William Cartwright
Michael P. Peterson
Georg Gartner

Multimedia Cartography

William Cartwright
Michael P. Peterson
Georg Gartner
(Editors)

Multimedia Cartography

Second Edition

With 105 Figures

Springer

PROF. WILLIAM CARTWRIGHT
RMIT University
School of Mathematical
and Geospatial Sciences
GPO Box 2476V
Melbourne
Victoria 3001
Australia

E-mail:
william.cartwright@rmit.edu.au

PROF. DR. GEORG GARTNER
Vienna University of Technology
Department
of Geoinformation
and Cartography
Erzherzog-Johannplatz 1
1040 Vienna
Austria

E-mail:
georg.gartner@tuwien.ac.at

PROF. MICHAEL P. PETERSON
University of Nebraska at Omaha
Department of Geography & Geology
Omaha, Nebraska 68182-0199
USA

E-mail:
mpeterson@unomaha.edu

Library of Congress Control Number: 2006930100

ISBN-10 3-540- 36650-4 Springer Berlin Heidelberg New York
ISBN-13 978-3-540- 36650-8 Springer Berlin Heidelberg New York

ISBN 10 3-540-65818-1 (1st edition) Springer Berlin Heidelberg New York

Springer is a part of Springer Science+Business Media
springer.com

Cover figure: Georg Gartner
Cover design: Erich Kirchner
Typesetting: camera-ready by the editors
Production: Christine Adolph
Printing: Krips bv, Meppel
Binding: Stürtz AG, Würzburg

Printed on acid-free paper 30/2133/ca 5 4 3 2 1 0

Preface

William Cartwright, Michael P. Peterson and Georg Gartner

Multimedia Cartography Edition 2 has been produced as a ‘companion’ title to the First Edition. This book includes some of the chapters from the First Edition, with 26 new chapters. These cover dynamic map generation via the Internet, Internet Atlas publishing, 3D (realistic and non-realistic) and the application of games tools as geographical visualization realisation and presentation techniques. It also addresses the issues of accessibility, privacy & security and user-centred design.

This second edition of *Multimedia Cartography* includes updated applications areas that are Internet and mobile mapping-focussed. Since the release of Edition 1 in 1999 the focus of the delivery of Multimedia Cartography applications now includes the World Wide Web and mobile services, as well as discrete media. New chapters in the book reflect this. As per the first edition, this book has been written to provide foundation materials for those beginning in Multimedia Cartography production and design. It also provides chapters on current and developing applications that will interest academic and professionals alike. These chapters have been included to illustrate the broad-ranging applications that comprise Multimedia Cartography – discrete, distributed and Mobile. The book is pertinent to both the mapping sciences and related geographical fields.

The first section of the book covers the ‘essential’ elements of Multimedia Cartography. This section elaborates on the theoretical ideas about Multimedia Cartography and the essential elements that make it unique from computer-assisted cartography and visualization. The following section covers applications of Multimedia Cartography – discrete, distributed and mobile. In each of these areas theory, design concepts and production tools are covered. Several chapters focus on how multimedia is used to author the product and the design and production considerations that need to be addressed when undertaking production of these artefacts. This section provides examples of products delivered on CD-ROM, via the Internet, using Location Based Services (LBS), 3D, Virtual Reality and Computer Games tools. The final section looks at a number of issues that relate to Multimedia Cartography and the possible applications of this new rich media. The penultimate chapter addresses future directions and applications of Multimedia Cartography.

Like edition 1, this book has again been an international effort, with contributing authors from many countries, and editors based on three continents. Contributing authors are involved in Multimedia Cartography applications as practitioners, researchers and academics. The diverse nature of the backgrounds of the contributing authors and a global outlook about what Multimedia Cartography ‘is’ that they provide, gives a unique vehicle for conveying contemporary thinking and practice related to Multimedia Cartography.

We commend and value the efforts that contributing authors have made to this collaborative effort. We believe that the contents of the book provide a resource for those who are moving into Multimedia Cartography, as well as experienced readers. We hope that *Multimedia Cartography* Edition 2 becomes a valuable addition to your bookshelf.

William Cartwright, Melbourne, Australia
Michael P. Peterson, Omaha, USA
Georg Gartner, Vienna, Austria

Contents

List of Contributors

Andrienko, Gennady, Dr.
Fraunhofer Institut Autonome Intelligente Systeme (FhG AIS)
Schloss Birlinghoven, Sankt-Augustin, D-53754 Germany
gennady.andrienko @ais.fraunhofer.de

Andrienko, Natalia, Dr.
Fraunhofer Institut Autonome Intelligente Systeme (FhG AIS)
Schloss Birlinghoven, Sankt-Augustin, D-53754 Germany
natalia.andrienko@ais.fraunhofer.de

Armenakis, Costas, Dr.
Mapping Services Branch, Geomatics Canada,
615 Booth Street, Ottawa, Ontario K1A 0E9, Canada
armenaki@NRCan.gc.ca

Axford, Stephen
Urban Futures Consulting, Interactive Information Institute, RMIT University, GPO Box 2476V, Melbourne, Victoria 3001, Australia
Stephen.axford@rmit.edu.au

Cammack, Rex G., Dr.
Department of Geography, Geology & Planning, Missouri State University, Springfield, MO 65804, USA
rexcammack@smsu.edu

Caquard, Sébastien, Dr.
Geomatics and Cartographic Research Centre, Department of Geography and Environmental Studies, Carleton University
Ottawa, Ontario K1S 5B6, Canada
sebastien_caquard@carleton.ca

Cartwright, William, Professor
School of Mathematical and Geospatial Sciences, RMIT University,
Melbourne, Victoria 3001, Australia
william.cartwright@rmit.edu.au

Champion, Erik, Dr.
Information Environments and Multimedia Program, ITEE, University of Queensland
erikc@itee.uq.edu.au

Doin de Almeida, Rosângela, Dr.
Departamento de Educação, Instituto de Biociências – UNESP, Av. 24A n. 1515, 13506-900, Rio Claro, SP, Brazil
rdoin@rc.unesp.br

Döllner, Jürgen, Professor
University of Potsdam, Hasso-Plattner-Institute for IT Systems Engineering, Helmert-Str. 2-3, D-14482 Potsdam, Germany
doellner@hpi.uni-potsdam.de

Dransch, Doris, Professor
GeoForschungsZentrum Potsdam,
Sektion 5.4 , Telegrafenberg, G 254, D-14473 Potsdam, Germany
dransch@gfz-potsdam.de

Ford, Martin
Martin Ford Consultancy
Sesona di Vergiate, 21019 (VA) Italy
martin.ford@martinfordconsultancy.net

Francis, Ken
Natural Resources Canada, Mapping Services Branch, Geomatics Canada, 615 Booth Street, Ottawa, Ontario K1A 0E9, Canada
cartohead@hotmail.com

Furey, Scott
Webraska Mobile Technologies
Melbourne, Australia
scott_furey@hotmail.com

Gartner, Georg, Assoc. Professor
Research Group Cartography, Department of Geoinformation and Cartography, Vienna University of Technology
Erzherzog-Johann-Platz 1,
A-1040 Wien, Austria
georg.gartner@tuwien.ac.at

Germanchis, Timothy
School of Mathematical and Geospatial Sciences, RMIT University,
Melbourne, Victoria 3001, Australia
tim.germanchis@rmit.edu.au

Huber, Stefan
Institute of Cartography, ETH Zurich
8093 Zurich, Switzerland
huber@karto.baug.ethz.ch

Jobst, Markus
Research Group Cartography, Department of Geoinformation and Cartography, Vienna University of Technology
Erzherzog-Johann-Platz 1,
A-1040 Wien, Austria
markus.jobst@tuwien.ac.at

Katterfeld, Christiane
Institute of Cartography and Geoinformatics
University of Hannover, Appelstrasse 9a, D-30167 Hannover, Germany
christiane.katterfeld@ikg.uni-hannover.de

Katzlberger, Gernot
Department of Geography and Regional Research, Universität Wien, Universitätsstr. 7, A-1010 Wien, Austria
katzlberger@atlas.gis.univie.ac.at

Keltie, Garry
Virtual Reality Centre, RMIT University
GPO Box 2476V, Melbourne, Victoria 3001, Australia
garry.keltie@rmit.edu.au

Kraak, Menno-Jan, Professor
Department of Geo-information Processing, ITC
P.O. Box 6, 7500 AA Enschede, The Netherlands
kraak@itc.nl

Kramers, R. Eric
GeoAccess Division, Canada Centre for Remote Sensing, Natural Resources Canada
Ottawa, Canada
kramers@nrcan.gc.ca

Kriz, Karel, Dr.
Department of Geography and Regional Research, Universität Wien, Universitätsstr 7, A-1010 Wien, Austria
kriz@atlas.gis.univie.ac.at

Lauriault, Tracey P.
Geomatics and Cartographic Research Centre, Department of Geography and Environmental Studies, Carleton University
Ottawa, Ontario K1S 5B6, Canada
tlauriau@magma.ca

Miller, Suzette, Dr.
Consultant Cartographer
Melbourne, Australia
suzettem@bigpond.com.au

Mitchell, Kirk
Webraska Mobile Technologies
Melbourne, Australia
kirk.mitchell@navteq.com

Nevile, Liddy, Assoc.Professor
Sunrise Research Laboratory
liddy@sunriseresearch.org

