

Visual Representations, Usability and Urban Planning in Real-time 3D Geovisualization

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SUMMARY

Urban landscapes and their possible changes can be visually represented in 3D Geovisualization. In this study, forthcoming changes at Aalborg University, Denmark, have been visualized in three different visual representations: a 2D Plan View, a simple 3D Model View and a photorealistic 3D World View. Ten subjects and two expert evaluators have been consulted with the purpose of studying the use of the three views in public presentation. The test indicates that the World View is considered informative, navigation-supporting and imaginative aside from providing volumetric information. It is therefore clearly preferred by the subjects, while the Model View only provides volumetric information. A public planner however, needs the Model View to avoid exaggerated expectations and misunderstandings caused by visualization of unknown factors. It is more likely to occur in World View, and for these reasons World View needs careful considerations in relation with public presentations of district plans.

KEYWORDS: 3D Geovisualization, real-time systems, visual representation, urban planning, HCI, usability study.

INTRODUCTION

3D Geovisualization has particular advantages when visualizing spatial problems. It can be easily interpretable, it is highly interactive and distributable and therefore many larger cities today exist in virtual copies. Geovisualization is defined by (MacEachren and Kraak 2001) as “the integration of visualization in scientific computing, cartography, image analysis, information visualization, exploratory data analysis and GIS, which all together provide theory, methods and tools for visual exploration, analysis, synthesis and presentation of geospatial data”. Focusing on real-time interactive 3D systems, 3D Geovisualization is closely related to Virtual Reality (Whyte 2002). 3D Geovisualization can be applied at different stages in the process of urban planning. To support these stages, three different visual representations has been suggested by (Verbree 1999). Verbrees suggestions include several interactive and technological regimes whereas this study exclusively focuses on the visual regime. Verbrees visual regime contain three views: the Plan View (PV), an ordinary 2D colour map for initial orientation, the Model View (MV), a simple 3D map for professional volume analysis and the World View (WM), a detailed photorealistic map in 3D for public presentations (figure 1).



Figure 1: The three views of (Verbree 1999) applicable at different stages in urban planning. a) PV, b) MV, and c) WV.

This paper questions the use of WV for public presentations, as suggested by (Verbree 1999) and applies usability methods in order to study the three views in a public presentation test case. The test case visualizes parts of district plan 08-061 (Aalborg Kommune 2003) proposing changes at the campus of Aalborg University, Denmark. The main landscape change is a 6 floor high new library building, centrally located in the eastern campus area (figure 2). The existing neighbouring buildings consist of 2-3 floor high mixed private properties and university buildings.



Figure 2: The new 6 floor high library building (black area) is placed centrally in the eastern campus area. This paper map constitutes PV in the test case.

METHODS

The campus area of Aalborg University has been generated in a highly detailed and photorealistic way in 3D Studio Max and imported for WV presentation in VR4Max Navigator Pro (figure 3a). The model was then imported to SketchUp and presented in a simple black-white real-time model corresponding to MV (figure 3b). The volumetric dimensions of the new library building were recently approved by the city council after a period of public hearings. The test was done after the approval and the final design was not decided upon yet at the time of the test. Only the volumetric dimensions including storey partition of the new library building are therefore included in both 3D representations.

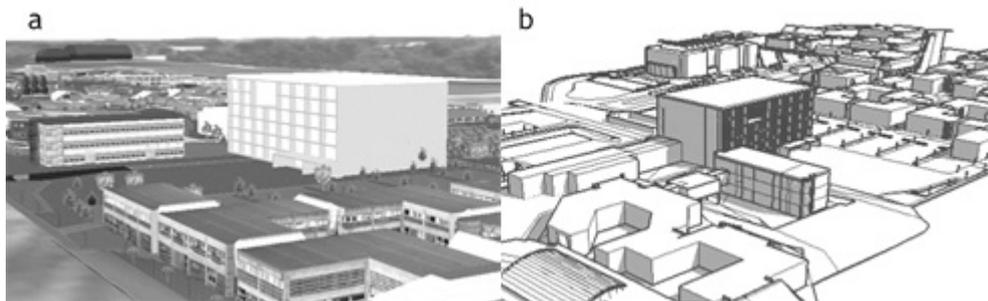


Figure 3: The new library building is the large centrally located building in both screen dumps: a) photorealistic WV in VR4Max, originally in colours and b) simple black-and-white MV in SketchUp.

PV is a paper copy of a digital map (see figure 2) including the new library building. Ten test persons from the local area participated in individual sessions consisting of an interview and a questionnaire. An interview is a qualitative method relying on the value of individual statements given by the subjects. The interviews are supplemented with a questionnaire of 32 questions to

elaborate and raise the certainty of the results. Finally, interviews with two expert evaluators, an architect and an urban planner, are performed.

