Towards an Understanding of how the 'Geographical Dirtiness' (Complexity) of a Virtual Environment Changes User Perceptions of a Space

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EXTENDED ABSTRACT

A project current research project is developing and evaluating the use of Web-delivered tools to supplement the community decision-making process. This has involved building and testing a 3D tool for Community Collaborative decision-making in the Jewell Station Neighbourhood (JSN). The focus of this decision-making tool provision is placed in an urban planning context.

VRML (Virtual Reality Modeling Language) was used to build two tools: a 'Sandbox' and a virtual world. Building the tools was done so that community members, or planning consortia, could use the tools in a group meeting or individually through home Internet computers, or even at Internet cafes. The underlying criterion for design was simplicity and accessibility. The virtual world was created as a test-bed for determining the 'best' content/presentation method. The development of the model and subsequent evaluations are the focii of this paper. The model was developed as a test bed to determine 1. What the model should contain – a trade-off between development costs and usability, 2. How much information needs to be included for professional and public users and 3. How landmarks might be incorporated to facilitate a 'balance' between minimal information provision and usability.

Figure 1. VRML world.

An initial evaluation of the tools was made with a focus group to provide general feedback. A second evaluation was conducted so as to better understand how complex a computer graphics 3D environment needed to be for community discussion of urban planning developments. Here we determined how 'dirty' (complex/detailed) 3D urban computer visualizations needed to be and what they should contain. An on-going third evaluation component seeks to ascertain how landmarks and the users' familiarity of a study area can be used as the basis for building simpler and thus more economical virtual worlds. This paper provides background information about the project and reports on the findings related to how complex the worlds need to be.

INTRODUCTION

One problem that community members have when considering planning applications that affect them is the lack of access to sophisticated tools. They rely mainly, if not solely, on paper maps and associated products, like aerial photographs and architectural drawings. What was proposed to members of the Jewell Urban Village community group, which operates in an inner urban area of Melbourne, Australia, was to provision them with a Web-delivered VRML product that would allow them to 'build' and assess 3D scenarios on-line.

A research team at RMIT is building virtual 3D audiovisual models of urban spaces to test their potential to enhance community discussions of future neighbourhood developments. The team started a pilot project in partnership with the Moreland City Council's urban planners in 2003 and has created an online 3D model of the Jewell Station Neighbourhood (JSN) that allows users to walk and fly through that locale. The JSN model can be screened in community forums to enhance exercises in visualising and discussing urban futures in their locality. The project goal is to make information available online so the team started with a Web site that provides access to tools and background information (Nelson *et al.*, 2004).

The research is two-pronged. It addresses:

1. The use of New Media, and particularly New Media delivered via the Web, as a potential tool for improving collaborative community decision-making (this is being assessed by the social scientists in the team); and
2. The effectiveness of the use of the tool, especially when users come from unknown and diverse backgrounds and have potentially different skills for using geographical visualization tools and for developing mental maps (this part of the research is being undertaken by members of the team from the geospatial discipline).

According to Batty (1995), to study cities it is necessary to use diverse methods of computation, varying from the straightforward browsing of digital data to much more sophisticated methods of simulating futures. He has stated that: "We will, in fact, make a distinction between real cities as viewed using computers and abstract cities as simulated on computers" (Batty, 1995, p. 4). This project simulates part of a city through the use of Web-delivered 2D and 3D tools. Of great interest to the team is how successful these simulations are, especially when delivered through the sometimes restricted 'pipe' of the Internet. Also of interest is how these tools are accepted by the user group and how the tools might best be designed and delivered to suit community use. And, since the geographical knowledge that the users have of the study area might, in some cases, be considered to be naïve well (similarly in the VRML – generated Virtual World). This has presented an interesting research component as well, which is the focus of this paper.

1. BACKGROUND: THE COMMUNITY'S ROLE IN PLANNING PROCESSES

Planning requires knowledge, foresight, and power. Contemporary urban planning incorporates social agreements with respect to visions, strategies and practices. Planners are trained in legal, technocratic, policy and design elements but working in local government highlights the social impacts of their role and the politics of decision-making. Planning implies social as well as physical change. It involves stages of forming social and environmental visions, decision making over options and implementation. In Australia local planning regulations and regional strategies are impacted on by federal and state legislation and policies. However forming sustainable and attractive neighbourhoods depends on individual activities of so many locally based property owners, residents and businesses. Therefore the implementation of sustainable neighbourhood plans relies on grass-roots efforts.