Ormeling, Ferjan, Professor
Department of Cartography, Universiteit Utrecht,
3508 TC Utrecht, The Netherlands
f.ormeling@geog.uu.nl

Paelke, Volker, Professor
Institute of Cartography and Geoinformatics
University of Hannover, Appelstrasse 9a, D-30167 Hannover, Germany
Volker.Paelke@ikg.uni-hannover.de

Peterson, Michael P., Professor
Department of Geography and Geology, University of Nebraska at Omaha, Omaha, NE 68182, USA
mppeterson@mail.unomaha.edu

Pettit, Christopher, Dr.
Department of Primary Industries, Government of Victoria
christopher.pettit@dpi.vic.gov.au

Pucher, Alexander
Department of Geography and Regional Research, Universität Wien, Universitätsstr. 7, A-1010 Wien, Austria
pucher@atlas.gis.univie.ac.at

Pulsifer, Peter L.
Geomatics and Cartographic Research Centre, Department of Geography and Environmental Studies, Carleton University
Ottawa, Ontario K1S 5B6, Canada
ppulsife@connectmail.carleton.ca

Radoczky, Verena
Research Group Cartography, Department of Geoinformation and Cartography, Vienna University of Technology
Erzherzog-Johann-Platz 1,
A-1040 Wien, Austria
verena.radoczky+e127@tuwien.ac.at

Ramos, Cristhiane
School of Mathematical and Geospatial Sciences, RMIT University, Melbourne, Victoria 3001, Australia
cris.ramos@rmit.edu.au

Reichenbacher, Tumasch, Dr.
Department of Cartography, Technical University Munich
Arcisstr. 21, 80333 München, Germany
tumasch@bv.tum.de

Reitmayr, Gerhard, Dr,
University of Cambridge, Department of Engineering
Trumpington Street, Cambridge CB2 1PZ, United Kingdom
gr281@cam.ac.uk

Riedl, Andreas, Dr.
Department of Geography and Regional Research, Universität Wien, Universitätsstr. 7, A-1010 Wien, Austria
andreas.riedl@univie.ac.at

Sester, Monika, Professor
Institute of Cartography and Geoinformatics
University of Hannover, Appelstrasse 9a, D-30167 Hannover, Germany
Monika.Sester@ikg.uni-hannover.de

Schmalsteig, Dieter, Professor
Technische Unversität Graz
Inffeldgasse 16, 8010 Graz, Austria
schmalstieg@icg.tu-graz.ac.at

Sieber, René, Dr.
Institute of Cartography, ETH Zurich
8093 Zurich, Switzerland
sieber@karto.baug.ethz.ch

Siekierska, Eva, Dr.
Mapping Services Branch, Geomatics Canada,
615 Booth Street, Ottawa, Ontario K1A 0E9, Canada
siekiers@NRCan.gc.ca

Taylor, D. R. Fraser, Professor
Geomatics and Cartographic Research Centre, Department of Geography and Environmental Studies, Carleton University
Ottawa, Ontario K1S 5B6, Canada
fraser_taylor@carleton.ca

van Elzakker, Corné P.J.M., Dr.
International Institute for Geo-Information Science and Earth Observation (ITC), Department of Geo-Information Processing
Hengelosestraat 99, P.O. Box 6, 7500 AA Enschede, The Netherlands
elzakker@itc.nl

Wallis, Christine
Urban Futures Consulting, Interactive Information Institute
RMIT University
GPO Box 2476V, Melbourne, Victoria 3001, Australia
christine.wallis@rmit.edu.au

Wealands, Karen
School of Mathematical and Geospatial Sciences, RMIT University, Melbourne, Victoria 3001, Australia
karen@wealands.net

1 Multimedia Cartography

William Cartwright and Michael P. Peterson

School of Mathematical and Geospatial Sciences, RMIT University, Melbourne, Australia
Department of Geography, University of Nebraska at Omaha, Omaha, USA

1.1 Introduction

The term *'multimedia'* was once used to refer to a sequential display of slides with a recorded voice-over. The concepts of *interactive multimedia* and *hypermedia* were introduced to refer to media combined with an interactive linking structure. The meaning of *multimedia* has evolved and now subsumes these newer concepts. Multimedia uses different media to convey information as text, audio, graphics, animation, and video, all done interactively. This provides 'rich media' content. It also refers to computer data storage devices, especially those used to store multimedia content. Multimedia enhances user experience and makes it easier and faster to grasp information. Multimedia *is* interaction with multiple forms of media supported by the computer. The computer is both the tool of multimedia and its medium. Without means of creation or distribution, the current interactive form of multimedia would not exist. The World Wide Web, both static and mobile, has dramatically increased the audience and use of interactive multimedia products.

Multimedia Cartography evolved from a need to present geographical information in an intuitive manner. Multimedia Cartography is best defined through the metaphor of the world atlas that revered assemblage of maps in book form that has introduced people to the world for centuries. Displayed prominently in people's homes, or stored for reference in the library or school, the atlas has been a window to the world for millions of people. It is consulted when one needs to know where something is located or something about a region of the world. The atlas forms the basis for how people conceive the world in which they live.

The atlas also has a general audience. Its use does not require any particular expertise or motivation. It is not intended for the expert user or people from any particular educational background or for only a few, highly-trained individuals. Rather, it is an inclusive form of cartography that invites the user to explore the world through maps.

The traditional, printed atlas is not without its limitations. The maps lack interaction. It is not possible to change the scale of the maps or add detail. There is no provision to consult an underlying set of data. It is not possible to link features to other types of media, such as sound, pictures, or video. It is not possible to view cartographic animations that would depict the dynamic character of the world.

Interactive media is now commonplace and ubiquitous. Through the influence of the World Wide Web, users now expect a linking structure to be incorporated on any computer display. A display that is static is uninteresting and so it is with maps as well. The surface depiction is no longer sufficient. People want to “go into” the map, both spatially and conceptually. They want to explore at a deeper level. They want to put the pieces of information together themselves. These tendencies are not idle pursuits but can be attributed to the way we learn and structure knowledge. Interaction is the key to knowledge formation.

1.2 Visualizing geography

The general public use maps daily as a general information source, or as a tool to find specific locations when using a street directory or an atlas. They are bombarded with spatial information on television news reports, in newspapers and magazines and as part of computer packages for gaming, education and training. Technological developments have led to a wider range of different cartographic products that can be made faster and less expensively, and the interaction with visual displays in almost real-time. This has moved the emphasis from static to dynamic map use (Taylor, 1994), from discrete to distributed information provision, and from ‘wired’ access to ‘wireless’ access.

The ‘real’ geographical picture can be seen to be one that consists of many attributes. An efficient system for exploration would allow users to gain access to the ‘picture’ via a general, surface access mode or through a rigorous process of deep interrogation (Norman, 1993). At the ‘viewing end’ of the electronic mapping process users would be offered depiction methods which either painted a general information overview or else gave a very specific and precise graphic profile of essential user-defined geographical characteristics.

1.3 Access to geographical information

The spatial science professional is no longer the only one who should gain access to and present geographical information. Cartography has developed in two directions: the refinement of the means to represent natural points of reference; and the depiction of multiple phenomena. Therefore there exists the need to include more human-oriented elements in new media presentations and resources. There have been many comments about the needed evolution of current-day tools like GIS into one that will offer the required components for the next generation of user interaction, and it is suggested that this product should move from the ‘technical elite’ to the ‘everyday user’. Commenting on GIS technology, Roe and Maidlow (1992) have noted that to date the vast majority of the emphasis has been placed on technical issues and that if it (GIS technology) is going to create value for the masses it is going to have to become more intuitive to use.

Many proposals have been made to rectify the shortfalls of digital mapping and GIS. Future systems were envisioned that incorporated image analysis and processing technology (Gallant, 1987); ones that included the cultural argument and information that highlighted human and social aspects, so as to reflect the basic goals of society (Chrisman, 1987); and new forms of data portrayal for the purpose of understanding, controlling and monitoring the multiple layers of space that make up the focus of human relationships (Müller, 1989). Other types of spatial data that were largely disregarded until fairly recently by the existing technology - photographs, free text, video images and sound, were seen in the future to play a greater role in decision-making than did all of traditional GIS (Lewis, 1991).

This technology-elaborated map could actually be many maps and provide access to information in ways dictated by the user. This would have the benefit of providing a map that is not just a picture of geographical reality, but also a search engine which, as well as giving access to geographical data and a means of data selection and display, also allows users to access further data and information plus a background on how things, data systems, data suppliers and facilitators, and mapping systems, and so on actually work. The geographically linked ‘things’ are a conglomerate of items, systems, processes and conventions.

1.4 A *Different* map

What multimedia offers is the ability to create a different map. By different map, what is meant is not merely something that is an ‘electronic page turner’, but a product which really extends the technology and allows for a different way of presenting geographic information to change geographical information access. A multimedia-based mapping product is seen as a real alternative to conventional mapping (including those maps now being produced electronically). Most electronically-produced are still not really that different to the maps produced when 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 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 buildings. 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. Peterson (1995, p. 12) speaks of a ‘paper-thinking’ that still pervades how we think about maps and the process of producing them. The print mindset has ‘harnessed’ map designers to the idea that computer-generated maps should mimic printed maps (Cartwright, 1994).

