○ GEOGRAPHICAL VISUALIZATION: A PARTICIPATORY PLANNING SUPPORT TOOL FOR IMAGINING LANDSCAPE FUTURES

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The geographical visualization of urban and regional landscapes is a powerful technique for engaging actors involved in decision-making processes. Tools developed can empower professional and citizen alike to make better-informed decisions. The paper reports on collaborative research being undertaken to develop and apply a range of 3D geographical visualization products to enhance both planning and scientific communication processes. In this paper we discuss some developments and applications of 3D geographical visualization tools and work being undertaken to evaluate the effectiveness of such tools for solving spatial planning problems. The paper concludes by discussing the lessons learnt in undertaking a cross-disciplinary approach to developing and applying landscape visualization tools and offers some future research directions with respect to technical specifications and the usefulness of geographical visualization as a participatory planning support tool.

INTRODUCTION

The wider adoption of spatial technologies, such as geographical information systems (GIS), planning support systems (PSS), more readily available spatial data layers, and a continued improvement in computer performance has in recent times lead to a greatly enhanced ability to generate in 3D, existing and future spatial scenarios (Lovett 2005).

In recent times there have been a number of applications of 3D geographical visualization to assist in collaborative planning processes, both in urban and rural contexts (Bishop et al. 2005; Pettit et al. 2004). This growing body of literature and the related 3D geographical visualizations of future planning scenarios are referred to by Lovett (2005) as 'futurescapes'.

Our research examines 3D geographical visualization, also referred to as landscape visualization (MacFarlane et al. 2005) as an important communication tool for urban and regional planners. The paper commences by providing a context for landscape visualization as a tool for spatial planning and assisting with participatory decision making. Our research reports on the development of a 3D-object library and we describe some current and future applications of geographical visualization within the State of Victoria, Australia. The case study sites discussed include (i) Township of Queenscliff, (ii) Jewell Station Neighbourhood and (iii) Township of Sunbury – see locality map, **Figure 1**. The paper includes a discussion of the evaluation process being deployed to evaluate the effectiveness of applying geographical visualization in the context of participatory planning. We conclude by discussing the lessons learnt in undertaking a cross-disciplinary approach to developing and applying landscape visualization tools and offering some future directions in the application of 3D geographical visualization in relation to planning, community engagement and envisioning processes.

Figure 1 Geographical Visualization Case Studies – Locality Map

VISUALIZATION – A TOOL TO ASSIST WITH PARTICIPATORY PLANNING

In order to examine the role of visualization as a participatory planning tool for imagining landscape futures it is first important to briefly define and discuss both *geographical visualization* and *participatory planning support systems*.

WHAT IS VISUALIZATION?

Scientific visualization in the statistic and computer science literature is principally concerned with the use of graphic tools. While geographical processes and related datasets need to deploy spatial science related technologies such as geographical information systems (GIS) to display different forms of maps. The representation of this information, either in two-dimensional (2D) or three-dimensional (3D) space is commonly referred to as spatial data visualization, or geographical visualization (GeoViz).

A formal definition of geographical visualization is as follows:

“Geographical Visualization focuses on the application of scientific communication theory to mapping artefacts” (Cartwright et al. 2004, 28).

Most planning support and decision support system technologies are underpinned by ‘collections’ of maps and geographical artefacts that enable decisions-makers to interrogate credible,

current and extensive data sets. These systems for visualising geography provide tools in 2D and 3D to enable users to explore existing and planned future environments.

Since the advent of desktop GIS in the 1980s the representation of existing and futures scenarios have typically been represented in digital 2D-map/plan format. This was progressed with the development of a larger GIS market created by a combination of developments, that included desktop GIS, object oriented products; the move away from independent GIS, accessible GIS and GIS databases through the use of multimedia geographic tools and World Wide Web browsers for spatial data. The development of 2D geographical visualization decision support tools has been undertaken by most commercial GIS vendors. There have also been products developed and delivered as 'open' format packages, for example the CommonGIS package (<http://commongis.jrc.it/>), developed as a tool for interrogating datasets from the European Union.

