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Public participation in a spatial decision support system for public housing

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Abstract

This paper reports the development of a Spatial Decision Support System (SDSS) that is currently in the early stages of implementation and testing. The project is a joint undertaking between the University of New South Wales (UNSW) and the NSW Department of Housing (DoH). It features a robust, non-proprietary data structure incorporating 3D spatial models, use of VRML/X3D for graphics modelling and incorporating XML based data and customised tools to support effective web-based user interaction. Although the broader project aims to develop an SDSS that supports all aspects of the management of public housing for a governmental authority, this paper focuses specifically on a module to support public participation through the capture of community feedback and other input. The paper begins with an outline of the immediate context of this work, both in terms of the local community being used as the test bed for this implementation as well as comparing this work to similar undertakings in other places. It goes on to describe the unique approach taken in this project toward the structuring of the geo-spatial data that lies at the heart of the system and the tools developed to support user interaction and community participation. The paper concludes with a discussion of on-going issues encountered during the development and implementation of this system, and proposals for future developments. This paper is an extension of the work presented at the *24th Urban Data Management Symposium*, in Chioggia, October 2004.

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1. Introduction

Although no-one doubts the essential contribution made by traditional GIS (Geographic Information Systems) technologies to local and regional planning, it is commonly recognised that these systems tend to be used more for information provision than participation, frequently leading to negative results and the disenfranchisement of the community. Evans, Kingston, Carver, and Turton (1999) assert this position when stating that it "has been well documented among scholars that traditional GIS methodologies often exacerbate the marginalisation of community stakeholders who lack access to GIS technologies". An important development in GIS has been the recognition of the need to engage the community in the planning process, giving rise to a variety of terms to describe this process: Public Participatory Geographic Information Systems (PP-GIS); Community Information Systems (CIS); or the term we have preferred, Public Participatory Spatial Decision Support Systems (PP-SDSS). Although the terms vary, the concept is to allow for a two-way exchange of data with the public to form cumulative banks of site-specific data, information and knowledge that may be combined to assist in collaborative decision-making processes. There is much discussion in the literature about the strengths and weaknesses of this approach, including several examples where attempts have been made to exploit the web to engage the public in such participatory processes. In this introduction, we begin by briefly reviewing some of that material and then go on to describe the social context of our own study.

2. Review of related work

A very good example of an effective Community Information System is reported by VanderMeulen (2002) from the Land Information Access Association in the US. This is a publicly accessible CIS providing both professionals and the general public with access to information about the local community as well as simple analysis tools to manipulate that information. VanderMeulen (2002) states that, "this collaborative effort yields a valuable web-based, information resource while providing the benefits of increased community involvement, public education, interpersonal trust, shared interpretation of data, and an overall improvement in the quality of local land use planning data". The information was derived from government instrumentalities as well as through community-based information collection activities involving small community workshops with titles like 'Crayon your Community' where important features were mapped from scratch, or the 'Picture your Place' where residents were given a disposable camera to map their community and form a shared interpretation of community assets. This system acts as an important catalyst for community ownership and the formation of what VanderMeulen calls a 'sense of place', in that way serving as a good model for the work reported in this paper.

Evans et al. (1999) outline the 'Shaping Slaithwaite' project. A test case for this CIS was the 'Planning for Real' initiative that the Neighbourhood Initiative Foundation developed and patented. During a village fair people (usually schoolchildren) were

offered coloured flags that represented different levels of health or crime, and asked to place them onto a physical model of the community. This was supplemented by a web-based version that supported a two way flow of information, allowing people to add comments and also to query existing comments. Further to that, in another project, an email discussion group was formed regarding nuclear waste disposal. All these projects had a noticeable effect on mobilising the community. In a survey conducted, people indicated that they found the study useful and popular. However, the survey also revealed that there were strong biases in the type of people who participated: for example, there was a strong male to female bias (70.6% to 30.4%); occupation was biased toward professional, managerial and educational positions; and the participants were heavily age-skewed toward schoolchildren, probably on educational trips. A particular finding relevant to our study was that users proved to have a high degree of proficiency with map usage, but experienced much frustration with interfaces.

In the Bronx area of New York, Silva, Saul, and Kim (2002) describe a project used for asset evaluation and assessment. Both professional evaluators and community members collaborated on the collection of data and its presentation and analysis using maps as the medium. Inventory questionnaires and a series of indices were used to measure the condition of properties, vacant lots, community gardens, greenery and where there was a presence of rubbish in the area. Again, the process involved lots of running feedback and revisions to include the full range of community concerns. The process integrated local knowledge into evaluation procedures with community feedback measures, revealing qualitative dimensions that statistical approaches failed to capture. Overall, the use of maps to tell a story gave insight, fostered collaboration, co-production and allowed non-technically inclined members to visualise and critique the results. The employment of this system made the final report a valuable product for the community.

In another example, Chua and Wong (2002) elaborate on a study in Philadelphia, where the PP-GIS encompassed themes for crime, housing, poverty, people, education and business. The PP-GIS was found to form connections that now make the service irreplaceable. It is noticed that many requests from the community for information call for non-GIS information, for example, school environment and performance, mailing lists of non-profit organisations, details of social service programs, grant writing resources and planning studies and reports. Requests for GIS data tended to be specific in nature, such as tree locations or building conditions. It was noted however that often, "the requested GIS information cannot be met by available public records or administrative data and requires substantial amount of data collection" (Chua & Wong, 2002, p. 8).

In a somewhat earlier study, Horan, Serrano, and McMurran (1991) analysed the built environment from a social-cognitive perspective to assist in planning transportation improvements and to contribute to an overall sense of community and place. Intended to serve as a model for place-based planning strategies, a PP-GIS was used to map Lynch's mental maps of paths, boundaries, districts, nodes and landmarks.[1]

[1] After the classic work by Kevin Lynch, The image of the city, MIT Press, Cambridge [Mass], 1960.

