A 3D, Interactive, Multilayered, Web-enabled Model as a Tool for Multiple Sets of End User Groups: a Case Study and End User Analysis

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This research investigates the potential of 3 dimensional, interactive, multilayered models, to enhance users' understanding of sets of geographic and building information, allowing them to make quicker and more informed decisions, than when using traditional 2 dimensional methods. This paper addresses the issues associated with creating a testable research hypothesis, and evaluates a methodology which addresses those issues and answers the hypothesis. The research approach adopted is to develop a functional prototype model and present it to sets of end-users in a series of focus groups, involving hands-on interactive examples, individual feedback surveys and group discussions. This design of the methodology is such that it can be applied to additional user-groups in future research. It is a practical example of how focus groups can analyse the successful communication of information via digital technologies.

I. Introduction

This Building Science Masters project investigates the potential of 3 dimensional (3D), interactive, multilayered models, to enhance users' understanding of sets of geographic and building information, over traditional 2 dimensional (2D) methods. The ability to create a single model which also satisfies the needs of multiple sets of end-user groups within the Urban Planning industry is also to be examined.

Developments in the digital world are increasing at a huge speed. In order to take advantage of these new technologies users can play a positive part by interacting with and critically analysing the technologies. The research approach is to work with end user groups systematically to develop a 3-dimensional model that is responsive to their needs. These user groups become the means of testing the research hypothesis and reaching general conclusions about the value of 3D models of the urban environment.

The case for the single 3D model was evaluated through a prototype 3D model of Wellington City, New Zealand. It presented different 'views' of information in Wellington: a rendered visualisation in an animated "walkthrough"; the impact of planning constraints on daylight; interactive "plots" of property values. The development and delivery of the prototype model was analysed in regards to how complex, costly and time consuming it may be to exploit one base model for several purposes; and also therefore how beneficial, affordable and potentially successful a single model may be.

Close collaboration and consultation with companies throughout the research (such as Terralink International Limited: www.terralink.co.nz; and the Wellington City Council: www.wcc.govt.nz) revealed huge interest. Of particular interest were examples relating to increasing tourism, aiding the resource consent process and planning industry and subsequently enhancing the public consultation process, or creating a virtual film set.

The research takes an industry-based, practical direction, through the granting of a New Zealand Government-funded Bright Futures Enterprise Scholarship, which supports research in conjunction with an industry partner, in this case, Terralink International Limited. The primary objective of the research is to establish a methodology which can be applied to a variety of different end-user groups to measure the ability of 3D, interactive, multilayered models, to enhance users' understanding of sets of geographic and building information.

2. Objectives

The research design addresses the issues associated with creating a testable research hypothesis around these questions:

1) How might we measure "enhanced understanding" and "more informed decision making"?

2) What are the potential dimensions of improved interactivity and understanding communicated in 3D rather than 2D?

3) How might a test of a 3D interactive prototype set a genuine 2D baseline for comparative purposes?

4) If the test is to look at the utility of 3D models to different user groups, how might these groups be chosen to represent widely different potential applications of the 3D information?

Within these overarching issues the following detailed questions of scale will also be answered:

5) If the research is to be genuinely applicable, must it examine a number of 3D models compared to a number of 2D models, and if so, what is that number?

6) If the research is to demonstrate utility to multiple user groups, what number is sufficient as a test?

7) If the research is to demonstrate the potential of one multi-layered model, enabling separate user groups to 'mash up' their own information, then how might this opportunity for cross-referencing (mashing) information between end-user applications be tested?

The research is to develop a functional prototype model and present it to sets of end-user groups in a series of presentations, hands on interactive examples, group discussions, and individual feedback surveys. The data collected during these workshops will establish how a 3D, interactive, multilayered model might best be developed to successfully communicate important sets of geographic and building information to a range of end-users, and whether this 3D method leads to the users' increased understanding of the information, allowing them to make quicker and more informed decisions than when using traditional methods.

In response to the seven questions outlined above, the following testable hypothesis was developed:

"That 3D interactive, multilayered models which meet the needs of multiple sets of end-user groups, will enhance their understanding of geographic and building information, more so than traditional 2 dimensional methods, allowing them to make quicker and more informed decisions."

3. Methodology

The following numbered sections describe the research methodology as a step by step process in establishing a case for the value of 3D interactive multi-layered models. These steps should form a logical argument that provides a structure for the evidence of the value of the 3D model, if indeed such value exists.

3.1 How might we measure "enhanced understanding" and "more informed decision making"?

"Enhanced understanding" is to have an improved or more valued comprehension and interpretation of something, in this case geographic and building information [Dictionary.Reference.com]. An enhanced understanding may often be reached by the addition of extra information or by displaying information in a way that is easier and faster to comprehend.

