MULTIMEDIA INTERACTIFS ET NOUVEAUX PRODUITS DE CARTOGRAPHIE.

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RÉSUMÉ

Les cartographes utilisent les multimedias interactifs comme instrument pour produire des cartes qui répondent à l'interaction des usagers par la "surface" de l'écran de carte. Les cartes électroniques conventionnelles étaient capables de représenter l'information spatiale d'une manière effective, mais il leur manquait l'aptitude à aller 'au-delà' de la carte et à montrer davantage de renseignements à propos des choses ~~représentées~~ , des données associées aux objets de cartes ou toutes autres données.

La technologie a agi comme catalyseur pour produire une renaissance des sciences spatiales. Les problèmes techniques sont pratiquement résolus, les logiciels peu coûteux et les hardwares puissants abondent. Effectivement, certains futurologues présagèrent une époque dans un proche avenir, où le hardware serait disponible chez les détaillants et les logiciels seraient vendus chez les disquaires(Bank, 1995). Les cartographes peuvent donc présenter l'information d'une manière mise en valeur qui est facile à utiliser et qui peut présenter les renseignements d'une façon différente et plus utilisable. On considère la cartographie multimedia, les hypercartes, les cartes interactives et les VideoAtlas comme des solutions viables pour la transmission de l'information sur les phénomènes spatiaux.

Cet article donne une vue d'ensemble sur les méthodes qui ont été utilisées pour produire des cartes interactives. Des exemples de progiciels de cartographie y sont donnés en utilisant un nombre de présentations différentes et les avantages de chacun y sont décrits en gros. Finalement, des indications sur les options futures de la cartographie interactive y sont données.

INTRODUCTION

For the spatial sciences multimedia offers the ability to create a «different» map, one that allows for a different way of presenting geographic phenomena and changes the spatial data access paradigm. A multimedia-based mapping product must be designed, tested, evaluated and refined if it is to be properly seen as a real alternative to conventional mapping (including those maps now being produced electronically).

Electronically-produced maps should not be perceived as inferior or lacking in some areas, but they are still not really that different to those maps produced since the printing press harnessed cartographers to think in terms of page sizes, print-derived specifications and products which had to be technically correct the very first time they came off the press. For example topographic maps design and therefore the efficient uses to which these maps can be put owes much to eighteenth century generals and nineteenth century engineers (Raper, 1996). They served their purpose as a tool for the accurate depiction of hills, roads, streams and other strategic terrain elements for military strategy, but the advent of the aircraft made the importance of high ground less prominent. Similarly, engineers required accurate, large-scale representations of landforms to enable the planning and conduction of their Victorian age masterpieces. The role that these types of maps were used for and the depiction methods used served particular functions. The «print mindset» has been extended into some areas of automated mapping, GIS maps, applied computer graphics-generated maps (like those in contemporary printed products and those used as support devices for television news and weather services) and even to digital data stored on CD-ROM. The «print mindset» has «harnessed» map designers to the idea that computer-generated maps should mimic printed never intended or thought about (Cartwright, 1994).

Maps themselves have been designed for purposes that are far more intimate than the plethora of uses to which contemporary maps are put. If the types of graphic representations provided with contemporary spatial information products are looked at critically, then it could be said that the depiction methods used are still not that dissimilar to those that have developed from the specifications provided by military and engineering authors. Multimedia offers the tools for depicting spatial information through the use of many media tools. To limit depictions afforded by multimedia to just maps and plans does not exploit the rich media portrayal possible. Multimedia allows many other ways of presenting data sets and the results of analysis.

MULTIMEDIA AND THE SPATIAL SCIENCES

The multimedia map needs to be thought of as a means by which a better «picture» of the information a user needs can be painted: a map which, as well as using traditional map and GIS metaphors, can give users access through the use of additional metaphors. This approach is supported by Cassettari (1993, p. 233) who stated: «*The integration of multimedia data and hypertext strategies also require consideration in terms of communication and visualisation, access and operating software, user interfaces and data formats. All these need to be addressed if an effective integration is to be achieved successfully*».

A multimedia map provides not just a picture of geographical reality, but also gives access to geographical data. It also allows users to access further data and information plus background information about how things - data systems, data suppliers and facilitators, and mapping systems, and so on, actually work. The geographically-linked elements that can be displayed using a multimedia map are a conglomerate of items, systems, processes and conventions. What could be called the first multimedia mapping project (in fact the first time a real multimedia product was ever made), the Aspen Project, was devised and undertaken by the MIT Media Lab in 1978 (Negroponte, 1995). The ground-breaking package used videodiscs, controlled by computers, to allow the user to 'drive' down corridors or streets of Aspen, Colorado. Every street was filmed, in each direction, and every turn was filmed in both directions. By putting the straight street segments on one videodisc and the curves on the other, an artificial seamless driving experience was made available. Users could enter buildings, see archival photographs, undertake guided tours and leave a trail like Ariande's thread. Military contractors built working prototypes for the field, for use in assisting the protection of airports and embassies against terrorism.

