GeoMultimedia and Multimedia Cartography

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1 ABSTRACT

The term 'GeoMultimedia' conjures up a number of exploration and realisation tools that can be applied to the visualization of the Earth and the built environment. Cartography has developed geo(visualization) tools apace with the development of general multimedia software and hardware and the cartographic profession now embraces interactive multimedia as a key component of what this geo-scientific community offers to planning professionals and the general public. It is argued that Multimedia Cartography, a 'new' method of access to and representation of geospatial information, is different to what could be described as the 'traditional' cartographic methods and therefore a 'fledgling' cartographic genre that demands investigations regarding how it might be used for the exploration of geospatial information and the exploitation of the myriads of geospatial databases now available and being generated.

This paper will specify what is unique about multimedia cartography, how it can be applied to the visualization of landscapes and cityscapes and its applications for both expert and novice users. It addresses the issues that demand research to ascertain the 'best' method of usage for particular applications. And, it proposes methods by which multimedia cartography research and applications might be advanced.

2 MULTIMEDIA CARTOGRAPHY

Multimedia has involved the integration of the three most powerful industries of the 20th Century - computing, video and communications, reflected in the convergence of what had been discrete components of the entertainment industry. Multimedia Cartography can be seen as the cartographic application of New Media, which includes a range of new delivery and display platforms, among them are the World Wide Web, interactive digital televisions, mobile Internet technologies, interactive hyperlinked services, and enhanced packages that are linked to large databases – national or global.

GeoMultimedia is described as "Multimedia presentation and illustration of spatial relations" by the organisers of CORP 2001. And, Multimedia Cartography has been described theoretically by Cartwight and Peterson (1999, p. 7). The combination of a Cartographer / User-controlled geographical information visualization package, provided with Multimedia Cartography, enables the 'preferred' method of viewing information, from the user's perspective, to be made available according to 'best practice' rules or methods developed by the cartographer / geographical information designer.

Future maps, when applied to the access of spatial information, will become computer interfaces and retreival engines for spatial data. Due to their familiar nature, map interfaces are largely intuitive and require little training. The popularity of geographical information product should fuel a demand for more maps, along with the need for more cartographers - the 'real mapmakers' behind the 'point and click' Wizard of Oz Curtain (Hargrove, 1996). Geographical information product components can provide embedded map and image display, as well as access to spatial operations (Anderson, Ledbetter and Tepovich, 1996). Access to data in geographical information products need to be made through either thematic operations that focus on the attributes that describe map features and spatial operations that focus on location (Berry, 1996).

More realistic presentations are being output, with more user control, and generally innovation has spawned many exciting products. They are quick to produce, they provide powerful expressions of geographical stories and they do (in most cases) allow users to experience geography in innovative ways. Almost anything is possible, and graphics and geographical exploration media once thought impossible to produce and deliver, are consumed daily.

The multi-purpose maps of yesterday, essentially descriptive, static and deterministic, are now completely challenged by new map products that are extremely volatile, single purpose and probabilistic. The traditional function of maps as a spatial storage device is on the decline, whereas their communication function and analytical power are increasingly emphasized. Now the world of mapping can be said to be involved in simulation and the creation of Virtual Worlds and Virtual Environments. Virtual Worlds or Virtual Environments are those that result from the interaction between the cognitive level of humans, usually called cognitive maps, and the visual and audible images produced by computers (Neves *et al.*, 1996). They offer facilities for advanced human/machine interaction through 3-D image presentation and the direct manipulation of (virtual) objects, and allow a more natural interaction with the inherently spatial data in a geographical information product (van der Schee and Jense, 1995).