Similarly Singh (1996) combined Lynch's elements of physical form into GIS themes to help identify and map the attributes of a place for urban design and sketch planning. These examples highlight the long-held recognition of the importance of mapping and understanding community perceptions of place in order to effectively guide the management and planning of urban precincts.

Highlighting one of the potential problems with PP-GIS, Kwaku Kyem (2002) focuses on the difficulties encountered in the shift of power to communities and critically analyses claims of empowerment, political access, equity and legitimacy when bureaucratic organisations present themselves as "benevolent institutions that entertain and address the concerns of underprivileged groups" (Kwaku Kyem, 2002, p. 1). A PP-GIS was studied in its role of assisting indigenous groups redefine boundaries and reclaim traditional lands. Although highly successful in including social narratives, local knowledge and helping put issues on the agenda of national and regional organisations, it was conceded that goals were rarely attained and very little feedback information exists. Kwaku Kyem concludes, "empowerment is an investment that involves risk taking, occasional failures and disappointments, constant reviews of strategy and persistence" (Kwaku Kyem, 2002, p. 2). Community empowerment requires that power relationships be redefined. A community may have to advance through a hierarchy of empowerment, undergoing a process of transferring authority and relegating responsibilities. Attention needs to be paid to this process where public officials relinquish power and permit local organisations and individuals to take on that responsibility. This is exacerbated where, as is so often the case, there are discrepancies between individual and collective goals.

The next piece of work to be reviewed has many similarities to that of the authors of this paper. It is the Woodberry Down project that began in 2000 in the London Borough of Hackney. Comparable to one of our study areas at the Redfern/Waterloo region in Sydney, the area consists of high-rise residential developments borne from slum clearance in the 50s and accommodating around 6000 residents in 2500 housing units. Woodberry Down is described as "one of the biggest regeneration projects in Western Europe" (Hudson-Smith, Evans, Batty, & Batty, 2002, p. 1). The Centre for Advanced Spatial Analysis (CASA) was commissioned by the Woodberry Down Regeneration Team (WDRT) to develop an online method for participation. The resulting system has a strong emphasis on informing local residents about the redevelopment process, enabling visualisation of different urban plans, promoting discussion and permitting votes on a variety of options over the web (Evans & Hudson-Smith, 2001). The portal for the site[2] provides: links to textural information about the process of regeneration with respect to the users own housing; mappable information supported by panoramas providing low-bandwidth immersion to enable users to visualise key areas of the site as they stand; a bulletin board for registered users to discuss issues; and a 3D part of the site presenting different options for development and opportunities for user participation in selecting between these alternatives. The WDRT reveals its belief in this process stating, "it is

[2] See: http://www.156.61.16.5/woodberry/ [last accessed: August 2004].

certain that when it comes to involving the local community in the regeneration, the quality of their involvement in the process may well be more important than the final outcome of many key decisions'' (WDRT, 2001, p. 18 cited in Hudson-Smith et al., 2002).

As Web-based technologies able to support 3d visualisation have evolved in recent years, there has been a marked increase in their use in PP-SDSS. These can provide many functions, such as design presentation and evaluation (Al-Kodmany, 1999; Gruen & Wang, 1999; Krygier, 2002; Levy, 1999); better communication with the public (Krygier, 2002; Manoharan, Taylor, & Gardiner, 2001); an interface for 3-dimensional data and analytical support such as time based visualisations (Benhamu & Doytsher, 2002) and presenting qualitative and quantitative data to assist the decision-making process (Manoharan et al., 2001). Computer models of environments are constructed to test design decisions and visualise phenomena that would be otherwise unrecognisable. Conversely, sketch plans may be dynamically linked to GIS for urban designers (Batty et al., 2000). Levy (1999) sees the value of spatial technologies and design visualisation in encouraging ''examination of critical urban issues: scale, density, public access, open space, zoning, viewscapes, sun and shade... an accurate image of a proposed development can empower a local community group by focusing energy on areas of common concern'' (Levy, 1999, p. 2). This is particularly relevant to the government department associated with the work reported in this paper, where they have established Neighbourhood Improvement Programs (NIP), Intensive Tenancy Management (ITM) programs and Community Renewal Strategies (CRS). A non-expert can interpret an image of a built environment, quickly decipher the intent and discuss issues with greater clarity than where the information is communicated via more traditional (and abstract) methods such text or charts. At the same time, the use of computer visualisation may be misleading in that visual fudging is still possible; people equate visualisations with a scientific level of accuracy and the visual dominance of the image can detract attention from other issues (Levy, 1999; Smith, Dodge, & Doyle, 1999).

In all these examples, the emphasis has been on the use of the web to disseminate information in order to facilitate community awareness, promote discussion and provide vehicles for community response. Evans et al. (1999) recognised the value of these support systems to develop community interest groups around spatially-based problems and to promote solutions. The exercise can be seen as a formal process for participants to reach an informed decision, submit it to those responsible for implementation, see the results and gain feedback on the reasons for the final choice. This helps in the formation of a democratic consensus. Chua and Wong (2002), VanderMeulen (2002) and Feick and Hall (1997) all highlight the importance of trust in such systems, identifying it as a critical factor for the success of PP-GIS processes. Langendorf (1999) highlights the importance of the image in all these systems: ''If collaboration is required among parties that have not built trusting relationships, visual images often provide an easier basis for building trust than do, for example, words. There are examples of community design efforts that bring together developers, planners, architects, environmentalists, citizens, and government officials that have illustrated the persuasiveness of the image'' (Langendorf, 1999, p. 18).

3. Project context

The work reported in this paper forms part of a larger project commissioned by the NSW Department of Housing (DoH) and carried out by a research team in the Faculty of the Built Environment at the University of New South Wales (UNSW). In broad terms, the project has sought to investigate ways that a SDSS could be implemented to support the work of the DoH. The focus of this paper is on a prototype web-based PP-SDSS designed to encourage user participation in the management of public housing communities.