Initially, the potential of the large storage capacity of CD-ROMs for the distribution of geo-data fostered interest in publishing digital maps using a new medium (Rystedt, 1987, Siekierska and Palko, 1986). This followed closely behind the interest in interactive analogue mapping with videodiscs (Aubrey, 1992a, 1992b; ; Bilodeau and Cyr, 1992; Cartensen and Cox, 1989; Cartwright, 1989, 1990a, 1990b; Duncan, 1992; Energy, Mines and Resources Canada, 1987; Mohl, R., 1980; Mounsey, 1988; Rhind et al., 1987, 1988; Riddle, 1988; Tschudi, 1990). However, the real potential to produce exciting and innovative maps was seen to be the application of new interactive multimedia, or hypermedia, media to mapping.

NEW MEDIA AND MAPPING

The use of new media in mapping has, as its core, electronic mapping. But electronic mapping alone does not allow for innovation in mapping to take place. The use of hypermaps, multimedia and hypermedia provide the opportunity to provide interactive of 'clickable' maps. Kraak and van Driel (1996) have explained the various forms of hyper-publishing and the concepts behind it. They describe the core as hypertext - related to text only. If images and sound are added it becomes a hyperdocument. The addition of user interactive control makes it a hypermedia system. The provision of a geographic reference system creates a Hypermap.

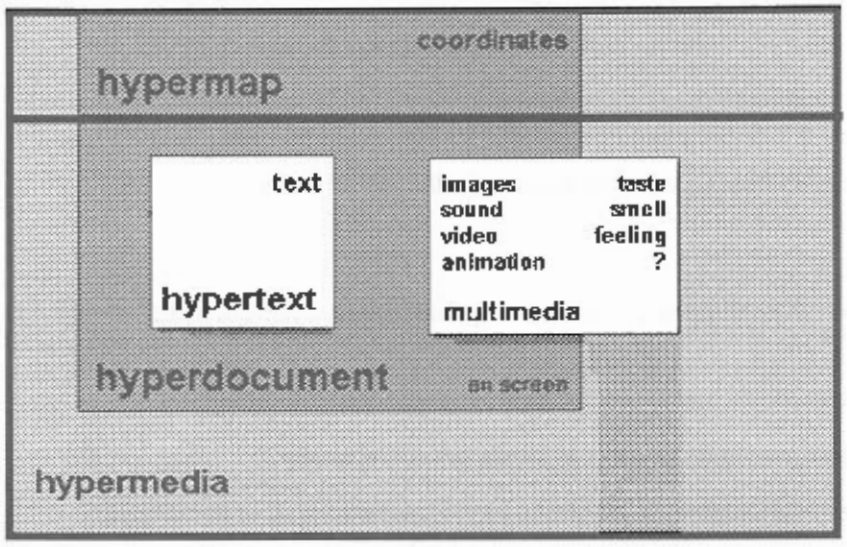

Figure 1. Kraak and van Driel's explanation of hyper-terminology. (redrawn from Kraak and van Driel, 1996).

In order to appreciate how interactive multimedia has been used for map production the various formats that have been used are outlined, together with examples of typical products; These are :

- Hypermaps,

- Multimedia maps,

-Interactive or «clickable» maps,

- VideoAtlases, and

- Internat and World Wide Web Mapping Applications.

HYPERMAP

The term 'hypermap' was first introduced by Laurini and Millert-Raffort (1990). Hypermaps (Wallin, 1990, Laurini and Milleret-Raffort, 1990) are seen as a unique way of using multimedia with GIS. The hypermap is an interactive, digitised multimedia map that allows users to zoom and find locations using a hyperlinked gazetteer (Cotton and Oliver, 1994). Geographic access is provided via a co-ordinate-based access in which by clicking a point or a region on a map, all information relating to that point can be retrieved. A similar concept, the 'HyperGeo model', was described by Corporel (1995) as a dynamic map created by user queries. Laurini and Millert-Raffort (1990) proposed access via a pyramid structure, consisting of a base of small scale maps, with many layers of larger and larger scale maps built upon it. An illustration of their concept is illustrated in Figure 2.