Results from a survey administered to a number of Council representatives from the UK, undertaken by Appleton & Lovett (2005) revealed that overwhelming the participants feel that members of the public struggle to turn 2D maps and plans into 3D mental images. This might help explain the recent shift towards representing existing and future scenarios using 3D visualization technologies. There are now available a number of innovative tools available for creating 3D visualizations of both built and natural landscapes. Such tools include: off the shelf GIS packages and 3D extensions (for example: ESRI's ArcScene and CommunityViz's Scenario360), 3D Globe products (for example: Google's *GoogleEarth*, NASA's *World Wind* and ESRI's *ArcGlobe*), OpenSource languages such as Virtual Reality Markup Language (VRML) and Extensible 3D (X3D), and a range of computer gaming engines (for example, FarCry, Unreal and Torque). An example of applying gaming engine technology for visualising real world topography is illustrated in **Figure 2**. In this example Germanchis et al. (2004) are interested in the application of 3D geographical visualization technology for understanding people's perceptions of space and place.

Figure 2 Example 3D Geographical Visualization – Queenscliff, Victoria

WHAT ARE PARTICIPATORY PLANNING SUPPORT SYSTEMS?

Traditionally, urban and regional planners consulted various land resource and development professionals and combined this knowledge base with their own expert judgements in undertaking land use planning. However, in many cases this results in outcomes not acceptable to stakeholders and the wider community. Today the dominant paradigm has moved towards planning *with* the community rather than *for* the community. This more inclusive approach to land use decision making is known as participatory planning.

Planning Support Systems can be defined as:

- (1) systems dedicated to planners' analytic, forecasting or design tasks, and (2) systems designed to improve their presentation and/or communication.
- (Klosterman & Pettit 2005, 477–484)

There are a number of PSS tools available to planners to perform simulation, sketching, and evaluation of land use change. Thus, the concept of a 'planner's toolbox' is appropriate when defining and describing such a set of loosely coupled set of tools (Geertman & Stillwell 2003). 3D Visualization is one of the tools in the planners toolbox, an effective medium for which a wide range of scientific knowledge can be better communicated to communities and decision-makers in a collaborative way. Hence, 3D visualization is considered an important technique for assisting in participatory planning tasks and is thus considered a participatory planning support system tool. In the context of spatial planning 3D geographical visualization provides a tool for enhancing the understanding on implications of planning metrics. Planning metrics are the results generated from a planning instrument such as land-use change/land-cover change, comprehensive projection or impact assessment, as applied by urban and regional planners in consultation with suitable expert bodies. The role of visualization as a presentation and communication tool for planning is shown in Figure 3.

Figure 3 3D Visualization – A Presentation and Communication Tool for Planning

Community participation and engagement in planning decisions can range from simple consultation and informing to close collaboration and full empowerment. Visualization techniques offer powerful enabling tools along this spectrum or 'ladder' of participation. Traditional planning approaches by way of public meetings, statutory printed displays and formal letters are often less effective ways of informing, consulting with and empowering communities impacted by

urban development. These approaches typically rely on highly formal (legalistic) written statements and simple plan-elevation 2D representations. Although formally allowing for input and ideas from impacted groups, albeit within very limited constraints, they do not encourage the exploration of ideas and alternative development scenarios. Recent developments in visualization techniques and applications provide one of the key (but not sufficient) conditions for genuine community engagement in planning processes and outcomes, offering the possibility of interactive communication at all stages of development.

Appleton & Lovett (2005) noted that relatively little research has been done to investigate how audiences relate to geographical visualization based 'images'. This is more so the case in the context of direct community engagement. Research currently being undertaken by Community Spatial Scenario Simulation Group (C-S3) and Primary Industries Research Victoria (PIRVic) aim to evaluate further the effectiveness of 3D geographical visualization technology as a tool for understanding of places and space, in both urban and rural landscapes.

The ensuing sections of this paper discuss the multi-disciplinary research endeavours being undertaken by C-S3 and PIRVic in applying geographical visualization as a planning tool for making collaborative land use decisions.