The DoH faces the task of managing not only physical assets, but also the communities of the housing estates. Randolph and Judd (1999) emphasise the importance of effective public participation in the management of housing estates, arguing that "community based institutional structures are needed that will encourage and facilitate effective community involvement in local decision making on neighbourhood-based renewal initiatives" (Randolph & Judd, 1999, p. 15). The DoH is committed to facilitating community involvement as much as possible as part of a holistic approach, encouraging community involvement to inform the design process and provide valuable information as to how limited funds may be used more effectively. Neighbourhood Advisory Boards, Resident Action Groups, tenant participation representatives and community workshops are all encouraged in order to facilitate community participation. This is a discursive and iterative process, paced and structured accordingly over an extended period of time. One interesting comment, made by a DoH staff member, highlights the importance of the medium when dealing with the community: "Butter paper looks like a work in progress, whereas [Microsoft's] PowerPoint looks like a finished article".[3] Thus, a focus of this study has been on how best to facilitate community interaction via a visual medium.

Community Action Planning has become an important DoH operation, where lessons learnt from past projects illustrate the shortcomings of schemes with no community involvement or ownership: "[the] community has expectations and knowledge of what works and what does not work. This may have been harnessed to avoid Radburn planning[4] which was misinformed by designers and other non-community members".[5] Began in 1995, the *Neighbourhood Improvement Program* (NIP) is currently integrated into core DoH policy. The NIP combines a focus on physical improvements to estates with social aspects of tenancy management, social inclusion strategies and seeks more involvement of tenants in decision-making related to their estates. This holistic approach was seen to result in higher resident satisfaction and lower tenancy turnover (Johnston, 2003); increased accountability of the DoH for the effectiveness of the service provided with the use of public funds and enhanced credibility of the estate renewal proposals (Farrar, 2004). Combined

[3] Comment made during a DoH staff survey that formed part of this research.

[4] Radburn style planning attempted to separate pedestrian spaces and vehicle networks by having tracts of housing 'facing' onto common landscaped areas and 'backing' onto networks of cul-de-sacs for vehicular access.

[5] Comment made during a DoH staff survey that formed part of this research.

with this, consultative and presentational workshops have been successful in identifying issues, potential solutions and to show works in progress to tenant groups and assorted stakeholders. These endeavour to draw on a large cross-section of the community, including, the local school community, university students and representatives from local agencies and charities. Although it is recognised that individuals may dominate small groups, independent Resident Action Groups have formed to act as an intermediary between the community and the DoH, presenting issues of concern from the community to the DoH and feeding back important information from the DoH to the community (DoH, 2002b). These structures can be seen as the foundation of increased self-governance: structures within the community influencing directions, policies, monitoring performance, enhancing relations and constructing networks and supports that may lead to work, education or training opportunities (Farrar, 2004).

The sociological aspects of the estate and the existing community also inform highly localised operational decisions of the DoH. Social issues manifested by graffiti and vandalism may be registered by tenant complaints. In one instance, unfamiliar youths were burning piles of rubbish in DoH areas. Tenants assisted the DoH with anonymous phone-based tenant reporting (effectively working with the DoH) and identified that problematic areas were poorly lit, leading to the installation of sensor lights. On the other hand, lighting areas indiscriminately might attract nuisance such as glare, or annoyance, such as noisy recreation. Working with the tenants enables optimal provision of spaces in a particular place where a relationship has been established with the community members and issues. This may assist in securing funding from government for community projects, such as constructive graffiti mural projects. The process revolves around good information, clients, future clients (5–10 year predictions) and the issues identified by them to chart the community's needs sustainably into the future.

Another area in the Sydney region under the control of the DoH serves as a good example of this commitment to community participation, but highlights the need for a spatially-based approach. Minto,[6] a housing estate near our focus area, was the subject of a $350 million program to rejuvenate housing in 2002. A masterplanning phase identified the opportunities and limitations of the site and detailed proposals for housing, community facilities, cycleways, parks and open spaces, footpaths and roads including an analysis of the stormwater flow, utility services and environmental considerations such as existing significant trees. In acknowledging that the local community "has a wealth of expert local knowledge" (DoH, 2002b, p. 1), detailed feedback was sought from community consultation over the masterplan. Six open meetings were held between May 1 and 8 2003 including progress reports from planners and engineers. Residents were asked to discuss their likes and dislikes with respect to the area and to come up with ideas for future improvements. Common suggestions included: the removal of laneways from housing areas, improving street

[6] See: http://www.housing.nsw.gov.au/redevelopments/index.htm#Minto%20Renewal [last accessed: January 2005].

lighting and making streets safer, better planned open spaces, better playground equipment and facilities in parks, and more suitable accommodation for existing community services. In conjunction with these suggestions, questions from the community were collated and responded to with a leaflet.[7] The majority of those questions were spatially based, and presentable through WebGIS, although at the time residents were expected to view plans at council, the community library or simply retain information from the workshops. The redevelopment of the Minto estate is scheduled to be staged over a 10-year period. At each stage, the work can be reviewed in consultation with local stakeholders. It is proposed that in the first stage of the program, around 220 townhouses will be replaced with 240 new homes (DoH, 2002a). This process, although successful in its application, presents the opportunity to add a new component of spatial visualisation and spatially enabled feedback loops between the community and the DoH. For instance, a group of residents have begun compiling a history of the Minto estate. Photographs, plans, newspaper articles etc are being gathered and stories are being tape-recorded (DoH, 2002b). These artefacts have precise spatio-temporal attributes and are mappable in geographic space and time and if combined, would serve to act as a unique information source for all those involved in community renewal.

4. Focus estate: Cranebrook

The public housing estate of Cranebrook was selected for the purpose of testing the PP-SDSS developed for this project. Cranebrook, on Sydney's outer western fringe and lying within the Penrith local government area (LGA), was the last broad-acre estate developed in 1979 by the public housing authority and consists of three-story apartments, townhouses, cottages and Radburn style detached housing (Fig. 1).

The DoH Special Projects Unit is undertaking an *Integrated Strategic Planning Process* for the Penrith LGA, and has already established an operational GIS for that purpose. Our aim is to integrate with that existing GIS, providing a web-based SDSS that can be used by the DoH in its on-going planning and management programs. Within that project context, Cranebrook has been identified as an ideal setting to explore the possibilities of enhanced public participation.