Community consultations allow elected representatives and public servants to hear how people feel and what they do and, more often than not, do not want. Their impact on formal and authoritative governance structures depends on the resources and authority given to the organisers and the status given to the result. While elected and administrative members of council acknowledge community expectations for them to change in response to challenges involving sustainability and urban growth, they are constrained by well-established legislative responsibilities and regulatory powers and processes embedded in political party structures that limit the power of community consultations.

Moreland City Council, where our JSN case study is set, has a consultation framework but is still in the process of updating it and developing a formal community engagement strategy (MCC 2003).

2. PUBLIC PARTICIPATORY PLANNING SUPPORT SYSTEMS (PPPSS)

The development of PPPSS has been contingent both on the emergence of Geographical

Information System (GIS) tools to support government and commercial urban and rural planners and the international movement to enhance and expand local participation in discussions and decision making on future changes in their neighbourhood (Elwood and Leitner 1998; Obermeyer 1998). Therefore the 'Public Participation GIS (PPGIS) Guiding Principles' stress: social inclusion; holistic, interdisciplinary approaches; ecological stewardship; capacity building and interactive e-democracy (Aberley and Sieber: 2002).

In Australia, aside from government agencies like the National Land and Water Resources Audit (www.environment.gov.au/atlas), many groups like the Urban Forest Biodiversity Program (UFBP 1997) have advocated for the potential of GIS for displaying information and improving planning processes. A lateral reference can be made here to the 'visual traditions of citizenship' that provide questions for researchers and bases for local PPPSS to build on too (Williams 2004). In short GISPP can assist in explorations of urban futures as well as support joint decision making over forming and selecting preferred options.

The working hypothesis of the C-s3 team is that PPPSS offer enabling mechanisms to facilitate community discourse and support community input in decision-making associated with local land use planning. As such they offer the potential to enrich existing community consultation processes. Further, in engaged and active communities and with the appropriate social techniques in place, such tools might allow for more direct decision-making.

3. PROJECT AREA

The JSN is located Brunswick, an inner urban area of Melbourne. The prototypes were developed in part of the corridor between the railway track to the west, Sydney Road to the east, Glenlyon Road to the north and Park Street to the south. The extent of the initial study area was determined during discussions with urban planners from the Moreland City Council.

The study area contains a diverse range of building types – housing, light industrial, commercial, retail and some open space. It could be considered to be typical of the somewhat crowded inner city areas that ring the Melbourne Central Activities District.

4. PRODUCT DEVELOPMENT

The main aim of the C-s3 team was to develop effective and efficient processes for enhancing community participation in future scenario planning, policy development and implementation at a local level. Therefore the C-s3 focus was on process rather than substantive issues of planning and on assessing the capacity of visual images and online submissions to engage communities and enhance dialogue and decision making in future planning. Developing and assessing ways that screened images support face-to face discussions in small and large groups is as important as guiding online explorations and devising submission pathways for individuals to comment on local planning issues.

5.1. GIS component

The World Wide Web (WWW) has become an extremely efficient channel for transferring data across the Internet because of its visual capabilities and the relatively advanced hypermedia and on-line geographical information tools currently being developed. Subsequently, there has been a growth in web-based GIS portals and services. Quite early in the 'life' of the Web, the use of the Web to deliver GIS for spatial decision support was recognised as a useful tool (Carver *et al.*, 1998). The use of the Web based GIS technology for assisting in public participation and collaboration process has been well documented (Carver and Peckham 1999; Geertman and Stillwell 2002; Pettit & Nelson, 2004). An example of an on-line PPGIS is the Virtual Slaithwaite Project – (http://www.ccg.leeds.ac.uk/slaithwaite/). This website enables participants to interrogate geographical datasets relating to the 2km^2 area of land centred on the West Yorkshire village of Slaithwaite. The project was developed by Kingston *et al.* (2002) as part of an experimental project into e-democracy.

