. 2009). Citizens can build scenarios and investigate planning alternatives based on different trade-offs in the planning decisions. Furthermore, the integration of non-visual factors in the development of scenario models provides more meaningful interactivity and thus more collaborative discussion of the planning proposals. Sheppard points out the direction and impact such software can have on public participation:

“Visualizations may move from being an end-product of planning activities or stand modelling exercises, to acting as a gateway to the planning or modelling process, through which new model runs or ‘what-if’ scenarios can be triggered directly and results browsed.” (SHEPPARD & SALTER 2004)

The type and characteristics of a visualization become less important. Instead, the challenge is how to manage, introduce, and utilize the visualizations and the supporting information.

8.7 Outlook

The results show that low-end visualization methods such as aerial photos and topographic maps still have their place in the discussion with citizens and can complement the newer visualization methods. As the hardware becomes more powerful and the software more sophisticated and flexible, the trade-off between interactivity and realism may become less problematic. When this is the case, the choice of visualization methods for participation may become less critical. Instead, the questions of how, when, and where visualization should be used will become more decisive. This investigation substantiated the fact that visualization is a vehicle to understand the planning, and its presence brings actors together to discuss the planning issues. A common image – whether right or wrong – means that people discuss and exchange ideas, debate opinions, and hopefully learn from each other. In the future, facilitating the discussion and use of visualization may be as important as the actual choice of visualization method.

Furthermore, the question of the future may no longer be "What do participants need in order to understand the visualization?" but rather, "At which point do they become overwhelmed by the information and choices presented in the visualization?" In an information-rich society, the preparation of the information, so that citizens can understand the issues, and the pre-selection of the information based on its importance and relevance become critical considerations for the visualization.

With the increased ability to ask “what-if” questions of modelled scenarios, new credibility questions will most certainly arise. Can we trust the new outputs? Are they a black box? Will people trust them because they are “scientific”, or will there be a healthy mistrust as there is with photorealistic visualizations? The software can now integrate more information into the scenario, and users can interactively manipulate the scenario and see the output image quickly and easily. Can the scenario-modelled visualization be made transparent enough so that citizens can evaluate its validity?

Throughout the literature, there are warnings against simulating future conditions with more detail and exactness than is possible based on the available data. Will future visualization methods such as virtual globes have similar problems? How can interactive models with unlimited access be regulated, and how should the planning community respond to the new capabilities of such visualizations? In the future, the core issues associated with visualizations will undoubtedly remain the same: credibility, validity, and comprehension.

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Appendix A

Table 35: Overview of investigation parameters used in the preliminary visualization survey

PRELIMINARY VISUALIZATION SURVEY (Quasi-experimental setting)				
Test group Date	**Research questions**	**Research method**	**Data**	**Visualization type**
Informed students 01.07.2003	• Which visualization types provide good support for orientation and spatial understanding? • Which visualization types are preferred for discussing point, line, or area information? • How important are the visualization characteristics of realism, dynamic navigation, multiple viewpoints, and before-and-after images for understanding the planning? • Do participants prefer certain visualization types or combinations of types and, if so, why? • Which visualization types do participants prefer for developing and explaining their ideas?	Questionnaire (quantitative and qualitative data)	17 students (4th semester; 13 female, 4 male)	Comparison of visualization types with demonstration and questionnaire • topographic map, • aerial photos, • rendering of 3D model • photo, • panorama photo • 3D animation in bird's-eye and pedestrian perspectives • interactive photomontage simulation
Lay group 19.08.2003	• Which visualization types support orientation and spatial understanding well? • Which visualization types are preferred for discussing point, line, or area information? • How important are the visualization characteristics of realism, dynamic navigation, multiple viewpoints, and before-and-after images for understanding the planning?	Questionnaire, (quantitative and qualitative data)	20 participants (8 < 20 years old, 11 female, 9 male)	Comparison of visualization types with demonstration and questionnaire • topographic map • aerial photos • rendering of 3D model • photo • panorama photo • 3D animation in bird's-eye and pedestrian perspective • interactive photomontage simulation

Test group Date	Research questions	Research method	Data	Visualization type
Lay group 19.08.2003 (continued)	• Do participants prefer certain visualization types or combination of types and, if so, why? • Which visualization types do participants prefer for developing and explaining their ideas?			
Young planners 22.10.2003	• How do different visualization types compare in terms of credibility, realism, and support of spatial understanding? • What is the importance of dynamic navigation, realism, and viewpoint interactivity of content (before/after)? • Which visualization types are suitable for different planning tasks?	Questionnaire (quantitative and qualitative data)	62 participants	Comparison of visualization types with demonstration and questionnaire • black-and-white plan • orthoperspective • diagram • topographic map • aerial photograph • VNS rendering • 3D model rendering (Virtual GIS) • photo • panorama photo • 3D animation in bird's-eye and pedestrian perspectives • interactive photomontage simulation

Table 36: Overview of research questions, research, and visualization methods, and participant groups involved in the case study investigations in Königslutter am Elm

CASE STUDY IN KÖNIGSLUTTER AM ELM				
Place Date	**Research questions**	**Research method**	**Data**	**Visualisation methods tested**
Visual Assessment				
Rottorf 04.06.2003 (town meeting)	• How do participants respond to realistic visualizations in a meeting setting? To dynamic navigation (panorama photo)? Do participants accept photorealistic simulations (photomontage) as credible? • What is the public's general acceptance of visualization and digital media in a town meeting situation?	Questionnaire (quantitative), observations	24 participants 11 question-naires returned	Visualization: • Photomontage simulation • Panorama photos
Rottorf 13.06.2003 (site visit and discussion)	• Which kinds of visualization types are used in a discussion, when and for what reason?	Observation, conversations	12 participants Written minutes of observation of the discussion (1 h 15 min)	Presentation and discussion: • Panorama photos • Aerial photos • Topographic maps
Gross Steinum 20.06.2003 (town meeting)	• Which visualization types are preferred by participants to understand the planning suggestions? • Which visualization type supports spatial orientation? • Importance of seeing planning alternatives (interactivity)? • Is there sufficient realism? • Is the viewpoint satisfactory?	Questionnaire, observations	17 participants, 8 questionnaire s returned	• Interactive hedgerow simulation (photomontage) • Maps • Panorama photo
Rottorf 8.07.2003 (workshop)	• Does photomontage support collaborative planning? • Can participants use the visualization to develop their own ideas and suggestions? • What are the constraints?	Observation	3 participants	• Hands-on photomontage simulation of planting along the Lutter River • Panorama photo

Place Date	Research questions	Research method	Data	Visualisation methods tested
Rottorf July 2003	• How do participants evaluate the visualization in the planning setting?	Telephone interview	3 participants	
		Nature Protection		
Bornum 15.03.2004 (town meeting)	Comparison of four visualization methods in practice	Questionnaire (quantitative), observation, video	30 participants, 29 questionnaires returned observation record	Town meeting topic: Nature protection scenario • Photomontage (LaViTo) • LandXplorer/Lennè 3D • VNS rendering (LaViTo) • Sketches
		Flood Plain Renaturalization		
Beiendorf 25.05.2004 (town meeting)	• How do participants respond to dynamic 3D models in a participation setting? • Is the visualization sufficiently realistic to convey planning content? • How difficult is orientation in interactive 3D models? • Do participants follow or even use the dynamic navigation of a VRML model? • What needs to be considered for the integration of a combination of visualization methods in a participation setting? • What is the importance of before-and-after images? • What role does film play in participation setting? How do participants respond?	Questionnaire, (quantitative, one open question), video record	22 participants, 15 questionnaires returned, video? record	Town meeting topic: river renaturalization • VNS rendering (LaViTo) • Scene Express VRML model • Topographic map

Table 37: Overview of the expert groups and investigation focus of the different expert surveys

EXPERTS				
Survey group Date	**Research question**	**Research method**	**Data**	**Setting**
IALP expert workshop (Hannover) 13.11.2003	• How important are photorealism and interactivity in the different planning phases?	Questionnaire	21 respondents	Expert workshop
IALP advisory board meeting (Königslutter) 09.06.2004	• Which methods support orientation? • Which methods help assess planning? • Are visualization methods sufficiently realistic to understand planning content? • How important are dynamic navigation and interactivity? • Which methods are most convincing in participatory planning?	Keypads, questionnaire, (quantitative) discussion	Advisory board, approx. 15 participants	Advisory board workshop in Königslutter – comparison of : • Photomontage (LaViTo) • LandXplorer/Lennè 3D • VNS rendering (LaViTo) • Sketches
Visualization expert interviews 05.2007-11.2008	• Review preliminary results with visualization experts	Interviews with experts, review of IALP supervisory board protocols	7 experts	Face-to-face and telephone interviews

Table 38: Interviewed visualization experts
Professor Ian Bishop, Department of Geomatics, The University of Melbourne, Parkville, Victoria, Australia, (Interview from 09.2008)
Stephen Ervin, Director of Computer Resources and Assistant Dean for Information Technology, Harvard Design School, Cambridge, Ma., (Interview from 05.2007)
Professor Eckart Lange, Department of Landscape, The University of Sheffield, Sheffield, UK, (Interview 11.2008)
Professor Mark Lindhult (FASLA), Department of Landscape Architecture and Regional Planning, University of Massachusetts, Amherst, MA 01003, (Interview from 05.2007)
Professor Andrew Lovett, School of Environmental Sciences, University of East Anglia, Norwich, UK, (Interview from 08.2008)
Associate Professor Jim Palmer, Department of Landscape Architecture, SUNY College of Environmental Science and Forestry, Syracuse, NY, (Interview from 05.2007)
Stephen Sheppard, Department of Forest Resources Management Faculty of Forestry The University of British Columbia, Vancouver, British Columbia Canada, (Interview from 06.2008)