The Cranebrook community has a history of exhibiting enthusiastic involvement in community projects, and has demonstrated a genuine willingness to access the basic technology infrastructure available, as long as the tools provided are carefully designed. This was illustrated with the *E-Community Demonstration Project*, a partnership between DoH and the Office of Information Technology (OIT), instigated in 2001 as part of the *Community Renewal Strategy* (CRS) for Cranebrook. The project aimed to address the residents' low levels of access to Information Technology, and

[7] See: http://www.housing.nsw.gov.au/redevelopments/minto/MintoQ&A.pdf [last accessed: January 2005].

Fig. 1. Images of the Cranebrook estate, with the Neighbourhood Technology Centre on the right.

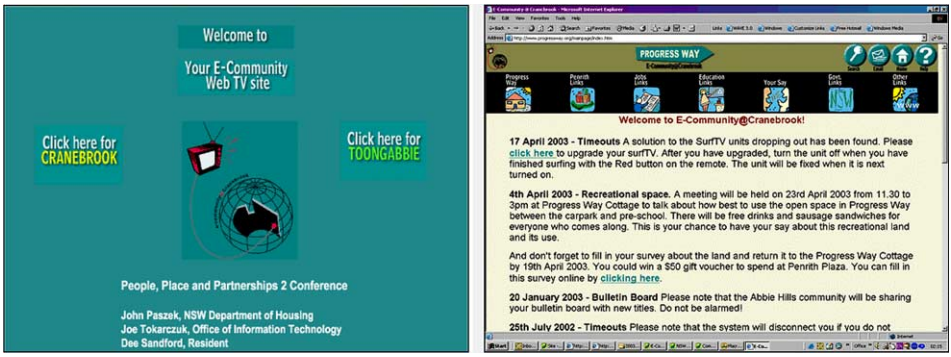

Fig. 2. The 'E-Community' portal and the 'Progress Way' webpage.

in turn provide a localised, technologically-enabled social infrastructure supporting increased participation of individuals in community activities (see Fig. 2).

In May 2002, 96 households in Cranebrook were given set-top boxes (also known as 'iTV') to enable Internet access through personal television sets, albeit with limited interactivity, some printing capability and no data storage facilities. Residents quickly took to the technology, operating it to capacity. In parallel with this, a neighbourhood technology centre was trialed as part of the E-Community strategy: known as '17 Progress Way', the facility provides several computers offering Internet access, scanning, printing and related services to the local residents. The website (Fig. 2) hosts a moderated discussion board, community information regarding services, events, social activities, employment and training, government services, commercial transactions, entertainment, information services and a collaborative helpdesk. Importantly, free training sessions were conducted at the technology centre with 67 tenants participating. A resource and training officer was also appointed, funded by the local charity Barnados,[8] to provide support for technical problems, training needs and to assist residents set up and maintain a website maintenance group. A full project evaluation was performed in mid 2003.[9]

[8] See: http://www.barnardos.com.au [last accessed: January 2005].
[9] See: http://www.oit.nsw.gov.au/content/6.1.1.16.ecommunities.asp [last accessed: January 2005].

The DoH have no immediate plans for major building works in the Cranebrook area, though some minimal physical alterations are being proposed for the estate, such as the construction of a community garden, the closing of some back lanes and minor upgrades to existing houses. These relatively simple interventions and the spatial decisions surrounding these issues, combined with an increasingly technologically empowered community, make Cranebrook an ideal test bed for developing our PP-SDSS. Many of the initial hurdles of community mobilisation and digital infrastructure have been addressed; yet a void remains for integrated spatial technologies. Once trialed, we hope our model may then be applied to other estates.

5. Technical context

Our PP-SDSS is designed in the light of guidelines for community engagement set out by the *Australian Government Department of Planning and Natural Resources* (DIPNR) on their *iPlan* website.[10] The techniques suggested by the DIPNR range across an increasing scale of public impact: to inform, consult, involve, collaborate and empower. It is suggested that websites be deployed at the 'inform' and 'consult' phases. In the detailed breakdown for web-based consultation, most standard web tools are suggested and encouraged: information pages, threaded discussion boards, virtual meetings, webcasts, etc. However, there is no mention of web-based, spatially enabled and interactive community mapping, which has been the focus of our work.

The Australian Government already has a robust spatial information infrastructure. The *Government Interoperability Technical Framework* sets out guidelines for the *Australian Spatial Data Infrastructure* (ASDI) providing national data standards and guidelines to enable efficient use and sharing of information and structuring of spatial data to maximise the potential for interoperability. The *Australian Spatial Data Directory* (ASDD) is a concise guide to the various documentation and resources that define core metadata elements for land and geographic directories in Australia and New Zealand, structural rules for representing metadata as documents in XML and defining the metadata elements, their order, structure and relationships. The joint *Australia/New Zealand Land Information Council* (ANZLIC)[11] has been working with the ISO Technical Committee (ISO/TC 211) on ISO 19115, which defines the international standard metadata schema. The *ANZLIC Metadata Guidelines* are designed to comply with this standard. ANZLIC has recommended that federal, state and local governments use the *Australian Government Locator Service* (AGLS) metadata schema to describe agency information and services, to improve their visibility and accessibility on the Internet. The *Spatial Information Management Toolkit*,[12] a content standard, represents a collaboration between ANZLIC and the *Australian Local Government Association* (ALGA). The toolkit outlines best practice for collection, management and use of spatial data. The *Intergovernmental*

[10] See: http://www.iplan.nsw.gov.au/engagement/techniques/ [last accessed: August 2004].
[11] See: http://www.anzlic.org.au/ [last accessed: January 2005].
[12] See: http://www.anzlic.org.au/projects_LGtoolkit.html [last accessed: January 2005].