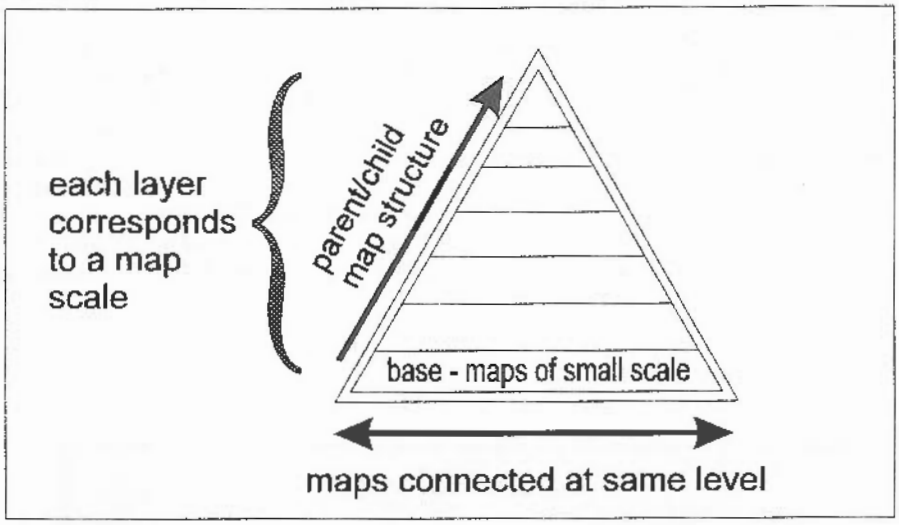

Figure 2 Laurini and Milleret-Raffort's Hypermap Pyramid Access Structure.

(Re-drawn from Laurini and Milleret-Raffort, 1990)

Hypermaps include both textural and graphical contexts and provide multiple perspectives on a dataset that allows for cross-referencing. This provides a useful tool for applications like the visualization of accuracy, fuzzy data exploration and the realisation of fuzzy data through cartographic principles (Jiang et al., 1996). Kraak and van Driel (1996) described the attributes of hypermaps and how they could be used. They stated that hypermaps:

- allow users to navigate multimedia datasets by theme and spatial location;

- can structure the individual multimedia component with respect to each other and the map;

- afforded geo-referenced multimedia;

- provided links within a formal (predetermined) navigation scheme, as well as links outside the specified search area;
- allowed the map to be used as a starting point for search routines;

- allowed the user to retrieve spatial information based on associative and logical combinations; and

- functioned as an interface to a database that contains multimedia data that are related to a specific co-ordinate (or 'go-tag').

Hypermedia is the extension of Hypertext through the use of multimedia (graphs, sound, animation and video) (Jiang et al., 1996). It is a communications medium created by the convergence of computer and video technologies and it describes the whole spectrum of new interactive media spanning telecommunications, High Definition Television (HDTV) interactive cable television, videogames and multimedia. The term was originally termed by Ted Nelson to describe hypertext systems that include multiple media (text, image, sound, animation and video) (Cotton and Oliver, 1994). Hyperdocuments could also include things like tastes, odours and tactile sensations (Conklin, 1987), items that are along the lines of those included in Kraak and van Driel's (1996) explanation of hyper-terminology depicted in Figure 1.

Hypermedia Hypermedia incorporates text, sound and graphics. The hypermap concept is predicated upon the hypertext philosophy and extends it to geo-data. Hypermedia programs can be utilised for the production of systems that incorporate nodes as maps, text and spreadsheets. Links between one node and other(s) nodes allow navigation to move the user between maps, spreadsheet data, and explanatory text (Camara and Gomes, 1991). There are two forms of integrating a map into a hypermap - document-to-map and map-to-map, plus the addition of an internal heirachical structure and relationships (Jiang et al., 1996).

MULTIMEDIA MAP(S)

Interactive multimedia resulted from developments of computer-controlled interactive video in the 1980s and refers primarily to videodisc and CD-ROM-based programs (Cotton and Oliver, 1994). Multimedia allows for the combination of geo-referenced and non-georeferenced data and maps (especially hypermaps) can be used as an interface (Kraak and van Driel, 1996). Commercial mapping products like MicroStation in the Windows environment are able to link audio to graphics features using the Edit-Paste pulldown and create Dynamic Data Exchange (DDE) links to spreadsheets and word processing documents. Also, VistaMap allows multimedia elements to be launched via 'point-and-click' commands (Goodman, 1995).

The advantages of CD-ROM are:

- It has a well established, accepted standard - ISO 9660

- Operating system independent files can be created.

- Drives are backwardly independent (new readers will be able to read 'old' CD-ROMs.