Table 39: Correlation of young planners' ratings of credibility, spatial understanding and realism using the Kruskal-Wallis test, (α=0,0208 according to the Boniferroni Adjustment)

Visualization type	Correlating factors, α=0,0208			p value	Pearson chi²	df
Black-and-white plan	credibility,	spatial understanding,	realism	0,0001	32,145	8
Black-and-white plan	spatial understanding,	realism		0,2822	5,05	4
Persp. plan	credibility,	spatial understanding,	realism	0,0002	30,432	8
Persp. plan	spatial undersatnding,	realism		0,045	9,878	4
Persp. plan	credibility,	realism		0,0178	11,941	4
Persp. plan	credibility,	spatial undersanding		<,0001	21,642	3
Topo map	credibility,	spatial undersanding,	realism	< 0,0001	39,152	8
Topo map	spatial understanding,	realism		0,0044	15,15	4
Topo map	credibility,	realism		0,0002	22,496	4
Topo map	credibility,	spatial understanding		0,0069	12,16	3
Aerial photo	credibility,	spatial understanding,	realism	0,4066	8,28	8
Aerial photo	spatial undersatnding,	realism		0,2174	5,765	4
Aerial photo	credibility,	realism		0,338	3,37	3
Aerial photo	credibility,	spatial understanding		0,7301	2,031	4
VNS rendering	credibility,	spatial understanding,	realism	< 0,0001	31,417	8
VNS rendering	spatial understanding,	realism		0,0003	20,948	4
VNS rendering	credibility,	realism		0,6377	2,6377	4
VNS rendering	credibility,	spatial understanding		< 0,0001	25,756	4
Panorama photo	credibility,	spatial understanding,	realism	0,6218	4,407	6
Panorama photo	spatial understanding,	realism		0,6888	1,472	3
Panorama photo	credibility,	realism		0,2427	4,133	3
Panorama photo	credibility,	spatial understanding		0,5537	2,091	3

Table 39: Correlation of young planners' ratings of credibility, spatial understanding and realism using the Kruskal-Wallis test, (α=0,0208 according to the Boniferroni Adjustment)

Visualization type	Correlating factors, α=0,0208			p value	Pearson chi^2	df
Rendering (VirtualGIS)	credibility,	spatial understanding,	realism	< 0,0001	33,158	8
Renderingr (VirtualGIS)	spatial understanding,	realism		< 0,0001	26,559	4
Rendering (VirtualGIS)	credibility,	realism		0,0063	14,342	4
Rendering (VirtualGIS	credibility,	spatial understanding		0,017	12,042	4
Photomontage	credibility,	spatial understanding,	realism	0,089	13,732	8
Photomontage	spatial understanding,	realism		0,4847	2,009	3
Photomontage	credibility,	realism		0,0976	7,839	4
Photomontage	credibility,	spatial understanding		0,059	9,087	4
Animation bird's-eye	credibility,	spatial understanding,	realism	0,0008	26,601	8
Animation bird's-eye	spatial understanding,	realism		0,0004	20,759	4
Animation bird's-eye	credibility,	realism		0,0007	19,137	4
Animation bird's-eye	credibility,	spatial understanding		0,5469	3,065	4
VRML model (VirtualGIS)	credibility,	spatial understanding,	realism	0,0065	21,261	8
VRML model (VirtualGIS)	spatial understanding,	realism		0,0017	17,242	4
VRML model (VirtualGIS)	credibility,	realism		0,0096	13,382	4
VRML model (VirtualGIS)	credibility,	spatial understanding		0,9494	0,716	4
Interactive Photomontage	credibility,	spatial understanding,	realism	0,5467	6,907	8
Interactive Photomontage	spatial understanding,	realism		0,8707	1,245	4
Interactive Photomontage	credibility,	realism		0,4121	3,956	4
Interactive Photomontage	credibility,	spatial understanding		0,2857	3,784	3

Appendix B

Questionnaire I (Informed students, 01.07.2003) (Lay group, 19.08.2003)

Questionnaire I (Young planners, 22.10.2003)

Questionnaire (IALP expert workshop,13.11.2003)

Questionnaire (IALP advisory board experts, 09.06.2004)

Questionnaire (Rottdorf investigation, 04.06.2003)

Questionnaire (Bornum investigation, 09.06.2004)

Questionnaire (Beienrode investigation, 26.05.2004)

Questionnaire (Groß Steinum investigation, 23.06.2003)

Befragung zum Einsatz von Visualisierung in der Landschaftsplanung

am 19.08.2003

Liebe Teilnehmer,

im folgenden werden Ihnen verschiedene Visualisierungsmöglichkeiten vorgestellt. Um deren Eignung für den Planungsprozess einschätzen zu können, möchten wir Sie bitten, die folgenden Fragen möglichst spontan und vollständig zu beantworten. Vielen Dank!

A. Allgemeine Angaben

1. Geschlecht ☐ männlich ☐ weiblich
2. Alter ___ Jahre
3. Beruf ______________________________
4. Wie oft haben Sie in den letzten 3 Monaten virtuell begehbare 3D-Modelle benutzt (z.B. Computerspiele, virtuelle Landschaftsmodelle u.ä.)?

   ☐ Nie. ☐ 1-5 mal. ☐ 5-10 mal. ☐ Über 10 mal.

5. Das visualisierte Beispielgebiet befindet sich in Groß Steinum, Ort der Stadt Königslutter am Elm. Kennen Sie dieses Gebiet?

   ☐ Ja. ☐ Nein.

B. Fragen zur räumlichen Orientierungsleistung der verschiedenen Visualisierungen

Versetzen Sie sich in folgende Lage: Sie möchten dem Ort Groß Steinum einen Besuch abstatten. Vorher verschaffen Sie sich einen Überblick über das Gemeindegebiet.

I. Topographische Karte

1. Fällt Ihnen die räumliche Orientierung mit Hilfe der Topographischen Karte eher schwer oder eher leicht?

   schwer 1 2 3 4 5 **leicht**

2. Welche Inhalte der Darstellung helfen Ihnen bei der Orientierung?

   ____

   ____

3. Was könnte Ihnen Ihrer Meinung nach die Orientierung erleichtern?

   ____

   ____

4. Fällt es Ihnen eher leicht oder eher schwer, sich die dargestellte Landschaft vor Ihrem „inneren Auge“ vorzustellen?

   schwer 1 2 3 4 5 **leicht**

II. Luftbild

5. Fällt Ihnen die räumliche Orientierung mit Hilfe des Luftbildes eher schwer oder eher leicht?

   schwer 1 2 3 4 5 **leicht**

6. Welche Inhalte der Darstellung helfen Ihnen bei der Orientierung?

   ____

   ____

7. Was könnte Ihnen Ihrer Meinung nach die Orientierung erleichtern?

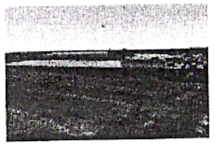
   ____

   ____

8. Fällt es Ihnen eher leicht oder eher schwer, sich die dargestellte Landschaft vor Ihrem „inneren Auge“ vorzustellen?

schwer 1 2 3 4 5 **leicht**

III. Ausschnitt 3D-Modell



9. Fällt Ihnen die räumliche Orientierung mit Hilfe des Ausschnittes aus einem digital erzeugtem 3D-Modell eher schwer oder eher leicht?

schwer 1 2 3 4 5 **leicht**

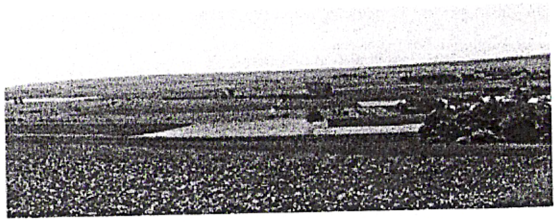
10. Welche Inhalte der Darstellung helfen Ihnen bei der Orientierung?

11. Was könnte Ihnen Ihrer Meinung nach die Orientierung erleichtern?

12. Fällt es Ihnen eher leicht oder eher schwer, sich die dargestellte Landschaft vor Ihrem „inneren Auge“ vorzustellen?

schwer 1 2 3 4 5 **leicht**

IV. Fotographische Abbildung



13. Fällt Ihnen die räumliche Orientierung mit Hilfe der Fotographischen Abbildung eher schwer oder eher leicht?

schwer 1 2 3 4 5 **leicht**

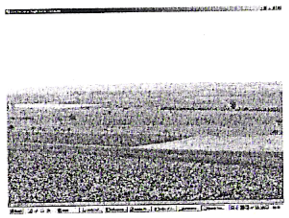
14. Welche Inhalte der Darstellung helfen Ihnen bei der Orientierung?

15. Was könnte Ihnen Ihrer Meinung nach die Orientierung erleichtern?

16. Fällt es Ihnen eher leicht oder eher schwer, sich die dargestellte Landschaft vor Ihrem „inneren Auge“ vorzustellen?

schwer 1 2 3 4 5 **leicht**

V. Panorama-Bild



17. Fällt Ihnen die räumliche Orientierung mit Hilfe des Panoramabildes eher schwer oder eher leicht?

schwer 1 2 3 4 5 **leicht**

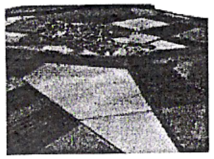
18. Welche Inhalte der Darstellung helfen Ihnen bei der Orientierung?