Multimedia is intended to expand the channels of information available to the user. Users should then be able to thread their way through a database query in ways not anticipated by the system designers. Multimedia is an accessible tool, both practically and economically, even though it has been ‘hijacked’ by the 'glossy' nature of many multimedia products. But, if multimedia is viewed as multi-media, then its potential in the application of access and display interfaces to geographical information in a variety of ways can be seen. Multimedia offers a different way to view data that has been generated and stored by the many existing spatial resources packages.

In the real world some things can appear to be something that they are not. How things appear on the surface of an interactive multimedia product is not representative of what is happening with the human part of the interaction. Designers of multimedia geographical information products are undertaking work to ensure that the media allows for individual mental maps or virtual worlds to be composed and thus making available artifacts that allow geographical information and the real world to be better understood. Users must be encouraged to include their own experience in the ‘reading’ of the presented data. Multimedia allows the virtual world to be unfolded, scene by scene, where each unfolding offers a further unfolding.

1.5 Multimedia as an information interface

The traditional map form can be seen as a form of multimedia, whereby lines, colours, text, rendering, symbols, diagrams and carefully chosen content, were used to impart a 'story' about reality. Everyone is a product of their past training, and the limitations of the printed graphic map are still embedded in our thoughts and habits (Morrison, 1994). Those involved in the art and science of map-making should be content that these devices, paper or digital, accurately portray the phenomena that has been selected. However, the traditional delivery mediums cannot be viewed as an isolated entity in the digital electronic age, an age where arrays of information resources can be output in many different ways. This will restrict the possibilities for offering a package of information-enhanced map products. The multimedia revolution should be exploited to augment the capabilities of existing methods of geographical information processing (Groom and Kemp, 1995) and extend the use of the map as an isolated display device by adding extra data and information depiction methods. Interactive maps, using hot-spots and buttons to give access to the underlying data and metadata would allow for the map display to link to other information offering an enhanced spatial information resource.

Contemporary mapping, although providing timely and accurate products, may be still using formats which disallow them to be fully utilised. If one was to make a very general observation, the conclusion could be made that the formats and types of presentations used for the depiction of spatial data do not fully exploit the plethora of other information delivery devices in common usage. Telephones, television, faxes, computers, email, Web browsers, radio, newspapers, magazines, films and interactive mediums are all used to keep us informed in our own everyday lives. Maps can also adapt these other devices to enhance the communication of spatial information.

Tools like word processors and drawing programs are now commonplace. Users work with many tools on one computer and, increasingly, computer-based tools are used for communication with other people. Interactive systems are becoming gateways to communities and endless information spaces (Rijken, 1996). Hybrid tools, like the use of television for shopping and the use of metaphors to navigate through fairly complex data sets, have been developed. The choice of an ‘ideal’ tool is becoming complicated as we move from the simple one-user, one-device to computer-supported collaborative work and the design of interfaces for entire organisations (Rijken, 1996).

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 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 forms of media that are available. Multimedia allows many other ways of presenting data sets and the results of analysis.

Multimedia is a new form of visual and aural presentation and expression. As a new communication form it has taken on its own grammar and made its own rules. The grammar is developing and (script)writers are only beginning to master it. The rules are new and already being broken, as new forms of multimedia are explored and other means of exploiting this conveyor of ‘rich media’ are tried, tested and developed. Multimedia has much to offer users of GIS in improving access to data and facilitating displays of that data in formats most compatible with an individual user’s preferences for aiding their journey through a virtual world.

1.6 Visualizing Multimedia Cartography

Multimedia Cartography can be viewed as sphere that may moved by the user across and into a plane of geographical reality (see Figure 1). The Plane of Geographical Reality is composed of levels of abstraction. The user controls the sphere and can move down these levels. Moving the sphere across the surface affects a variety of other interrelated aspects of the display, such as scale and perspective. Critical in the use of multimedia

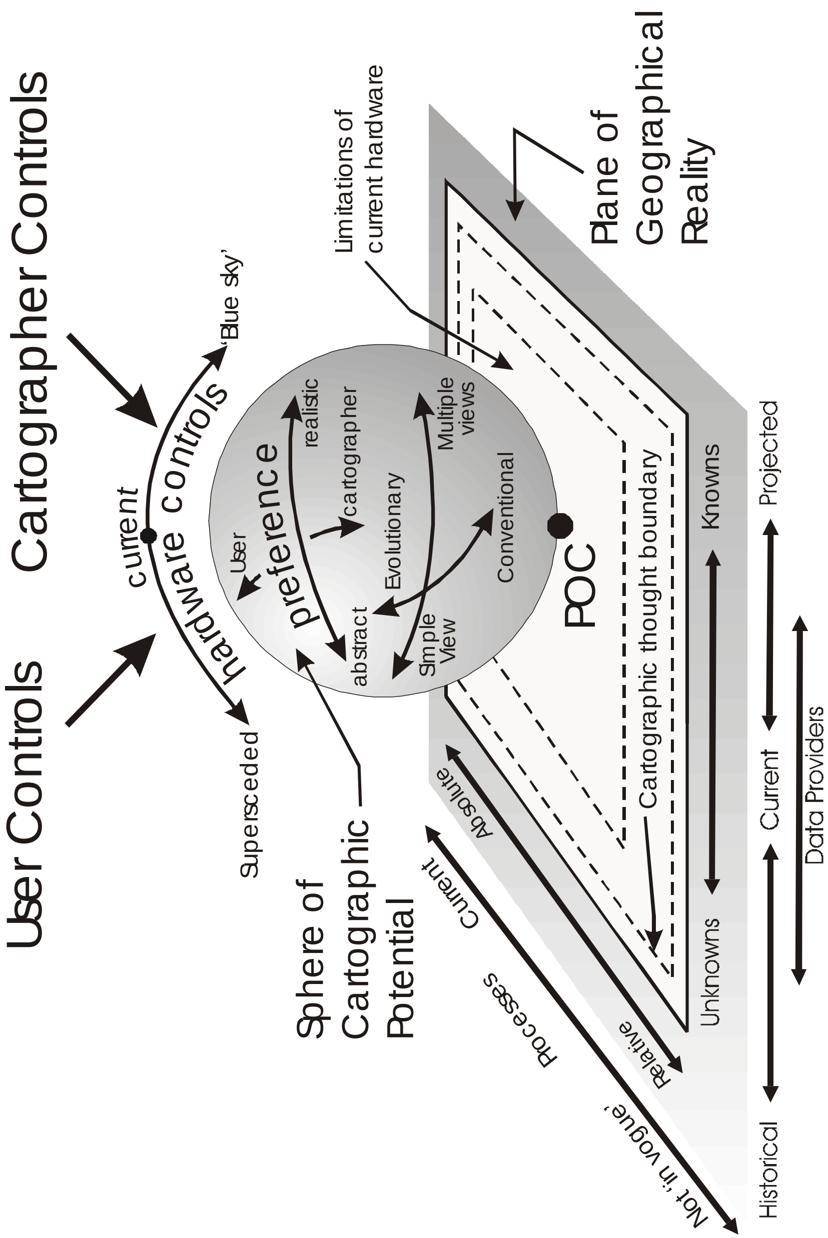


Fig. 1. The Sphere of Cartographic Potential and the Plane of Geographical Reality.

cartography is the Point Of Contact (POC) – the 'ideal' method for data/ information/ knowledge transfer/ understanding.

The POC is where the Sphere of Cartographic Potential (the best method of enabling the user to fully exploit a multimedia package according to cartographic allowances and hardware/software affordances) comes into contact with the Plane of Geographical Reality (the geographical 'window' through which the real world is viewed). The Sphere of Cartographic potential is controlled both by the user, who can choose a particular presentational method according to their ability and psychomotor skills, and the cartographer, who can apply their own biases or *depiction preferences* (and thus add *weight patches* to the Sphere and dictate, to some extent, its attitude and thus the relationship with the Plane of Geographical Reality.

The Sphere of Cartographic Potential is positioned according to controls that are within and outside of the sphere. The major external force are the hardware controls that can range from the need to use outdated equipment if, say, archival data located on a laserdisc needs to be viewed, to developing a product that needs 'blue sky' hardware that does not currently exist, or is cost exclusive, but will be available or economically accessible when a multimedia project is completed over some considerable time. The Sphere can be controlled by both user and cartographer to make display settings that will provide displays that range from the abstract to the realistic, from simple views to realistic views, and from the conventional to evolutionary displays.

The Plane of Geographical Reality is restricted by several factors. Firstly limitations of current hardware will disallow certain parts of the real world to be depicted. This limitation can be seen to be a movable feast and in the ever-changing scene that depicts today's computer hardware industry, what is currently impossible can be tomorrow's standard method of operation. The Cartographic Thought Boundary is the theoretical constraints of what could be depicted as can be conceived by cartographers. This perception of what can actually be done is a function of what is possible with contemporary cartographic visualization tools. The Plane of Geographical Reality is positioned also by the desire to view either relative or absolute information or whether knowns or unknowns (in terms of geographical information) need to be depicted. Processes that can be undertaken to take raw data and convert it into cartographic visualizations can be selected from the methods currently in use and even past methodologies that are not 'in vogue', but may be chosen to ensure that all possible procedural strategies are explored. Finally, what can sometimes override the best laid plans for delineating the Plane of Geographical Reality, the access to data, will affect its position and thus where the POC is made. Data providers can make available data to underwrite depictions of historical, current or projected scenarios.