THE DEVELOPMENT AND APPLICATION OF 3D GEOGRAPHICAL VISUALIZATION FOR PLANNING

The population of Metropolitan Melbourne (Australia) is expected to increase by over 1 million by 2030, which translates to approximately 620,000 new households. If this growth is not properly managed this will pose serious land-use conflicts both within the existing cityscape and also within the rural-urban fringe. Melbourne 2030 is the strategic planning document prepared by the Victorian State Government to regulate future urban growth. Melbourne 2030 contains a number of planning instruments to control and shape projected urban growth such as: an urban growth boundary, a green wedge strategy, transit cities and activity centres. Public engagement has been a core component to the Melbourne 2030 approach, where over 3000 residents have been consulted. However to date, planning support system technologies such as 3D geographical visualization have not been deployed in Victoria to assist the planning processes. It is believed that technologies such as 3D geographical visualization can assist planners in better communicating planning outcomes to decision-makers and to engage the public, and thus make better collective spatial planning decisions.

A CROSS-DISCIPLINARY APPROACH TO DEVELOPING URBAN AND RURAL FUTURES

A cross-disciplinary approach has been deployed to visualise urban and rural futures by both the C-S3 at RMIT University and the Landscape Systems Spatial Sciences Group, Primary Industries Research Victoria (PIRVic). These groups have worked in collaboration towards developing and applying a range of 3D geographical visualization products to enhance both urban and regional planning practice and empower communities and stakeholders in decision-making processes.

C-S3 and PIRVic have collaborated internally, with each other, and with external groups, in applying geographical visualization techniques to address spatial planning problems in the State of Victoria, Australia.

BUILDING A VISUALIZATION PPSS TOOLKIT FOR URBAN PLANNING – JEWELL STATION NEIGHBOURHOOD

The Jewell Station Neighbourhood project was inspired by the groundbreaking work of Shiffer (1995) where he developed a hyper-media collaborative planning system for increasing accessibility of information to planners for making better land use decisions. The Jewell Station Neighbourhood online site also provides access to the what-if scenarios via a number of metaphors, including; *panorama*, *sketch*, *map*, *virtual reality* (See Figure 4), and the *sandbox*. The idea of providing a number of hyper-media tools for exploring what-if scenarios was inspired by research undertaken by Cartwright (1999) in extending the map metaphor using web delivered multimedia (hyper-media).

Figure 4 Jewell Station Neighbourhood Virtual Interface

As part of the broader strategy to engage the community in planning scheme reforms in accordance to the Melbourne 2030 plan, the Moreland City Council conducted consultations on future urban development scenarios for the Jewell Station Neighbourhood. Initial work undertaken by C-S3 resulted in the formulation of a number of planning scenarios for the Jewell Station Neighbourhood (Petit et al. 2004). Figures 5a, b, c illustrate snapshots from a common viewpoint facing north along Sydney Road. Figure 5a is the existing Sydney Road streetscape. Figure 5b represents a proposed redevelopment option with a modified building structure in accordance with the existing planning scheme’s permissible maximum building height requirements. Figure 5c represents a modified streetscape with shortened building awnings and additional street planting (topiary trees). Figure 5d illustrates the interactive collaborative *sandbox* design tool where participants can build their own scenario using a drag and drop approach. The *sandbox*

design tool has been developed for the Station St parkland, adjacent to the railway station. This trial of an innovative suite of visual and participatory planning techniques focussed on developing transit oriented development (TOD) scenarios to encourage consolidated development to occur around transportation hubs, such as the Jewell railway station. Each of these scenarios are accessible online (<http://www.c-s3.info/jewellwebsite/content/first.htm>) where the user can interact and explore in 3D geographical space.

Figure 5a Existing Conditions

Figure 5b Modified Building Height

Figure 5c Modified Streetscape

Figure 5d Modified Park Design

A cross-disciplinary, multi-agency approach was undertaken in developing the Jewell Station Neighbourhood project. This involved drawing upon the expert knowledge of various professionals including architects, planners, social scientists and the local knowledge of the community to evaluate options. In the start up phase of this project architects and planners from the Moreland City Council participated in the scoping of likely future scenarios for the neighbourhood, providing spatial data, plans and expertise. In later phases of the project members from the local community and the Sydney Road Traders Association were invited to participate in an interactive forum, where they tested some of the geographical visualization tools and explored various what-if scenarios. The use of geographical visualization tools served as a common communication medium between the experts and local community. Also, the authors believe that through the involvement of a number of experts and community participants a more rigorous research process was undertaken, using real expertise and information, rather than generalised and theoretical constructs.

