Mot et digitalt 3D visualiseringsverktøy for kommunikasjon og samarbeide innen planlegging og design

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Vitenskapelig bedømt (refereed) artikkel

Ramzi Hassan: Toward a 3D digital platform for collaborative planning and design

Digital tools such as GIS, BIM, CAD, 3D and VR are being used more and more at various levels in the planning and design process to help formulate, present and communicate project proposals. However, planners, architects, engineers, landscape architects and government institutions work at different scales, use different data sources and employ different sets of digital tools that are not designed to work together. For many years the planning and design community has seen the need to establish a common platform to facilitate collaboration and communication among professionals and to improve participation of community groups. In this study we investigate various 3D digital and visualization tools for participation, communication and collaboration in the planning process at the Virtual Reality Laboratory (VR-Lab) at the Department of Landscape Architecture and Spatial Planning at the Norwegian University of Life Sciences. We describe how these methods are currently being practiced, understood and experienced by lay people and professionals. We then discuss how the results of these investigations can support the development of an integrated digital platform for planning and design.

Keywords: Digital tools, planning, design, communication, collaboration.

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Introduction

In the design and planning process there is a need for the ability to use a mix of various types of digital and visualizations methods to express a certain planning scenario. Planners and architects are trained to understand and follow project plans. However, lay people might have difficulty reading them or imagining what future physical elements such as buildings, roads or trees will look like and how they will integrate into the area. This may restrict their active participation in the planning process. For many years, planners created beautiful perspective drawings and paintings in which reality is mixed with planned objects. Several studies have highlighted the importance of using visualizations in planning to improve understanding of projects in architectural design, urban planning and landscape planning (Daniel and Boster, 1976; Hanzl, 2007; Oh, 1994; Tress and Tress, 2003). Other studies found that 3D visualizations tools are better able to convey experiential qualities than 2D methods, and are especially beneficial for collaboration involving people untrained in spatial design disciplines (Lewis and Sheppard, 2006; Danahy, 2001; Bishop, 2005; Kwartler, 2005; Lindquist. 2010).

Frequent introduction of new digital 3D technologies creates a need to evaluate practices, traditions and types of digital tools in the planning process against already known ones. It is also important to consider whether the design and planning community and the public have witnessed any new significant transformations and challenges, such as the following: First, there is increased demand for more efficient planning. Second, there is pressure to develop project proposals

that are more accurately related to the actual geographic site. Third, the project aims of projects involving multiple disciplines are in many cases difficult to understand. Fourth, there is strong competition to secure projects. Fifth, there is a struggle to engage community groups effectively in the planning process.

The latest developments in digital tools for planning and design provide new possibilities and potentials. The field of 3D visualization has recently advanced to the point where it is now possible to present alternative planning and design scenarios with a high degree of realism and interactivity. Using these tools provide the possibility to explore many aspects of the design in real-time, which can enhance collaboration and communication in the design and planning process. In this study we summarize results from research studies at the VR-lab on visual tools used by the Norwegian architectural design and planning community and propose a model for integrating various kinds of digital tools into a single platform.

Experimentation with visualizations for planning

The paper presents the outcome of studies at the VR-Lab at the Department of Landscape Architecture and Spatial Planning at the Norwegian University of Life Sciences. The paper is part of a project aimed at strengthening research on digital applications in landscape architecture and planning. It includes data from master research projects and courses for students and local planning practitioners. The project aims are to explore the potentials and complications associated with 3D digital tools and visualizations when applied in the areas of landscape, urban systems, architecture and construction. The VR-Lab provided an ideal arena for testing and experimenting with new ways of sharing knowledge, aiming to increase collaboration, motivation and engagement in a learning process. Three studies were conducted on this subject from 2007 to 2013: 3D for enhancing participation in planning processes (Dannevig and Thorvaldsen 2007), trends in application of visualizations (Hansen 2013) and 3D as a project management tool (Solheim 2011).

Table 1: Table shows the aims, procedure and survey subject type of the three studies.