3 DEMANDS OF PLANNING AND ARCHITECTURE ON GEOMULTIMEDIA CARTOGRAPHY

The role of cartography for regional and urban planning can be seen as a theoretical and practical science which provides appropriate tools, know-how and services or as a directly related part of the tools used in the planning process. The practical elements of every planing process usually depend on the usage of cartographic products and the mastering of visualization expertise and production techniques. As multimedia usage expands the possibilities of providing cartographic information via contempory communication processes now means that the information transmission can be facilitated with due reference to the way spatial information is mentally processed by individuals (Peterson 1999, Dransch 1999). The application of new multimedia cartography techniques for architectural and planning processes and procedures can help to improve the actual process itself, and therefore facilitate better support for the decision-making process. Within the context of architecture and regional and urban planning, cartography and, more specifically, multimedia cartography can offer the following functions:

3.1 Data source

Cartographic products are essential elementary sources for the acquisition of data and information needed in the planning process. Knowledge is needed about the inherent characteristics of scale-dependent and time-sensitive cartographic data, which is a result of

the cartographic visualization processes, that includes scaling, map projections, symbolization and generalization. It is therefore an essential component for using cartographic products as a primary information source that can display, and allow for the interrorgation of spatial information.

3.2 Base and fundamental data and mapping for the actual analysis and planning

The actual architectural design and planning processes need spatially relevant phenomena for modelling ideas and as a base for comparing ideas to the natural and built environment. The attributes of cartographic products can, and do, determine the way 'space' is perceived and mentally 'understood', and finally comprehended. Therefore, we argue, the way architectural and planning concepts are developed, have to be seen in close context to this mental understanding of space and its final 'mental map' that results in a user interacting with a cartographic artefact – a simple map or an elaborate geographical visualization. The application of multimedia techniques to mapping has been seen as advancing the provision of tools for visualizing geography (Cartwright and Peterson 1999).

3.3 Presentation tool

The results of architectural planning ideas and concepts need to be presented, discussed and considered. As the study of and decision-making associated with architectural developments and urban and regional planning issues are based upon the due consideration of spatial phenomena, a media has to be chosen that will enable the presentation or simulation of spatial realities. As concepts have to be presented to decision-makers, effected citizens and the general public, presentations have to be made in such a way that the transmission of ideas from the expert (architect/planner) to the novice is facilitated effectively, and that the 'true' geographical concepts are displayed in a format that can be easily understood. The presentation can be judged by attributes related to ease of understanding, perception and the general understanding of the concepts developed and presented, plus their geographical location. In the context of presenting spatially-referenced architectural/planning concepts, the artefacts used do not only have to be correct in terms of transmitting geoinformation, but they also need to be able to support the creation and the efficient exploration of new ideas and knowledge. By exploiting what multimedia cartography offers, working within a geomultimedia-environment, all of these characteristics can be supported. And, using the skills offered by multimedia cartography, the most relevant methodologies for data collection, evaluation and depiction can be implemented.

Therefore, we assert, there exists a correlation between the recent developments in multimedia cartography and an improvement in the provision of tools for visualizing architectural and planning concepts and proposals. Technological innovations like interactivity, multimedia, animation or Virtual Reality (VR) now provides new cartographic presentation tools and products, extending the spectrum of transmission possibilities for (geo)information. These improvements are firstly the issues of distributing data, products and presentations. The 'transfer' of concepts and plans to decision-makers, and the related possible improvement in the efficiency of connecting these ideas with other related existing issues illustrates the real power of providing (geo)tools with which to empower both producers and users of information alike.

Considering all of these points, the application of multimedia cartography within the context of geomultimedia offers not only a fascinating new possibility for the provision of architectural and planning information, but it also poses a number of challenges. These are seen as:

- The efficiency of spatial information transmission using geomultimedia. How efficient is the information transmitted?
- The potential and the benefit of geomultimedia in practical architectural and planning work. How best can we choose geospatial information-provision tools in terms of methodologies, tool functionality and presentation systems?
- The perception of dynamic, animated or interactive presentations. How can we improve the sensory and non-sensory perception of geospatial information visualizations?
- 'Quality' of the presentation. In terms of their supporting function for the main contextual issues, how do we provide quality products and how do we guage quality in geomultimedia products used for architecture and planning?