Committee on Surveying and Mapping (ICSM) has also produced the *Harmonised Data Manual*, setting out guidelines to establish minimum and potential standards to ensure data interoperability. Similarly, the *National Community Services Information Management Group* (NCSIMG) has developed the *National Community Services Data Dictionary* (NCSDD).[13] Informed by the Spatial Information Management Toolkit, the National Community Services Data Dictionary recognises the importance of consistent classification of community services in Australia to enable interoperability and add value and meaning to the bulk of data that is collected by government bodies and their collaborators (NCSDD, 2004). We draw extensively from these initiatives as a foundation for positioning our system with standards of best practice.

Since our focus area is a public housing estate, and the client a government department, the public nature of the work and limits on funding suggested using open source code and formats. Open source software was identified in 2002 in the Australian Government's e-government strategy *Better Services*, *Better Government* as providing "opportunities for innovation, greater sharing of information technology systems, improved interoperability and cost savings" (AGIMO, 2004, p. 1).

6. Structure of the PP-SDSS

Virtual Reality Modelling Language (VRML) has been in existence since 1995 and has become the most popular tool for providing interactive 3D models on the Web. VRML is now being replaced by X3D (Bullard, 2003) based on the eXtensible Mark-up Language (XML). The Web3D Consortium and the World Wide Web Con- sortium (W3C) have established X3D as an XML-compliant ISO standard for interactive 3D on the web (Kumaradevan & Kumar, 2001). X3D uses XML to express the geometry and behaviour capabilities of 3d models (Brutzman, 2002), yet as it is extensible, metadata may be embedded in the file and linked to any other spatial or non-spatial dataset. The power of this technology is that it permits a user to interact with the embedded datasets in the 3D model in real time over the Internet. The use of level-of-detail nodes enables data that is 'out of scope' to be ignored, assisting navigation and management of complex large environments.

One of the advantages of X3D is that it supports the ability for a Web user to add geometry and metadata to the 3D model 'on the fly'. Our proposed system exploits that ability to support public participation. We have used the ability to add semi-transparent, extruded polygons to the model to enable users to 'outline' geographic areas as part of a neighbourhood mapping exercise. These objects are scripted through the use of JavaScript, utilising the W3C 'Document Object Model'[14] functionality of the X3D/VRML format, enabling the actual content of the files to be extended by the user on the fly. By hybridising with other technologies such as

[13] See: http://www.aihw.gov.au/publications/index.cfm/title/9995 [last accessed: January 2005].
[14] See: http://www.w3.org/DOM/ [last accessed: August 2004].

GIS and CAD, Web-based VR can act as a powerful real-world design tool (Smith et al., 1999). It is noted that web-based GIS technologies are well established and tool sets exist to enable the construction of a site that may display geographic information graphically and invite user interaction. Often, these programs may claim to accommodate public participation in the form of a 'post-it' note facility, with user input limited to a text based input. Expanding on this, we propose a simple application supporting user input of polygons with height attributes, attached comments and metadata. This covers the scope of what would be useful to perform in a trial community workshop at this point in the development.

In summary, our full SDSS is a 3D visualisation system in X3D/VRML format using an open source platform developed by *Ping Interactive*, our collaborators on this project and reported in Thorne and Weiley (2003) and Barton, Parolin, and Weiley (2004). It is illustrated in Fig. 4. A SDSS must bring together data from many different sources to operate in a holistic manner. Maximising interoperability with other systems is critical. We propose a module-based system built on an open 3D-GIS, of our own design, facilitated by server side MySQL[15] and jboss,[16] as demonstrated on Ping's vEarth spatial server.[17]

Fig. 3 illustrates the structure of the proposed system. We envisage the system to accept data from within the DoH, as well as from external sources. In this paper, we focus on the data collected from public participation, input via the interface illustrated in Fig. 4.

In Fig. 4, the shaded areas have been created in an example session—the user specifying colour, height and forming the polygons point by point. Some XML-based metadata is generated automatically, such as date and time, along with user specifiable fields such as links to other URLs. The information input via this interface is parsed and added to a PostGIS[18] database. This is immediately fed back via the HTTP protocol to update the screen, enabling a realtime and direct interface within the virtual model of the estate.

It is the database driven VR environment that adds value to the data collected from public participation. The geographic data is searchable, queryable and may be filtered thematically with the assistance of the metadata. When rich datasets are formed, expert systems and software agents may be employed to assist future applications. In the long term, if successful, cumulative, site-specific resources of local knowledge will be formed. However, these datasets may contain sensitive information and as a security precaution, two separate servers are proposed- one open to the World Wide Web for 'published' data, and one hosting unreleased information accessible only by authorised personnel within the DoH and community. If left unchecked, these datasets could re-enforce stigmatisation, rather than their intended use to assist in local empowerment and serve as a community-owned information

[15] See: http://www.mysql.com/ [last accessed: January 2005].
[16] See: http://www.sourceforge.net/projects/jboss/ [last accessed: January 2005].
[17] See: http://www.ping.com.au/ [last accessed: January 2005].
[18] An open source spatial database technology developed as a research project by Refractions Research Inc.: http://www.postgis.refractions.net/ [last accessed: August 2004].

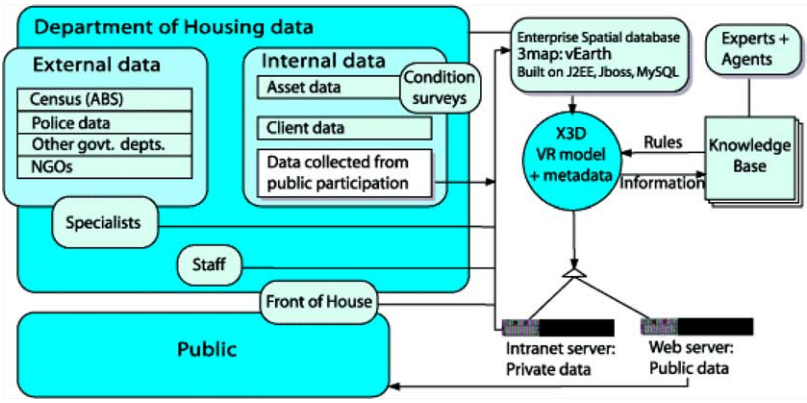

Fig. 3. Structure of the prototype SDSS.