19. Was könnte Ihnen Ihrer Meinung nach die Orientierung erleichtern?

20. Fällt es Ihnen eher leicht oder eher schwer, sich die dargestellte Landschaft vor Ihrem „inneren Auge“ vorzustellen?

schwer 1 2 3 4 5 **leicht**

VI. 3D-Animation/ Vogelperspektive



21. Fällt Ihnen die räumliche Orientierung mit Hilfe der 3D-Animation aus der Vogelperspektive eher schwer oder eher leicht?

schwer 1 2 3 4 5 **leicht**

22. Welche Inhalte der Darstellung helfen Ihnen bei der Orientierung?

___

___

23. Was könnte Ihnen Ihrer Meinung nach die Orientierung erleichtern?

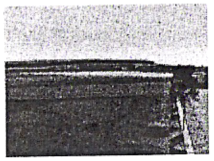
___

___

24. Fällt es Ihnen eher leicht oder eher schwer, sich die dargestellte Landschaft vor Ihrem „inneren Auge" vorzustellen?

schwer 1 2 3 4 5 **leicht**

VII. 3D-Animation/ Spaziergängerperspektive



25. Fällt Ihnen die räumliche Orientierung mit Hilfe der 3D-Animation aus der Spaziergängerperspektive eher schwer oder eher leicht?

schwer 1 2 3 4 5 **leicht**

26. Welche Inhalte der Darstellung helfen Ihnen bei der Orientierung?

___

___

27. Was könnte Ihnen Ihrer Meinung nach die Orientierung erleichtern?

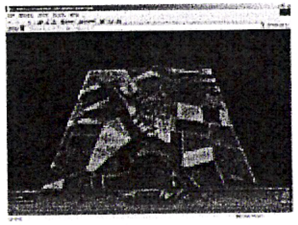
___

___

28. Fällt es Ihnen eher leicht oder eher schwer, sich die dargestellte Landschaft vor Ihrem „inneren Auge" vorzustellen?

schwer 1 2 3 4 5 **leicht**

VIII. Interaktives 3D-Modell



Versuchen Sie der Navigation zu folgen und kennzeichnen Sie bitte die jeweiligen Standpunkte in der beiliegenden Topographischen Karte (nächste Seite) in der Reihenfolge, in der sie angesteuert werden (1 für den ersten Haltepunkt, 2 für den zweiten Haltepunkt, etc.).

29. Fällt Ihnen die räumliche Orientierung mit Hilfe des interaktiven 3D-Modells eher schwer oder eher leicht?

schwer 1 2 3 4 5 **leicht**

30. Welche Inhalte der Darstellung helfen Ihnen bei der Orientierung?

___

___

31. Was könnte Ihnen Ihrer Meinung nach die Orientierung erleichtern?

___

___

32. Würden Sie sich leichter orientieren können, wenn Sie selber navigieren würden?

☐ Ja. ☐ Nein. ☐ Weiß nicht.

33. Fällt es Ihnen eher leicht oder eher schwer, sich die dargestellte Landschaft vor Ihrem „inneren Auge" vorzustellen?

schwer 1 2 3 4 5 **leicht**

34. Welche der vorgestellten Visualisierungen eignet sich Ihrer Meinung nach für die räumliche Orientierung am besten? (*bitte nur eine Antwortmöglichkeit ankreuzen*)

- ☐ Topographische Karte
- ☐ Luftbild
- ☐ Ausschnitt 3D-Modell
- ☐ Foto des Planungsgebiets
- ☐ Panorama-Bild
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ interaktives 3D-Modell

Warum? ______________________________

____

____

35. Würden Sie zum Zweck der Orientierung eine Kombination der vorgestellten Visualisierungen bevorzugen oder erachten Sie eine Darstellung alleine als völlig ausreichend?

☐ Ich finde eine Darstellung reicht für die räumliche Orientierung völlig aus.

☐ Ich würde eine Kombination von verschiedenen Visualisierungen wählen, um mich räumlich zu orientieren.

Bevorzugte Kombination:

- ☐ Topographische Karte
- ☐ Luftbild
- ☐ Ausschnitt 3D-Modell
- ☐ Foto des Planungsgebiets
- ☐ Panorama-Bild
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ interaktives 3D-Modell

36. Stellen Sie sich vor, Sie möchten die Standorte besonders schöner Bäume in der Landschaft zeigen. Welche Darstellungsmöglichkeit(en) finden Sie dafür am besten geeignet? (*mehrere Antworten möglich*)

- ☐ Topographische Karte
- ☐ Luftbild
- ☐ Ausschnitt 3D-Modell
- ☐ Foto des Planungsgebiets
- ☐ Panorama-Bild
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ interaktives 3D-Modell

Warum? ______________________________

____

____

37. Stellen Sie sich vor, Sie möchten einen Vorschlag für einen neu anzulegenden Radweg machen. Welche Darstellungsmöglichkeit(en) würden Sie verwenden, um Ihren Vorschlag zu erläutern? *(mehrere Antworten möglich)*

- ☐ Topographische Karte
- ☐ Luftbild
- ☐ Ausschnitt 3D-Modell
- ☐ Foto des Planungsgebiets
- ☐ Panorama-Bild
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ interaktives 3D-Modell

Warum?____

38. Stellen Sie sich vor, Sie möchten vorschlagen, wo einzelne Bäume in der Landschaft neu gepflanzt werden sollen. Welche Darstellungsmöglichkeit(en) würden Sie verwenden, um Ihren Vorschlag zu erläutern? *(mehrere Antworten möglich)*

- ☐ Topographische Karte
- ☐ Luftbild
- ☐ Ausschnitt 3D-Modell
- ☐ Foto des Planungsgebiets
- ☐ Panorama-Bild
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ interaktives 3D-Modell

Warum? ____

39. Stellen Sie sich vor, Sie möchten in einer Diskussionsrunde zeigen, welche Flächen für den Naturschutz wichtig sind. Welche Darstellungsmöglichkeit(en) finden Sie dafür am besten geeignet? *(mehrere Antworten möglich)*

- ☐ Topographische Karte
- ☐ Luftbild
- ☐ Ausschnitt 3D-Modell
- ☐ Foto des Planungsgebiets
- ☐ Panorama-Bild
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ interaktives 3D-Modell

Warum? ____

C. Fragen zur Visualisierung einer Planung

Ein Vorschlag aus dem Dorferneuerungsplan von Groß Steinum zur Pflanzung von Hecken in der Landschaft wird diskutiert. ***Als interessierter Bürger werden Sie gefragt, über die Auswirkung der Hecken auf das Landschaftsbild mitzureden.*** *Die folgenden sieben Darstellungen werden Ihnen als Hilfsmittel präsentiert, um sich den Planungsvorschlag vor Ort besser vorstellen zu können.*

I Topographische Karte

1. In wiefern hilft die **topographische Karte**, sich die Planungsvorschläge vorzustellen?

sehr geholfen 1 2 3 4 5 **nicht geholfen**

2. Hilft der Vergleich mit dem Ausgangszustand der Landschaft, sich die Planungsvorschläge besser vorzustellen?

☐ Ja ☐ Nein ☐ Teilweise

Kommentar____

II. Luftbild

3. In wiefern hilft das **Luftbild**, sich die Planungsvorschläge vorzustellen?

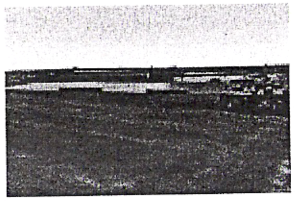
sehr geholfen 1 2 3 4 5 **nicht geholfen**

4. Hilft der Vergleich mit dem Ausgangszustand der Landschaft, sich die Planungsvorschläge besser vorzustellen?

☐ Ja ☐ Nein ☐ Teilweise

Kommentar____

III. Ausschnitt 3D-Modell



5. In wiefern hilft der **Ausschnitt aus dem 3D-Modell**, sich die Planungsvorschläge vorzustellen?

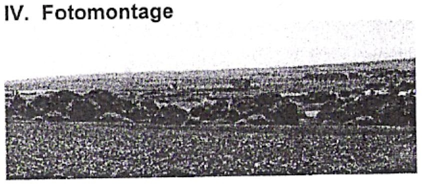
sehr geholfen 1 2 3 4 5 **nicht geholfen**

6. Hilft der Vergleich mit dem Ausgangszustand der Landschaft, sich die Planungsvorschläge besser vorzustellen?

☐Ja ☐Nein ☐Teilweise

Kommentar____

IV. Fotomontage



7. In wiefern hilft die **Fotomontage**, sich die Planungsvorschläge vorzustellen?

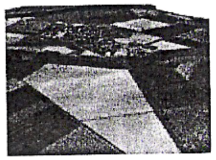
sehr geholfen 1 2 3 4 5 **nicht geholfen**