4 EXAMPLES OF APPLICABLE GEOMULTIMEDIA APPLICATIONS

New Media products and devices like the World Wide Web, interactive digital televisions and emerging WAP technologies (Nielsen, 2000; Mitchell, 2000) provide interactive hyperlinked mapping services, enhanced mapping packages 'linked' to large databases – innovative products. These new devices can be generally be called a 'New Map', a device which aids in producing what Jacobsen (1994, p. 37) has termed Virtual Worlds - produced by the interaction between human cognition - essentially mental maps - and the visual and auditory images that can be produced by computers. The systems usually consist of interactive maps, which should embody the characteristics of continuity, fluid response and visual clarity (Ishazaki and Lokuge, 1995) and 'other' elements / devices to enhance the process of data access. It is therefore imperative that the cartography community addresses the issues related to using New Media and contemporary communication systems to deliver geographical information. Scientists and designers involved in the spatial sciences now have the means by which users can experience the 'fun' and 'thrills' that each of us have experienced in the use of spatial information and representations of geographical phenomena (Morrison, 1994).

4.1 Examples of Multimedia cartography applications

Multimedia Cartography has been applied to many applications. This section of the paper provides a brief overview of a number of applications so as to give an abridged 'snapshot' of current and developing uses of Multimedia Cartography. Each of these applications illustrates the rich media components that Multimedia Cartography offers users of geospatial information. The composite image in Figure 1 contains 'snapshots' from the list of applications and Table 1 provides specific details and appropriate locations for more information. This information has been incorporated into the paper to illustrate the wide-ranging applications of Multimedia Cartography.

Figure 1. Montage of Multimedia Cartography examples.

Multimedia Cartography Example	Reference or URL
MapQuest - An on-line product providing maps, globally from a digital database.	http://www.mapquest.com
Atlas of Switzerland - Multimedia in GIS approach to atlas provision. A unique combination of high quality maps and multimedia functionalities	http://www.swisstopo.ch/en/digital/adsi.htm
Coastal Atlas of Australia – a multi-server Web atlas covering the coastal environment of Australia	www.environment.gov.au/marine/coastal_atlas/
Webraska – Real-time location-based personal navigation, maps and traffic information services via mobile Internet devices.	http://www.webraska.com/
Oxford University Bodleian Library historic map collection – a selection of images is taken from items in Bodleian map collection	http://www.rsl.ox.ac.uk/nnj/mapcase2.htm
Alexandria Digital Library Project - a working digital library with collections of geographically referenced materials and services for accessing those collections	http://www.alexandria.ucsb.edu/
GeoVRML - Working Group of the Web3D Consortium developing tools and recommended practice for the representation of geographical data using VRML.	http://www.geovrml.org/ Brkljac and Counsell, 1999 http://virtual.er.usgs.gov/MtRainier2.html
Virtual Field Trip / ***Panoramap*** - support for fieldwork and a visual environment for exploring spatially referenced information	Dykes *et al.*, 1999 http://www.geog.le.ac.uk/vfc/index.html
National Geographic *Map Machine* – Dynamic maps generated 'on-the-fly' from an underlying GIS	http://plasma.nationalgeographic.com/mapmachine/
Digital Earth - The US government-sponsored initiative to use the Digital Earth interface as an access metaphor to geospatial information.	http://www.digitalearth.gov/ *Digital Earth Initiative* 2000 Goodchild, 1999
US EPA *EnviroMapper* Server – Web-delivered environmental information	http://www.ionicsoft.com/ionic/ultra/usl.html