1.7 About this book

Multimedia Cartography is complex and the factors influencing its design and operation many. Much experimental work has been undertaken to explore the possibilities that Multimedia Cartography offers. Lessons learnt from the application of this multimedia data depiction tool can be used to guide future enterprises in the display of geographical information.

This book includes a number of chapters from Edition 1, as the topics covered are still relevant for providing a complete 'picture' of what Multimedia Cartography is – discrete, distributed, mobile and 'at location' geographical information provision. Chapters that follow cover all of these areas of cartographic endeavour. It is a truly international effort, and it brings-together contributions from academics, researchers and producers.

The first section of the book provides the underpinning concepts of interactive multimedia and its application to cartography – 'Multimedia Cartography'. Then multimedia atlas applications on CD-ROM and the Web are covered. This is followed by chapters on Virtual Environments and Virtual landscapes, and it includes an application on how this might be applied to cartographic education. Then chapters are provided on animation and dynamic maps. Chapters then cover the use of computer games technology for displaying geographical information in new ways. Mobile applications are discussed next, and the section provides chapters on research into this form of cartographic information provision as well as practical implementation. The Web, Web standards and Web applications then contribute to knowledge about how the Web can be best used as a geographical information conduit. Users are considered next, with chapters on usability and adaptability. The last section of the book examines future directions for Multimedia Cartography and then sumarises the book's contributions.

References

Cartwright , W.E. (1994) Interactive Multimedia and Mapping. In Visualization in Modern Cartography, Fraser Taylor and MacEachren (eds), London: Permagon Press.

Chrisman, N.R. (1987) Fundamental Principals of geographic Information Systems. Proceedings of Auto Carto 8, Baltimore: ASPRS/ACSM, pp. 32 - 41.

Gallant, D.Q. (1987) The misguided evolution of future mapping technology. Proceedings of Auto Carto 8, Baltimore: ASPRS/ACSM, pp. 386 - 391.

Groom, J. and Kemp, Z. (1995) Generic multimedia facilities in geographic information systems. In Innovations in GIS 2, Ed. Peter Fisher, London: Taylor and Francis, pp. 189 - 200.

Lewis, S. (1991) Hypermedia Geographical Information Systems. Proceedings of EGIS ‘91, Brussels: EGIS Foundation, vol. 1, pp. 637 - 645.

Morrison, J.L. (1994) The paradigm shift in Cartography: the use of electronic technology, digital spatial data, and future needs. In: Advances in GIS Research, eds. T.C. Waugh and R.G. Healey, London: Taylor and Francis, vol. 1, pp. 1 - 15.

Müller, J.C. (1989) Challenges Ahead for the Mapping Profession. Proceedings of Auto Carto 9, Baltimore: ASPRS/ACSM, pp. 675 - 683.

Norman, D. A. (1993) Things that make us smart: defending human attributes in the age of the machine, Reading, Mass.: Addison-Wesley.

Peterson, M P (1995) Interactive and Animated Cartography. Englewood Cliffs, NJ: Prentice Hall.

Raper, J. F. (1996) Unsolved Problems of Spatial Representation. Proceedings of Spatial Data Handling ‘96 (SDH’96), Delft, The Netherlands: IGU, pp. 14.1 - 14.11.

Rijken, D. (1996) Tools and Media. Public Discussion About Doors of Perception, http://www.design-ins...x/fpbin/get/p129/6174

Roe, G.V. and Maidlow, L. (1993) VIS - Visually Integrated Systems. The Canadian Conference on GIS, Ottawa: The Canadian Institute of Geomatics, vol. 1, pp. 485 - 489.

Taylor, D. R. F. (1994) Cartographic visualization and spatial data handling. In: Advances in GIS Research, eds. T.C. Waugh and R.G. Healey, London: Taylor and Francis, 1, pp. 16 - 28.

2 Development of Multimedia

William Cartwright

School of Mathematical and Geospatial Sciences
RMIT University
Australia

2.1 Introduction

Ideas take some time to develop, but once proven it may only be the progression of time and the development of techniques and technologies that convert strokes of genius to 'matter of fact' realities. For example the first fax was sent from Lyon to Paris in 1865, but it only become a widely used form of communication when advances in encoding technology and transmission matured and became economically viable almost 100 years later when Xerox sold its *Telecopier* in 1966 (Swerdlow, 1995).
The term multimedia didn't exist until the late 1970s. Views differ on what constitutes multimedia and, in the early developmental period, how it would mature. It is seen to be different to the film industry, the toy and games industries, the computer industry, the video industry, or any other pre-existing industry (Multimedia Digest, 1994). Multimedia involves the integration of computing, video and communications. It saw a convergence of previously discrete components of the entertainment industry. That is, large corporations which, in the past dealt exclusively with film, computing or communications, formed consortia or enveloped other media concerns to produce conglomerates with the ability to publish electronically, produce and distribute video and films, author computer packages and games and provide digital communication facilities worldwide.
From the general map using public's observation point, the mapping sciences community didn't really begin exploiting the possibilities of multimedia until the advent of optical discs, CD-ROM and the Internet. The mapping sciences have always adopted new technology for making their products more accurate, more quickly produced and produced in formats that were attuned to user expectations and requirements.

This chapter begins with an outline the development of multimedia from the first theoretical description of what was later to become known as hypertext to discrete interactive multimedia systems. Then it provides an overview of multimedia formats for delivering different spatial information delivery products. The chapter ‘stops’ at multimedia, and multimedia mapping products on discrete media. The following chapter by Peterson covers the Internet and Internet Cartography.

2.2 In the beginning ...

The beginning of today's global distributed interactive multimedia is attributed to the foresight and unique concepts of Vanaveer Bush, Professor in Electrical Engineering at MIT in the 1930s. After Pearl Harbour US President Roosevelt appointed Bush as Director of the Office of Scientific Research and Development (OSRD), a special agency that reported directly to the White House. Its charter was to organise research and scientific programmes to assist the US war effort. Amongst the programmes that fell under Bush's direction was the Manhattan Project.
In 1945 Bush wrote "As We May Think" in *The Atlantic Monthly* (1945) in which he proposed MEMEX, a multi-dimensional diary with links to all connected things. He envisaged a peripheral information machine that stored and retrieved information, plus the information owner's specific memories (hence MEMEX). Bush saw that this would work on an analogue computer delivering information via microfilm along with 'archived annotations'. The three main advantages that Bush saw with his theoretical machine were that it would:

- Greatly reduce information overload;
- Record intimate thoughts, or 'associated trails'; and
- Engender a family of thinking that could someday make possible human-machine consciousness (Zachary (1997, p. 158).

Even though Bush's ideas based his MEMEX system on an analogue computer was made redundant when ENIAC was perfected in 1946, his writings foreshadowed both the Personal Computer and the World Wide Web.

2.3 Pre-electronic multimedia

Before digital interactive multimedia became established and later ubiquitous cartography trialled other ‘multiple media’. Many innovative products did not use mainstream technologies. These included microfiche, motion film, video and videodisc. As a ‘primer’ to the use of interactive digital multimedia, an overview of these applications is provided.

2.3.1 Microfiche

Microformats were entertained as a medium for the storage of maps during the late seventies and early eighties. Exploratory work was carried out by a research team led by Massey (Massey, Poliness and O'Shea, 1985) who produced an 'Atlas' depicting the socio-economic structure of Australia on thirteen monochrome microfiche. Each microfiche featured one of Australia's capital cities, states and territories. This revolutionary product was jointly produced between the Geography Department at the University of Melbourne and Latrobe Comgraphics. The US Census produced colour microfiche depicting Census data that had been previously made available on colour paper maps. An excellent overview of the issues pertaining to the use of microfilm for map storage and archive that were discussed during this period was made in a paper by Lines (1982).

2.3.2 Motion film and interactive cinema

Film animation was first proposed as a method to depict the fourth dimension by Thrower in the late 50s and early 60s. Moellering (1980) produced the first animated map that depicted traffic accidents in Chicago. In Australia CAD-generated stills for animation were trialled by the National Capital Development Commission in Canberra to depict the impact of building the new Parliament House and how the vegetation would mature over time. Also, Massey (1986) produced an animated 16mm film that compressed climate data for Victorian Local Government Areas (LGAs) into one unit that allowed the user to gain an appreciation of the cyclic nature of drought and flood. More recently Web-delivered newspapers use animations to support their news items.

On a much larger scale the *HyperPlex* system (Sparciano, 1996), developed in the Vision and Modeling group at the Media laboratory, with the Interactive Cinema group at MIT, used interactive cinema (a combination of a large database, a big display screen and video browsing techniques) to provide navigation through a graphical virtual environment, providing users with visual cues to help them orient themselves.

2.3.3 Video

In 1927, Logie Baird gave the first demonstration of television. It took quite some time, until 1954 for the first regular broadcasts to be made. Developments in television accelerated due to the popularity of this communication medium. Even before the first transmissions to the public, a test colour broadcast had been made in (1950 and a VTR (Video Tape Recording) was demonstrated by Bing Crosby Enterprises in the US., with the first broadcast using videotape occurring in (1956. Once this had been perfected and 'time switching' - watching programmes at a time after the broadcast was made - sounded interesting to the general public, consumer demand led to Sony Corporation of Japan providing its first home VTR unit in 1963, an open reel ½" helical scan deck. Sony followed this with the videocassette (the ¾" *U-matic* (that remained a popular professional format well into the 1980s). The videotape scene became a little confused with the introduction of two formats - *Betamax* in 1975 and VHS in 1976 - and finally stabilised when *Betamax* fell out of favour with the public and was gracefully withdrawn from the marketplace. The dominance of television as a communication is highlighted by the fact that half of all television households in the US in 1988 had a VCR (VideoCassette Recorder) (The Media History Project, 1998). In 1992 the FCC in the US gave permission for telephone companies to offer video services, allowing for and opening up possibilities for cable home banking, shopping and movies. (Kindleberger, 1993).

