3 DIMENSIONAL, DIGITAL, INTERACTIVE, MULTILAYERED INFORMATION MODELS FOR ENHANCING DECISION MAKING BY TWO END-USER GROUPS WITHIN THE URBAN PLANNING INDUSTRY:

A Case Study to quantify the benefit or otherwise over alternative 2 dimensional systems

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Abstract. This research investigates the potential of 3 dimensional (3D), digital, interactive, multilayered information models, to enhance users' understanding of sets of geographic and building information, allowing them to make quicker and more informed decisions, than when using alternative 2D methods. The research aims to quantify the benefit or otherwise of 3D methods of information interrogation over 2D methods by developing a test based around the decision making of two widely disparate user-groups within the Urban Planning industry. The underlying purpose of the research is to examine the human ability to interact with and understand datasets of information which are represented in the digital world. This paper specifically focuses on the methodology by which a robust test is developed to be carried out, thus proving or disproving the advantages of 3D display of information when compared to 2D. The ability to apply this same test to additional case studies in the future is a major consideration in the research design. There is a specific focus on integrating and testing a range of research instruments to best establish "language" of the industry and user groups within it, before conducting the major case study. The final research approach adopted is develop and present functional prototype models in a focus group scenario, involving hands-on interactive comparable 2D and 3D tasks, individual feedback surveys and group discussions.

1. Introduction

The primary goal of this research is to determine whether 3D digital, interactive, multi-layered, models enhance users' understanding of geographical and building information over using comparable 2D models. 2D and 3D methods of information interrogation are analyzed by developing a methodology, testing decision making by users within the Urban Planning industry. The ability of a single model to meet the needs of more than one user-group within the industry is investigated by involving two widely disparate professions: Property Developers and City Council Urban Designers.

This paper investigates the application of three research instruments, Tests, Surveys and Focus Groups, to assess the comparative practical analysis of 2D versus 3D as experienced by the two user-groups involved. The research instruments are combined to develop an efficient means of testing the success or otherwise of the two models for assisting decision making in these selected industries. While the sample size is small and cannot be extrapolated to represent the groups as a whole, the detailed Case Study methodology allows an in depth analysis of the impact 2D and 3D has on the typical task requirements of the individuals involved. This allows the study to get past the initial hype and "wow-factor" associated with the visual impact of 3D models and provides a focused analysis of the usefulness of the two different models.

A Focus Group methodology is selected as the base instrument and a Test Case Focus Group carried out to evaluate and refine the instrument as a process. An Initial Online User Survey is employed to confirm the typical language and tasks each user-group is concerned with, which facilitates the design of a suitable test to be carried out during the main Focus Group. Questionnaires individually assess each user regarding their experience with either the 2D or 3D resources before the participants join a guided group discussion.

This research initially derived from a feasibility study for a single 3D prototype model of Wellington City, New Zealand. That research proposed that "a single core 3D digital model of a city, to which many different information systems could be linked, was a better approach to the needs of the city than many individual models optimized for each information system" (Ryan and Donn, 2005). It presented four different potential information layers within a small block of the city: a rendered visualization of building textures; Wellington City Council District Plan height restrictions expressed as interactive 3D extruded blocks of building sites; daylight and shadow analysis integration; and color coded "plots" of property values. The development and delivery of the prototype model was analyzed in regards to how complex, costly and time consuming it may be to

prospective user-groups, it did not focus on where the benefit of these 3D methods lies over alternative 2D methods.

2. Objective

The objective of this paper is to discuss the development of a universal testing methodology, which will quantify the benefits or otherwise of 3D information display over comparative 2D methods. The approach taken uses an efficiently designed Case Study to allow an in depth analysis of a small number of experienced users, rather than a broad, large scale study that would only provide a general overview of the nature of 2D and 3D information communication, due to the varying distraction of the two models in relation to initial visual impact. The methodology design is such that it can be applied to additional user groups in future research.

3. The evolution of 3D data visualization

Spatial ability is "the measured aptitude for perceiving and comprehending relations involving space or extension." (Oxford, 2007). 2D models display data in a simple X-Y flat plane, while 3D models display data in an X-Y-Z fashion, forming a volume. Because of this third dimension, 3D environments often allow a better comprehension of space, depth and height than simple 2D, enabling users to develop a greater spatial ability.