using the Digital earth interface metaphor	
Open GIS Consortium Web mapping initiative - Web Mapping Testbed Public Page	http://opengis.opengis.org/wmt/
Lonely Planet – Web map and information service to support paper publications, including CitySync, palm PC city information downloads.	http://www.lonelyplanet.com/ http://www.citysync.com/feat.htm
Atlas du Quebec et ses Regions - interactive atlas to visualize census data in different types of maps.	http://www.unites.uqam.ca/atlasquebec/
Schachnerhöhle interactive cave map - shows a virtual model of this cave in Swizerland	http://www.karto.ethz.ch/~an/caving/cis/index.html
WIEN GRAFIK - contains different kind of maps from the Austrian capital city of Vienna ranging from a city map and bicycle-routes up to cadastral maps.	http://www.wien.gv.at/gdvmo2/wiengrafik/
DORIS - Server which provides detailed on-line maps at different scales from Upper-Austria.	http://doris.ooe.gv.at/
Digital Atlas of Styria - topics range from Josephinische Landesaufnahme 1787, to environmental and meteorology themes and community planning.	http://www.stmk.gv.at/land/gis/default_atlas.htm
Online Information System of Salzburg - conservation, planning, hydrology.	http://www.land-sbg.gv.at/sagis/
Department of Housing and Urban Development (HUD) - *ArcIMS*-powered site contains up-to-date data sets from community planning and development, multifamily housing, Brownfields tax incentive zones, and public housing.	http://hudemaps.esri.com/
Chatham County, North Carolina, Tax Parcel Information System - create, and print maps, as well as query tax parcel data, and print property cards.	http://www.emapper.com/chatham
National Atlas of the United States - explore America's potentially active volcanoes with six dynamic maps.	http://www.nationalatlas.gov/volcanohi.html
Interactive map of University of Alabama's campus master plan - users can display the changes that affect them or their area	http://bigdog.landmgt.ua.edu/website/plan/
The David Rumsey Collection - focuses on 18th and 19th century North and South American cartographic materials. The collection includes atlases, globes, school geographies, maritime charts, and a variety of separate maps including pocket, wall, children's and manuscript maps.	http://www.davidrumsey.com/
Virtual Reality tour of Vancouver, Canada (British Columbia) - based on Apple's *Quicktime* technology.	http://www.virtuallyvancouver.com/
Nebraska Statistics prototype - client-side based interactivity with mouse-over-techniques.	http://maps.unomaha.edu/Peterson/compmapping/projects/Behrens/Java.html
Vienna - Social patterns and structures - combination of xml, svg and client-side based interactivity controls	http://www.karto.ethz.ch/~an/cartography/vienna/
Leeds carogram - Java-based cartogram animator	http://www.geog.leeds.ac.uk/pgrads/j.macgill/java/Cartogram.html
Slaithwaite - online Java-GIS	http://www.ccg.leeds.ac.uk/slaithwaite/
Virtual TU Wien - *QuickTime VR* based scenes of virtual Technical University of Vienna	http://www.iemar.tuwien.ac.at/projekte/tu/index.html
Lech - *Flash*-based interactive multimedia tourist online map	http://www.lech.at/content/Ortsplan.asp
TeleCartography - location based services for wireless information devices	http://www.ftw.at/uebersicht_de.html
Hagenbrunn - vector-based fully interactive online map side using layer technique	http://www.hagenbrunn.at
EarthView - interactive online images and map server	http://www.fourmilab.ch/cgi-bin/uncgi/Earth/action?opt=-p
DialoGIS - Java-based thematic mapper for statistical data	http://business.carinthia.com/bgolob/virp/dmap/densit3.html
National Atlas of Canada - online multimedia atlas	http://atlas.gc.ca/

To enable the research interests of the authors to be highlighted, the following three sub-sections develop, briefly, three issues that are being addressed by the Multimedia Cartography community. The first section describes the research and development being undertaken at the Institut für Geographie und Regionalforschung, Universität Wien regarding the use of Virtual Globes that have been designed for exploiting the potential of VRML, and, more particularly GML. The second section provides an overview of the use of the Mobile Internet for making available 'here-and-now' geospatial information. Research is being conducted in this area by the Institut für Kartographie und Reproduktionstechnik at the Technischen Universität Wien. Finally, a research project that focuses on the application of alternative metaphors to the map metaphor, and the provision of an appropriate 'metaphor set' to explore geospatial information is being done at the Department of Geospatial Science at RMIT University, Australia.