GIS ortho-rectified aerial photographs acquired from the Moreland City Council at a scale of 1:15,000 were used as the base dataset. Using this imagery the building footprints and trees data layers were created via on-screen digitising using ESRI's *ArcMap* software. Fieldwork was undertaken to obtain building height attribute information and to validate the building footprint data layer. The other spatial data layers used in formulating the two-dimensional map representations of the Jewell Station Neighbourhood scenarios were the cadastral and roads boundaries. To create 3D GIS representations of the study area the two-dimensional building footprint data layer produced in *ArcMap* was imported into ESRI's *ArcScene* software and extruded by the building height data (z values contained within the associated attribute table).

5.2. 3D

VRML was chosen as a development tool as it allowed open, extensible formats to be used and the 'built' worlds could be constructed in Web browsers that included a VRML plug-in. VRML is extensible, interpreted language and it became an industry-standard scene description language. It is used for 3D scenes, or worlds, on the Internet. To produce 3D content 2D components are defined / drawn and the viewpoint specified. Once this is defined the drawing package renders the 3D image onto the screen. VRML code defines objects as frameworks that are rendered. This makes file sizes very small. The appearance of rendered surfaces can also be modified using different textures. By using the computer's fast processing speeds, and specifying multiple, sequential viewpoints 'walkthroughs' can be produced.

All buildings in the study area were surveyed to ascertain position, use and building height. Also, each building façade was photographed for use in 'stitching' the images onto the sides of VRML primitive shapes. All buildings in the study area were subsequently inserted into the model that allowed the JSN to be viewed in a browser. The *CosmoPlayer* plug-in was initially used with Microsoft's *Internet Explorer* browser, but later this was replaced with the *BitNet Management* (Germany) VRML browser plug-in. This plug-in provided substantial improvements over the *CosmoPlayer* plug-in.

On the busy Sydney Road commercial retail strip it was important to add other media elements that would enhance the perception of a densely developed inner city area. And, one that had to cope with the problem of dense traffic. Sound recordings were made at every street intersection along the road and included in the VRML world, creating a 'soundscape'. Soundscapes are described as "the overall sonic environment of an area, from a room to a region" (Porteous and Mastin, 1985, p. 169). The theory of using soundscapes is generally attributed to Granö (1927). His pioneering work produced an agricultural soundscape, which illustrated cartographic representations with acoustic sensations of human activity, birdsong and grazing cattle on the Finnish island of Valosaari (Porteous and Mastin, 1985). As the user 'moved' along the street they were 'enclosed' by one sound 'circle' and then another.

Users accessing the VRML modelled scenarios can hear sounds created from recordings acquired from key nodal points in the area, recordings of noises made by trams, trains, road vehicles and pedestrians. Sound recordings from street intersections produced by RMIT University's Spatial Information Architecture Laboratory (SIAL) have been encoded into the scenes through VRML. This idea builds upon previous research efforts by the authors (Pettit *et al.* 2003).

Also at each intersection panoramas were inserted. The panoramas were hyperlinked and allowed users to move from one panorama, to a hot spot that linked to another panorama, etc..

There was also a need to allow users to see how developments might affect the area. The Council has specified maximum building heights for re-development proposals, and this was used as a basis for 'building' new multi-storey developments and then placing them into the real world. Several scenarios were developed for the world and one is shown in figure 2.

Figure 2. Illustration of multi-storey building.

5. EVALUATION

The evaluation was planned to be done in three stages:

1. An initial qualitative evaluation of an Alpha product with an expert group of users;
2. Testing how the 'geographical dirtiness' of the Virtual Environment changes the perception of a space; and
3. Discovering the appropriate wayfinding aids needed in the model to support searching and exploration.

The results from Stages 1 and 2 are outlined here.

An alpha prototype online model was usability tested as Stage 1 of evaluation at a special workshop for local community members who had past experience in consultations on planning issues. They were asked to explore the models and signal difficulties in its online use. The participants were asked to complete a questionnaire to assess the potential of the tools and suggest further developments.

It was found that the test group generally liked the concept of the tools, but they thought that the actual product needed to be refined. They thought that the use of 3D improved the interpretation of the area being studied. There was some comment on the use of navigation tools associated with the actual VRML browser plug-in and the use of other plug-ins was subsequently explored. In the end it was decided that better results with community groups, that were unfamiliar with Web-delivered 3D and VRML, would be achieved if we were to provide an experienced operator to 'drive' the 3D world. This was done in subsequent evaluation sessions with much success. Users could concentrate on the 3D world without having to worry about the browser navigation tools.