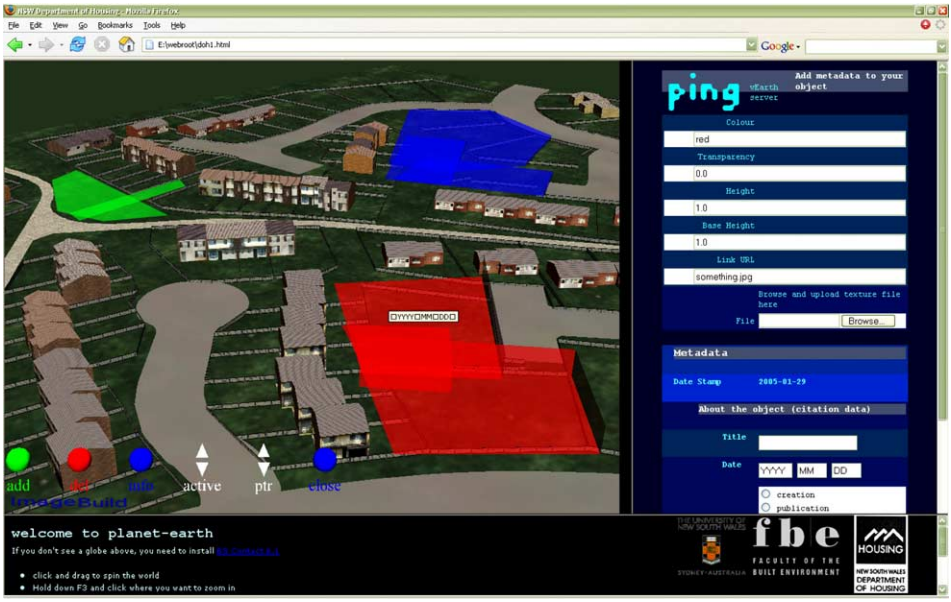

Fig. 4. Screenshot of an example community mapping survey.

bank. The '17 Progress Way' website had a full time moderator to check that no posts were obscene or otherwise anti-social. Filtering software was also supplied to participants to limit access to pornographic and gambling sites. This moderator approach will be employed for our spatial component as well, presenting an added opportunity for training and community employment. Furthermore, data input by users can be incorporated into more powerful GIS systems if required. As such, all entries must be viewed by a moderator to check for pre-determined standards before publishing.

We are not expecting participants to engage in any ambitious urban design activities or complicated technical tasks, rather the system should facilitate the collection of voluntary local knowledge, support spatial reporting and compliment existing tenant engagement processes. Some exercises the system enables are listed below:

1. *Neighbourhood mapping*: Users are invited to indicate where they perceive their neighbourhood extends by means of drawing a polygon, or submit a response to a question such as, "where are the social places?", or "where are the lonely places?". Users may indicate assets in the community, or identify areas that show potential for improvement. Free text comments may be added as metadata to the geometry, and sliders are used to give weight to the comments, e.g. by simply dragging a marker across a scale, the user can indicate a weighting from very negative to very positive (Fig. 5).
2. *Safety audit*: In a similar fashion to neighbourhood mapping, areas of perceived safety and risk may be mapped. Users are asked to identify areas where they feel safe or unsafe in the day and in the night. This mirrors similar work done previously and reported in Samuels, Judd, O'Brien, and Barton (2004). In that work, the polygons defined by the users were collected, assigned a transparent fill and overlaid to form cumulative maps as illustrated in Fig. 6.
   This analysis may be performed at intervals to see changes in perceptions over time. It is also possible to collect police incident data and overlay that in order to observe any correlations between public perception and actual occurrences of victimisation on the estate. There are several ethical issues raised by such analysis, but the techniques to carry out such work are readily available.
3. *Maintenance reporting*: This can be made very easy and controlled by permitting users to report required maintenance by dragging icons representing electrical, plumbing, landscape, building or mechanical problems onto localities on the map.

Fig. 5. An example value slider.

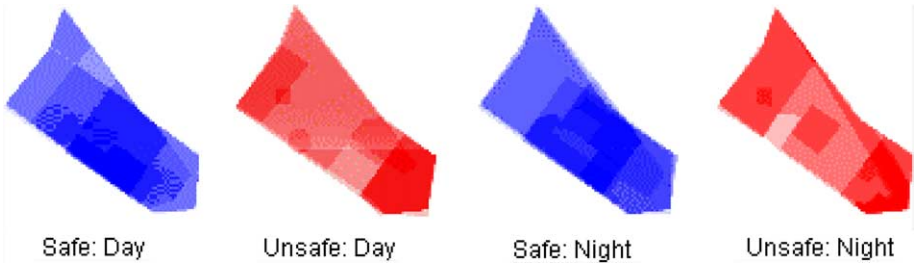

Fig. 6. Fear and safety mapping.

4. *Spatial discussion board*: Drag and drop icons could also be used to indicate where tenants may buy, sell, swap and operate a lost and found. This potentially could provide a highly valued spatial web service for the community.
5. *Verification*: After uploading information, users are able to cycle through preset viewpoints or freely walk through a 3D model of the estate showing their input registered as areas and volumes. Considering participants in the project will be generally non-expert users with a limited range of computer and map reading literacy, we generally restrict the input stage to 2D, with the final non-interactive verification and exploration phase being in 3D.
6. *Survey*: Ultimately, this tool must be useful for the community. During any session, participants will be presented with a feedback survey. Each input page contains feedback questions with more complete survey at the completion of the process, querying such things as the ease of use of the system, how comfortable people felt volunteering information, their level of computer literacy and suggested inclusions or removals to the process.
7. *Evaluation*: There is a paucity of holistic evaluation methods for spatial technologies. How well can such systems 'support decisions', not only by an individual user, but an entire community? The system will be trialed with the internal DoH staff and DoH tenants. The feedback surveys will be examined based on the way users respond to the functionality of the system. Do users demonstrate an ability to carry out more detailed evaluations of problems and needs within focus areas? Can some tasks can be carried out quicker (e.g. preparation of reports or maps)? Do users see the potential of extending the SDSS to other estates? We also recognise that feedback to the community is important. What problems identified have been successfully resolved? Which ones have not? Are residents still using the system? The managerial aspects of this project have not yet been fully resolved, but there is recognition by the DoH that such matters must be handled in an appropriate way.