4.2 Virtual Globe

The current (information)society is enhanced with an enormous change in the communication industry and by the general outcomes of globalisation. The virtual globe can be used to show the effect of these trends. On one hand a Virtual Globe is the result of the possibilities provided by New Media and on the other is the model for understanding and interpreting global connections and relationships.

The globe matches the term "model of the real world" more than many other (mostly 2-dimensional) presentation forms. This is because it preserves the 3-dimensional shape, and therefore associated relationships, of the original data sets. Digital technologies

and Virtual Reality systems make feasible the development of a virtual globe. This Virtual Globe can show worldwide themes in a collective way, so that different themes can be compared and relationships more easily found. Visualisation using the general concept of VR expands the possibilities of geomultimedia as VR-systems allow the implementation of multimedia techniques in what appears to the user as a real existing space. Users are able, as they would in the real world, to move freely within this space or to rotate/move and investigate the digital model, or parts of the model. The interface provides users opportunities to commence an active communication process and perform specific user defined tasks and queries. The resultant use of a Virtual Globe, which can provide purposeful and specific information via different interactive functions, depending upon user needs, which may change according to the varying degrees of geometric or thematic complexity.

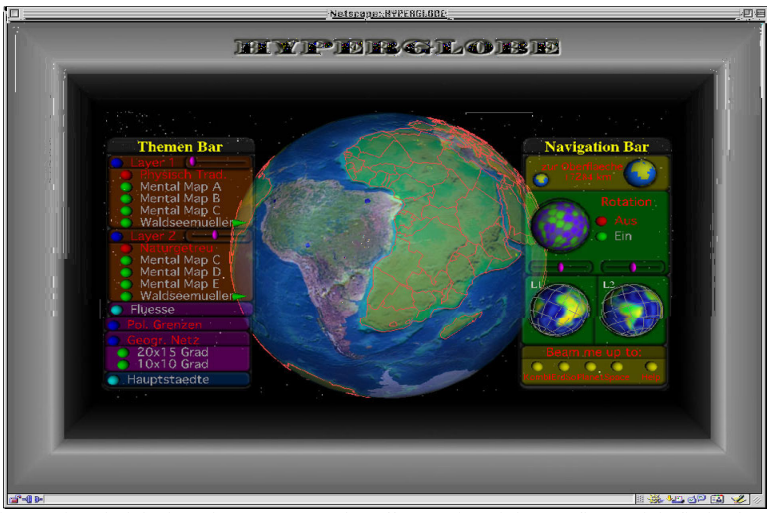

Fig. 2: Virtual globe based on VRML97 (http://www.gis.univie.ac.at/hyperglobe/index.html)

If we compare Virtual Globes with traditional analogue physical globes the advantages of the Virtual Globe becomes apparent. By generating a digital (virtual) model of the globe we not only eliminate the disadvantages of traditional physical globes, but also preserve their advantages. Most globe specifying parameters can be significantly improved, in particular those characteristics like transportability, choice of topics, updating, minimising production costs, scalability, interactivity and educational suitability. An example of such a globe is illustrated in figure 2.

A Virtual Globe offers the potential for providing a tool that could act as a knowledge transmitter and a starting point for access to geospatially- related topics – for a multitute of users (novice to expert) anywhere, at any time. We see Virtual Globes as a viable replacement for physical globes.