There are a number of independent research papers which both support and reject the claim that 3D methods increase spatial ability and are a more powerful way to communicate information to people than 2D. "The main advantage of 3D perspective views is the capability to easily convey the shape of complex objects" (St. John, Oonk and Cowen, 2000). In a research test of graphical interfaces, it was found that "subjects performed significantly better using the 3D display" (Tavanti and Lind, 2001) and in a study of the benefits of abstracted data, "the results show that structured 3D motion and stereo viewing both help in understanding… providing strong reasons for using advanced 3D graphics for interacting with a large variety of information structures" (Ware and Franck, 1996). However, an evaluation of the effectiveness of spatial memory in 2D and 3D virtual environments revealed that "although it is tempting to believe that moving from two- to three-dimensional user interfaces will enhance user

performance through natural support for spatial memory, it remains unclear whether 3D displays provide these benefits" (Cockburn, 2004). These papers focus primarily on testing to establish if there is a benefit in the mode of display. This research builds on these papers by testing to establish if there is a benefit in the understanding of the data displayed.

Over the last 5 years a number of 3D information systems have been developed, suggesting that there is growing demand and preference for these types of models, particularly as the data is generally already displayed in alternative 2D Geographic Information Systems (GIS). Two such examples are the Centre for Advanced Spatial Analysis (CASA)'s Virtual London and Google Earth.

Virtual London is a digital model of the greater London region, created by Professor Michael Batty and Andrew Hudson-Smith of the University College of London's CASA. At November 23 2006 the model consisted of 3,601,392 individual 3D land parcels, buildings and objects, each with additional GIS data associated with them. The purpose of the model is to populate the base data with wide variety of additional information relating to the attributes and activities of the streets and buildings of London, such as the potential effect of the River Thames rising 10m, should the Greenland ice caps melt; and the display of real time air pollution data collected from sensors around the city streets, which shows the impact of nitrogen dioxide build-up, particularly around intersections, bridges and tunnels during peak time traffic (FIG 1).

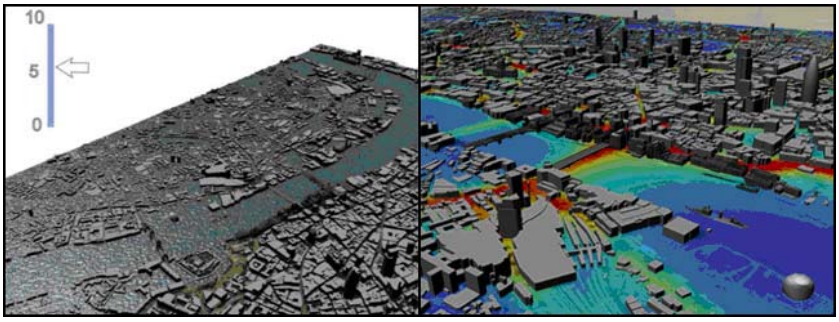

Figure 1. River flooding Prediction and Real-time Pollution data in Virtual London (http://digitalurban.blogspot.com)

Google Earth is a virtual globe of the world, made up of aerial and satellite imagery and 3D terrain data, allowing the user to freely navigate around. It is unique in that Google have left the Earth open to development, enabling users to add any information they please and allowing potential for growth. The free version of Google Earth also allows users to locally overlay aerial photographs, maps or other images. Google Earth PRO version allows a

number of additional features – such as the ability to draw lines and simple polygons, or to import spreadsheets of data, create animated fly-through movies and load Geographic Information Systems (GIS) data and 3D shapefiles. A wide range of "hacks" (extra methods of displaying new information within the existing interface) have been created already by public users of Google Earth, including tracking the progress of a whale shark's migration with a GPS device; Real time sunlight, cloud cover and low level wind data; Real time updates of traffic flow; the position of commercial flights above America, updated every 5min; Color-coded census results; and detailed 3D models with the use of modeling software, Google SketchUp (FIG 2).