DEVELOPING AN AUSTRALIAN 3D OBJECT LIBRARY

There are a number of techniques, tools and languages available for 3D visualization modellers to construct realistic and conceptual landscape representations. Modellers can create their own 3D objects to populate landscapes or they can access existing 3D object libraries. Some PSS have their own 3D object libraries, such as CommunityViz. Alternatively, there are a number of OpenSource and commercial 3D data repositories including 3D Café, 3D consortium, Virtual Terrain Project (VTP), and Visual Nature Studio (VNS) – www.3dnature.com.

Furthermore, it is noted by MacFarlane et al. (2005) that visualization techniques remain highly expert-oriented. Part of our impetus in developing a 3D object library is to try and make visualization technologies more accessible to non-expert visual modellers, albeit making 3D visualization more accessible to spatial scientists to implement through desktop GIS packages.

This has resulted in the development of a prototype Australian 3D-object library. The idea behind the library is that when creating 3D geographical visualizations that are communicated to the community and decision-makers there is a need to provide an appropriate visual context to existing and what-if future scenarios. For instance, it would not be suitable to represent the peri-urban greater Melbourne area using cypress trees and Tuscan villas as this would not convey an appropriate sense of place. **Figures 6a, b & c** provide examples of 3D Virtual Reality Markup Language (VRML) objects, which populate the Australian 3D object library. These include: native tree species such as Casuarina and River Gum, and a common modern colonial style house with surrounding veranda found in peri-urban areas of Melbourne. Future landscape visualization projects, particularly focussed on peri-urban and rural scenarios will utilise the 3D-object library in generating representation of existing and future landscapes.

Figure 6a Young Red Gum – VRML

Figure 6b Casuarina – VRML

Figure 6c Modern Colonial Style House – VRML

VISUALIZATION OF PERI-URBAN AND RURAL LANDSCAPES

Research is under way to develop and deploy 3D geographical visualization to peri-urban and rural landscapes in Victoria to assist decision-makers and the community in understanding the ramifications of decisions relating to land use change and impact. **Figure 7a & b** depict examples of 3D geographical visualizations of rural landscapes. Like the urban landscapes previously discussed, this demonstration rural landscape is accessible online (<http://www.c-s3.info/html/ruralproject.html>), and provides an interactive 3D geographical environment. Users can explore a rural landscape, populated by 3D objects, sound files, and augmented reality buttons to adjust water level heights and visualise the effects of different rainfall scenarios.

Figure 7a Rural Landscape Example – VRML

Figure 7b Rural Landscape Example – VRML

A peri-urban 3D geographical visualization is currently being developed for the township of Sunbury, which is situated within the Hume Local Government Authority (LGA), the most northern LGA comprising the greater Melbourne region. This research will develop 3D visualizations of the township and its surrounding agricultural landscape using objects such as rural houses and native trees species contained within the 3D-object library discussed in Section 3.2. These objects will be imported into ESRI's 3D GIS package ArcScene in VRML format. So far work has been carried out, developing preliminary peri-urban visualizations for Sunbury using the 3D objects from the existing ArcScene object library, as illustrated in **Figures 8a and b**. Future work will replace these Americanised 3D objects with local Australian 3D objects to give local

planners and community users a greater sense of place and identity. The purpose of this project is to demonstrate to Council and State Government decision-makers the potential of 3D Geographical Visualization as a tool to engage communities in understanding the potential ramifications of planning decisions on peri-urban areas.

Figure 8a
Peri-urban Visualisations: The Township of Sunbury

Figure 8b

EVALUATING VISUALIZATION AS A PLANNING TOOL

Visualization can be applied as a planning tool in order to undertake visual impact assessment (VIA), as discussed in the ESRI Virtual Campus “Urban and Regional Planning” using Arcview GIS (<http://campus.esri.com/>). Also, landscape visualization has become a significant part of the environmental impact assessment (EIA) process (MacFarlane et al. 2005). As 3D geographical visualization becomes further embedded in planning culture it is essential that we evaluate visualization from both an application and user perspective. The following evaluation has been undertaken for the Jewell Station Neighbourhood project, described in Section 3.2.