"Informed decision making" is the act of reaching a justified conclusion resulting from analysis of available information [Dictionary.reference.com]. A more informed decision is often reached due to one or more of the following aspects: access to greater range of relevant information; the ability to comprehend the information better; or, increased time available to consider the decision.

Measuring "enhanced understanding" requires a qualitative analysis, as it is necessarily based on the users' perspective. It will be analysed by setting tasks for the users to complete and then surveying and asking them to rate their understanding using questions like the following:

"Using this method to complete the set task, do you think your comprehension of the relevant information was improved, worsened, or unchanged, when compared to using your traditional methods?"

1 - Significantly harder to understand / method too complex. I would not use this method again.

2 - Slightly harder to comprehend

3 - Neither better nor worse to traditional methods / the same level of comprehension

4 - Slightly easier to comprehend

5 – Significantly easier to complete the task / understand relevant information. It improved my understanding.
Using a 5-point scale like this makes analysis of the 'average' or 'typical' response simple to estimate.

In order to establish a baseline for comparison, this type of task must be performed by the people using a 3D model and by a similar group of people using non-3D information systems (see 3.3 below).

Measuring "more informed decision making" will be done in two ways: Firstly, using a qualitative opinion-based question, as described above; secondly, by allocating a set time limit to complete a task, and timing from the beginning to the end of the required use of the tool, and then the time remaining to make the decision. The basis of this measure is the presumption that given a set amount of time to complete a task, if less time is needed for interrogating the information, then more time is available for decision making.

3.2 What are the potential dimensions of improved interactivity and understanding communicated in 3D rather than 2D?

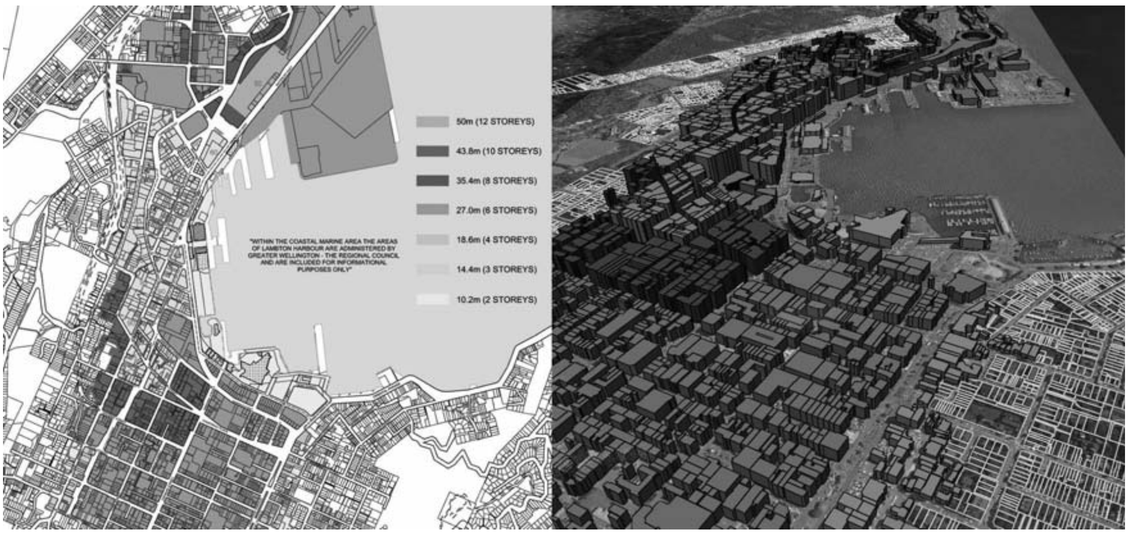
3D models have a third, spatial dimension. This spatial dimension often allows users to develop "spatial awareness", an increased knowledge of position relative to other objects in the surrounding environment. This research assumes that 3D interactive environments allow better comprehension of space, depth and height, than traditional 2D methods. In order to test this assumption, users will be given identical tasks to complete, and two different methods to complete them. To take an example of a task relating to building height: in 2D form, the heights of 100 buildings in a city may be expressed on a plan with associated numerical values or by colour coded key. In 3D form, the heights can be directly interacted with by standing at ground level and looking upwards, giving the buildings a more relative scale.

3.3 How might a test of a 3D interactive prototype set a genuine 2D baseline for comparative purposes?

It is essential to ensure the methodology addresses this comparative issue. In creating these tests, the choice of 2D and 3D models used must avoid creating a comparative situation in which the 3D model is guaranteed to look or function better than the 2D model. For example, it is inappropriate to compare a 2D non-interactive tool to a 3D interactive tool, as it may be that the benefit of the latter is the interactivity, not the 2D/3D aspect. The research tasks posed to users will be based on traditional uses of existing 2D industry Geographic Information Systems tools. These will be compared with a 3D enhanced prototype.