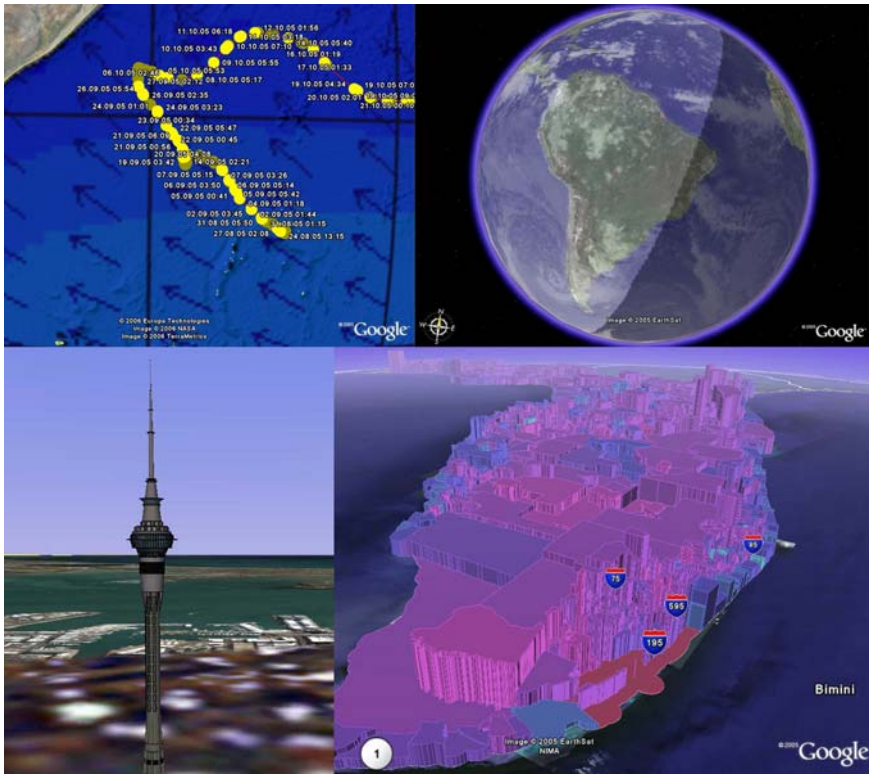

Figure 2. Google Earth Hacks, including (clockwise from top left) Whale Shark migration, Real-time cloud cover, Color-coded Census results for Florida, 3D modeling. (http://bbs.keyhole.com)

These two systems allow user interaction with a range of information and data sets, however the major focus of this research lies with what the users do with this information and how successfully they interpret it. In this

context, a focus on the practical use and comprehension of 2D versus 3D information is measured by establishing a robust comparative test.

4. Research Instruments

Developing a test for this research must take into account both the comparative situation of 2D versus 3D and the practical involvement of two widely disparate user groups within the Urban Planning industry. There is a range of research instruments which can be used to analyze real productivity of real people using real design tools, such as observation, case studies, experiments, questionnaires or interviews. The following section outlines three research instruments which can be adapted to allow analysis of the usability and effectiveness of 2D and 3D resources with industry-based users.

4.1. TESTS AND EXAMINATIONS

Tests or examinations consist of either questions or tasks which most commonly aim to assess the participant's abilities or skill level, relating to a specific subject matter. This is a particularly useful approach to evaluate the usability and the success, or otherwise, of the communication of 2D and 3D information. The main advantage of using a test methodology is the ability to measure the participant's speed by timing the task and to measure their accuracy by analyzing the answers or results they come to. One disadvantage of tests and examinations is that they are often time consuming, particularly if the design is such that they can only be completed by one participant at a time. This can be avoided by developing the test to be completed by groups of participants, rather than individually.

4.2. SURVEYS

Surveys are a method of quantitative data collection, mostly used to gather opinions, attitudes or behavioural information. They involve asking participants a range of questions in a structured manner that does not influence or bias their response. A survey is designed to have a standardised format, so that each participant is exposed to the same questions, in the same order, ensuring the results are valid and reliable. Surveys are an appropriate instrument to analyze the individual thoughts of participants, revealing their preferences and opinions in regards to 2D and 3D tools, without influence from others in the research sample. There are a number of advantages to using a survey method. They are generally easy to administer to a large sample of participants; they yield standardised results with very few errors,

which can be easily categorised and analysed; and they provide sufficient flexibility in the range of questions that can be asked. The primary disadvantage is that the results of an individual participant's survey depend on emotional factors such as their mood, motivation, memory and honesty at the time of completing the survey. Other issues include an inability to express themselves or even non-response, which can sometimes bias the overall sample.