- They are durable.

- Technology is widely accepted.

- Appropriate for wide distribution

- Large amounts of data can be stored on a single disk .

- It is a suitable replacement for storing large amounts of archival data on magnetic tape (Wallace and Mencher, 1994).

A very good example of the types of product developed on CD-ROM are the Dorling Kindersley World Reference Atlas and the Encarta Encyclopedia. The first example is illustrated in Figure 3, the opening page from the Dorling Kindersley World Reference Atlas. Users can move to world political or relief maps or move to individual countries or atlas content via the 'A-Z of Countries' or the 'Index' 'hot spots'.

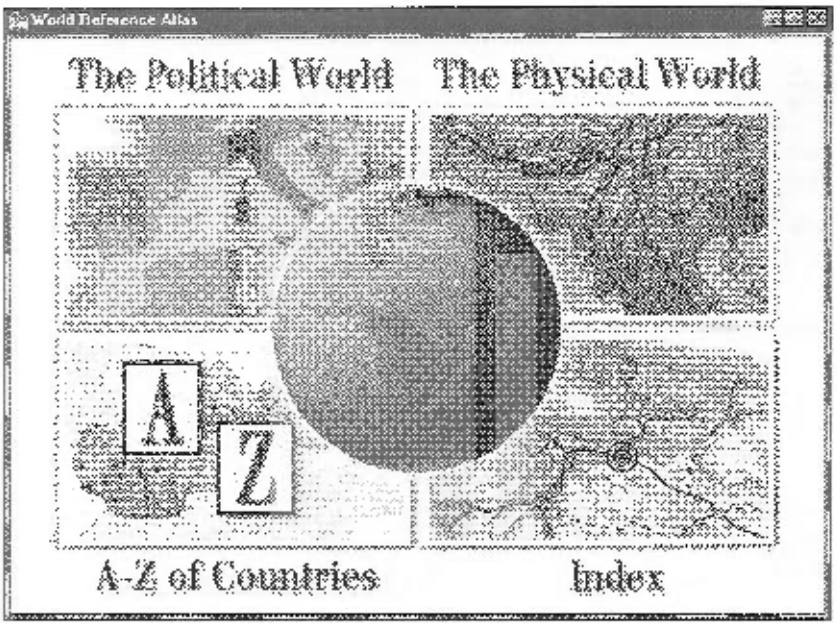

Figure 3. Opening page from the Dorling Kindersley World Reference Atlas.

(Source: Dorling Kindersley, 1995)

Users can then move about the atlas and zoom into selected regions and obtain selected information. For example, using the 'A-Z of Countries 'hot spot' users can move to individual countries and then obtain facts about each country from resources accessed through the media icons. This is illustrated in Figure 4.

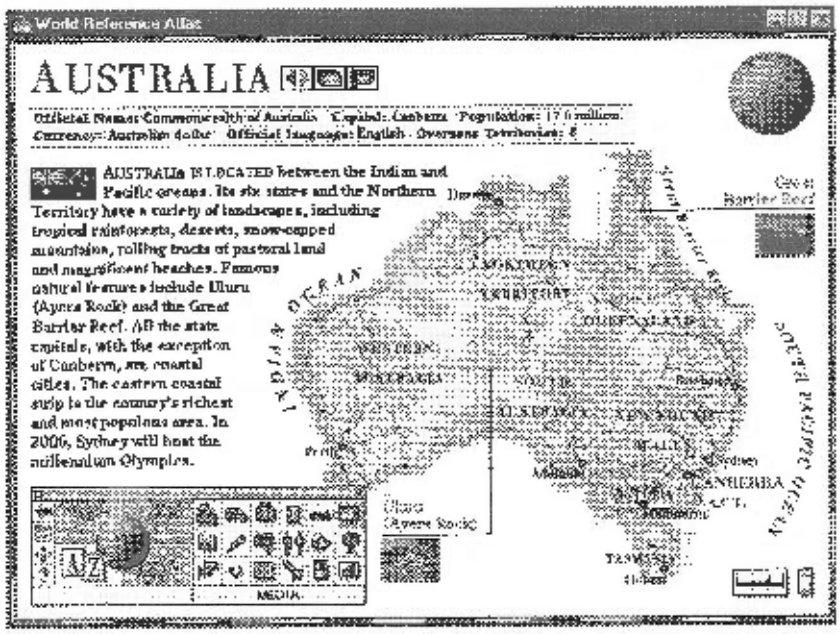

Figure 4. On this example the icons relating to 'Great Barrier Reef' and 'Uluru' link to *QuickTime* movies about those locations. (Source: Dorling Kindersley, 1995)

Encarta is the most popular title and it is the largest selling print or electronic encyclopedia in the world (Caruso, Denise, 1996). It contains a wide range of map and support documentation and offers a contemporary package of useful spatial resources. The atlas includes many navigation tools that enable users to 'roam' around and 'browse' the atlas, as well as finding specific information. Figure 5 illustrates a page from Encarta and the type of navigation tools provided. The atlas also includes a cartoon character guide that helps users with the package and the use of the various functions.