8. Hilft der Vergleich mit dem Ausgangszustand der Landschaft, sich die Planungsvorschläge besser vorzustellen?

☐Ja ☐Nein ☐Teilweise

Kommentar____

V. 3D-Animation/ Vogelperspektive

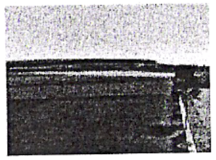


9. In wiefern hilft die **3D-Animation aus der Vogelperspektive**, sich die Planungsvorschläge vorzustellen?

sehr geholfen 1 2 3 4 5 **nicht geholfen**

Kommentar____

VI. 3D-Animation/ Spaziergängerperspektive

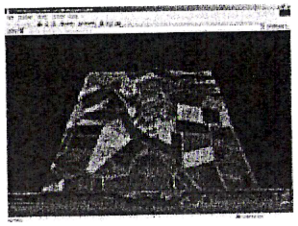


10. In wiefern hilft die **3D-Animation aus der Spaziergängerperspektive**, sich die Planungsvorschläge vorzustellen?

sehr geholfen 1 2 3 4 5 **nicht geholfen**

Kommentar____

VII. Interaktives 3D-Modell



11. In wiefern hilft das **Interaktive 3D-Modell**, sich die Planungsvorschläge vorzustellen?

sehr geholfen 1 2 3 4 5 **nicht geholfen**

Kommentar____

12. Einige Darstellungen wirken realistischer als andere. Wie wichtig war es für Sie, **eine realistische Darstellung der Planungsvorschläge zu sehen**, um sich die geplanten Veränderungen in der Landschaft vorzustellen?

sehr wichtig 1 2 3 4 5 **unwichtig**

Warum?______________________________

13. Bei einigen Darstellungen war es möglich, die Landschaft von mehren Standorten aus zu betrachten. Wie wichtig war es für Sie, **die Planung aus unterschiedlichen Richtungen zu betrachten**, um sich die geplanten Veränderungen in der Landschaft vorzustellen?

sehr wichtig 1 2 3 4 5 **unwichtig**

Warum?______________________________

14. Wenn Sie nur eine Darstellung zu sehen bekämen, um sich die Planungsvorschläge in der Landschaft vorzustellen, welche würden Sie wählen? *(bitte nur eine Antwortmöglichkeit ankreuzen)*

☐Topographische Karte
☐Luftbild
☐Ausschnitt 3D-Modell
☐ Fotomontage
☐3D-Animation/ Vogelperspektive
☐3D-Animation/ Spaziergängerperspektive
☐ interaktives 3D-Modell

Warum? ______________________________

D. Fragen zur Visualisierung von eigenen Planungsvorschlägen

Jetzt sind Sie als Bürger gefragt, Ihren eigenen Vorschlag zu formulieren, welche von den geplanten Hecken übernommen werden sollen. ***Sie sollen überlegen, welche Hecken das Landschaftsbild verbessern würden.***

1. Können Sie aufgrund der vorherigen Darstellungen der geplanten Hecken einen eigenen Planungsvorschlag machen?

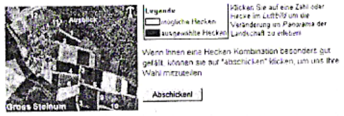
☐ Ja ☐ Nein ☐ Weiß ich nicht

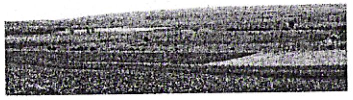
Wenn nein, welche Darstellung(en) möchten Sie noch mal sehen um ihren eigenen Vorschlag zu entwickeln? *(mehrere Antworten möglich)*

☐Topographische Karte
☐Luftbild
☐Ausschnitt 3D-Modell
☐ Fotomontage
☐3D-Animation/ Vogelperspektive
☐3D-Animation/ Spaziergängerperspektive
☐ interaktives 3D-Modell

Warum?______________________________

Als Entscheidungshilfe haben Sie die Möglichkeit im Internet, die unterschiedlichen Varianten der Hecken interaktiv auszuprobieren. Sie können die unterschiedlichen Hecken selber in der interaktiven Fotosimulation ein- und ausblenden.





Ques. 2

2. In wiefern hilft Ihnen die interaktive Simulation der Hecken, sich die Auswirkungen Ihres Vorschlags vorzustellen?

sehr geholfen 1 2 3 4 5 **gar nicht geholfen**

Warum?______________________________

3. Würden Sie die interaktive Darstellung im Internet nutzen, um verschiedene Vorschläge auszuprobieren? Oder halten Sie die Darstellungen eher für eine Spielerei?

Was meinen Sie? ____________________

____

____

4. Welche Darstellung hat Ihnen am meisten geholfen, ihre eigenen Planungsvorschläge zu entwickeln?

- ☐ Topographische Karte
- ☐ Luftbild
- ☐ Ausschnitt 3D-Modell
- ☐ Interaktive Fotosimulation
- ☐ Foto des Planungsgebiets
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ interaktives 3D-Modell

Warum? ____________________

____

____

5. Können Sie sich eine andere Darstellung oder Visualisierungsmöglichkeit vorstellen, die Ihnen helfen würden, ihre Planungsidee zu entwickeln?

☐ Ja ☐ Nein ☐ Weiß ich nicht

Wenn ja, welche? ____________________

____

____

Wir möchten Ihnen für Ihre Teilnahme an unserer Befragung herzlich danken!

Barty Warren-Kretzschmar und Daniela Hogrebe

Befragung zum Einsatz von Visualisierung in der Landschaftsplanung am 22.10.2003

Liebe Teilnehmer,

im folgenden werden Ihnen verschiedene Visualisierungsmöglichkeiten vorgestellt. Um deren Eignung für den Planungsprozess einschätzen zu können, möchten wir Sie bitten, die folgenden Fragen möglichst spontan und vollständig zu beantworten. Vielen Dank!

A. Allgemeine Angaben

1. Geschlecht ☐ männlich ☐ weiblich
2. Alter ___ Jahre
3. Semester ______

4. Wie oft haben Sie in den letzten 3 Monaten virtuell begehbare 3D-Modelle benutzt (z.B. Computerspiele, virtuelle Landschaftsmodelle u.ä.)?

   ☐ Nie. ☐ 1-5 mal. ☐ 5-10 mal. ☐ Über 10 mal.

5. Das visualisierte Beispielgebiet befindet sich in Groß Steinum, ein Ortsteil der Stadt Königslutter am Elm. Kennen Sie dieses Gebiet?

   ☐ Ja. ☐ Nein.

B. Fragen zur Visualisierung einer Planung

Situationsbeschreibung: *Ein Vorschlag aus dem Dorferneuerungsplan von Groß Steinum zur Pflanzung von Hecken in der Landschaft wird diskutiert.* ***Als interessierter Bürger werden Sie über die Auswirkung der Hecken auf das Landschaftsbild informiert****. Die folgenden zehn Darstellungen werden Ihnen als Hilfsmittel präsentiert, um sich die Planungssituation vor Ort und den Planungsvorschlag besser vorstellen zu können.*

I Schwarz / Weiß-Plan

1. Inwiefern hilft der **schwarz/weiß Plan**, sich die Planungsinhalte vorzustellen?

hilft sehr 1 2 3 4 5 **hilft nicht**

2. Wie wirkt die Darstellung auf Sie?

____

____

3. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalte in der Abbildung dargestellt?

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

4. Wie könnte man die Glaubwürdigkeit erhöhen?

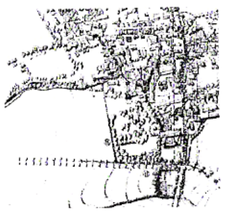
____

____

5. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1 2 3 4 5 **abstrakt**

II Perspektivische Plandarstellung



6. Inwiefern hilft die **perspektivische Plandarstellung**, die Planungsinhalte zu verstehen?

hilft sehr 1 2 3 4 5 **hilft nicht**

7. Wie wirkt die Darstellung auf Sie?

____

____

8. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalte in der Abbildung dargestellt?

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

9. Wie könnte man die Glaubwürdigkeit erhöhen?

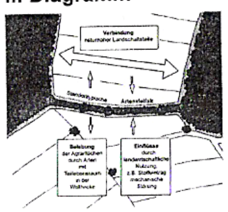
____

____

10. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1 2 3 4 5 **abstrakt**

III Diagramm



11. Inwiefern hilft das **Diagramm**, die Planungsinhalte zu verstehen?

hilft sehr 1 2 3 4 5 **hilft nicht**

12. Wie wirkt die Darstellung auf Sie?

____

____

IV Topographische Karte

13. Inwiefern hilft die **topographische Karte**, die Planungsinhalte zu verstehen?

hilft sehr 1 2 3 4 5 **hilft nicht**

14. Wie wirkt die Darstellung auf Sie?

____

____

15. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalte in der Abbildung dargestellt?

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

16. Wie könnte man die Glaubwürdigkeit erhöhen?

____

____

17. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1 2 3 4 5 **abstrakt**

V. Luftbild

18. Inwiefern hilft das **Luftbild**, die Planungsinhalte zu verstehen?
hilft sehr 1 2 3 4 5 **hilft nicht**

19. Wie wirkt die Darstellung auf Sie?

____

____

20. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalt in der Abbildung dargestellt?

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

21. Wie könnte man die Glaubwürdigkeit erhöhen?

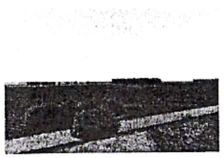
____

____

22. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1 2 3 4 5 **abstrakt**

VI. Fotorealistische 3D-Darstellung (VNS)



23. Inwiefern hilft die **fotorealistische 3D-Darstellung,** sich die Planungsinhalte vorzustellen?
hilft sehr 1 2 3 4 5 **hilft nicht**

24. Wie wirkt die Darstellung auf Sie?

____

____

25. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalte in der Abbildung dargestellt?