The evaluation is completed 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.

A prototype online Jewell Station Neighbourhood visualization 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.

Results from Stage 1 found that the community based test group generally liked the concept, but the actual Jewell Station Neighbourhood visualization product needed to be refined as per the feedback. Participants thought that 3D improved interpretation of the urban landscape, but

'help' tools like a navigation map with "you are here" information needed to be added. Also, an experienced operator was needed to 'drive' the 3D landscape visualization in community meetings, so that community members could concentrate on the planning scenarios presented, not how to 'drive' the Web 3D interface. This helped to guide the building of a test model for Stage 2, where five 3D models were built, each containing sequentially increased levels of detail and clutter – Geographical Dirtiness.

Stage 2 focussed on better understanding how complex a computer graphics 3D environment needs to be to support decision-making related to urban planning developments. The interest here was to ascertain how the 'geographical dirtiness' of the virtual environment changes the perception of a space. Items were subtracted from the complex landscape visualizations built for Stage 1 of the evaluation process, ending up with a very simple block type visualization product. This basic block model only contained basic building outlines. Another four models were built for the evaluation, each with an increasing amount of complexity. **Figure 9a** illustrates the most basic level of detail representation compared to the most detailed landscape visualization product, as shown in **Figure 9b**.

Figure 9a Simple World

Figure 9b Complex World

Stage 2 of the evaluation was undertaken with community members and professional planners. The community group was drawn from the local Brunswick area. The professional group comprised planners from the Victorian State Government and planners attending the Australian Planning Institute conference held in Melbourne in April 2005. From the evaluations completed with the community and professional groups a wealth of information has been assembled that can be 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. A model with a 'modest' amount of detail has been built to test the amount of geographical dirtiness that is needed to support the 'realness' of the image, but a level of detail that can be built within a reasonable time frame and with a limited budget.

Specific feedback from participants from Stage 2 of the evaluation determined that a simple model (**Figure 9a**) would 'work', but is needed to be enhanced by the addition of a number of elements:

- Colour coded land use;
- A legend;
- Street signs for navigation; and

- Landmarks.

Based upon these guidelines another iteration of visualization models were refined for evaluation by professional planners in Victoria, comprising Stage 3 of the evaluation. What was ascertained was information about the minimum number of landmark buildings needed and the level of *a priori* knowledge required by a participant to instil a sense of place and understanding conveyed by a 3D landscape model. The Stage 3 evaluation was done with two groups – one with local knowledge of the area and a second without. The evaluation has been completed and the results are currently being assessed. Further work will also be undertaken to understand how participants (planners, decision-makers, and community members) utilise virtual ‘wayfinding’ devices to navigate and understanding particular decision spaces. Such ‘wayfinding’ devices might represent the elements of design (paths, nodes, landmarks, edges and districts) as defined by Lynch (1960).

A CROSS-DISCIPLINARY LEARNING EXPERIENCE IN DEVELOPING AND APPLYING GEOGRAPHICAL VISUALIZATION TOOLS

The cartographer’s and spatial scientist’s role in developing the Jewell Station Neighbourhood product involved collaborating with the planners and social scientists in developing and test a suite of visualization tools that might be useful for community participation. The set of design guidelines, as agreed upon by researchers, specified that the 3D tools must:

- Be built using Open Standards.
- Work with just a Web browser and free plug-ins.
- Work on low-end machines available to community members via the local municipality or at Internet cafes.
- Use little text, as the study area has a high proportion of citizens whose first language is not English.
- Provide adequate visualizations of current conditions and possible re-development schemas.
- Provide a ‘fresh’ viewpoint from which to see the community.

From the cartography and spatial sciences perspective, working with planners, social scientists, made for interesting discussions in determining the requirements of potential users (community participants, planners and policy makers). Likewise through this process it was felt that the social scientists and planners learnt what was possible to achieve in applying visualization technology and also the limitations imposed by the development criterion. Overall the research group agreed that a useful product was developed, one that could be used as a model for future collaborative ventures.