Figure 5. Typical page from Encarta. Note the navigation tools that complement the map product. (Source: Microsoft, 1996)

The atlas contains maps, family portraits, information on different cultures, 'sights and sounds', 'facts and figures' and a glossary. A so-called 'host', a cartoon figure called Cosmo, is used to guide novice users through the package (Microsoft, 1996). At a much larger scale are street directories on CD-ROM, for example MapVision Plus for London (Sargeant, 1994). It contains all roads in central London, based on scanned maps from Nicholson's London Guide. Users can access and build-upon a large database on streets, accommodation, entertainment, museums etc. These can be 'toggled' on and off. maps are able to be printed. Figure 6 illustrates a typical screen pages.

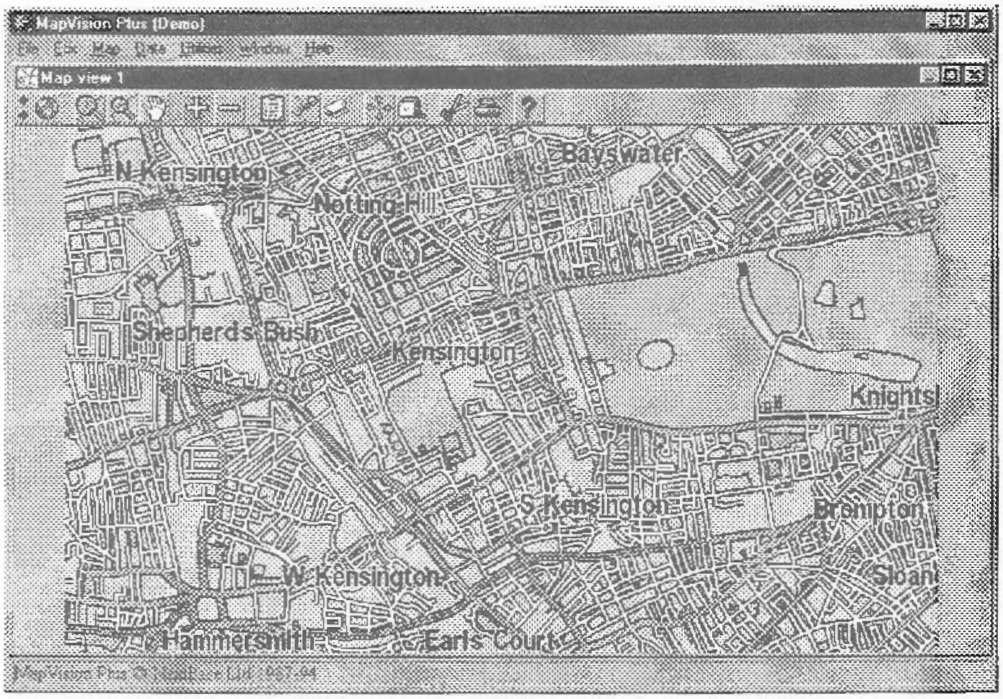

Figure 6. MapVision plus. A CD-ROM-based street directory of Central London. The map image can be enhanced by the addition of 'hidden' information.

A large part of the research being carried out in the area of multimedia maps is the use of animation to represent both the spatial and temporal elements of dynamic processes and to show the dimensions of space-related time and movement. By integrating animation with interactive mapping users are able to define the interactive manipulation of spatio-temporal data sets (Asche and Herrmann, 1995).

INTERACTIVE MAP (OR 'CLICKABLE' MAP)

An interactive or clickable map functions as an index to other documents in the database, whereby pointing and clicking an object on the map results in the display of associated objects (Kraak and van Driel, 1996). According to Ishizaki and Lokuge (1995), interactive maps need to embody the characteristics of: . Continuity - the consideration of previous query, in order to respond to the current input query; . Fluid response - the ability to generate a map or a visual response (in a fluid manner) as if it was a continuous conversation, when interaction is taking place in a form of dialogue; and . Visual clarity - assurance that a display remains visually clarified and highly comprehensive during dialogue-based interaction. Based on this scenario they developed a knowledge representation scheme for representing domain knowledge together with visual design knowledge and a computational mechanism whereby the system reacts to a series of user requests. This scheme, GeoSpace, dynamically generates a map display according to a series of user requests.