Pre-Web dominance of information delivery thinking, the use of broadcast television that provided hyperlinks to other types of information was one possible scenario explored theoretically. Negroponte (1996) considered that one possible future scenario for allowing consumers to interact with information resources was hyperlinked television, whereby 'touching' an athlete’s image on a television screen will produce relevant statistics, or touching an actor reveals that his tie is on sale this week. This would involve embedding extra information from a central database into broadcast television signals. Television could react according to the information delivery designer’s intention when viewed under different circumstances. Negroponte saw *Java* contributing to the idea of hyperlinked television.
Television is where most members of the general public receive most of their information. Television, pre-dating the Internet, provided global coverage through the use of a number of interlinked satellites. Television was seen as a way in which information could be readily disseminated through the use of teletext in its many forms. Services like *Oracle*, *CEEFAX* and *Prestel* (*Viewdata*) in the United Kingdom, *Antiope* in France, *Prestel* and *Telidon* in Canada and *Viatel* in Australia were used to provide (relatively coarse) information that included text and simple graphics. Australia is covered by the Intelsat system. Much research on the use of television for weather mapping, perhaps the most widely-viewed television maps, has been undertaken by Carter (1997).

2.3.4 Videodisc

The first optical storage medium, videodisc, was demonstrated in Germany by Philips in 1972. This initial version was a playback-only laser disc. It was made publicly available in 1979 by Philips.

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). The basic design parameters are to develop code in any of a number of programming languages, and then use commands to guide the laser reader in the videodisc player to specific frames. Each side of a 12" videodisc holds 52,000 frames. If video is required, the start frame, end frame, play rate (slow, normal and fast) and direction of play is specified. The analogue videodisc can contain stills, video and animation.

Some of the advantages of videodiscs are:

- compactness;
- high storage capacity;
- store and playback any form of image data, sound and computer-readable data;
- stores full colour and black and white images;
- stores high-resolution images;
- excellent image quality for stills or moving pictures;
- resistance to wear and tear;
- play does not wear disc;
- resistance to vibration;
- precise random access;
- low error rates;
- plays multiple discs on a single player;
- can be computer-controlled;
- extended play freeze frame;
- high data transfer rate;
- non-erasable;
- storage life more than 10 - 15 years;
- inexpensive hardware costs; and
- a large library of existing material.

However, there were seen to be several disadvantages (Duncan, 1992): they were expensive to create; they had incompatible formats; and copyright infringement of material to be stored on disc was of concern.

2.4 Hypertext

The most used form of hypermedia initially was hypertext. It allowed authors to produce seemingly unstructured texts that enabled readers to move through the publication at their own pace and to follow their own preferential reading pattern. The Hypertext model can be described as “a set of nodes connected together by undifferentiated links”, where the nodes can be abstractions made up from any kind of text or graphic information elements (Raper, 1991). ‘Electronic books’ produced using hypertext preserve the best features of paper documents, while adding rich, non-linear information structures (hypermedia) and interactive user-controlled illustrations (Reynolds and Derose, 1992). The idea of producing ‘Electronic Books’, using something like *HyperCard* (which didn’t exist until Apple introduced it in 1987) was first talked over 30 years ago by Andries van Dam, a pioneer in user interface languages.

Californian computer guru Ted Nelson transformed Bush's idea of associated trails and coined the term Hypertext in 1965 (Cotton and Oliver, 1994; Nelson, 1987) when the word was first used in a paper presented at the Annual Conference of the Association of Computing Machinery (ACM) (Nelson, 1965). Just two years later van Dam, then a Professor of Computer Science at Brown University, with his research associates, built the Hypertext Editing System (HES), which was implemented the next year in collaboration with Nelson. HES basically pioneered what is taken for granted with computers nowadays (things like What You See Is What You Get (WYSIWYG) (that debuted on the Xerox *Star*, the first computer offering a Graphic User Interface (GUI), from Xerox PARC in 1981), multiwindowing (sic) and seamless text) (Reynolds and Derose, 1992). Also in 1968 Engelbart began the Augmentation Research Center at the Stanford Research Institute (SRI) International and demonstrated NLS, an online Hypertext system (Rheingold, 1996; The Electronic Labrynth, 1998). With his concept of Hypertext Nelson published *Dream Machines* (1974) and he visualised and began to develop Xanadu (Reynolds and Derose, 1992; Nelson, 1990), which he then predicted would be ready by 1976. He also examined the implications in terms of the associative linking of facts and ideas and created prototypes (Raper, 1991). 1975 saw ZOG (now KMS), a distributed hypermedia system developed at Carnegie-Mellon University.

In 1981 Nelson was still developing his ideas for *Xanadu*, which he now saw as a central, pay per document, Hypertext data base encompassing all information (Nelson, 1981). Other Hypertext developments continued to occur. TELOS introduced *Filevision* in 1984, a hypermedia database for the Macintosh, which was released in the same year. In 1985 Norman

Meyrowitz and associates at Brown University conceived *Intermedia*, a hypermedia system that was described as a functional Hypermedia system. And, in 1986 OWL introduced Guide, the first widely available Hypertext browser. Developments in Hypertext became more formalised with the first Hypertext workshop (Hypertext '87) held in North Carolina, and ECHT, the European Conference on Hypertext, first took place in 1990.

Nelson produced a new edition of *Literary Machines* in 1987 and proposed delivery of a working Literary Machine for the following year. Nelson was supported in his developmental enterprise when AutoDesk took on *Xanadu* in 1989 as a project, but the company dropped it three years later (Sanders, 1987). Although Nelson's work has not yet come to fruition, his innovation and ground-breaking ideas were recognised in November 1993 when he spoke as Guest of Honour at the November Hypertext Conference in Seattle, USA.

The technology and theoretical structures developed in the 1970s and 1980s and second-generation systems appeared and were further advanced with access to inexpensive computer memory, making it possible for Bush’s and Nelson’s ideas to be implemented.

2.5 Hypermedia and Multimedia

2.5.1 Hypermedia

Hypermedia is the extension of Hypertext through the use of multimedia (graphs, sound, animation and video) (Jiang *et al.*, 1995). 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, interactive cable television, videogames and multimedia. Hypermedia incorporates text, sound and graphics. 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 (1997) explanation of hyper-terminology.

In 1968 Nicholas Negroponte formed the Architecture Machine Group at MIT (Negroponete, 1995a). This was a laboratory/think tank that researched radical new approaches to human-computer interfaces. This was later to become the Media Lab. In 1976 the Architecture Machine Group devised the notion of a Spatial Data Management System, a seminal step in the development of multimedia, for the Defense Advanced Research Projects Agency. It was to be a 'Multiple media' system that was given the name 'Dataland'. Negroponte and Bolt developed a demonstration room equipped with an instrumented Eames chair, a wall-size colour display, and octophonic sound. Users sitting in the chair could ‘fly’ over Dataland as if it were a landscape, touching down on calculators, electronic books or maps (Leutwyler, 1995). Bolt undertook more development work and produced SDMS II in (1980.

2.5.2 Multimedia

In 1985 Negroponte and Wiesner opened the MIT Media Lab. Negroponte, who became the Director of the Lab, promoted the raison d’etre for work done in that laboratory as being to take both human interface and artificial intelligence research in new directions. This idea was marketed to the broadcasting, publishing, and computer industries as the convergence of the sensory richness of video, the information depth of publishing, and the intrinsic interactivity of computers. He said that the digital age had four very powerful qualities that will result in its ultimate triumph: decentralising, globalising, harmonising, and empowering (Negroponte, 1995c).
Apple also took a keen interest in the use of multimedia, especially for educational applications. In 1990 the Apple Multimedia Laboratory was formed by Hooper-Woolsey. The following year it produced its first product, *Visual Almanac*, a classroom multimedia kiosk. During this period many multimedia platforms appeared from Apple, Commodore, Amiga, MicroSoft, IBM and Lotus (*Australian Multimedia*, 1992).

In 1992 a 12-corporation coalition - 'First Cities' was formed to deliver what was described as *real* multimedia services. The companies came from the computing, communications and media fields. It was their intention to develop a US infrastructure to develop applications in multimedia conferencing, shopping services on-demand, distance learning and healthcare. This was the first concentrated effort to properly establish and implement a true multimedia industry (AudioVisual International, 1993a). Looking at the companies involved - Microelectronics & Computer Technology Corp., Apple Computer, Kaleida Labs (Apple/IBM) and Tandem Computer from the computing industry; Bellcore, Southwestern Bell, US West and Corning from the communications area; and Eastman Kodak and North American Philips from the media supply arena, the amount of interest in multimedia at the time can be gauged. Another consortium was formed in Europe to develop the links between multimedia and teleconferencing, the Multimedia Communications Community of Interest (MCCI) in France. Its members are France Telecom, Deutsche Telekom, Northern

Telecom, Telstra Corporation, IBM and INTEL (Audio Visual International, 1993b).