4.3 Internet and Mobile - Internet mapping applications

The Internet has changed the way maps are delivered and used. It acts as a stimulant for map production and map distribution. Applied Web mapping techniques has been seen as a major step in the development of cartography (Peterson 1999). The main advantages of Internet Cartography are better accessibility for the user, facilitating higher actuality (van Elzakker 2000) or easier distribution of maps. But, the efficiency of the usage of Internet-based applications, as any other digital mapping application, is determined and restricted by the main attributes of the hardware used for accessing and interacting with on-line mapping systems. Computers are usually not highly mobile and, for many cartographic applications, this missing mobility, and the fact that the user has to find access to a computer in order to get information or to view a map is a big disincentive for using the system. However, this is not seen as a major disadvantage. But for enabling mapping systems which could serve information where that information was required, mobile input/output machines and the availability of an infrastructure for wireless submission of information to any location the Mobile Internet provides the necessary preconditions for this type of information access to occur.

The infrastructures and technologies of telecommunication systems are developing rapidly. They have reached a stage where they are seen as a mass market commodityy. In Austria, more than 5 million. cellular telephones are used amongst a total population of 8 million (Handy.at, 2000). New technologies like the Wireless Application Protocol (WAP) or the Universal Mobile Transfer System (UMTS) together with new functionalities of cellular phones and other wireless handheld devices now allow now not only the display of graphics, using some kind of interactivity, but they also offer location-based services. This fact, together with the predicted merging of computer industries with telecommunication industries now enables, for the first time, the opportunity for serving interactive cartographic products that are independent of a desk-bound machine.

4.4 Metaphors

The user's real-world knowledge and experience to the tasks, procedures and interactions can be transferred to an application by using appropriate metaphors. The best are well-defined, consistent metaphors that refer to people's knowledge of the world (Marcus, 1995). Metaphors have been given the role of presenting one ides in terms of another. They provide clues for abductive and adductive inferences and act as natural links or percepts. That is, they enable the selection and application of existing models of familiar objects and experiences in order to comprehend novel situations or artefacts. Metaphors seed the learning process and allow the discovery of hooks onto which users can hang appropriate mental models (Smyth and Knott, 1994). Ideally, different metaphor 'sets' are needed for different groups of users, each 'set' needing the application of different conceptual tools, interface design techniques and ways in which to interact with a computer.

Maps alone shouldn't be seen as the only type of metaphor available to users of geographical information. Whilst the map is, and has been, an effective means of access, its use should not be considered in isolation. Interface designers working on appropriate access metaphors for a geographical information product have looked at things like multidimensional, immersive, 'inhabitable' virtual world 'spaces', using it to convey the sense of space (concrete and absrtact) as no other interface can. According to Jacobson (1995) this type of interface ia imminent, due partly to the evolution of technology and partly due to a new audience of users who demand it. As geographical information products seek out a wider audience, many of whom are map illiterate, other forms of access are being

investigated. The use of just the map metaphor to access geographical information limits the flexability that particular users have in retreiving relevant and current data.

There has always been much interest in using different metaphorical approaches to depicting/providing access to information. With the ever-increasing amount of information being generated there needs to be made available more efficient means of finding and viewing that information. Metaphors used in cartography, which, until relatively recently, have been almost exclusively used to visualize geospatial information, now offer cartogaphers the potential for visualizing information from 'non-geographical' worlds.

A prototype has been developed to provide information about buildings of architectural significance in the historic township of Queenscliff, situated on the western headland of the entrance to Port Phillip Bay, Victoria, Australia. The content of the Queenscliff prototype (Cartwright, 1996) provides a historical and geographic information base for the township, while fully utilising dynamic discrete (CD-ROM) and distributed (Web) multimedia. The discrete unit contains a coordinated collection of different types of information that can be readily accessed on demand. A package of mapping, photographic and video screen frames is supported by a textual base that offers information about the images displayed. Figure 3 shows the initial user Web page for the prototype.

Information is provided in the form of maps, plans, photographs and artifacts, as well as via a number of links through the metaphorical icons that lead to both external` and internal resources. The product has been developed as a test package to allow for the evaluation of the *GeoExploratorium* (Cartwright, 1999).