From the social science and planning perspective the use of geographical visualization as a spatial planning tool raises important questions about how people access, process and use information as they go about their lives in complex urban societies. The multi-disciplinary experience in building participatory planning support systems for envisioning likely urban and rural futures raised a number of interesting questions, including:

1. How important are 2D and 3D representations of alternative planning scenarios in: (a) informing residents, local businesses, government authorities and visitors of the possible and likely future developments in a particular locality, (b) providing these stakeholders with the conceptual and IT tools necessary to effectively contribute to the evaluation of alternative scenarios, and (c) empowering stakeholders to influence the actual planning and development outcomes?
2. How do people actually respond to and use such tools and how do patterns of use vary by the socio-economic status, ethnicity, age, length of residence, etc.? In particular, what groups are likely to be excluded from using these tools – e.g. the visually impaired, people lacking basic IT skills, itinerant and temporary residents – and how might barriers to use be overcome? Conversely, what groups who were previously excluded from participating in spatial planning and development decisions are now able to be involved in these processes? Examples of previously excluded groups are the frail and aged (unable to access conventional media and information points), non-English speaking people and the very young.
3. Given that the new tools have the potential to change planning practice, how will this impact on the professional role and power of professional planners and the position of existing decision making elites?

Although the research presented in this paper is still in progress, the results to date suggest that, as expected, professional planners are quite comfortable operating at a low level of visual specificity; that is, they are well able to navigate represented spaces that are not presented in highly realistic forms. However, it appears that people with only basic computer skills are also able to adequately navigate their way through both familiar and unfamiliar landscapes that are represented at moderate rather than highly realistic levels. This suggests that for many planning situations a middle-level degree of specificity or ‘geographical dirtiness’ will be sufficient to enable effective communication across a wide range of stakeholders. This conclusion – if supported by further research – is important because it means that the information demands and cost of deploying the tools can be kept to moderate levels, by comparison to approaches that rely on very realistic, information-rich visualization procedures.

Further research could focus on tracing the boundaries to the applicability of middle-level visualization tools, by identifying those planning situations and stakeholder configurations that are likely to require a higher degree of realism if stakeholders are to be effectively informed and involved in land use change processes. It is also important to explore the degree to which the new geographical visualization tools potentially reinforce or threaten the power of government planning authorities to control the planning agenda. On the one hand, these tools may improve effective communication with groups who will be impacted by planning outcomes, in a given situation, reducing opposition based on misunderstanding and misinformation, as well as encouraging the emergence of innovative development solutions. On the other hand, to the extent that the tools empower previously excluded or ignored groups, with interests partly opposed to the interests of dominant groups and the professional or other aims of planners, their deployment in particular planning situations may increase levels of opposition and cause significant delays or even abandonment of the planning process. This latter outcome is not necessarily an unambiguous ‘bad’, as decisions not to proceed may – depending on the values held – contribute to efficient and/or equitable planning outcomes.

What this planning toolbox approach offers – drawing as it does on the range of disciplines noted above – is an opportunity for interdisciplinary teams to pose and attempt to answer the questions posed above, and in doing so, to better understand the dynamics of land use change and the contributions that geographical visualization techniques can make to more effective planning in societies characterised by unequal access to wealth, information resources and power.

FUTURE RESEARCH DIRECTIONS

There are two key research areas on which future research efforts will be concentrated: (1) the application of geographical visualization as tool to assist in participatory planning exercises; and (2) the development of emerging visualization technologies and platforms to further support planning.

GEOGRAPHICAL VISUALIZATION A PARTICIPATORY PLANNING TOOL

There exist exciting possibilities for utilising the new visualization techniques to facilitate genuine community participation along the entire spectrum from:

- Informing: creating user-friendly, interactive web sites and CD ‘fact sheets’.
- Consulting: generating feedback at crucial stages in the design and development process through interactive consultation meetings.
- Involving: exploring alternative development scenarios in workshops and online.
- Empowering: influencing final planning decisions through ‘citizen juries’ and online ballots focused on the development options generated through collaboration informed by visualization outcomes.