Aims (research question)	Procedure	Survey subjects
3D for enhancing participation in planning process (Dannevig and Thorvaldsen 2007)		
Can VR be used to enhance the communication process between professionals and amateurs and between professionals	Present subject groups with a traditional presentation of a project or a VR presentation.	Planners and laypeople. 69 subjects total.
Trends in application of visualizations (Hansen 2013)		
– What type of visualizations are used by Norwegian architectural design and planning companies? – What visualization methods are most suitable for different types of users?	– National survey of visualization techniques being used by planners in Norway. – 2D, BIM and 3D realistic model presentations at the VR-lab for various groups of subjects.	Experts and laypeople. 27 subjects total.
3D as project management tool (Solheim 2011)		
Can VR be used as a multidisciplinary communication tool to improve the spatial understanding of a project in an early stage of the project?	VR presentation of a complex 3D model to one group. Measure and compare level of understanding, engagement and motivation.	Mixed group of experts. 15 subjects total.

In addition, the latest developments in digital visualization tools for design and planning were tested in two courses in autumn 2013. The courses provided information on the learning process and capabilities of commercial available software that could be used in the planning and design process. Outcomes from both the courses and research trials are used as the point of departure for a proposal for an approach to utilizing digital tools to facilitate a better collaborative and multidisciplinary platform in planning and design.

3D for enhancing participation

The Norwegian planning law (PLBL 1985, § 16) states that all affected parties should have the opportunity to participate in the planning process, and that the planning authorities are required to actively spread information. The aim is to make the public aware of different plan proposals, and to ensure that these are available at the planning authorities' office. It should also be noted that there is a distinct difference between the dialogue that occurs when the public is given the opportunity to comment on plan proposals developed by the authorities, and when the public are allowed to participate more fully by being involved in the actual development of the plan (Aslaksen 1995). In work leading up to the introduction of the 1985 law, the main reason mentioned for this focus on participation was the desire for more efficient social planning. It was believed that a higher level of public understanding and acceptance of the decision would lead to more efficient implementation (Holsen 1996). A study by Falleth and Hansen (2011) outlines the complicated interactions and power struggle in the planning system in Norway among planning administration, politicians, developers and local community groups. A recent study by Mantysalo et al. (2011) shows that the planning process can promote creativity and value creation by providing an arena for information exchange, communication and negotiation among various stakeholder interests. Pløger (2002) believe that more widespread involvement of the public can improve the planning process as well as implementation of the plan, if communication between the different parties is improved. The reason is that decision makers will be provided with needed knowledge before they take action.

The public usually has access to the project`s technical drawings. The documents may also include perspective drawings or computer rendering supplied by the stakeholder. Most affected parties are non-professional in terms of planning and have little or no experience dealing with plans. They therefore rely mostly on information from maps, perspective images, and technical drawings which easily can be manipulated. Dannevig and Thorvaldsen (2007) investigated use of 3D advanced visualizations in the planning process. The main topic of investigation was whether 3D advanced visualizations represented by Virtual Reality (VR) technology in an actual building project could enhance participation and the communication process between professional and amateurs and between professionals. The study used a VR environment at the VR-Lab that enabled all parties to move freely in 3D digital environment providing different levels of interactivity. Questionnaires were used to measure the groups' response to traditional presentation material (plans, maps and drawings) compared to a full immersed 3D model of the same project. The subjects in the survey were local students. A total of 69 subjects participated during the two days of the experiment. Four different groups were given two different presentations during two days in May 2007. Using 3D to present and communicate an actual building project was found to have advantages compared to traditional presentations. Building volumes are more easily understood when presented as a 3D model than as technical drawings and perspective still images. The response from groups shows that they understand the project configuration better when it is shown with a 3D presentation. No difference was found in how positive the subjects perceived the development to be or how well they believed the project would fit into the environment. The subjects felt increased engagement after being presented with the 3D presentation, but, this was also the case for subjects viewing the traditional presentation. Therefore, the study couldn't confirm that presentation based on 3D is a more inspiring tool for public participation than traditional tools.