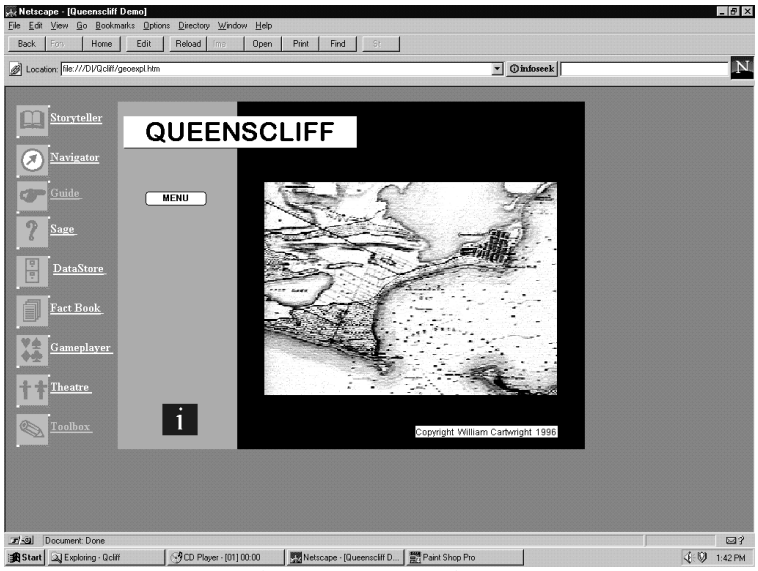

Figure 3. Prototype Web page

Although these three research and development examples are being conducted at different universities, the authors have been collaborating in the advancement of the application of New Media for assisting in exploring and using geospatial information. It is by such collaborative enterprise that new methods for users to focus on exploiting the vast amount of information now available, rather than needing to worry about developing sometimes duplicate systems to that which already exist, or are under development.

5 OPPORTUNITIES FOR COLLABORATIVE RESEARCH

There are a lot of similar or even identical research areas between visualization in cartography and in planning/architecture. The line drawn between those two disciplines is mainly based on scale. Here the dividing-line is not sharp, but blurred. There is just a tendency for cartography to focus on smaller scales compared to the larger scales used in planning and architecture. But at least in New Media systems those two disciplines converge. We make three observations about this:

- Both disciplines have to deal with the process that begins at data-collection and results in visualization products;
- Suitable digital models are needed for investigation./exploration using intuitive tools; and.
- A user-friendly interface is needed to provide access to tools for navigation, orientation and information retreival.

Multimedia cartography provides a different way of access to and visualizing geographical information. Delivering a new way of 'seeing' geographical information by providing different viewpoints, using selected New media tools and therefore, hopefully, ensuring that the 'voids of geographical understanding' are filled with information gathered from other perspectives and used to assemble a more complete picture of reality.

6 CONCLUSION

Architecture and planning already have established partnerships with the engineering and building professions. Structural engineers collaborate in large architectural projects and builders are collaborators in realising designs insitu. Transport engineers laise with the planning profession and landscape designers facilitate the formal application of designs for the built environment. And, more recently, architects developing concepts for 'information spaces' are working with programmers and computer artists to facilitate the visualizations designed to provide multi-dimensional spaces where information can be viewed and comprehended. Collaboration with cartographers working with multimedia cartography can produce effective results like these existing and evolving partnerships. Multimedia cartography products are being developed with an appreciation of the media being used to convey that information and the realities of depicting simulations of the real world with New Media.

Multimedia Cartography offers skills for realizing geospatial simulations with regard to the particular problems of representing geographical space with New Media. It provides access to skills that are already attuned to working with graphic depictions that are designed with the appreciation of the real problems associated with illustrating the real world within the restricted framework of geographical facsimiles – geographical visualizations (geoviz). Partnerships between architects, planners and cartographers, all

working with New Media and developing concepts for integrating real world depictions with planned environments, can result in more usable information artefacts that can be exploited as unique (geo)information resources.

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