It was also thought that support materials, in the form of 'help' tools needs to be added to the package. There were some comments on the need to provide high levels of detail for all buildings. This was addressed in Stage 2 of the evaluation.

Stage 2 evaluated Naive Geography vs. Real Geography. Naive geography was defined by Egenhofer and Mark (1995) as "the body of knowledge that people have about the surrounding geographic world" – the primary theories of space, entities and processes (Mark and Egenhofer, 1996). And, as: "the field of study that is concerned with formal models of the common-sense geographic world" (p. 1). The term describes a formal model of common-sense geography (Mark and Egenhofer, 1996). This would form the basis for developing intuitive and 'easy-to-use' Geographic Information Systems. It captures and reflects the way humans think and reason about geographic space and time. Naive stands for instinctive or spontaneous" (Egenhofer and Mark, 1995, p. 4).

A naïve world was built that only contained basic building outlines. This was called Level 1. Four other worlds were also constructed, each becoming increasingly 'real'. These were named levels 2 – 5. Figures 3and 4 illustrate worlds at each end of the naïve-real spectrum. As the worlds became more complex (more real) the addition of urban elements was termed 'Geographical Dirtyness' and the 'dirtyness' increased the more real the virtual world became.

For this evaluation, two user groups were canvassed for their opinions: a community group and professional planners. Each group met on separate occasions. The community group was drawn from the local area and the professional planners comprised the second group.

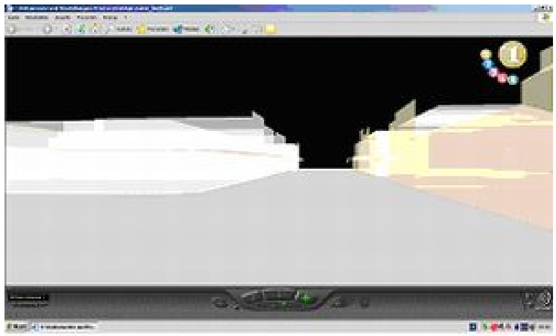

Figure 3. 'Environmental Dirtyness' level 1.

Figure 4. 'Environmental Dirtyness' level 5.

From the evaluations completed with the community and professional groups a wealth of information has been assembled that was used for developing guidelines for building a world that satisfies the needs of both user groups, but also is 'buildable' with modest inputs of time and data maintenance. The model for final testing was a Level 2 world, enhanced by the addition of:

- Colour code land use;
- A legend;
- Street signs for navigation and location awareness;
- An aerial viewpoint for orientation;
- 'Level of detail' to reduce detail at the aerial view, but have increased detail at street level;
- To avoid 'end of the world' models, and use images at the end of each street. (Perhaps include collision detection that disallows users penetrating these images).
- The sky image;
- Appropriate landmarks;
- Different road textures; and
- Some street furniture for specific use.

These guidelines were used to build the final model for evaluation - Level 2.5. It is shown in figure 5.

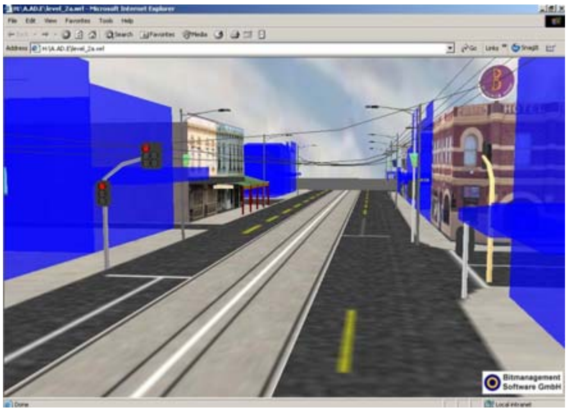

Figure 5 Level 2a.

6. ELEMENTS OF LEVEL 2A

Level 2a was built on a level 2 world, with the addition of some street installations like telegraph poles and street lights. Only major buildings (called 'landmark' buildings') were shown as complete forms (figure 6). Other buildings were colour-coded according to their actual land use, as per the blue colour coding in figure 6.