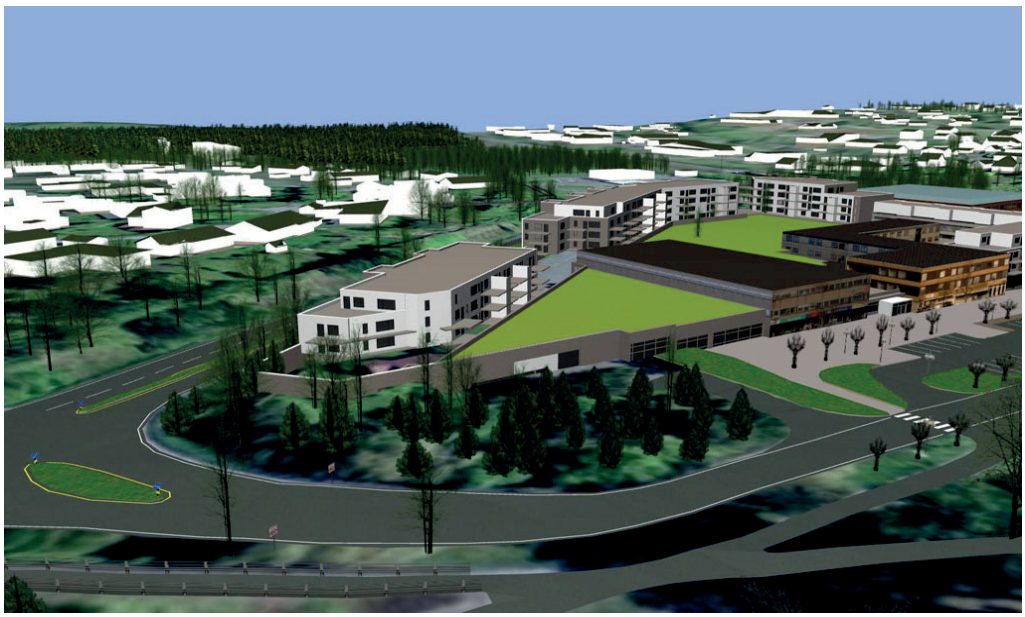

Figure 1: VR model for the town of Ås used in testing at VR-Lab.

Trends in application of visualizations

Hansen (2013) investigated how visualizations are used in Norway, in planning and to communicate information. Two types of pilot studies were conducted. The first was a survey of visualization techniques used by planners in Norway today. The second study was conducted at the VR-Lab and explored how different methods of visualization are understood and experienced by lay people and professionals. The first study was based on questionnaire sent out electronically to architecture-, design- and planning offices in Norway to map the use of various digital tools in practice. It includes questions related to the size and type of company, type of visualizations tools used and how and at what stages the projects were communicated to lay people and experts. The second study utilized an ongoing project for development of the new university campus in Ås. Three types of presentations were made: 2D[1], BIM[2] and a 3D realistic model[3]. The presentations were shown directly after each other to groups at the VR-Lab. A questionnaire was then handed out asking questions, for each presentation, related to geographical location, location of the project buildings in relation to other buildings at campus, size of the project and use of vegetation. Questions were also asked about how the presentation was experienced in relation to engagement, preciseness and the participants' opinion of suitability as a presentation technique. To explore differences between lay people and experts, both groups were invited to participate. Experts were represented by people from the municipality, the university and Statsbygg (the owners/managers of the buildings), and «lay people» were represented by students. 14 experts and 13 students participated in the study. The same questions were asked to both experts and lay people. Data collections were completed on 20th April 2013.

1. 2D presentations are based on two dimensional technical drawings and maps.
2. BIM stands for «Building Information Modelling». A BIM model is a 3D technical model showing data about the objects and their properties.
3. A 3D realistic model visualizes a true-to-life configuration of a site, with textures and surrounding features.

Figure 2: Presenting various types of visualizations during an experimentation session at the VR-Lab.

The survey of visualization methods showed that the most common method used in an early phase of the project was digital 2D maps and drawings followed by hand drawings and 3D models. Hand drawings and 3D models were used less by smaller companies. According to the survey, lay people were found not so good at interpreting 2D maps and drawings. Most responses were on the lower half of the scale, i.e. low level of interpretation. However, lay people's interpretation of 3D images was reported to be much higher. Results from the VR-Lab study showed that the 3D realistic model visualization was the most engaging for both professionals and lay people. The 2D and the BIM visualizations were equally engaging. The 2D visualization was experienced as the most precise by both groups. The two groups' experience of the models was the same, except for the level of engagement for the BIM model visualizations. Professionals found the BIM presentation more engaging than lay people did. Perception of suitability for showing different aspects also varied among the presentation forms. The 2D visualization presentation was considered the best to present geographical location, while the 3D realistic model visualization was considered the most suitable for describing the location of the project building in relation to other buildings. The 3D realistic model was also judged to be the best way to present the size and scale of the project and the use of vegetation.

Lay people were recorded as commenting that the 3D realistic model brought a new understanding of the project. «After the 3D realistic model presentation my understanding of the 2D presentation increased». However, many of the respondents mentioned that the 3D realistic model did not work well on its own, but was a good complement to other visualization forms. Both lay people and experts thought that all three visualization types (2D, BIM, 3D) were suitable presentation forms if the audience were professionals. Both groups also agreed that the 3D realistic model was more suitable when presenting projects to lay people.