The Subjects

Public presentation of district plans mainly aim at citizens that are directly influenced by the forthcoming changes. All the subjects participating in the test either work in the area or live in the neighbourhood (or both) and they therefore suit the focus group well. Eight of ten are very familiar with the area and only two do not know the area well since they have only worked in the area for a short time. The subjects receive a general orientation about the new library building upon arrival at the test session and an orientation in the landscape and the views. A volume, view and shadow analysis (only in MV) is then performed. The view analysis includes visiting windows either at their office or at their home to see the landscape changes caused by the forthcoming building (figure 4a). Also the view from the top floor was visited (figure 4b). Finally, the subjects then fill in a questionnaire and the test is finalized with an interview.

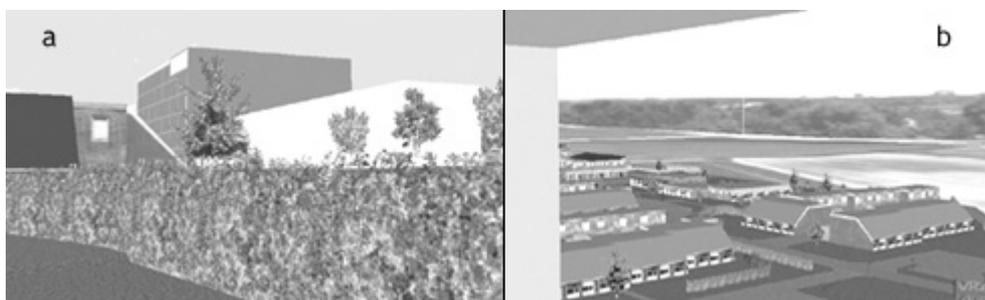


Figure 4: a) Example of a view from one of the subject's private garden. The centrally placed white and grey buildings replace the existing lawn and constitute the volumetric dimensions of the new library building. b) View from the top floor window of the new library building looking down at the neighbouring private properties.

The Expert Evaluators

An architect and an urban planner are invited as expert evaluators. The architect works at the university having years of experience as an architect working in private companies. The urban planner works at the municipality and is responsible for the district plan of the campus. The three views of the new library building and the campus surroundings are presented to them and an interview focusing on the relevance of the three views in their work is performed.

RESULTS

Results from questionnaires and interviews are presented in the following, starting with the subjects and finalizing with the expert evaluators. The interview results are compared and grouped, while statements are selected for reproduction here, due to either a notable singular statement or to exemplify through-going statements made by subjects and experts. The group of ten subjects is just enough for the results to be statistically sound. Hence, the results of the questionnaire are not used for statistical analysis, but only used to highlight tendencies.

Interviews

The subjects claim to be aware of that any of the three views are an abstraction: *"I understand that it is just a volumetric problem. It is actually the same as the 2D paper where it is just the area that is the issue. And it is clear what building is in question. When you have identified it, you can abstract from it and start focus on the volume"*. Being neighbours, most of the subjects received 2D paper information a few months before the test. This information was sent from the municipality as a part of

the public hearings connected to the district plan. Several subjects referred to this information: *“It is interesting to see in 3D, it gives a different impression than the paper information that was sent to me by the municipality”*.

Throughout the interviews the subjects generally prefer the WV because they find it easier to imagine the implications of the project. In addition, photorealism works as recognizable landmarks: *“I prefer WV, because the landmarks help you to determine where you are. It is more difficult in MV”*. Most subjects also found the MV applicable, though not optimal. However, two subjects especially highlight MV for its simplicity: *“If it is only the building then it does not make a difference whether it is WV or MV. Because you do not find more details about the building itself, and the rest you know already. WV is fun to see, but it does not provide you with more information”*. Generally the interest in working with both WV and MV are not pronounced, though one comments: *“For the shadow analysis, the simplicity of MV is perfect. But to get an idea of the size I find the WV is nice to have”*.

The subjects who are familiar with the area do not need orientation support, whereas those unfamiliar with the area prefer PV either alone or as one of more available views. The two 3D views are considered to be much more interesting than PV because you can compare a building with the neighbouring buildings: *“Actually I use maps a lot, but still it is difficult to imagine how high seven floors are compared to the surrounding buildings using only 2D maps”*. Another subject still found assessment of size difficult in 3D: *“What is missing in the model are people. To see how must space they take up. I can see the trees and the lamp-posts but they could be many meters high. I can also see the bus stop, but some human beings would help to assess proportions better”*.

Finally, many subjects note the unilateral focus on visual representations and mention that in a realistic case attributes and interaction will improve communication: *“I almost think that the most important is that you know how to fly through the model. Zoom in and so on. And then you should know that it is not exactly going to be like this, regarding for instance colours”*.