It has to be noted that at this point in the development of the system, the research team has encountered a number of ethical and managerial hurdles that have impeded full implementation. Several of these issues are explained in the discussion section that follows and at the time of writing, we are no longer certain which aspects of this system can in fact be released into the public domain. Indeed, the proposition of this research has opened up a large set of issues that were not anticipated when it was first conceived, and have now become the focus of this work on public participation and spatial decision support systems.

7. Discussion

The system implementation described in the previous section is a speculative view of the possibilities of the system. The technologies mentioned are readily accessible, however substantial ethical and managerial hurdles are being encountered as our project progresses through the implementation process. These issues are not unique

to our project, however, we are accountable to the strict rules of the University of New South Wales, the DoH and, furthermore, we are dealing with sensitive communities already subject to disadvantage and stigmatisation. It is important to explore the major issues that have surfaced, and that will form the major component of this discussion section.

1. *Level of detail*: By simply identifying properties owned by the DoH, within a context, the privacy of the tenants is breached. Private real estate owners in an area in the past have isolated DoH tenants and pressured them to vacate. Presenting public housing as distinct from its surrounding context may exacerbate stigmatisation, vilification and marginalisation. As a rule, we have been operating on what may be seen from the street, or an aeroplane as a reasonable level of detail. For reproducing images in published research we have had to remove basic spatial identifiers, such as street names, street patterns and photographs in context. Focus areas are restricted to public neighbourhood space and not private property or individuals. For ethics clearance within the university, it is critical individuals cannot be personally identified. Surveys must be conducted anonymously, and where spatial indicators are introduced, we must be careful to remove personal identifiers.
2. *Panopticonism*: Although a system may conform to privacy laws and ethical guidelines, its very existence may re-enforce a perception of overt surveillance. Tenants may be already mistrustful of the DoH and authorities, or individuals may upload false and unverifiable information maliciously to vilify a geographic area associated with a group or individual.
3. *Gatekeeping*: Pre-defined standards for moderation and censorship would be anticipated to maintain a civil and inoffensive environment, with the long-term aim of making the system self-moderating. Keeping count of anti-social behaviour on the system and moderated deletions may be an interesting thing to monitor over time to assess changes in community coherence. Hudson-Smith et al.'s (2002) Hackney example contained a completely unmoderated discussion board with the intention of improving communication between housing tenants and local council, yet, was rendered useless by the council's refusal to let any of its members participate in discussion with the community for fear of accountability, even anonymously. On the topic of anonymity, to allow 'anyone' to say 'anything' gives a democratic right to expression, yet when analysing these knowledge bases, how do we separate the 'signal' from the 'noise', especially when noise to one person may be signal to another? At the input stage we endeavour to collect as much metadata as possible and employ it for searching, querying, data mining and analysis. Identifying geographic areas of communal concern is a strength of PP-SDSS over text-based media. When fed back into community meetings for discussion, any malicious or inaccurate input may be quickly identified and conflicts, correlations and hotspots discussed. On the note of gatekeeping, the databases the community are forming may be an asset of commercial value. It should be noted that the custodians of these datasets have the potential to sell or retain securely all or part of the dataset as any corporate entity would with such a detailed database.

4. *Double-edged sword*: Recently in Australia, an individual was suspected of plotting 'acts of terror' using the governmental online planning portal, *iPlan*. Surprisingly, it was the use of this system that exposed the suspect. Some online GIS content providers have cautiously withdrawn spatial information from websites, such as the location of public rubbish bins, or lowered level of detail and even built in inaccuracies. The other edge of the sword is the capacity for these systems to be used for constructive information dispersal such as emergency management and the civil local-level applications we propose.
5. *Maintenance reporting*: 38% of the total annual funding available for housing bodies in Australia is spent on the maintenance and upgrade of dwellings (NSW Treasury, 2002, pp. 37–38). There already exists a maintenance backlog for the DoH. The phone-based maintenance reporting facility currently employed by the DoH provides a (human) diagnostic service to correctly identify each report remotely and schedule appropriate action. A web-based maintenance reporting system was tested on the Woodberry Down estate with the result that they were saturated with reports, some trivial, some urgent (Evans & Hudson-Smith, 2001). Such a system may again flood the DoH with nuisance items and we must balance accountability with prioritisation to work through the maintenance backlog efficiently and effectively. For a robust web-based system we would need a specially designed diagnostic expert system, ideally, with a tailored VR component resolved to a level of detail that would indicate, for instance, individual components of a toilet. The more directed the user input, the better the value of the system. Although these issues are workable and with the adoption of other technologies, such as handheld computers with GPS capability and the like, we see this as being an operational issue and peripheral to the central research questions for this project.
6. *Planning for the future*: Other 'design your community' systems are perhaps overly ambitious as expert decisions are informed by many criteria. The Woodberry Down example had a trial voting component where participants could vote on three sub-urban building layouts for a site, out of context, each sub-area combining to the form the whole (Hudson-Smith et al., 2002). We do not expect community members to have to make these urban-scale design decisions, rather, to volunteer information that highlights local opportunities and constraints that a professional team can then incorporate into their design process. Certainly, 3D visualisation is an excellent tool for presenting designs and options to a community and, furthermore, a platform to facilitate a multi-partisan exchange of information.
7. *Equity of access*: Australia's Strategic Framework for the Information Economy 2004–2006[19] acknowledges the potential of new technologies to act as a platform for stronger social cohesion and underpin social development. A strategic priority of this framework is to ensure equality of access to capabilities, networks and tools of the information economy and that particular groups are not margina-

[19] See: http://www.dcita.gov.au/ie/framework [last accessed: January 2005].