Macromedia (formerly Macromind) *Director* became a de-facto standard for multimedia authors, replacing the quickly-discarded device-independent scripting language, *Script X* from Kaleida Labs (a joint venture begun in 1991 between Apple and IBM (Pournelle, 1993; Brown, 1995)).

Initially, ‘full functional multimedia’ was seen to be composed of three elements (Pixel Vision, 1991):

- Natural presentation of information through text, graphics, audio, images, animation and full-motion video;
- Non-linear intuitive navigation through applications for access to information on demand; and
- Touch-screen animation.

But the development of optical disk storage, effective product authoring tools, communications systems and innovative approaches to publishing with this new medium promoted the development of a ‘multimedia’ that extended beyond just these three elements.

2.5.3 Discrete Multimedia – CD-ROM *et al.*

Discrete multimedia is products made available through the use of isolated computers regardless of whether they are desktop, notebook or Personal Digital Assistant (PDA). The packages made available are stored in digital form on disk drive, optical disk, videodisc or computer tape. It formed the core for multimedia development prior to the development of complementary distributed products.

The Compact Disc, more commonly referred to as the CD, was jointly developed by Sony of Japan and Philips of The Netherlands in 1982. CD-ROM proved a most popular medium, unit costs fell yearly and market penetration always increased. Optical discs allow the recording of information in such a way that it can be read by a beam of light. Formats are CD-ROM, WORM (Write Once Read Many), rewritable CDs (CD-R or CD-RW), CD+ or enhanced CD (combines a music CD with CD-ROM data), Digital Video - Interactive (DV-I) Sony's Minidisc, DVD-ROM, DVD-R and DVD-RAM (the rewritable DVD format).

CD-ROM is a read only technology that can store a minimum of 540 MB of data; has a 5 1/4" diameter, it is removable; cost is fairly low; easy to distribute; standards exist and the media are well established; and networking is possible. Philips and Sony continually worked on their CD-ROM Colour Book Standards, which complement ISO 9660. Other discrete developments explored the possibilities of using blue-green and blue lasers instead of the standard red lasers to maximise the amount of information stored on any one optical disc (Liebman, 1998).

The world of publishing embraced multimedia using mainly CD-ROM as an alternative to paper. Book abstracts, bibliographic references and encyclopedias, like *Compton's Interactive Multimedia Encyclopedia* and *Encyclopedia Britannica* (now available as a hybrid CD-ROM Web-supported product), have been published on optical storage media. *VERBUM Interactive*, a CD-ROM based product, was the world's first fully integrated multimedia magazine. Produced in August 1981 as a co-production of *VERBUM* magazine, MOOV design and GTE ImagiTrek, this project used a point-and-click interface to lead the user through an array of text, sound, graphics, animations, product demonstrations, talking agents and music (Uhler *et al.*, 1993).

The entertainment industry was quick to use the medium for publishing. Perhaps the first acclaimed music CD-ROM was Peter Gabriel's *Explora 1*, (Australian Macworld, 1994; Australian Multimedia, 1994b), which included interactive applications as well as the music content. *A HARD DAY'S NIGHT* was the first full-length movie to be translated into Hypertext and distributed on an interactive CD. It was released in 1993 by the Voyager Company (Jacobs, 1998), an early innovator in both videodisc and CD-ROM, This work was built around the Beatles 1960's film "*A Hard Day's Night*". It contains ninety minutes of *QuickTime* movie, full original script with author Richard Lester's annotations, a short interview with Lester, the full "Running Jumping Standing Still" film he made with Peter Sellers, the US theatrical trailer and 1982 release prologue, critical essays, and a photo gallery. It is interactive and gives a full search on words and music titles. Users can jump anywhere in the ninety minutes of *QuickTime* movie (Australian Multimedia, 1994a). Unfortunately very few copies of the CD-ROM exist; as it was quickly removed from sale after the validity of publishing the film on another medium, without appropriate copyright clearances, was questioned. The Voyager Company also produced the much-acclaimed interactive book, *Puppet Motel* by Laurie Anderson.

2.5.4 DVD

CD-ROM was overtaken by DVD-ROM during late (1995 and early 1996 (NewMedia, 1995b; Advanced Imaging, 1995, 1996; Green, 1996; Lynch, 1996, Ely, 1996, Fritz, 1996) and some titles previously published on CD-ROM were re-issued on DVD-ROM (Hamit, 1996). The format was first introduced in (1995 as a ‘compromise’ format between the Sony/Philips and Toshiba/Time consortia. Bonding two single-sided discs or making double-sided discs produces the medium. It offers 133 minutes of digital video, 9.4 Gb digital data on a 2-sided disk or 8.7 Gb on a single double-layered side, and 17 Gb on a 2-sided double-layer disc. They are backwardly compatible with audio CDs and CD-ROMs. In order to be backwardly compatible many drives incorporate two lasers at different wavelengths. For example the Hitachi GF-1050 used a 560nm laser for DVDs and a 780nm laser for CDs (Yates, 1998). The new format had such an impact on the multimedia industry that it was predicted in late 1997 that within 6 months of its release that products using this format would amount for 40 per cent of production (The Age,1997b). DVD-R and DVD-RAM drives (DVD-RAM is the rewritable DVD technology that stores 2.6 Gb of data per disk side) were available in late (1996, but prices excluded them, initially, from the mass market (Waring, 1997). As DVD-ROMs store about 40 times as much as a CD-ROM. Ely (1996) saw this format as the first ‘truly (discrete) multimedia’ format.

DV-D players were also made in their portable variation. In December 1997 Samsung released a 900-gram P-Theatre (Barker, 1997) and soon after, in January 1998 Matsushita released its L10, at 910 grams (The Age, 1998). Different versions of the optical disc storage medium continued to be developed, like Divx, an optical disc that expires after two days. It was designed for rental movies. Divx machines can read standard DVD, but DVD machines cannot read Divx (Wired, 1998). Many multimedia ‘purists’ like movie buffs still prefer the 12” laserdisc to its smaller counterpart, but this new format has been forecast to eventually make the laserdisc obsolete (Cochrane, 1997). But, DVD offers 500 lines of resolution compared to a 425 line resolution for an NTSC format laserdiscs (The Age, 1997a) and it was praised for its quality that exceeded the laserdisc (Hunt, 1997).

2.5.5 Games machines

A fairly recent phenomenon is the upsurge of the availability and impact of games consoles. From their beginnings as arcade games, they later migrated into homes via PCs and then linked to televisions, and finally as stand-alone devices. Gaming, computer games, games consoles and the games industry are now part of everyday life. A decade ago the games industry was worth somewhere between US$8 billion (Elrich, 1996) and US$11 billion (Storey, 1996). Now it is estimated to be around US$27 billion per year (3AW radio news, 17/5/05, reporting from the E3 conference in Los Angeles). Current games consoles are powerful - they provide a multi-task machine – for example the recently-released Microsoft *Xbox 360* provides players with the ability to display the games on a 16:9-ratio wide screen, it has a wireless controller, can it be used online to play collaborative games (Bullard, 2005). Console revenues have improved compared to PCs. In 2005 PCs sold were worth US$3.6 billion, while games consoles netted US$7.9 billion. Projected PC growth to 2007 is US$4.3 billion, and games consoles US$10.4 billion (Clickz.com, 2004).

Cartography has seen these devices as potential platforms for geographical information. Devices like the portable, powerful and Web-enabled PlayStation Portable (PSP) from the Sony Corporation of Japan offer the potential for portable multimedia cartographic information delivery.

2.6 Hypermaps

Laurini and Millert-Raffort (1990) first introduced the term 'hypermap'. Hypermaps are seen as a unique way of using multimedia with GIS (Wallin (1990, Laurini and Millert-Raffort (1990). 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 coordinate-based access in which by clicking a point or a region on a map can retrieve all information relating to that point. A similar concept, the 'HyperGeo model', was described by Corporel (1995) as a dynamic map created by user queries. The package favoured experimented users, but required a good mastery of syntax to be successful (Dbouk, 1995).

Much interest was centred on the production of electronic atlases during the late 1980s and early 1990s, mainly due to the availability of Apple's *HyperCard* software developed for the Macintosh computer and released in 1987 (Raveneau *et al.*, 1991). According to Raveneau *et al.* (1991) several factors contributed to the development of electronic atlases:

- The development of inexpensive and powerful microcomputers;
- The creation of geographic databases that may contain either digital base maps or spatially referenced thematic data;
- A renewal in the field of conception and production of instructional atlases, as well as the communication of geographic information in general;
- The integration of geographic information within computerised information systems; and

- The diffusion of the hypertext concept and its translation into such software as *HyperCard* facilities and the application of structured geographic information to an electronic atlas.

An early cartographic product was the *Glasgow Online* digital atlas, which operated around a hypermedia spatial interface (Raper, 1991). HyperCard products also came from the Department of Geography at l'Universitié Laval (Québec City, Canada) - *La Francophonie nord-américaine á la carte* (North American French-speaking communities á la carte) and *Mines et minéraux á la carte* (Mines and Minerals á la carte) (Raveneau *et al.*, 1991). The dynamic structure of *La Francophonie nord-américaine á la carte* provided access via ten navigation buttons - instructions, impression, stop, region, localisation, origin, a brief description and a flag icon of the local French community. Also of note is *HYPERSNIGE* (Camara and Gomes, 1991), which included Portugal's national, regional and sub-regional maps and information, and, Parson's *Covent Garden* area prototype (Parson, 1994a, 1994b, 1995). Parson's project presented users with a 'through the window' view of the market via a 3-D perspective view. Users could navigate around the package using conventional cursor controls and mouse clicks on directional arrows.