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

26. Wie könnte man die Glaubwürdigkeit erhöhen?

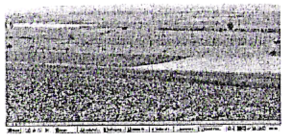
____

____

27. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1..... 2 3 4 5 **abstrakt**

VII Panoramabild



28. Inwiefern hilft das **Panoramabild**, sich das Planungsgebiet vorzustellen?
hilft sehr 1 2 3 4 5 **hilft nicht**

29. Wie wirkt die Darstellung auf Sie?

____

____

30. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalte in der Abbildung dargestellt?

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

31. Wie könnte man die Glaubwürdigkeit erhöhen?

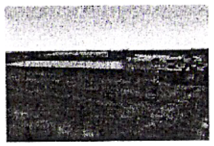
____

____

32. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1 2 3 4 5 **abstrakt**

VIII. Ausschnitt 3D-Modell



33. Inwiefern hilft der **3D-Modell Ausschnitt,** sich die Planungsinhalte vorzustellen?
hilft sehr 1 2 3 4 5 **hilft nicht**

34. Wie wirkt die Darstellung auf Sie?

____

____

35. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalte in der Abbildung dargestellt?

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

36. Wie könnte man die Glaubwürdigkeit erhöhen?

____

____

37. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1 2 3 4 5 **abstrakt**

IX. Fotomontage

38. **Inwiefern hilft die** Fotomontage, **sich die Planungsinhalte vorzustellen?**

hilft sehr 1 2 3 4 5 **hilft nicht**

39. Wie wirkt die Darstellung auf Sie?

____

____

40. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalte in der Abbildung dargestellt?

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

41. Wie könnte man die Glaubwürdigkeit erhöhen?

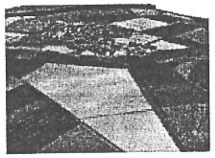
____

____

42. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1 2 3 4 5 **abstrakt**

X. 3D-Animation/ Vogelperspektive



43. Inwiefern hilft die **3D-Animation/Vogelperspektive**, sich die Planungsinhalte vorzustellen?

hilft sehr 1 2 3 4 5 **hilft nicht**

44. Wie wirkt die Darstellung auf Sie?

____

____

45. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalte in der Abbildung dargestellt?

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

46. Wie könnte man die Glaubwürdigkeit erhöhen?

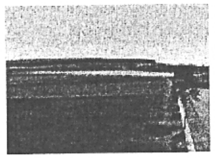
____

____

47. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1 2 3 4 5 **abstrakt**

XI. 3D-Animation/ Spaziergängerperspektive



48. Inwiefern hilft die **3D-Animation/Spaziergängerperspektive**, sich die Planungsinhalte vorzustellen?

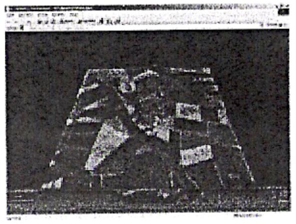
hilft sehr 1 2 3 4 5 **hilft nicht**

49. Wie wirkt die Darstellung auf Sie?

____

____

XII. Interaktives 3D-Modell



50. Inwiefern hilft das **interaktive 3D-Modell**, sich die Planungsinhalte vorzustellen?

hilft sehr 1 2 3 4 5 **hilft nicht**

51. Wie wirkt die Darstellung auf Sie?

____

____

52. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalte in der Abbildung dargestellt?.

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

53. Wie könnte man die Glaubwürdigkeit erhöhen?

____

____

54. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1 2 3 4 5 **abstrakt**

XIII. Interaktive Fotosimulation

55. Inwiefern hilft die **interaktive Fotosimulation**, sich die Planungsinhalte vorzustellen?

hilft sehr 1 2 3 4 5 **hilft nicht**

56. Wie wirkt die Darstellung auf Sie?

____

____

57. Wie **glaubwürdig** schätzen Sie die Darstellung ein? Damit ist gemeint, wie korrekt oder wahrheitsgetreu werden die Planungsinhalte in der Abbildung dargestellt?

glaubwürdig 1 2 3 4 5 **unglaubwürdig**

58. Wie könnte man die Glaubwürdigkeit erhöhen?

____

____

59. Wie **realistisch** oder **abstrakt** wirkt die Darstellung auf Sie?

realistisch 1 2 3 4 5 **abstrakt**

Allgemeine Fragen:

60. Einige Darstellungen wirken realistischer als andere. Wie wichtig war es für Sie, **eine realistische Darstellung der Planungsvorschläge zu sehen**, um sich die geplanten Veränderungen in der Landschaft vorzustellen?

sehr wichtig 1 2 3 4 5 **unwichtig**

Warum?____

____

____

61. Bei einigen Darstellungen war es möglich, die Landschaft von mehreren Standorten aus zu betrachten. Wie wichtig war es für Sie, **die Planung aus unterschiedlichen Richtungen zu betrachten**, um sich die geplanten Veränderungen in der Landschaft vorzustellen?

sehr wichtig 1 2 3 4 5 **unwichtig**

Warum?____

____

____

62. Einige Darstellungen haben die Möglichkeit geboten, den Ausgangszustand der Landschaft mit der Simulation der Planungsvorschläge zu vergleichen. Wie wichtig war es für Sie, beide Darstellung zu sehen?

sehr wichtig 1 2 3 4 5 **unwichtig**

Warum?________________________________

63. Bei zwei Darstellungen (Fotosimulation und 3D-Modell) war es möglich, die Darstellung selber zu steuern. Wie wichtig ist die Interaktivität für Sie?

sehr wichtig 1 2 3 4 5 **unwichtig**

Warum?________________________________

64. Wenn Sie nur eine Darstellung zu sehen bekämen, um sich die Planungsvorschläge in der Landschaft vorzustellen, welche würden Sie wählen? *(bitte nur eine Antwortmöglichkeit ankreuzen)*

- ☐ Schwarz/Weiß-Plan
- ☐ Perspektivische Plandarstellung
- ☐ Diagramm
- ☐ Topographische Karte
- ☐ Luftbild Ausschnitt 3D-Modell
- ☐ Fotorealistische 3D-Darstellung
- ☐ Panorama-Bild
- ☐ Ausschnitt D3-Modell
- ☐ Fotomontage
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ Interaktives 3D-Modell
- ☐ Interaktive Fotomontage

Warum? ________________________________

65. Welche Darstellung(en) würden Sie verwenden, wenn Sie Bürgern und Planungsbeteiligten Hintergrundinformationen zur Bestandserfassung und zum Landschaftsplan veranschaulichen möchten? *(mehrere Antworten möglich)*

- ☐ Schwarz/Weiß-Plan
- ☐ Perspektivische Plandarstellung
- ☐ Diagramm
- ☐ Topographische Karte
- ☐ Luftbild Ausschnitt 3D-Modell
- ☐ Fotorealistische 3D-Darstellung
- ☐ Panorama-Bild
- ☐ Ausschnitt D3-Modell
- ☐ Fotomontage
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ Interaktives 3D-Modell
- ☐ Interaktive Fotomontage

Andere:________________________________

66. Welche Darstellung(en) würden Sie verwenden, um die Ergebnisse der Konzeptentwicklung des Landschaftsplans den Bürgern und Planungsbeteiligten zur erläutern? *(mehrere Antworten möglich)*

- ☐ Schwarz/Weiß-Plan
- ☐ Perspektivische Plandarstellung
- ☐ Diagramm
- ☐ Topographische Karte
- ☐ Luftbild Ausschnitt 3D-Modell
- ☐ Fotorealistische 3D-Darstellung
- ☐ Panorama-Bild
- ☐ Ausschnitt D3-Modell
- ☐ Fotomontage
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ Interaktives 3D-Modell
- ☐ Interaktive Fotomontage

Andere:________________________________

67. Welche Darstellung(en) sind für die Visualisierung von geplanten Maßnahmen Ihre Meinung nach geeignet? *(mehrere Antworten möglich)*