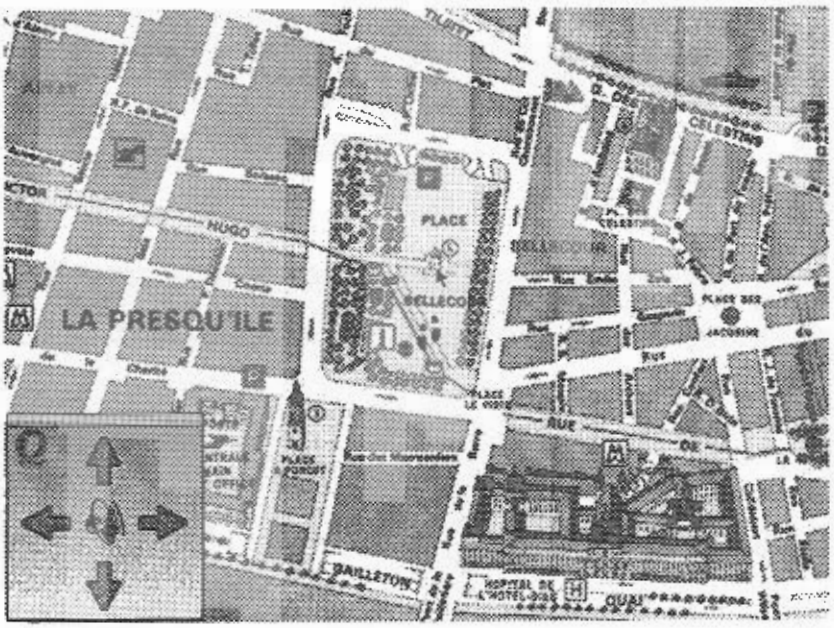

Figure 7. The map image from *Rendez-vous avec Lyon* (University of Otago, 1996).

An example of an interactive map project is Rendez-vous avec Lyon from the New Zealand University of Otago Language Learning Centre. While users navigate the hypermaps to visit various locations in Lyon they are in fact learning the language by accessing information 'behind' the map interface. The use of interactive mapping is not merely applied to applications that only contain spatial information.

VIDEOATLAS

The concept of the VideoAtlas (Cartwright, 1985) was first based around the use of interactive videodiscs. Electronic computer-generated and controlled multimedia is a relatively new tool for use with geo-spatial information. However, the concept of using multi-media for the portrayal of map information is really not a new concept for atlas users to accept. Looking at any atlas, one can see the innovative use of maps, graphics, text and photographs. Multimedia offers more tools with which to design and assemble contemporary map products (Cartwright, 1993).

Videodiscs store analogue video signals and can be controlled by programs executed on a computer to which the videodisc is attached. Two types of videodisc exist - CAV (Constant Angular Velocity) used mainly for interactive applications and CLV (Constant Linear Velocity) that are used for applications like linear movies (Cotton and Oliver, 1994).

Videodisc mapping offers a low cost map display background, providing many of the information coordination functions of a GIS (Aubrey, 1992b). Video laserdiscs have become a standardised product through NATO where a specification (STANAG 7035) has been set for the Worldwide Defense Mapping Agency (DMA) database. Also, the Canadian National Search and Rescue Secretariat (NSRS) adopted videodisc technology in 1988 as a relatively economic means of vessel location in search and rescue operations.

They have proven to be a viable alternative to vector/raster-based GIS until a more populated digital database is available and it is quicker to get a complete map coverage than digital data (Bilodeau, 1994). The Canadian Department of National Defence (DND) introduced videodisc mapping in 1987 and over 40 mapping systems have been installed. Products containing topographical maps at scales of 1:1,000,000 and 1:500,000 have been used for large scale planning, briefing and command and control purposes (Aubrey, 1992a). It has become the interim GIS of preference for the Canadian Forces due to its large storage capacity and rapid retrieval (Bilodeau and Cyr, 1992, Bilodeau, 1994).

The first real product of this type was the Domesday videodisc, the innovative multimedia 'picture' of Britain in the 1980's (Mounsey, 1988; Rhind et al., 1987, 1988). It was jointly produced by the BBC, Acorn Computers and Philips to commemorate the 900th anniversary of William the Conqueror's tally book. This double laservision videodisc system, driven by a BBC computer and incorporating the software on the disc itself is still looked upon an innovative package which, in the view of the author has yet to be matched in terms of coverage and innovation.