3.4 If the test is to look at the utility of 3D models to different user groups, how might these groups be chosen to represent widely different potential applications of the 3D information?

The 3D model displays information relating to the Urban Planning industry. Previous research has revealed an almost limitless list of groups which have an interest in urban information: architects, urban designers and visualisers, acousticians and aerodynamics engineers, daylight analysts, real estate agents, film producers, television companies,



[Figura 1: 2D vs 3D heights]

tourism companies and travel agents, tourists, environmental planners, community groups, the general public, and so on. The research cannot investigate all of these. The goal is to investigate representative groups.

Two areas in the Urban Planning sector have been chosen as the end-user groups for this test of the research methodology:

- Property Professionals (such as valuers, developers, investors); and
- Local Authorities (City Council)

One of the underlying assumptions of this research is that having one single model for multiple end-user groups could benefit the other groups by showing them information they wouldn't normally use. These groups have been selected so that potential overlaps can be displayed to test this assumption.

Both groups are both significantly different in their requirements for specific types of geographic and building information. Property Professionals are generally concerned with historical and current data such as values, ownership, sales, and information relating to buildings and services in the surrounding area. Local Authorities are commonly issuing resource consents and reviewing proposals, so are concerned with legal requirements and district plan related data.

However, both groups could also benefit from having the other's data available to them – an "information overlap". For example, Property Professionals could gain financial advantage from knowledge of the relationship of the height of all existing buildings relative to height limits set by the Local Authority.

3.5 If the research is to be genuinely applicable, must it examine a number of 3D models compared to a number of 2D models, and if so, what is that number?

The research proposes to test three models with the user groups. This number is constrained by the time limits of the research project and the focus group research methodology selected. Focus groups are a qualitative research method, designed to observe a large amount of interaction on a specific topic over a period of time. Focus groups are most successful as a methodology when they are kept small, around 6-10 participants, and are run by a moderator or researcher, who guides the topic of discussion [Morgan, D L]. Due to the time limits imposed during focus groups (as the participants apparently start to lose interest and energy if the duration is any longer than 1.5 hours) it would be difficult to test more than three simple tasks.

Each focus group will consist of three sections;
1 – tasks to complete;
2 – user feedback surveys; and
3 – group discussion.

During the first section, the three models will be delivered as simple tasks for end-users to complete. The tasks will be allocated a time limit and should take a maximum of 10 minutes each to complete. Three tasks should take approximately 30 minutes. The remaining hour will be allocated as follows: 15 minutes for the user surveys, relating to the tasks the participants completed in section one; and 45 minutes for guided discussion (which for 9 participants allows an average of 5 minutes of talk time each).

3.6 If the research is to demonstrate utility to multiple user groups, what number is sufficient as a test?

As previously discussed, Property Professionals and Local Authorities have been chosen as the representative end user groups, due to the fact that these groups are both significantly different in their information requirements and also allow for information overlaps. Two groups is the minimum number required to satisfy the term "multiple", and focus groups form the method of testing. Data analysis from focus groups is a timely process, involving complex interrogation and analysis of the tasks, discussions and surveys. [Breakwell, G M; et. al].

To ensure the Property Professionals and Local Authorities end user groups do not influence one-another, their relative focus groups will be held separately. These groups will be divided in half, with half of the users participating in a group which analyses 2D methods, and half participating in a group which analyses the comparable 3D methods.

2D	3D
1. Property Professional	3. Property Professionals
2. Local Authorities	4. Local Authorities

This total of four focus groups is both achievable and appropriate given the 18 month time frame of the research project.

3.7 If the research is to demonstrate the potential of one multi-layered model, enabling separate user groups to 'mash up' their own information, then how might this opportunity for cross-referencing (mashing) information between end-user applications be tested?

As outlined in section 3.4, one of the potentials of the research is that one single model aimed at multiple end-user groups could benefit the other groups by showing them information they wouldn't normally use. It is difficult to construct a test of this. Instead of directly testing this, the focus group discussion and user surveys will question the users on this potential – what other 3D information they would find useful or interesting whether in the model or outside it.

4. Conclusions

Time has become a major determining factor of the nature and extent of this research. The hypothesis addresses the general case of the benefit of 3D information. This project will examine two significantly different groups of end-users and test whether conclusive statements formed from the data collected. If successful, then this methodology will have to be applied to additional groups in the future, to completely address this hypothesis.

5. References

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