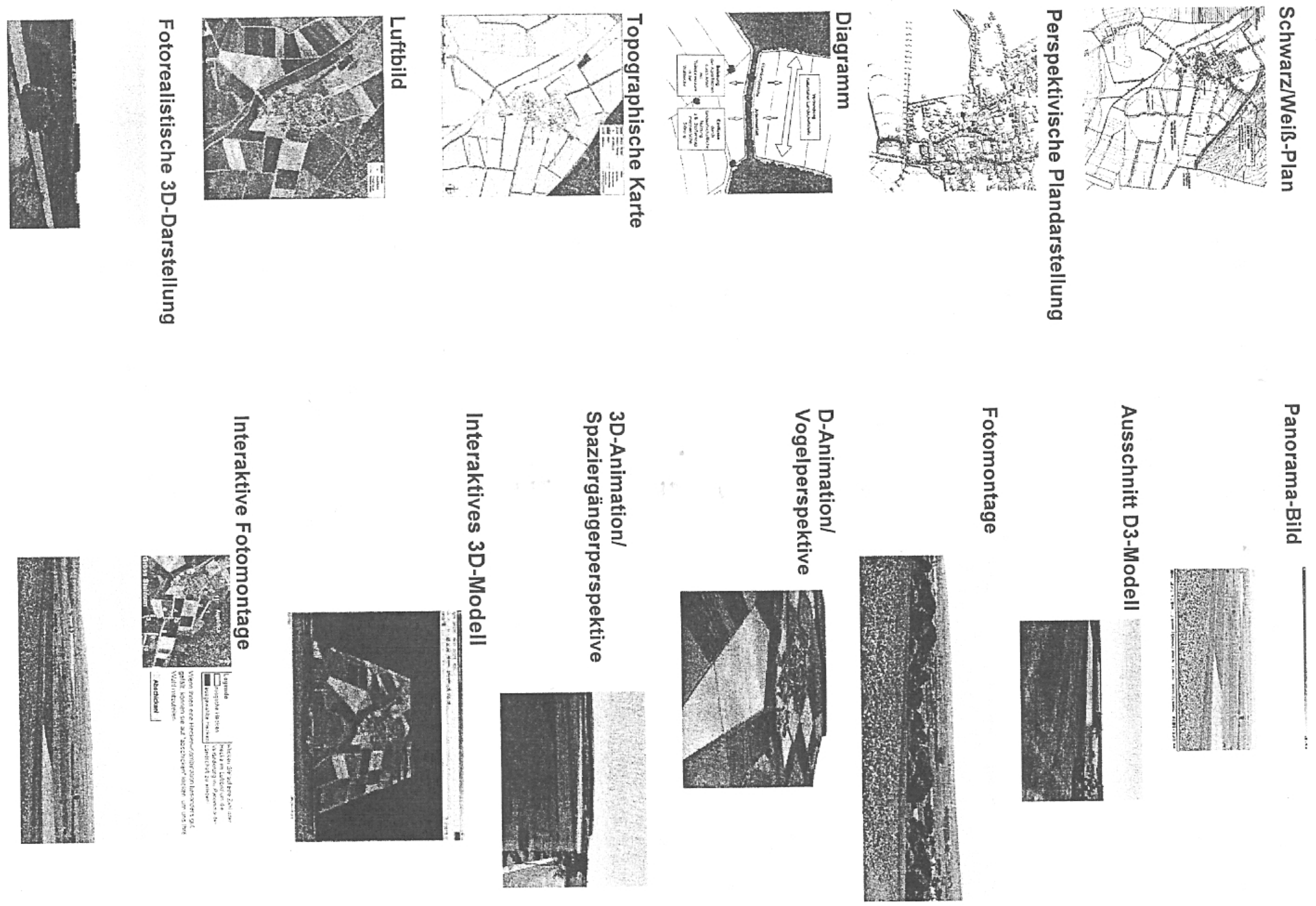
- ☐ Schwarz/Weiß-Plan
- ☐ Perspektivische Plandarstellung
- ☐ Diagramm
- ☐ Topographische Karte
- ☐ Luftbild Ausschnitt 3D-Modell
- ☐ Fotorealistische 3D-Darstellung
- ☐ Panorama-Bild
- ☐ Ausschnitt D3-Modell
- ☐ Fotomontage
- ☐ 3D-Animation/ Vogelperspektive
- ☐ 3D-Animation/ Spaziergängerperspektive
- ☐ Interaktives 3D-Modell
- ☐ Interaktive Fotomontage

Andere:________________________________

Die Visualisierungsbeispiele wurden von Daniela Hogrebe, Anne Meise und Barty Warren-Kretzschmar vorbereitet.

Ich möchte Ihnen für Ihre Teilnahme an unserer Befragung herzlich danken!

Barty Warren-Kretzschmar



Interaktiver Königslutter am Elm
Landschaftsplan

Visualisierung in der Planung - Expertenbefragung am 13. November 2002

Ein zentraler Aspekt in der Konzeption des interaktiven Landschaftsplanes ist die Einbindung von Landschaftsvisualisierung in den Planungsprozess. Die Herausforderung besteht darin, die unterschiedlichen Visualisierungsangebote effektiv und situationsgerecht einzusetzen. Inwiefern sind die Visualisierungsqualitäten **Realismus und Interaktivität** wichtig für ein besseres Verständnis der Planung?

Wie beurteilen Sie als Planungsexperten die Notwendigkeit von realistischen und interaktiven Visualisierungen in den unterschiedlichen Planungsphasen?` Mit anderen Worten:

- Wie wichtig ist eine möglichst **realistische Darstellung** der Planungsinhalte für das Planungsverständnis in den unterschiedlichen Planungsphasen?
- Wie wichtig ist eine möglichst **interaktive Visualisierung** der Information, d.h. selber navigieren oder unterschiedliche Simulationen selber steuern, um die Planung zu verstehen?

*Bitte bewerten Sie die Wichtigkeit der beiden Visualisierungsqualitäten in den Planungsphasen mit einer Skala von **1(unwichtig)** bis **3(sehr wichtig)**:*

Visualisierungsqualität	3= sehr wichtig **2** = wichtig **1** = unwichtig	**Planungsphasen** **Bestandserfassung** Heutiger Zustand der Schutzgüter	**Bewertung** Wirkungs- und Risikoanalyse	**Ziel- und Maßnahmenkonzept** Leitbilder / Entwicklungsziele Schutz-, Pflege und Entwicklungsmaßnahmen
	Realistische Darstellung: Luftbilder, Photos und Photorealistische Darstellungen			
	Interaktive Darstellung: selber Navigation, veränderbare Darstellung			

Kommentar:____

____

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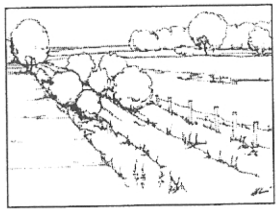
Universität Hannover

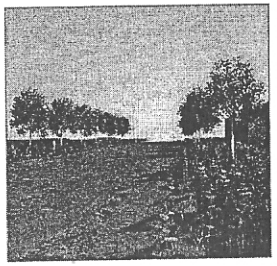
Königslutter

Workshop: Visualisierung

Beiratssitzung am 09. Juni 2004

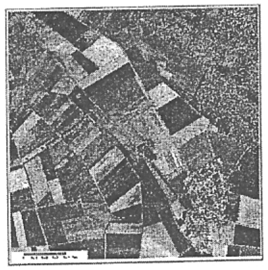


Skizzen

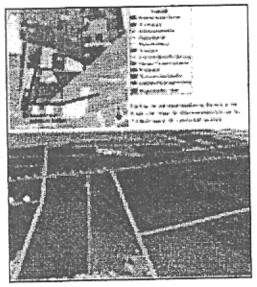


Virtuelle Spatziergang (Lenné3D)

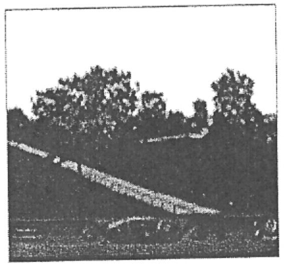
Fotomontage



3D-Karte (Land Explorer)



Computererzeugte Darstellung (VNS)



3D-Modell (VRML) (VRML)

Fragebogen: Befragung der Beiratsmitglieder am 9. Juni 2004

A. Allgemeine Angaben

A1- Wo ist Ihr Wohnort?

1. Königslutter und Umgebung **2.** anderer Wohnort

A2. Welchem Geschlecht gehören Sie an?

1. männlich **2.** weiblich

A3. Welcher Altersgruppe gehören Sie an?

1. 20-29 Jahre **2.** 30-39 Jahre **3.** 40-49 Jahre **4.** 50+ Jahre

A4. Überwiegende berufliche Tätigkeit:

1. Planungsbüro **2.** Behörde **3.** Lehre und Forschung **4.** Sonstige

A5. Wie oft benutzen Sie virtuelle 3D-Modelle (privat oder beruflich), z.B. Computerspiele, virtuelle Landschaftsmodelle u.ä.?

1. nie. **2.** einige Male im Jahr **3.**einige Male im Monat **4.** mehrere Male der Woche

B. Fragen zu allen Visualisierungsmethoden:

1. Skizzen

B1. Welchen Sätzen stimmen Sie für diese Visualisierungsmethode zu? (zutreffende Antworten ankreuzen)

1. Ich kann mich gut orientieren.
2. Die Darstellung ist realistisch genug, um die Planungsinhalte zu verstehen.
3. Die Darstellung ist glaubwürdig, d. h. ich glaube, die Planung könnte so aussehen.
4. Ich kann mir die Situation mit den und ohne die Planungsvorschläge gut vorstellen.
5. Die Visualisierung ist leicht zu bedienen.

B2. Hat Ihnen bei der Visualisierung etwas gefehlt? (zutreffende Antworten ankreuzen)

1. die Möglichkeit, selber zu bestimmen, von wo aus ich die Planung betrachte.
2. die Möglichkeit, die Situationen vorher und nachher miteinander zu vergleichen.
3. die Möglichkeit, unterschiedliche Planungsvarianten zu sehen.
4. die Möglichkeit, neue Planungsvorschläge einzubringen und darzustellen.
5. etwas anderes (bitte mündlich an die Moderation)

2. Fotomontage

B1. Welchen Sätzen stimmen Sie für diese Visualisierungsmethode zu? (zutreffende Antworten ankreuzen)

6. Ich kann mich gut orientieren.
7. Die Darstellung ist realistisch genug, um die Planungsinhalte zu verstehen.
8. Die Darstellung ist glaubwürdig, d. h. ich glaube, die Planung könnte so aussehen.
9. Ich kann mir die Situation mit den und ohne die Planungsvorschläge gut vorstellen.
10. Die Visualisierung ist leicht zu bedienen.