Figure 6 'Landmark buildings.

Also, at the end of each street 'end-of-the-world' images were added to ensure that the world did not 'end' at the edge of the model. Single images were captured at the end of each street and then 'pasted' at the edge of the VRML world to give the impression that the world continued beyond the extent of the model. A number of methods were trialled, and the final choice was between two types a 'posterised' image (figure 7) and a second image that was manipulated to appear more like the colour coded buildings (figure 8). The second method was chosen as the best visualization.

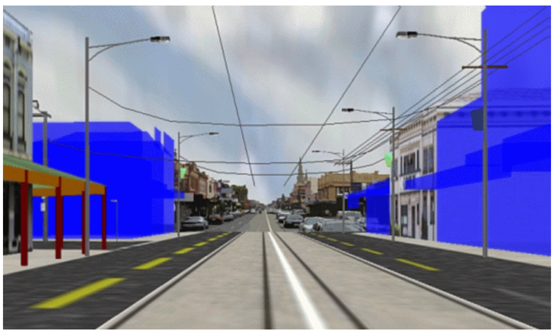

Figure 7. End-of-the-world image - posterised.

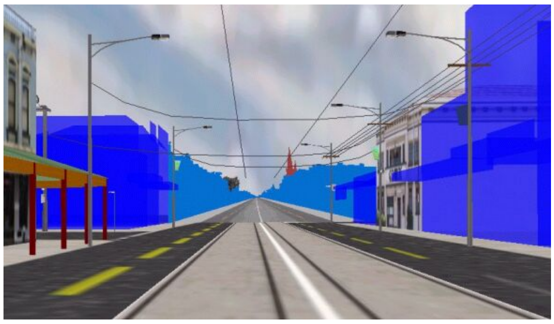

Figure 8. With colour-coding effect.

During general discussions with the test groups they indicated that the addition of the sky images made the model look more 'real'. This was achieved by placing the entire model inside a half-sphere that had an image of the clouds 'pasted' onto this object (see figure 9). The resultant sky is in all of the previous model image samples.

Figure 9 Creation of the sky 'dome' by pasting an image of clouds on the inside of a semi-sphere.

One interesting thing that came from the evaluation was that test candidates thought that the addition of 'clutter' in the model, in the form of cars, trams and people, did not improve the model. Much effort was made to populate the level 5 model with these items (figure 10), but these efforts, according to the test candidates were unwarranted. Candidates also commented that the inclusion of street furniture was only necessary in instances where this was actually being addressed.

Figure 10 Population of the level 5 model.

The level 2a model was subsequently completed, guided by the results from Stage 2 evaluation.

7. FURTHER TESTING

The next stage of the research will focus-on two questions: 1. What is the minimum number of landmark buildings that should be included in the model so that it provides adequate information about the area? And How does a priori knowledge of an area change navigation and exploration abilities when 'moving through' and exploring the Virtual World?

8. CONCLUSION

This paper has described the concepts behind the project and the methods used to construct the package. The evaluation programmes being employed to test the usefulness of computer-delivered tools to support community decision-making were outlined and the results from the first of three evaluation stages were provided. The results of this first evaluation will be used to improve and extend the functionality of the product. The development of the beta version of the package is underway.

This project is an example of how interdisciplinary research can be of benefit to all stakeholders. It has allowed discourse to occur between two research groups and, having partners in the social sciences has ensured that the project applications are not developed in isolation of the intended usage and user groups.

The uses to which new technology is *actuall*y put, in contrast to the uses technically possible, depends in large part on how people find out about the new tools, how they see the value *to them* of their use and how accessible -- in terms of cost and useability -- the tools are. Social context is also important. The manner in which the new tools are introduced to people, the timing and even the location and time of day can influence their reception and take up. Sponsorship or demonstration by respected people or organisations - like a local council or local business organisation -- can allay anxieties or fears that some potential users may have. Careful social research into how people learn, how they perceive, screen and prioritise new possibilities and how they rank the opportunities those possibilities open up to them will influence how successfully the computer-delivered tools perform 'on the ground'. Such research can also assist in evaluating which approaches are likely to be successful in integrating these decision support tools into planning practice in different circumstances and in communities of varying structure.

9. ACKNOWLEDGMENTS

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