Effective use of the new visualization techniques raises the key question – who should have power to make decisions with respect to both framing the alternative scenarios and determining the option or options chosen for implementation? The potential of the technologies to reach people previously excluded from participating in planning decisions – such as non-English speaking people, young people and the frail aged who may not be able to comprehend traditional media or access information points – also threatens the power to decide of established elites, including professional planners and local government officials. Conversely, the new technologies may exclude other groups – such as the visually impaired or people who are uncomfortable with information technologies in general. Visualization, then, opens up new possibilities for participation and engagement but also closes down other possibilities, such as for those groups with poor computer literacy or accessibility. Further social research is necessary to establish the contours of these opposing inclusionary and exclusionary processes and to addressing awareness and training issues associated with using computer based collaborative tools.

DEVELOPMENT OF EMERGING VISUALIZATION TECHNOLOGIES AND PLATFORMS TO SUPPORT PLANNING

There are many emerging technologies that need to be evaluated as to their suitability for assisting decision support where geographical information is paramount. In a report to members of the US University Consortium for Geographic Information Science (UCGIS) community in the USA,

a number of emerging technologies that would influence geographical visualization to varying degrees were listed:

- Computer hardware and software advances, and associated affordability.
- Alternative display media that are overcoming the limitations of CRTs.
- Internet capabilities.
- Personal Digital Assistants (PDAs).
- Immersive environments like CAVEs (Computer-Assisted Virtual Environments), walls, workbenches.
- Mobile computing and mobile computing enhances via wireless links to the Internet using Wireless Area Networks (WANs).
- Real-time displays, by integrating GPS with visualization tools.
- Hands-free computing, using voice recognition and other means of interaction.
- Wearable computers.
- New data coding schemes like eXtensible Markup Language (XML), GML (Geographic Markup Language), Synchronised Multimedia Integrated Language (SMIL) and SVG (Scalable Vector Graphics).

As well, other applications of new media and computer technology need to be considered. There is growing interest in the use of games tools for depicting real geography. Games like SimCity can be used in geography educational programs and popular games engines can be used to build 3D virtual environments (Germanchis et al. 2004). Augmented Reality (AR) can be employed to facilitate a better understanding of geography and to empower professionals to collaborate by 'sharing' a common AR artefact. Mobile telephones, especially current devices that have 'fused' together 'phones, PDAs and GPS, can be employed to deliver 'at location' services, and also to provide more general geographical information related to local government resources or tourist information.

SUMMARY AND CONCLUSIONS

Imagining our future is the collective responsibility of communities, planners and decisions makers. Generation X (cohort of people born post World War II baby boom) and future generations will likely expect 3D landscape visualization front-end when envisioning the future. This is because, as noted by Sheppard (2001) these up coming generations have been bred on video arcades and Nintendo™ and are familiar with and expert interactive virtual reality capabilities. Subsequently, it would come as no surprise, that visualization techniques constitute an increasingly significant element of the planning toolbox (Geertman & Stillwell 2003; Appleton & Lovett 2005).

To date our research has focussed discussion on the visualization of urban and peri-urban areas from a traditional land use planning perspective. However, in (re)-imagining our future we need to consider other landscape dimensions and influences. For example, Dockerty et al. (2005) have undertaken landscape visualization of climate change scenarios and MacFarlane et al. (2005) have reported on the visualization of biosecurity scenarios, specifically foot in mouth policy scenarios. A significant body of research also exists on visualising rural phenomenon; including applications in forest visualization (Myklestad & Wagar 1977) and assisting rural com-

munities contemplate landscape change (Bishop et. al. 2005). The challenge is to combine these different visualization domains to develop integrated landscape visualizations of possible futures that span across both urban and rural landscapes.

The paper has discussed a cross-disciplinary approach to developing and applying online and desktop geographical visualization tools for exploring various what-if planning scenarios, and the results of usability testing undertaken on the various actor groups accessing the site. We believe that geographical visualization tools can be used to create collaborative virtual environments, which can assist in the exploration of spatial decisions and options. Through the deployment of online geographical visualization tools we have endeavoured to bridge the gap between expert and local participants in (i) the decision-making process and (ii) the exchange of data, information and knowledge.

New geographical visualization tools have implications for the large concerns of social exclusion and inclusion, the role of both built and natural environment professions and the distribution of power in society. These are issues of vital public policy concern and offer fertile possibilities for interdisciplinary research that draws on the fields of sociology, geography, planning, natural resource management, public policy analysis and spatial sciences.

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