B2. Hat Ihnen bei der Visualisierung etwas gefehlt? (zutreffende Antworten ankreuzen)

6. die Möglichkeit, selber zu bestimmen, von wo aus ich die Planung betrachte.
7. die Möglichkeit, die Situationen vorher und nachher miteinander zu vergleichen.
8. die Möglichkeit, unterschiedliche Planungsvarianten zu sehen.
9. die Möglichkeit, neue Planungsvorschläge einzubringen und darzustellen.
10. etwas anderes (bitte mündlich an die Moderation)

3. Virtual Nature Studio

B1. Welchen Sätzen stimmen Sie für diese Visualisierungsmethode zu? (zutreffende Antworten ankreuzen)

11. Ich kann mich gut orientieren.
12. Die Darstellung ist realistisch genug, um die Planungsinhalte zu verstehen.
13. Die Darstellung ist glaubwürdig, d. h. ich glaube, die Planung könnte so aussehen.
14. Ich kann mir die Situation mit den und ohne die Planungsvorschläge gut vorstellen.
15. Die Visualisierung ist leicht zu bedienen.

B2. Hat Ihnen bei der Visualisierung etwas gefehlt? (zutreffende Antworten ankreuzen)

11. die Möglichkeit, selber zu bestimmen, von wo aus ich die Planung betrachte.
12. die Möglichkeit, die Situationen vorher und nachher miteinander zu vergleichen.
13. die Möglichkeit, unterschiedliche Planungsvarianten zu sehen.
14. die Möglichkeit, neue Planungsvorschläge einzubringen und darzustellen.
15. etwas anderes (bitte mündlich an die Moderation)

4. Lenné3D

B1. Welchen Sätzen stimmen Sie für diese Visualisierungsmethode zu? (zutreffende Antworten ankreuzen)

16. Ich kann mich gut orientieren.
17. Die Darstellung ist realistisch genug, um die Planungsinhalte zu verstehen.
18. Die Darstellung ist glaubwürdig, d. h. ich glaube, die Planung könnte so aussehen.
19. Ich kann mir die Situation mit den und ohne die Planungsvorschläge gut vorstellen.
20. Die Visualisierung ist leicht zu bedienen.

B2. Hat Ihnen bei der Visualisierung etwas gefehlt? (zutreffende Antworten ankreuzen)

16. die Möglichkeit, selber zu bestimmen, von wo aus ich die Planung betrachte.
17. die Möglichkeit, die Situationen vorher und nachher miteinander zu vergleichen.
18. die Möglichkeit, unterschiedliche Planungsvarianten zu sehen.
19. die Möglichkeit, neue Planungsvorschläge einzubringen und darzustellen.
20. etwas anderes (bitte mündlich an die Moderation)

5. VRML

B1. Welchen Sätzen stimmen Sie für diese Visualisierungsmethode zu? (zutreffende Antworten ankreuzen)

21. Ich kann mich gut orientieren.
22. Die Darstellung ist realistisch genug, um die Planungsinhalte zu verstehen.
23. Die Darstellung ist glaubwürdig, d. h. ich glaube, die Planung könnte so aussehen.
24. Ich kann mir die Situation mit den und ohne die Planungsvorschläge gut vorstellen.
25. Die Visualisierung ist leicht zu bedienen.

B2. Hat Ihnen bei der Visualisierung etwas gefehlt? (zutreffende Antworten ankreuzen)

21. die Möglichkeit, selber zu bestimmen, von wo aus ich die Planung betrachte.
22. die Möglichkeit, die Situationen vorher und nachher miteinander zu vergleichen.
23. die Möglichkeit, unterschiedliche Planungsvarianten zu sehen.
24. die Möglichkeit, neue Planungsvorschläge einzubringen und darzustellen.
25. etwas anderes (bitte mündlich an die Moderation)

C. Vergleich der Visualisierungsmethoden

C1 – Bei welchen Darstellungen ist Ihnen die Orientierung leicht gefallen? (mehrere Antworten möglich, Ranking nach Schwierigkeit: die leichteste Darstellung zuerst)

1. Karten und Luftbilder
2. Skizzen
3. Fotomontage
4. Computererzeugte Darstellung (VNS)
5. 3D-Karte (Lenné3D)
6. Virtueller Spaziergang (Lenné3D)
7. 3D-Modell (VRML)
8. alle unproblematisch

C2 - Welche bildlichen Darstellungen haben Ihnen geholfen, sich die möglichen Maßnahmen vorzustellen? (mehrere Antworten möglich)

1. Karten und Luftbilder
2. Skizzen
3. Fotomontage
4. Computererzeugte Darstellung (VNS)
5. 3D-Karte (Lenné3D)
6. Virtueller Spaziergang (Lenné3D)
7. 3D-Modell (VRML)
8. keine

C3 - Welche bildlichen Darstellungen haben Ihnen geholfen, die Auswirkungen der möglichen Maßnahmen besser zu beurteilen, um Ihre eigene Meinung zu bilden?

1. Karten und Luftbilder
2. Skizzen
3. Fotomontage
4. Computererzeugte Darstellung (VNS)
5. 3D-Karte (Lenné3D)
6. Virtueller Spaziergang (Lenné3D)
7. 3D-Modell (VRML)
8. keine

C4 - Wenn sie eine oder eine Kombination von Visualisierungsmethoden benutzen könnten, um Bürgern geplante Naturschutzmaßen überzeugend zu präsentieren, welche würden Sie benutzen?

1. Karten und Luftbilder
2. Skizzen
3. Fotomontage
4. Computererzeugte Darstellung (VNS)
5. 3D-Karte (Lenné3D)
6. Virtueller Spaziergang (Lenné3D)
7. 3D-Modell (VRML)
8. keine

D. Über den Einsatz der Abstimmungsgeräte

D1 - Wurde die Diskussion durch Einsatz der Abstimmungsgeräte in dieser kleinen Gruppe eher behindert oder gefördert?

1. behindert 4. gefördert 2. weiß nicht

D2 - Sind Sie Ihre Meinung besser losgeworden?

1. ja 4. nein 2. weiß nicht

D3 – Meinen Sie, dass die Abstimmungsgeräte zu einem demokratischen Ergebnis beitragen?

1. ja 4. nein 2. weiß nicht

D4 – Wie zufrieden sind Sie mit den Ergebnissen des Workshops?

1. sehr zufrieden
2. zufrieden
3. teils - teils
4. unzufrieden
5. sehr unzufrieden

Vielen Dank! Projekt-Team „Interaktiver Landschaftsplan“

P.S.: **Sonstige Anmerkungen** zum Einsatz der bildlichen Darstellungen bei der heutigen Veranstaltung können Sie uns auf der Rückseite dieses Fragebogens mitteilen.

Interaktiver Landschaftsplan Königslutter   Universität Hannover

Fragebogen zur Visualisierung in der Bürgerversammlung zum Thema Landschaftsbild am 4. Juni 2003

Wir interessieren uns für Ihre Meinung zum Einsatz von Visualisierungen heute abend und möchten Sie bitten die folgenden Fragen zu beantworten. Wir bedanken uns für Ihre Unterstützung.

Das Team des interaktiven Landschaftsplans
Ansprechpartner: Barty Warren-Kretzschmar Tel.: 0511 / 762-5279

Simulation der Beseitigung der Pappelreihe an der L644 in Rottorf:

1. Konnten Sie sich durch die Fotos gut orientieren?

☐ ja ☐ nein ☐ zum Teil

2. Wirkten die Darstellungen auf Sie realistisch?

☐ ja ☐ nein ☐ zum Teil

3. Haben die Fotos Ihnen geholfen, sich die landschaftliche Situation an dem Teich besser vorzustellen?

☐ ja ☐ nein ☐ zum Teil

4. War es für Sie nützlich, die Maßnahme aus verschiedenen Blickrichtungen zu betrachten?

☐ ja ☐ nein ☐ zum Teil

5. Hat die Simulation Ihnen dabei geholfen, die Auswirkungen der Maßnahmen zu verstehen?

☐ ja ☐ nein ☐ zum Teil

Einsatz von bewegten Panoramabilder in der Bürgerversammlung:

6. Haben die Panoramabilder Ihnen geholfen, sich die landschaftliche Situation in Rottorf und Groß Steinum besser vorzustellen?

☐ ja ☐ nein ☐ zum Teil

7. Haben die Panoramabilder Ihnen dabei geholfen, die Diskussion über das Landschaftsbild mitzuverfolgen?

☐ ja ☐ nein ☐ zum Teil

8. Konnten Sie sich in den Panoramabildern gut orientieren?

☐ ja ☐ nein ☐ zum Teil

Interaktiver Landschaftsplan Königslutter   Universität Hannover

Fragebogen zur Visualisierung im Arbeitskreis zum Thema Landschaftsbild am 20. Juni 2003

Lieber Arbeitskreisteilnehmer!
Wir interessieren uns für Ihre Meinung zum Einsatz von Visualisierungen in den Arbeitskreisen und möchten Sie bitten, die folgenden Fragen zu beantworten.