2.7 Multimedia and maps

2.7.1 Initial projects

What has been called the first multimedia mapping project was the *Aspen Movie Map Project*, devised and undertaken by the MIT Architecture Machine Group in 1978 (Negroponte, 1995b). This groundbreaking package used videodiscs, controlled by computers, to allow the user to 'drive' down corridors or streets of Aspen, Colorado. Every street and turn was filmed in both directions, with photographs taken every three metres. By putting the straight street segments on one videodisc and the curves on the other, an artificial seamless driving experience was made available. It used two screens - a vertical screen for video and a horizontal one showing a street map of Aspen. Users could point to a spot on the map and jump to that spot, 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. A follow-up, 'The Movie Manual' was for maintenance and repair (Eindhoven Tech. Univ., 1998).

2.7.2 Videodiscs and Cartography

Videodisc mapping offered a low cost map display background, providing many of the information coordination functions of a GIS (Aubrey, 1992). They were seen to be a viable alternative to vector/raster-based GIS until a more populated digital database was available and to be quicker to get complete map coverage than digital data (Bilodeau, 1994). The program controls the display of frames and access to a database that may reside on the controlling computer or be embedded on the actual videodisc. Programs could be developed as generic code, which could then be used to control other videodiscs produced to similar guidelines.

Video laserdiscs became a standardised product through NATO where a specification (STANAG 7035) was set for the Defense Mapping Agency (DMA) database. The Canadian Department of National Defence (DND) introduced videodisc mapping in (1987 and over 40 mapping systems were installed (Bilodeau, 1994). 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, 1992). It became the interim geographical information package of preference for the Canadian Forces due to its large storage capacity and rapid retrieval (Bilodeau and Cyr, 1992; Bilodeau, 1994). Also, the National Search and Rescue Secretariat (NSRS) adopted videodisc technology in 1988 as a relatively economic means of vessel location in search and rescue operations.

Other videodiscs projects were the Canadian Energy, Mines and Resources prototype, *Canada on Video Disk*, produced in 1987 (Duncan, 1992), a videodisc to teach map reading skills (Cartensen and Cox, 1988); and the *Queenscliff* prototype videodisc 1987 (Cartwright, 1989a, 1989b). The first real popular mapping application of videodiscs was the *Domesday* project, the innovative multimedia ‘picture’ of Britain in the 1980s (Goddard and Armstrong, 1986; Openshaw and Mounsey, 1986, 1987; Atkins, 1986; Openshaw *et al*., 1986, Owen *et al*. (1986; Rhind and Mounsey, 1986, Rhind *et al.*, 1988, Mounsey, 1988, Rhind and Openshaw, 1987). It was jointly produced by the BBC (British Broadcasting Commission), Acorn Computers and Philips to commemorate the 900th anniversary of William the Conqueror's tally book. This double *laservision* videodisc system was driven by a BBC computer and incorporated the software on the disc itself. The *Domesday* videodisc engine was later employed to operate other BBC *laservision* products. Rhind and Openshaw (1987) said of their *Domesday* videodisc that, even though the product was revolutionary, the system offered limited analytical capability, it could not be updated regularly, the database was limited the *Domesday* videodiscs only stored data on Great Britain) and there was the possibility of the misuse of data in combination through analyses carried out by unskilled users. Limited as they were, and constrained by underdeveloped user interfaces and interrogation routines, interactive videodisc products heralded the future of the application of hypermedia to the spatial sciences.

2.7.3 Cartographic products on CD-ROM

Initially, the potential of the large storage capacity of CD-ROMs for distribution of geographical information fostered interest in publishing digital maps (Rystedt, 1987; Siekierska and Palko, 1986). Products like the *Digital Chart of the World* (DCW) and the *World Vector Shoreline* (Lauer, 1991) were some of the first products to exploit this storage medium.

Discrete atlas products were quite quickly produced and publications include the Dorling Kindersley *World Reference Atlas*; MicroSoft *Encarta*; Mindscape's *World Atlas 5* (New Media,, 1995); *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; Armenakis, 1992, 1993) (this is discussed in Chapter 13 of the book); the *National Atlas Information System of the Netherlands* (Koop and Ormeling, 1990); *The Swedish National PC-Atlas* (Arnberg, 1990, Wastenson and Arnberg, 1997, Ögren, 1997); the Chinese Population Censuses and Electric Maps of Population (Taylor, 1996); and the *National Geographic Society's Picture Atlas Of the World* on CD-ROM.

An interesting example of a CD-ROM application was *Autoroute Plus*, one of a number of products developed by the NextBase company, and built around the same engine (Sargeant, 1994). It covered the whole of the U.K. The original maps (both scanned and digital) originated from the Ordnance Survey and can be reduced to 1:250,000. It included a database editor with search features; giving access to 30,000 placenames in the U.K. Nextbase also produced a street directory of London, also using the same engine. The advantage of this product was that layers of information could be turned on and off, enabling information to be made available when required, thus enhancing what could be immediately viewed - an apparent electronic version of a paper street directory

In the US DeLorme published a *Mac*/*Windows* CD-ROM, *Street Atlas USA*, containing every street in the US, as well as names for every city, town, street, geographic feature and prominent building (New Media, 1995). Other road map products were the Geosystems/Delorme *AAA Trip Planner* and *Global Explorer* and *Map Expert* (Kruh, 1995), US digital road atlases 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* (Booth (1996).

Travel guides published on CD-ROM included the titles *Lets Go* (a CD-ROM of their USA guide), Frommer (*Travel Companion*, containing 25 cities in the USA), Co-mInfo (Moscow Kremlin CD Guide), Superbase (*Getaway to Australia: an electronic book*) (Kruh, 1995), Expert Software (*Expert CD-ROM Travel Planner Gold*) Deep River Publishing (*Every-where USA Travel Guide*) (Akscyn et al., 1994) and DeLorme (*Map’n’go*) (New Media (1995); *the Great Cities of the World*, a multimedia travel guide of Bombay, Cairo, London, Los Angeles, Moscow, New York, Paris, Rio de Janeiro, Sydney and Tokyo (vol. 1) and Berlin, Buenos Aires, Chicago, Jerusalem, Johannesburg, Rome, San Francisco, Seoul, Singa-pore and Toronto (vol. 2) (Diehl, 1992).

Multimedia maps have also been used to extend the impact of exhibi-tions. The CD-ROM, *The Image of the World: An interactive exploration of ten historic world maps*, was developed as part of *The Earth and the Heavens: the art of the mapmaker*, an exhibition held in the British Library in 1995. It contains historical images of ten world maps, dating from the 13th to the late 20th centuries. Access to the maps is initially made through the introductory screen, which depicts small map icons that act as hot spots to other more detailed information about the maps.

2.7.4 Games, maps and gameplay

Computer games initially began as discrete applications, delivered on floppy disks, then CD-ROM. Later the trend in computer games was to-wards the development of multi-player games for the Internet, provided by cooperative ventures between gaming networks and Internet service pro-viders (Tanner, 1997). Generally, geography-related games have been de-signed as either home platform or entertainment applications.

Early geographically-related games delivered on discrete media used multimedia and hypermedia technologies. For example, the USGS's *Ge-oMedia* was used to teach upper elementary students in the USA geo-graphical concepts. Hypermedia techniques allowed students to make as-sociative links between graphics, text, animation and sound. Animations showed earth science processes such as plate tectonics and the water cycle and an ‘understanding maps’ section explains the use of maps (GIS World, 1993).

A cartographic game, *Magellan* (Taylor, 1994), was launched in late 1993, and it operated as an interactive ‘touchtalk’ globe that can be used as either a computer game or as an educational tool. ‘Virtual keypads’ could be added to the interface, allowing responses to touch that gave taped audio information on each country. Another computer game, *Where in the World is Carmen Sandiego?* taught geography whilst users were playing a mystery solving game.

Kuhn (1992) saw that, for mapping and GIS applications, play allows developers to emphasise creativity and encourage ‘trying-out’ and that video games ideas that included strong spatial components could be useful. He stated that: “… it seems tempting to further explore this kind of paradigm for GIS applications. In some sense, a GIS is like a toy world - a model of reality simplified to the point where users can play with it”(p. 98).

The contemporary use of gaming and games engines is explored in the chapter by Champion elsewhere in this book. Also, the chapter by Germanchis provides information on how to ‘build’ a games-delivered cartographic application. The chapter from Pulsiver and Caquard and another by Axford *et al.* discusses the potential that games machines offer for delivering geographical information to support more conventional mapping methods.