3D as a project management tool

A particularly difficult aspect of project management is communicating three-dimensionality and giving a perception of space for a project scenario amongst the members of the project team. This requires a trained team who can envision the three-dimensionality of spaces through written descriptions and available illustrations. Solheim (2011) investigated the potential of 3D modelling and VR to help a project team communicate and understand the three-dimensionality of a project scenario in an early stage of a design process. The study addressed communication among internal stakeholders: the client and users on the demand side, and the architect and engineers on the supply side. Clients and users often have to choose technical solutions, respond to plans, and give their acceptance to given solutions, which are often only presented and communicated as 2D drawings. Improved communication among the stakeholders in an early stage could give all of the parties a better understanding of the project, and therefore lead to fewer design errors and a better project.

In Solheim's study, project participants dealing with an actual project were gathered at the VR-lab and shown a selected project case in 2D and 3D. The participants in the survey were all professionals who were familiar with the planning and building process and understood technical drawings. A group of 15 people participated in the experiment. The participants were a mixed group of professionals from Statsbygg working with the project, professionals from Statsbygg not working with the project and professionals from the Universities Building Department (architects and engineers). The Saemien Sijte project was the case used. Saemien Sijte is a new building for the South Sami museum and cultural center in Snåsa, Norway. Both the communications situation and the design were challenging. The building had an unusual three-dimensional geometrical design. The architect was Spanish (SQ-Arquitectos, Valencia), the client and engineers were from Oslo, and the end users were situated in the partly Sami speaking area Snåsa in mid-Norway. Questionnaires were used to measure the level of understanding for both the 2D and 3D presentations and to measure the advantages of 3D visualizations as a tool for communication. The results from the experimentation sessions shows that the use of 3D visualizations as a

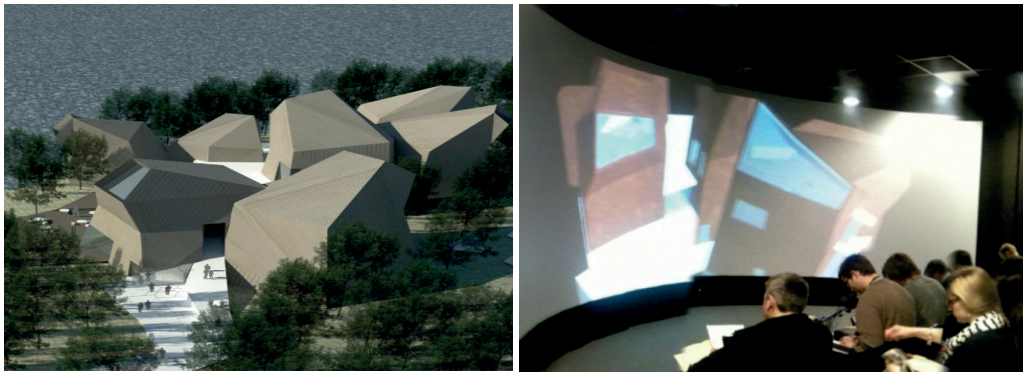

Figure 3: 3D rendering as produced by the architect office (left). Testing session at the VR-Lab (right).

multidisciplinary communication tool improves the participants' understanding and motivation when used in an early stage of the project. The results show that the participants not only had an improved 3D understanding of the project but also a greater motivation for the project after having experienced the project in the VR environment.

Testing software capabilities

The technical capabilities of commercially available software for planning and design were tested in two courses offered by autumn 2013 at the Norwegian University of Life Sciences. Students and professionals with intermediate digital modelling skills used case studies related to architectural design, urban planning scenarios, outdoor lighting, large scale landscape planning, and landscape architectural design. Two newly launched products were used in the courses: AutoDesk Infraworks and Lumion3D. AutoDesk Infraworks allows one to collect various types of data sets in a 3D environment. The software supported a BIM approach to creating data-rich 3D models. In addition, the software was able to create various types of planning scenarios in 3D and communicate these through the net using a special viewer. Lumion3D provides functionality to produce real-time realistic 3D model visualizations which are compatible with models produced by AutoDesk InfraWorks. Participants were exposed to a design methodology which forced them to think in 3D from the earliest stages of a design process. The experiment proved that the learning process is relatively short and straightforward, and that a designer can work with 3D while developing the design concept. A designer can concentrate on the design instead of struggling with creating 3D visualizations. The outcome shows that the digital tools which were tested offer greater clarity and continuity, allowing one to more quickly create project proposals and generate the alternatives necessary to evaluate design concepts at an early stage of the planning process.