There are two types of surveys: Those on their own are Questionnaires (administered by the participant) and Interviews (administered by the researcher in direct contact with the participant).

4.2.1. Questionnaires (Participant-Administered Surveys)

Questionnaires are designed and delivered in a way that the participant can complete them independently of the researcher. The main advantage of this is that a large sample of the population can complete a single survey at once, saving a significant amount of time. Online questionnaires are a popular format for large scale delivery. An online questionnaire allows the participation of users from around the county, yielding a broader geographic sample of Property Developers and City Council Urban Designers. The disadvantage of a questionnaire is that there is not a personal or physical connection made between the researcher and participant, making recruitment difficult and often causing a reduction in response rates.

4.2.2. Interviews (Researcher-Administered Surveys)

Interviews are essentially a survey that is delivered by the researcher in direct contact with the participant. Each participant interviewed must be asked the same questions, in the same order, and preferably under the same circumstances, typically in person or over the phone. Interviews have an advantage over questionnaires in that they sometimes yield more detailed or emotional responses, due to the direct human interaction involved. The main disadvantage is that they are time consuming, as only one can be completed at a time.

4.3. FOCUS GROUPS

Focus Groups are a moderated discussion, designed to allow interaction within a group of people on a specific topic. They aim to target a small sample of people who have a particular knowledge or skill, which makes Focus Groups a suitable approach for analyzing specific user groups concerned with specific decisions. The main advantage of Focus Groups is that they encourage discussion between the participants, rather than with the interviewer, often yielding more honest feedback. Focus group interviewing saves money and is time efficient. However, disadvantages include issues

such as lack of anonymity and biased opinions. Being part of a group of those in a similar field can sometimes cause participants to feel pressured to conform and agree or to withhold their thoughts. Hearing a range of different opinions during the discussion can also influence participant's original point-of-view, causing them to change their thoughts on the subject.

5. Refining the Research Instrument

From the aforementioned research instruments, Focus Groups have been selected as the base for the methodology design. This method allows participation by a variety of users and specifically focuses on their thoughts about the resources presented to them. Focus Groups can also be designed to incorporate additional research instruments, in this case being a Test and a Questionnaire. One limitation of the Focus Group method is that opinions can only be drawn from the selected people who attend. However this can also be an advantage, as the method allows targeted research by selecting participants with particular relevant knowledge or skills. These skills make them informed candidates for the tasks and questions, reducing bias as they do not have to learn about the tasks and questions in addition to learning about the tools presented to them. Two disparate user groups within the Urban Planning industry were selected for participation, Property Developers and City Council Urban Designers. These two groups were chosen due to their varying professional interests and in order to develop a better picture of whether the productivity and usability benefits can apply to more than one user group.

A small Test Case Focus Group was carried out with a local mapping company and their clients, so that the research process could be evaluated and refined in order to most effectively run the 2D vs 3D Focus Group. An Initial Online User Survey was then developed to gather essential data about the language and typical decisions of the Property Developers and City Council Urban Designers. The data from this Survey was summarized in order to best facilitate the design of practical tasks within the major Focus Group. The following section outlines the processes and outcomes of the Test Case Focus Group and Initial Online User Survey.

5.1. TEST CASE FOCUS GROUP

The purpose of the Test Case Focus Group was to observe the running of such a group in order to better understand issues such as selection and recruitment of participants, running and moderating a discussion, presentation techniques, the approximation of the time required for creation of models, analysis of data and the planning and running of the entire

process from start to finish. The Focus Group was run in conjunction with mapping company, Terralink International Limited (TIL), who wished to gain feedback from their clients about a software package as a new method for communicating data in a 3D interactive format.

The Focus Group aimed to recruit between 8-12 participants, plus 2-3 extra to allow for people who did not show up. This size was to allow each participant the chance to speak for at least 5 minutes each during a 1 hour discussion. Usual group size should be around 6-12 people and are held over 1-2 hours. Small groups of around 4-8 allow each person more time to ensure their personal opinion is well heard. Larger groups of 8-12 are often harder to control and manage their discussion, requiring a higher level of moderation. Generally, 4 is the smallest number required for participants and 12 is considered the maximum (Morgan, 1988).