Vielen Dank von dem Team des interaktiven Landschaftsplans
Ansprechpartner: Barty Warren-Kretzschmar Tel.: 0511 / 762-5279

1. In beiden Arbeitskreissitzungen wurden mehrere Visualisierungsmöglichkeiten benutzt, um die Diskussion zu unterstützen. Wir möchten wissen, ob sie tatsächlich geholfen haben, die Diskussionsvorschläge besser mitzuverfolgen? Wie würden Sie sie bewerten?

	sehr geholfen				gar nicht geholfen
Topografische Karte	1	2	3	4	5
Thematische Karte: (Grundbesitz, Biotoptypen)	1	2	3	4	5
Luftbilder	1	2	3	4	5
Panoramabild	1	2	3	4	5
Fotomontage	1	2	3	4	5

2. War die Vielfalt an Darstellungsmöglichkeiten hilfreich in der Diskussion oder verwirrend?
☐ hilfreich ☐ verwirrend ☐keine Meinung

3. Welche Darstellung hat Sie bei der räumlichen Orientierung am besten unterstützt?
☐Topographische Karte ☐Luftbild ☐Panoramabild ☐ keine

4. Würden Sie sagen, dass eine Kombination von Darstellungen für die Orientierung nützlich war oder ist eine Darstellung alleine ausreichend?
☐ Mehre Darstellungen waren nützlich für die Orientierung.

☐ Eine Darstellung reicht aus, und zwar:
1. ☐ Topographische Karte
2. ☐ Luftbild
3. ☐ Panoramabild

5. Meinen Sie, dass die Fotomontage der geplanten Hecken realitätsgetreu dargestellt wurde?
☐ ja ☐ nein ☐ zum Teil

6. War der Blickpunkt für die Fotomontage richtig ausgewählt oder hätten Sie die Situation von woanders lieber betrachten wollen?
☐ Blickpunkt war in Ordnung ☐ lieber von woanders, wo?________________

7. Wie wichtig war es für Sie, unterschiedliche Planungsalternativen zu der Heckenstruktur während der Diskussion zu sehen?
unwichtig 1 2 3 4 5 **wichtig**

8. Was hat Ihnen an der Visualisierung in den Arbeitsgruppen am Besten gefallen?

____

____

____

Fragebogen: Bildliche Darstellungen (Visualisierungen) in der Maßnahmendiskussion zum Landschaftsplan Königslutter am Elm

Während der Vorträge und der Diskussion zu den vorgestellten Maßnahmen haben Sie heute Abend unterschiedliche, bildliche Darstellungen gesehen. Wir interessieren uns für Ihre Meinung. **Inwieweit treffen die folgenden Aussagen auf Sie zu?** (bitte ankreuzen)

F1 - Die bildlichen Darstellungen (z. B. Vorher-Nachher-Fotomontagen, 3D-Darstellungen) haben mir geholfen, mir mögliche Maßnahmen vorzustellen.

☐ trifft zu ☐ trifft nicht zu ☐ trifft teilweise zu ☐ weiß nicht

F2 - Durch die bildlichen Darstellungen kann ich die positiven und negativen Auswirkungen der möglichen Maßnahmen besser beurteilen.

☐ trifft zu ☐ trifft nicht zu ☐ trifft teilweise zu ☐ weiß nicht

F3 – Die bildlichen Darstellungen haben uns heute in der Gruppe unterstützt, den Gegenstand der Diskussion immer im Blick zu haben.

☐ trifft zu ☐ trifft nicht zu ☐ trifft teilweise zu ☐ weiß nicht

F4 – Die dargestellten Orte konnte ich bei den bildlichen Darstellungen gut wieder erkennen.

☐ trifft zu ☐ trifft nicht zu ☐ trifft teilweise zu ☐ weiß nicht

F5 – Der Standort des Betrachters waren im Hinblick auf das jeweilige Diskussionsthema gut gewählt.

☐ trifft zu ☐ trifft nicht zu ☐ trifft teilweise zu ☐ weiß nicht

F6 – Bei den dreidimensionalen Darstellungen ist mir die Orientierung im Vergleich zu den Karten schwerer gefallen.

☐ trifft zu ☐ trifft nicht zu ☐ trifft teilweise zu ☐ weiß nicht

F7 – Die Karten wären bei der Vorstellung und der Diskussion ausreichend gewesen, um die Maßnahmen und ihre Auswirkungen verstehen und beurteilen zu können.

☐ trifft zu ☐ trifft nicht zu ☐ trifft teilweise zu ☐ weiß nicht

Bitte beantworten Sie nun die folgende Frage: (bitte ankreuzen)

F8 – Würden Sie die bildlichen Darstellungen im Anschluss an die Veranstaltung gern noch in Ruhe auf den Internetseiten zum Landschaftsplan Königslutter betrachten?

☐ ja ☐ nein ☐ teilweise ☐ weiß nicht

Vielen Dank! Die Begleitforschung und das Projekt-Team „Interaktiver Landschaftsplan"

P.S.: **Sonstige Anmerkungen** zum Einsatz der bildlichen Darstellungen bei der heutigen Veranstaltung können Sie uns auf der Rückseite dieses Fragebogens mitteilen.

Fragebogen zur Visualisierung und zum Einsatz des Internet zum Thema "Entwicklung der Schunteraue" am 26. Mai 2004

Liebe Teilnehmerin, lieber Teilnehmer!
Wir interessieren uns für Ihre Meinung zum Einsatz von Visualisierungen und Internet in den Veranstaltungen zur Bürgerbeteiligung und in deren Vorfeld und möchten Sie bitten, die folgenden Fragen zu beantworten.

Fragen zur Visualisierung:

1. **Bei welchen Darstellungen ist Ihnen die Orientierung schwer gefallen?** *(mehrere Antworten möglich)*

☐ Karten und Luftbilder ☐ interaktive Simulation ☐ bei allen unproblematisch
☐ Vorher-Nacher-Bilder ☐ 3D-Modell

Kommentar ____________________ (ggf. Rückseite benutzen)

2. **Waren die Darstellungen ausreichend realistisch, um sich die Planungsinhalte vorzustellen?**

- **Vorher-Nacher-Bilder** ☐ ja ☐ nein ☐ weiß nicht
- **Interaktive Simulation** ☐ ja ☐ nein ☐ weiß nicht
- **3D-Modell** ☐ ja ☐ nein ☐ weiß nicht

Kommentar ____________________ (ggf. Rückseite benutzen)

3. **Mehrere Visualisierungsmöglichkeiten wurden in der Diskussion benutzt. Welche Darstellung hat Ihnen geholfen, die Auswirkungen der möglichen Maßnahmen besser zu beurteilen, um sich eine Meinung zu bilden?**

	sehr geholfen				gar nicht geholfen
• **Karten und Luftbilder**	1	2	3	4	5
• **Vorher-Nachher-Bilder**	1	2	3	4	5
• **Interaktive Simulation**	1	2	3	4	5
• **3D-Modell**	1	2	3	4	5

Kommentar ____________________ (ggf. Rückseite benutzen)

4. **Wie wichtig war es für Sie, unterschiedliche Planungsalternativen während der Diskussion zu sehen?**
unwichtig 1 2 3 4 5 **wichtig**

5. **Hat die Bewegung im 3D-Modell Ihnen geholfen, die Planung besser zu verstehen?**
☐ ja ☐ nein ☐ keine Auswirkung

6. **Was hat Ihnen an der Visualisierung und an ihrer Vorführung gut gefallen? Was hat Ihnen nicht gefallen?**

____________________ (ggf. Rückseite benutzen)

Fragen zum Einsatz der Internetplattform:

7. Wie haben Sie von dieser Veranstaltung erfahren?

☐ aus der Presse ☐ über d. Terminkalender auf der Internetplattform
☐ über den Infobrief ☐ persönliche Einladung durch die Stadt
☐ über Freunde/Bekannte/Kollegen ☐ anders: ____________

8. Haben Sie sich die Internetseite zur „Entwicklung der Schunteraue" vor dem heutigen Abend angesehen?

☐ ja *(bitte weiter bei Frage 10)* ☐ nein *(bitte weiter bei Frage 9)*

9. Wenn nein, warum nicht?

☐ wusste nicht davon ☐ kein Internetzugang
☐ keine Zeit ☐ wollte es lieber auf der Veranstaltung hören
☐ sonstiges: ____________
(ggf. Rückseite benutzen)

10. Wenn ja: Waren die Vorab-Informationen ein Anreiz für Sie, zur Veranstaltung zu kommen?

☐ ja ☐ nein, hatte keine Auswirkung

11. Wie beurteilen Sie eine Vorab-Information über das Internet?
(weitere Kommentare gern auf der Rückseite)

Ich fühle mich besser vorbereitet.	☐ ja	☐ nein	☐ weiß nicht
Ich kann mir besser eine Meinung bilden.	☐ ja	☐ nein	☐ weiß nicht
Wenn ich Informationen über das Internet erhalten kann, brauche ich nicht mehr zu einer Veranstaltung zu gehen.	☐ ja	☐ nein	☐ weiß nicht

Die Vorab-Information hatte einen Einfluss auf den Verlauf der Veranstaltung.
☐ ja, positiv ☐ ja, negativ ☐ nein, kein Einfluss ☐ weiß nicht

Die Vorab-Information hatte einen Einfluss auf das Ergebnis der Veranstaltung.
☐ ja, positiv ☐ ja, negativ ☐ nein, kein Einfluss ☐ weiß nicht

12. Wie oft besuchen Sie die Internetplattform des Interaktiven Landschaftsplans?

☐ mind. 1x pro Woche
☐ mind. 1x pro Monat
☐ seltener
☐ nie
☐ habe mir vorgenommen, sie mal anzusehen

Herzlichen Dank für Ihre Mitarbeit!

Ihr Team des Interaktiven Landschaftsplans
Ansprechpartner: Barty Warren-Kretzschmar und Arne Neumann Tel.: 0511 / 762-5279