Questionnaires

Communicating visions and expectations at a realistic level are crucial in public presentations of district plans. The questionnaire address expectations in each of the three views (table 1). The answers centers on “d: the model is just a draft and reality could be rather different”. When using the photorealism expectations rise to “b: buildings and surroundings will look fairly like the model”.

Question	answer*	a	b	c	d	e
Which expectations do you think the 2D map promises?		0	3	1	5	1
Which expectations do you think the simple 3D map promises?		0	1	4	5	0
Which expectations do you think the detailed, photorealistic 3D map promises?		0	8	2	0	0

- *a. Buildings and surroundings will in reality look like the model
- b. Buildings and surroundings will look fairly like the model
- c. Only the area of the building will be reality
- d. The model is just a draft and reality could be rather different
- e. Reality will be much different than in the model

Table 1: Part of the questionnaire relating to expectations.

For presentations WV is preferred, which is also confirmed by the fact that the subjects appreciate it visually (table 2). WV also stands out as the preferred view when distinguishing between forthcoming objects in question and the existing objects even though PV also contained clear visual indications of the same. There is no general interest in using more than one view.

Question	answer	PV	MV	WV
Which of the views do you think presented the district plan best?		1	1	8
Which of the views do you think was the most attractive?		1	1	8
Which of the views made it easiest for you to distinguish between reality and forthcoming changes?		0	1	7
Question	answer	yes	indif-ferent	no
Is it important to you whether the presentation looks nice?		6	4	0
Would you like to use more than one view?		4	-	6

Table 2: Part of the questionnaire relating to presentation, appreciation and applicability.

Expert Evaluations

The architect expert use verisimilar and photorealistic WV visualizations, but would visualize the new library building with a more clear distinction to the surroundings by using transparency or dotted edges. There should of cause be information attached also to make implication of the project clear and vegetation should not constitute misunderstandings since the target group knows the trees already from the real world.

The urban planner prefers to use simple views like MV in stead of WM for public presentations in order to avoid exaggerated expectations. This consideration overrules other advantages such as orientation, size assessment, imagination and appreciation. *“But it is different from landscape to landscape. In a city centre the facades are usually preserved and then it is easier to use WV than in new urban areas where changes often occur”*. Vegetation softens the implications and should also be avoided in order to create a “worst case” scenario intentionally. Contracting a visualisation *“.. is just a question of stating what we can use for the district plan. But you have to be acute and aware of what is delivered to you”* - not only in terms of expectations but also technically. Errors occur in terrain and object data and can result in misinterpretation of the original vision.

DISCUSSION

Subjects and experts agree that a 3D presentation are optimal compared to a 2D presentation. The 2D map are mainly used by the few subjects unfamiliar with the area. Some subjects have second thoughts during the interview and mention that the 2D has been useful a few times when orientation was lost shortly. For that reason side maps has been suggested by (Fuhrmann 2002).

Discussing the two 3D views, MV and WV, subjects and architect expert generally prefer the WV. In contrast, the urban planner who is responsible for the communication process during a public presentation of a district plan is sceptical due to exaggerated expectations and misunderstandings. Though the subjects could mainly have thought of the surroundings in table 1, general expectations rise in WV indicating that exaggerated expectations more likely occurs in WV. Though the subjects here claim to be aware of the level of abstractions in WV, it could also reflect a high level of reliability provided by the WV.

If a MV is needed, as expressed by the urban planner, other possibilities than using WV for supporting orientation, size and relation assessment, imagination and appreciation exist. Orientation can be supported using other means like highlighting landmarks or a 2D side map as suggested by (Fuhrmann 2002). Size and relation assessment could be done by the use of avatars.

It is possible to introduce caricature style to imitate MV, use avatars as guides almost creating a virtual “game” with different entrances that represent different aspects of the project. These methods are used in “The Electronic Neighbourhood” (Municipality of Copenhagen 2003), in Copenhagen,

Denmark (figure 5). The virtual entrances and the interactive posts remind the user of his appearance in a virtual, abstract world, possibly lowering the user's expectations to the level of realism. Adding interaction and attributes in a real case constitute a large part of imagination and appreciation as well as they would lower the risk of misunderstandings of the implications of the project.



Figure 5: Example of the interactive spaces, in the The Electronic Neighbourhood. The houses act as entrances into different aspects of the project.

CONCLUSION

Using WV for public presentations is profitable in terms of information content, but for political reasons it is crucial for urban planners that misunderstandings can be avoided. Using a lower level of realism, like the MV, is a relevant possibility but the advantages in terms of orientation, size and relation assessment, imagination and appreciation that is served by the WV, will be lost – or partly lost. It should however be possible, with some effort, to establish or reinforce these advantages in MV.

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