The participants were a select group of TIL clients who were expected to be interested in the topic of the Focus Group. They were recruited via email and follow-up phone calls. The email did not discuss anything specific relating to the 3D interactive format of display, so to not pre-empt the participants into forming any opinions before they arrived. However, a single rendered image from the digital model was used to entice interest and convince the participants to come along.

The focus group used a digital 3D model of the Queen's Wharf area (Wellington Waterfront, New Zealand) as a demonstration, which has a good urban mix of commercial, private, public and industrial zones, along with significant historical interest, public transport routes, restaurants and bars, acoustic considerations and a network of services. The area contains the sites of a number of proposed buildings, some already in the early stages of construction, which had been modelled extensively in the past by TIL for other projects. A number of additional data layers were chosen to be displayed on top of the base model, consisting of sea, terrain and detailed textured buildings. The chosen data layers were selected by listing and ranking them in relation to the time constraints involved in their creation and the information interests of the confirmed participants.

The seven participants arrived at 2.00pm on a Wednesday and participated for approximately 2 hours. Mondays and Fridays were discarded as difficult days to run focus groups due to participant's concentration levels generally being lower on these days and the afternoon time slot was chosen as people often like an excuse to have an afternoon off work, although their post-lunch concentration levels should still be sufficiently high (Langley, 2007).

The Focus Group opened with a brief introduction from each of the participants in order to establish what they were concerned with in their

everyday jobs before the visual impact of the demonstration, which may have abstracted or modified their thoughts. They were asked:

- What visual tools does your business use now?
- What do you imagine current digital technology could do for you and your business?
- What do you hope technology might allow you to do in the future?

The digital 3D model was presented to the participants, followed by a guided group discussion focussing on the benefits and downfalls of the technology. Specific topics of discussion were:

- How could this technology benefit your business?
- What kind of benefits would it have?
- Who else could benefit from this technology?
- How might they use it?
- What else can be shown or modified to make the technology more powerful?
- What do other technologies offer that this does not?

5.1.1. The Lessons Learned

The Test Case Focus Group was most successful in achieving its purpose of establishing the issues related to planning and running a Focus Group. This section addresses the issues which arose regarding recruitment, background information, room set-up, moderating the discussion and general observations and their subsequent solutions for the major Focus Group.

Recruitment was a difficult process, particularly confirming participants' attendance and accounting for those who did not show up, reducing the size of the group. The recruitment process should be started early to ensure participants have plenty of warning in regards to dates and participation confirmed using a simple confirmation system, such as the use of an Initial Online User Survey. The group should be over recruited by around 30% to allow for people who do not show up.

Specific information about the participants and their concerns should be established before the Focus Group, rather than during the opening discussion. The participants arrived having considered a few background questions they were emailed prior to attending; however it would be more beneficial to receive written information relating to their concerns in the early stages of the focus group development. The tools they use and decisions they make are essential background data in order to successfully plan the group around relevant demonstrations, models and tasks. Making sure the model is organised in the early stages of planning is an important issue to address. Problems arose with expired software licenses and a method had to be established for selecting additional data layers, which was a time consuming process. The Initial Online User Survey should be used to

establish which layers of data should be chosen to best describe task scenarios.

Room set-up established an undesired formality to the Test Case Focus Group. The use of a company board room meant that the focus group felt very formal, primarily due to the oversized oval table which set a physical distance between the participants and Moderator. Seating for the major Focus Group should be placed in an evenly spaced small circle or U-shape, as this keeps everyone on the same level, rather than having the "leaders" at the head of a long table. Getting started on tasks in small groups of 4-5 people will get people talking and working together. This would be a much more successful way of making sure the participants do not feel too intimidated.

Ensuring the discussion stays focussed and on topic, is very important. The moderator plays an essential role in doing this and must be proactive in making sure the participants are all being heard. The Test Case Focus Group required a more detailed briefing for the moderator about the types of questions to ask. More open ended questions should be used to get people to express their thoughts and allow the discussion to flow naturally and successfully. Ensuring that for every main question, there are a number of sub-questions or similar questions will also help keep the discussion going. Some people naturally spoke out more than others. The moderator for the major Focus Group should try to involve everyone in the discussion by asking people who are talking a lot to keep their answers shorter, or by aiming questions specifically at the quieter contributors. At times, the discussion slowed down or stopped completely. When this happens it would be beneficial for the moderator to expand on questions by asking "can you give me an example?" If more depth is required about a particular question, the moderator should ask "what else?" as opposed to "anything else?" as this implies more discussion, rather than the ending of a discussion.