Maps and information were contained on two videodiscs - one containing 'National' information and the second 'Community' information. Information was stored and delivered on six levels. Level 0 provided an introductory map coverage of the whole country. Users could 'zoom' into the next level of maps, Level 2 by clicking the part of the country they wished to move to. Users are able to zoom in further to levels 2-4. Both Level 0 and Level 1 maps were purpose designed for the project, whilst the more detailed maps on levels 2, 3 and 4 were scanned from the existing Ordnance Survey coverage of the country. The information on level 5, the most detailed information level, provides imagery of mapped areas.

At each level users are able to access text related to the area mapped. Searches can be made by placename, region or position on the national grid. Figure 8 illustrates the types of information provided at each level.

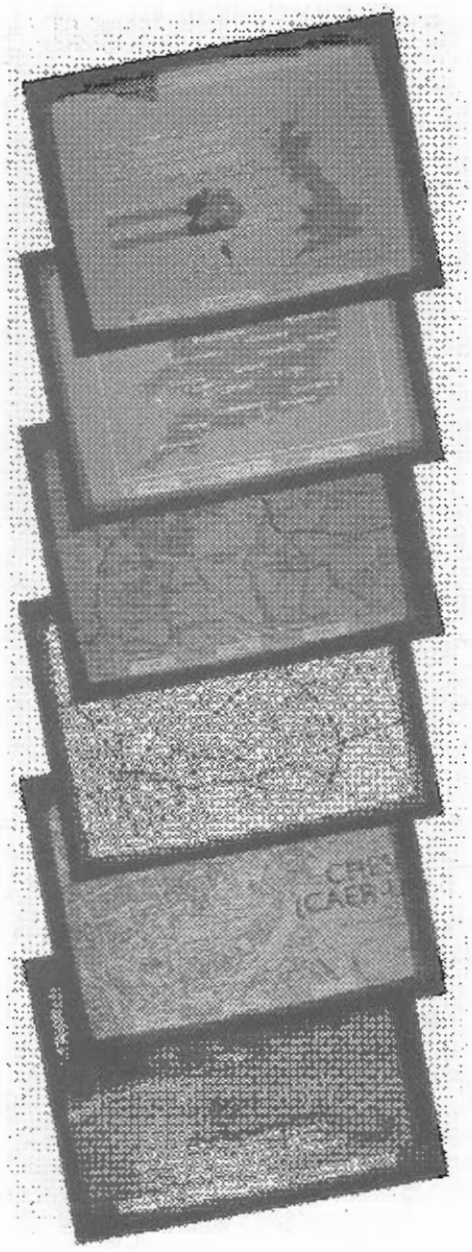

Figure 8. Levels of informations available on the Domesday 'Community' videodisc.

(Copied from British Broadcasting Commission, 1985).

The hardware/software package, that sold for approximately UKstlg4000 in 1985, consisted of two double-sided videodiscs, an Acorn-produced BBC Professional computer, a Philips analogue/digital integrated monitor (multi-format - NTSC/PAL/SECAM) and a Philips videodisc player. Users interacted with the system either through the keyboard or through a trackerball. The hardware configuration is illustrated in Figure 9.

Figure 9. The Domesday videodisc system, consisting of a PC, colour screen, laservision videodisc player, keyboard and trackerball. (Copied from British Broadcasting Commission, 1985).

INTERNET AND THE WORLDWIDE WEB MAPPING APPLICATIONS

Map collections are available both as discrete multimedia on CD-ROM and as accessible files via the World Wide Web. One Web source of maps is the Maps Store. It represents a Publishers Depot collection of topographical and political maps created in a variety of formats and colours. Suppliers to the Maps Store include the US firms Eureka Cartography, Mountain High Maps (Digital Wisdom) and Magellan Geographix. The pictures in the Maps Store and additional high quality high-resolution digital images are available for licensing once users register for Publishers Depot access.

Also on the Web is Map Maker, an integrated Web interface to the GMT 3.0 (Generic Mapping Tools) package and a geographic database developed by Steinke at the Charles Sturt University in Australia. GMT is a software package developed by Wessel and Smith. Although not exactly a map collection, the package commands produce Postscript output that is converted to a .GIF file for display on the Web (Steinke, 1996).

Kraak and van Driel (1996) have produced a prototype hypermap of the city centre of Delft, The Netherlands. The prototype was made available on the Web as the Delft Hypermap and provided two interactive functions - query/navigate and an update of the hypermap database. Multimedia components provided were sound, video, animation and text.