Collaborative platform

The three studies showed that using 3D digital visualization tools could enhance the level of understanding of development projects scenarios. Also, both community groups and experts felt that they were more involved when 3D visualizations were used for project presentations. This should improve collaboration and communication at various levels in the planning process. Bearing in mind the challenges mentioned earlier, the planning community should adopt a new approach based on 3D digital tools that could promote a better collaborative platform for planning and design. The objectives for such approach would be: First, to realize an efficient stream-line work flow for creating, communicating and sharing planning proposals. Second, to promote more constructive and interactive discussions that will provide greater clarity, allowing for feedback and faster evaluation of concepts. Important characteristics of such a platform would be: first, that all participants who are involved in the planning and design process would be able to incorporate their work. Second, that data would be communicated in 3D as a common language understood by all the involved parties, both professionals and non-professionals. Third, that the platform would make use of online infrastructure technologies for dissemination of information, collaboration and communication.

Discussion and conclusion

Based on research testing the communication and understanding of project scenarios using 3D digital visualizations, I propose here an approach to establishing a common planning platform. Building projects involve many participants who either are not trained or who do not have the motivation or time necessary to understand a project adequately. Engineers, project leaders, project owners and future end users are dependent on attaining a complete 3D understanding of the building. This will enable them to do the planning correctly, to make the right decisions, or to give adequate and correct feedback (Hauk et al. 2013). The technical capabilities of already available digital tools could be utilized to establish a common 3D collaborative planning platform. The approach proposed will provide possibilities for creating functional

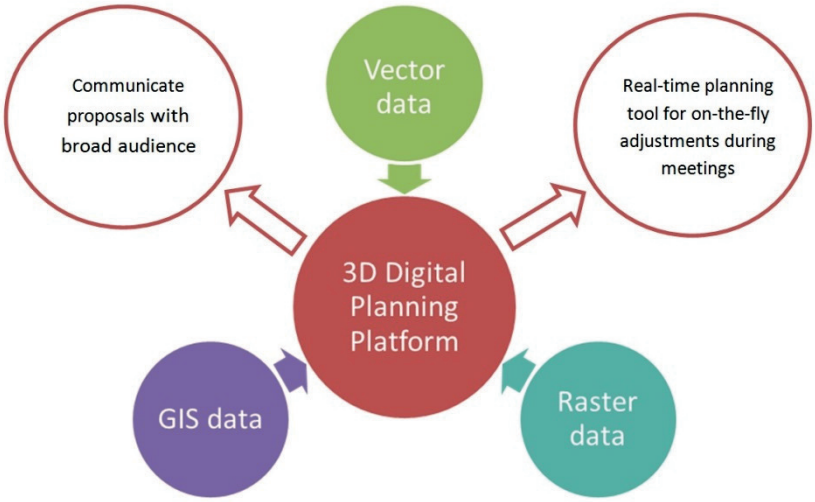

Figure 4: Illustration showing principles for a 3D planning platform for collaboration and communication.

design models including details for preliminary reviews, all within a 3D environment. Professionals could evaluate and consider possible scope changes in interactive feedback sessions. Adjustments to the models can be made on-the-fly during the evaluation sessions with stakeholders. The 3D data-rich model promotes better understanding of the project options. Digital tools have new capabilities allowing planners to work on different scales using wide variety of data-sets, including GIS, CAD, BIM, 3D models and raster data. An important functionality is the capability to work with very large data sets in large projects, which was previously almost impossible to work with. Using the various tools available, planners could also demonstrate many aspects of projects which exceed the usual minimum requirements.

The approach outlined here shows how information and data flow could be communicated, both among professionals and toward lay people. However, further studies are needed to investigate how 3D technology could be utilized by citizens to provide feedback on development projects. There should be a more interactive, fun and concrete way to facilitate contribution of ideas from community groups. The available information communication network, supported by greater use of tablet computers and smart mobile phones, should provide possibilities for the average citizen to visualize their ideas and share their own proposals for consideration. This will lay the foundation for democratizing the planning process by providing citizens with the opportunity to engage and envision changes to their surroundings and landscape.

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