When assembling and writing transcripts after the Test Case Focus Group, it would have helped greatly to have a voice recorder or Dictaphone rather than relying on summarized and often brief observation notes.

Allowing participants to converse amongst themselves with tea and coffee at the beginning of the major Focus Group would establish a more relaxed environment. Thanking participants for their effort and input should be a simple gesture such as morning/afternoon tea and a take-home information DVD.

A two hour session on a Wednesday starting at 2.00pm was successful as the participants' energy levels and mood were excellent. Any less time would see too little discussion and any more would result in a drop in concentration levels.

5.2. INITIAL ONLINE USER SURVEY

As a result of the experience from the Test Case Focus Group, an Initial Online User Survey was set up in the early stages of the major Focus Group development to allow a substantial amount of written information and feedback to be collected from potential participants before the 2D and 3D task models began being built. The approach was to contact all of New Zealand's 17 City Councils and a random selection of 17 Auckland-based Property Developers for the purpose of establishing a commonality of language, decisions and tasks, rather than to statistically represent the two groups throughout the country. The data collected was used to direct the design of the models and tasks so that they specifically address the issues defined by the actual users.

The primary purposes for the Initial Survey were as follows:

- To establish a range of job descriptions from Property Professionals and City Council Urban Designers;
- To find out what 2D and 3D visual digital information tools were currently being used by these user-groups;
- To find out what kind of common decisions were made using these tools as a resource;
- To gauge further interest to participate in the major Focus Group.

The initial draft of the survey was tested and reviewed by a Statistician to allow revision of some of the questions. The way in which the questions were written or described was crucial in order to receive response from the participants which could be measured or counted. For example, when asking a participant to describe their job and what it involves, analysis would involve assessing their worded answer – i.e., counting the use of certain verbs (assessing, applying, reviewing, processing, promoting, preparing, developing) and identifying the key nouns (resource consent, district plan, land use, buildings) which were used in the description. The Initial Online User Survey was distributed via the internet and set out as follows:

- What region are you located in or nearest to?
- Please choose the user group you are a part of in the Urban Planning industry.
- What is your job title?
- Briefly describe your job and what it involves.
- Consider some of the major decisions your job requires you to make. Please describe two of those decisions, and the typical process you would use to make them.
- Do you use 2D visual digital information tools to assist you in your decision making? If yes, please list 2 or 3 tools you most often use.
- Do you use 3D visual digital information tools to assist you in your decision making? If yes, please list 2 or 3 tools you most often use.

- If you answered Yes to Questions 5 or 6, please state which type of tools you use the most.

5.2.1. Generated Data

The Initial Online User Survey provided essential background data, establishing the nature of the two user groups' language and typical task and data requirements. Word association, counting and grouping was used to analyze the results. To take the example of Local Authority City Council Urban Designers, where a total of 24 participants were recruited from ten of New Zealand's 17 City Councils; the most common job description were Planners, followed by Architects, Designers and Geographers; typical decisions related mostly to compliance and consent processing, followed by assessment of the impact and effects of a proposal, design work, and the development of local District Plans; and the most commonly used resources for decision making were 2D based, with only two responses relying primarily on 3D resources. This data guides the choice of task development for each user group, ensuring an accurate and representative task is created for each respective group using both a 2D and 3D display method and also allows overlaps in information requirements to be tested.

6. Proposed Testing Methodology

The Focus Group research instrument forms a base from a three part test that has been devised to systematically compare participants' assessment of the models and software. The Focus Group will be made up of willing volunteers who were participants in the Initial Online User Survey and are therefore already informed in the task areas.

TABLE 1. Typical dividing of participants into groups.