FUTURE DIRECTIONS

Many mapping products have already been produced using many of the «building blocks» of multimedia. Two general categories of multimedia systems have been developed for work with spatial information. Some, like the Domesday system (Mounsey, 1988; Rhind et al., 1987, 1988), function primarily as spatial storehouses. Others are more narrowly targeted tools for spatial decision support. Spatial storehouses are basically map collections or atlases on CD-ROM, videodisc, hard disk drive or via Internet sites displayed as Web pages. Spatial decision support tools can range from travel guides, to street directories, to encyclopedias. As well as these two categories there also exists another group of products that overlaps both - teaching packages that incorporate map collections as well as tools to learn how to use map elements contained within the product. The wide range of products now available illustrate the ever growing range of interactive maps and atlases being made available. Travel guides, route planners, atlases and teaching packages are just some of the items now on the market. Travel guides that have been published include the titles Lets Go (a CD-ROM of their USA guide), Fodor (Travel Manager - top US cities on the Apple Newton), Moon (Travel Matters newsletter on the Internet and a World Wide Web guidebook with UCLA), Frommer (Travel Companion, a CD-ROM containing 25 cities in the USA), ComInfo (Moscow Kremlin CD Guide), Superbase (Getaway to Australia: an electronic book) (Kruh, 1995), Expert

Software (Expert CD-ROM Travel Planner Gold) Deep River Publishing (Everywhere USA Travel Guide) (McCracken, 1994) and DeLorme (Map'n'go) (NewMedia, 1995a); multimedia the Great Cities of the World, a multimedia travel guide of Bombay, Cairo, London, Los Angeles, Moscow, New York, Paris, Rio de Janerio, Sydney and Tokyo (volume 1) and Berlin, Buenos Aires, Chicago, Jerusalem, Johannesburg, Rome, San Francisco, Seoul, Singapore and Toronto (volume 2) (Diehl, 1992). As well as general travel guides there exists a wide range of `specialist' guides. Typical of this type of product is New York At Its Best (Compton's NewMedia, Inc.) that provides tips on the best restaurants, hotels and sights of New York. It evaluates 80 hotels and more than 200 restaurants, and it takes users inside museums and historic homes. Road maps have been published by Geosystems/ Delorme (AAA trip planner CD-ROM) and Global Explorer and Map Expert (Kruh, 1995). US digital road atlases have been produced on a national level by Microsoft (Automap Road Atlas) and Rand McNally (Trip-Maker) and at a `local' level portraying town maps as well - Microsoft's Automap Streets and Rand McNally's Streetfinder. The local products allow for the plotting of directions, the determination of `track time' between points, the printing of maps and the ability for users to record their own notes (Booth, 1996). Atlases have been published on CD-ROM by Delorme (Street Atlas USA and Global Explorer) and Mindscape (World Atlas 5) (NewMedia, 1995a); as the Glasgow Online digital atlas, which operates around a hypermedia spatial interface (Raper, 1991); The Territorial Evolution of Canada interactive multimedia map-pack that developed from an experimental prototype atlas as part of the National Atlas of Canada program in the Geographical Sciences Division, Survey and mapping Branch, Department of Energy and Resources (Siekierska and Palko, 1986); the National Atlas Information System of the Netherlands (Koop and Ormerling, 1990) and the National Geographic Society's Picture Atlas Of the World on CD-ROM. Teaching packages have been produced with the titles of GeoMedia and GeoMedia 2 earth science educational systems teaches middle school students in the USA about the hydrologic cycle, earthquakes and maps using the first product and the carbon cycle, the greenhouse effect and monitoring environmental changes over time in the latter (Wiltshire and Ferrigno, 1993 and Ferrigno and Wiltshire, 1994). These USGS packages run on Apple Macintosh computers with a CD-ROM drive. Hypermedia techniques allow students to make associative links between graphics, text, animation and sound. Animations show earth science processes such as plate tectonics and the water cycle and an «understanding maps» section explains the use of maps (GIS World, 1993b). This wide ranging list of products illustrate how contemporary cartography has embraced interactive multimedia. The innovative products now available are artefacts that show how interactive mapping, on both discrete media like CD-ROM and distributed media on the Internet have changed the perception of mapping

CONCLUSION

Map producers and map users alike should revel in what multimedia offers. Multimedia is the matchmaker between the logical world of computers and the abstract world of video. Cartographers, already attuned to dealing with multimedia in terms of atlases and mapping packages that contain a plethora of map tools, are well placed to exploit the medium. The challenge for map designers and producers is to use multimedia as a new tool for mapping. Mapping packages/programs can be assembled by applying skills which cartographers already have to multimedia.

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