lised. This is sometimes referred to as the 'digital divide' or 'information gap' created by inequality of access to the Internet. Originally, only computer hardware was provided to marginalised and disadvantaged groups. Several computer recycling ventures operate today, recycling machines donated from offices (often opting for open source solutions) and reallocating them to community groups. Hardware, however, is only one component of the bridge for the gap. Social, cultural, economic, educational and material factors continue to exclude people from participating and demand attention, planning and resources to holistically manage the human and social systems that support technology use.[20] The DoH is managing this process quite competently as demonstrated in the 'E-Communities' project. Sensitive areas for our project are the capacity for the hardware to negotiate our graphically heavy VR environments and for users to interact smoothly with the interface in a stress-free and intuitive manner. Good system design may be inspired from computer games to identify what is popular, engaging and enticing virtual environments. Indeed, existing gaming hardware already in possession of tenants could even be used as part of the system in the long run.

8. Reflections since UDMS 04

Since presenting this paper at the 24th Urban Data Management Symposium, we have become aware of certain parallels and shared concerns in the field. The context of the symposium was framed initially by Blakemore (2004), raising issues related to spatial data infrastructures such as globalisation vs. ungovernability; hyperspeed vs. risk damage; binaries vs. complexities, and an increased ubiquity of surveillance technologies raising ethical paradoxes. Blakemore noted that there was no distinction in the manner that domestic and broader national issues were being dealt with, advocating that a greater diversity of systems would, in turn, reduce the risks to which a singular 'monoculture' would be vulnerable. This suggests the local level technologies may be economically and efficiently combined from the ground up to form a diverse heterogeneous collective with certain benefits over homogeneous, yet unmanageable, 'monoliths' as may be created by top-down approaches.

Craig and Ramasubramanian (2004) highlighted the need for holistic evaluations for PP-GIS, beyond standard cost-benefit models. The question of longevity in PP-GIS systems was also raised, noting, ''the experts always leave, yet the residents stay''. After the initial investment of expertise, what is the capacity of such systems to empower groups to deal effectively with the ongoing issues? On this note, Prosperi (2004) critically analysed what is entailed for true public participation beyond simple provision (by bodies such as local governments) of GIS tools and information to different community groups. Were claims of citizen empowerment substantiated by

[20] See: http://www.dcita.gov.au/ie/community_connectivity/social_impacts_of_ict [last accessed: January 2005].

	No or Low Levels of Access	High Levels of Access
No or Low Levels of Participation	I	II
High Levels of Participation	III	IV

Fig. 7. Combinations of the presence and absence of access and participation (Tulloch & Shapiro, 2003).

actual participation in the decision making process? It seems the best way to evaluate a system is if, at the end of the day, the system successfully supports a real-world decision and the benefits to the community are tangible and reflected in its physical fabric. Odendaal (2004) examined the difference between traditional community participation models and the technological ones, raising the distinction between using these tools simply for service automation or as an integral tool to extend the capacity of a community's self-governance. Once again, what share did the end users have in the wealth of geographic data, and how effectively was this capitalised upon?

Tulloch and Shapiro's intersection of data access and public participation (Fig. 7) relates to our project in an interesting manner. The *type 1* outcome may be high security sites or ones that hold information that is not in the public interest, such as for military purposes. *Type 2* may be where an abundance of information exists, yet the public may not be interested, or do not have specialist knowledge required to access it, as could be experienced with detailed scientific information, such as environmental impact statements. *Type 3* is illustrated as an 'unlikely' situation combining high levels of public participation with low levels of access; and *type 4* as being the type of situation an NGO or interest lobby may have where high levels of access are met with high levels of participation. It is worth noting that the past situation with the DoH seemed to be a *type 3*. The DoH policy of tenant participation in community renewal led to the formation of groups focussed on the immediate problems faced on their estates. Tenant groups are generally mobilised and active in working with the DoH face-to-face and in workshops. However, there has been an undersupply of useful online information and accessible spatial tools provided by the DoH in the past. Currently, the DoH site has just been updated with the *2003 NSW Social Housing Tenant Conference*,[21] where downloadable pdf's and ppt's are available. Still, little provision is offered for meaningful public feedback loops within the digital environment: the web is currently used purely as a presentation tool.

[21] See: http://www.housing.nsw.gov.au/Tenant-Conference-2003/tenant_conference_2003_intropage.htm [last accessed: January 2005].

9. Conclusion

It seems like an understatement to say that local knowledge is something that has consistently had a profound effect throughout history. Literature regarding spatial systems consistently highlights the benefits of public participation, and indeed, the risks. Systems without a participatory component run the risk of becoming out of date and irrelevant to the ultimate stakeholders, plus the end result is simply inadequately informed. The benefits of sharing spatial documentation are enormous compared to closed systems, as involving the community adds value to existing datasets, adds a 'live' element and allow new datasets to grow that capture community attitudes, perceptions, experiences and vision. The act of a community sharing spatial knowledge with a public institution gives that institution quantitative and qualitative information, providing access to issues of immediate importance or the general mood of an area. In turn, transparency and accountability of the institution is increased, something that is often central to the institutional mission.

The Internet has added ubiquitous and irreplaceable facilities to our social landscape. Websites, email, discussion boards, online forums and even webcams are extensively employed and supported by governing authorities, so much so that their absence is often a signal of incompetence or neglect. The popularity of spatial technologies, especially those of a highly interactive nature have, however, taken a back seat. Sites may offer a downloadable document depicting an area map or online viewing of GIS data, but the medium remains peripheral. The technology to enable the public to participate online in a geographic context is now both available and mature. With regard to our project, however, the constraints lay not with the technology of the medium, but rather its potential for misuse, abuse and the sheer efficiency with which sensitive and private data can be released into a public forum. This has led to significant setbacks in the implementation and testing of our system, but at the same time reinforces the essential conclusion of this paper: whilst issues of security, privacy, moderation and ownership warrant careful attention, further testing and rigorous evaluation must be undertaken to estimate the value of PP-SDSS to public housing communities.

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