Participants (An average total of 8)		1 x Property Developer Task	1 x City Council Design Task
Group 1:	City Council Designer #1 City Council Designer #2 Property Developer #3 Property Developer #4	2D resource (ArcGIS)	2D resource (ArcGIS)
Group 2:	City Council Designer #3 City Council Designer #4 Property Developer #1 Property Developer #2	3D resource (GeoVirtual)	3D resource (GeoVirtual)

The 2D/3D Focus Group will consist of three parts over approximately 2 hours, to allow maximum collection of usable and measurable data. A short

(5 minute) introduction and overview of the research will begin the session, followed by the participants being divided into two groups 3-5 people per group of mixed users. One of the groups will be assigned to use the 3D resource and the other group to use the 2D resource (TABLE 1).

6.1. PART 1

Firstly, the participants will complete a brief but clear introductory tutorial according to the software group (either 2D or 3D) they were assigned to. Then they will be timed to complete two short decision making tasks, one based on a Council task and one based on a Developer task, allowing approximately 15 minutes per task, 30 minutes in total. This task section is aimed to get the participants working together, assessing the information and thinking about the display of the data assisting them in their decision making.

6.2. PART 2

After completing the tasks, the participants will be given 10 minutes to complete a self- administered survey (questionnaire). They will be asked about the decisions they came to and how, and their understanding of the information resource. The questionnaire will be administered without discussion, in order to collect the participants' thoughts before they are exposed to the opinions of others.

6.3. PART 3

Following the questionnaire, the participants will form a single group and take part in a guided discussion based around 4-5 key questions. The discussion group aims to allow the participants to share and discuss their thoughts and experience with the others in the group, particularly those who completed the same task with the alternative resource.

7. Recommendation

This research proposes to use a combination of three research instruments, Tests, Surveys and Focus Groups, to create an efficient and detailed testing methodology to determine whether 3D digital, interactive, multi-layered, models enhance users' understanding of geographical and building information over comparable 2D models. Two user-groups within the Urban Planning industry; Property Developers and City Council Urban Designers,

have been selected to investigate the ability of a single model to meet the needs of more than one user-group within the industry.

The users will participate in a three-part Focus Group, incorporating a practical timed task, a participant-administered survey and a group discussion. This breakdown of activities ensures all of the participants are involved in each section of the Focus Group and their thoughts expressed both independently and as part of a collective group. The combination of independent and collective research instruments will provide a small sample of evidence for the benefit or otherwise of both the 2D and the 3D resources for the participants involved. While this small sample would not allow the evidence to be extrapolated to the user-groups as a whole, it provides a detailed comparison of the two resources and their effect on typical decision making tasks, ensuring that the study has enough depth to get past the initial hype associated with the visual impact of 3D models.

The research process is refined by the evaluation of the Focus Group method in a Test Case Focus Group, and then an Initial Online User Survey provides essential background data, establishing the nature of the two user groups' language and typical task and data requirements.

This research methodology could be applied to additional end user groups within the Urban Planning industry in the future, or expanded to incorporate a wider geographic representation of Local Authorities and Property Developers within the New Zealand context.

References

COCKBURN, A., 2004. Revisiting 2D vs 3D Implications on Spatial Memory. *Proceedings of the Fifth Australasian User Interface Conference (AUIC), January 2004.* Dunedin, NZ: 25-32.

LANGLEY, T., 2007. Focus Group Planning. *Meeting at Terralink International House, 13 February 2007.* Wellington, NZ

MORGAN, D.L., 1988. *Focus Groups as Qualitative Research.* Newbury Park, California: Sage

OXFORD, 1989. *Oxford English Dictionary Second Edition.* Oxford University Press, UK

RYAN, R. AND DONN, M., 2005. A 3D Interactive, Web-enabled, Multilayered Wellington City. *Building Science Honours Research Report.* Victoria University of Wellington, NZ

ST. JOHN, M., OONK, H.M. AND COWEN, M.B., 2000. Using Two-Dimensional and Perspective Views of Terrain. *SPWAR Systems Center Technical Report Number 1815.* San Diego, USA

TAVANTI, M. AND LIND, M., 2001. 2D vs 3D, Implications on Spatial Memory. *Proceedings of IEEE InfoVis Symposium on Information Visualization, 22-23 October 2001.* San Diego, USA

WARE, C. AND FRANCK, G., 1996. Evaluating Stereo and Motion Cues for Visualizing Information Nets in Three Dimensions. *ACM Transactions on Graphics,* 15 (2), 121-140.

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