2.8 From packaged media to distributed media

There are presently three commonly used types of communication systems - the telephone for voice, cable and transmission signals for television programming and computer networks for data. There has been a digital convergence of communications equipment, office machines, domestic equipment and personal entertainment items. This has been brought about by all of the elements talking the same electronic language and the digitising of pictures, sounds and video (Computer Age, 1995). Zahler, co-director of the Center for Arts and Technology, at Connecticut College, New London, supports convergence and has stated:

> *“I think convergence is a good thing because what comes with convergence is simplicity ... It lets every individual find what they want, when they want it, and use it however they like” (Computer Age(1995, p. 26).*

Things like the hype of marketing and the Internet in the mid-nineties was viewed with some with skepticism - some seeing the predictions made about the information superhighway very closely paralleling the predictions made in the (1950s about atomic energy (Elliott, 1995).

Video approaches or computer approaches? During discussions at the beginning of the 1990s about where discrete multimedia would progress to, Hartigan (1993) from Philips Professional Interactive Media Systems saw a debate between video and computer developers of multimedia. Film/video developers would argue that a movie should not be stopped or interrupted, whilst those from the computer side see programs which include moving images and those things like finesse of colour, contrast and composition are a waste of time. He said:

"Are we really facing, in Multimedia, 'the image that ate the computer industry' - or 'the data that ate the video industry' ".

There would be a need to establish standards for advanced data interchange and system integration, agents will be needed to anticipate users' needs and computers will be able to write computer code. Apple predicted this in 1987 with their futuristic *Knowledge Navigator* (Sculley, 1989).

Writers like Negroponte (1995a) saw all kinds of package media slowly dying out. This was predicted for two reasons: the approaching ‘costless’ bandwidth, allowing almost a limitless distribution system on the Internet; and solid state memory catching-up to the capacity of CDs, giving the prospect of massive data storage at minimal cost. As with the predicted demise of paper products, the future demise of discrete multimedia was predicted as well. On-line publishing was seen as the ‘next phase’ of electronic publishing, one that would superscede optical storage media. Most observers saw that CD-ROM had a limited life, but it would still be quite a number of years before networks with sufficient bandwidth were available to adequately handle multimedia (Multi Media Digest, 1994). Louis Rosetto, the founder of *Wired*, called CD-ROMs the ‘Beta of the ‘90s’, referring to the now-defunct *Betamax* video. Negroponte (1995a, p. 68) agreed with him and said that:

“It is certainly correct that, in the long term, multimedia will be predominantly an on-line phenomenon.”

By the mid 1990s the Internet had ‘matured’ and spread, information was being made available and browser software was wide-spread. The next communication medium was waiting in the wings, one that revolutionised the way in which maps were designed and delivered. This was distributed multimedia. Distributed multimedia uses communication resources to link computers locally or internationally. Multimedia packages are delivered either using intranets, computers linked internally, say in agencies or corporations using the standard access methods of all distributed multimedia, or through the use of the Internet, whereby the World Wide Web with appropriate ‘browsers’ and ‘plug-ins’ is used to access hyperlinked multimedia resources. The further development of interactive multimedia Cartography using the Internet is covered in the following chapter.

2.9 Conclusion

This Chapter outlined the development of the ideas and 'tools' necessary to allow publishers, including cartographers, to produce maps using interactive multimedia. Other delivery mechanisms were described, from microfiche to computer games, as alternative media for geographic information delivery. The distribution of these products is effected by the use of discrete media like CD-ROM or videodisc or through the use of the Internet or Intranets. Typical products developed using multimedia and hypermedias were outlined and the profiles of the different types of titles produced for the different new media types have been described.

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. It offers the cartographer the means of dynamic displays, high interaction and direct access to the database. The challenge for map designers and producers is to use multimedia, in its broadest sense, as a new tool for cartography.

References

Advanced Imaging (1995) The Digital Video Disk Format War Truce: Good News..Maybe, October, p.8.

Advanced Imaging (1996) CD-R, 8xCD-ROM and Imaging Now: You Don't have to Wait for DVD, April, p.9.

Akscyn, R M, McCracken, D L, and Yoder, E A (1988) KMS: A Distibuted Hypermedia System for Managing Knowledge in Organizations, *Communications of the ACM*, 31, 7, pp 820-835.

Armenakis, C. (1992) Electronic Mapping of Time-Dependent Data, *ASPRS/ACSM/RT 92 Technical Papers*, Washington, D. C.: ASPRS-ACSM, vol. 3, pp. 445 - 454.

Armenakis, C. (1993) Map Animation and Hypermedia: Tools for Understanding Changes in Spatio-Temporal Data" *Proc. Canadian Conference on GIS*, Ottawa,1, pp. 859 - 868.

Arnberg, W. (1990) The user interface of the Swedish National PC-Atlas, *proceedings of the 3rd Scandinavian Conference on GIS*, pp. 183 - 189.

Atkins, S. (1986) The Domesday Project, *Media in education & development*,18,3, pp.110-113.

Aubrey, L. (1992) Videodisk Mapping Production Program" *Proc. Canad.Conf. GIS*, 1, p.684.

AudioVisual International (1993a) Multimedia Set to Boom, March, p. 12.

AudioVisual International (1993b, p. 8.

Australian Macworld (1994) XPLORA 1: Peter Gabriel's Secret World, June, pp. 68 - 69.

Australian Multimedia (1992) What is Multimedia?, vol. 1, no. 1.

Australian Multimedia (1994a) "Hard Disks Might, May, vol. 2, no. 2, p. 15

Australian Multimedia (1994b) Real World XPLORA, May, vol. 2, no. 2, pp. 18 - 21

Baird, P. and Percival, M. (1989) Glasgow Online: database development using Apple's Hypercard, *Hypertext: theory into practice*, McAleese, R (Ed.), London: Intellect.

Barker, G. (1997) Samsung's mini mobile movie theatre, *The Age*, December 9, P. E4.

Bilodeau, P. (1994) Video disk mapping in Canada,*Proc. Canad. Conf. on GIS*,2,pp.1157-1162.

Bilodeau, P. and Cyr, D. (1992) Video Disk mapping - An Interim GIS for the Canadian Military, *proceedings Canadian Conference on GIS*, Ottawa, vol. 1, pp. 696 - 699.

Booth, S. A. (1996) More Software To Make Your Day, *World Traveller*, February, p. 20.

Brown, E. (1995) Authoring Programs, *NewMedia, Tool Guide (1995*, pp. 17 - 25.

Bullard, D. (2005) "X marks the box, Connect, Herald Sun, Wednesday May 18, 2005, p. 6.

Bush, V. (1945) As we may think, *Atlantic Monthly*, no. 176, pp. 101 - 108.

Camara, A. and Gomes, A. L. (1991) HYPERSNIGE: A Navigation System for Geographic Information, in *proceedings of EGIS '91*, Second European

Cartensen, L.W., Cox, A.B. (1988) The Map-Environment Interface: Surrogate Travel by Videodisc, *proceedings of AutoCarto 8*, Baltimore, Maryland: ASPRS/ACSM, p. 594.

Carter, J. C., (1997) Television weather broadcasts: animated cartography aplenty, proceedings of the Seminar on Electronic Atlases II, Köbben, B., Ormeling, F. and Trainor, T. eds., Enschede, The Netherlands: International Cartographic Association Commission on National and Regional Atlases, pp. 41 – 44.

Cartwright, W. E. (1989a) The use of videodiscs for mapping applications, *proceedings of the Australian Optical Disc Conference*, Melbourne, Australia.

Cartwright, W.E. (1989b) Videodiscs as a Medium for National and Regional Atlases, *paper presented at the 14th International* Conference on GIS, Brussels, April 2-5, pp. 175 - 179.

Cochrane, N. (1997) DVD Mania, *The Age*, December 9, pp. E1 and E4.

Computer Age (1995) This is the toaster telling you I'm on fire, April 25, p. (19 & 26.

Conklin, E.J., (1987 "Hypertext: an Introduction and Survey, *IEEE Computer*, Sept., pp. 17 - 41.

Clickz.com, 2004, Console revenues,

http://www.clickz.com/stats/big_picture/hardware/article.php/1492881, Web page accessed September 2004

Corporel, J. (1995) HyperGeo: A Geogr. Hypermedia System, *Proc. JEC*, The Hague,pp.90-95.

Cotton, B. and Oliver, R. (1994, *The Cyberspace Lexicon - an illustrated dictionary of terms from multimedia to virtual reality,* London: Phaidon Press Ltd.

Dbouk, M., (1995) HyperGeo: A Hypermedia Based Geographical Information System Design Framework, *Proc. JEC*, The Hague, pp. 116 - 121.

Diehl, S., (1992) The Armchair Tourist, *Byte*, August, p. 267.

Ditz, R. (1997) An Interactive Cartographic Information System of Austria – conceptual Design and Requirements for Visualization on Screen, *Proc.18.ICC*, Stockholm:ICA,1,pp. 571-578.

Duncan, D. J. (1992) Videodisk Mapping for Commercial Use" *Proceedings Canadian Conference on GIS,* Ottawa, 1: pp. 833 - 844.

Elrich, D., (1996) Bouncing Mario on the Rebound, The Age, May 28, p. C7.

Eindhoven Technical University (1998) The Aspen Movie Map, http://www.kluge.net/~arv/class/rh/nl/static/aspen.html, Web page accessed November 6.

Elliott, S. (1995) Interactive marketing faces daunting future, *The Age*, 6 June, p. 31.

Ely, M. (1996) Digital Video Disc Pre-Mastering: New Tools Demanded by the New Format, *Advanced Imaging,* April, pp. 26 - 29.

Fritz, M. (1996) Digital Video Discs: Compact Discs on Steroids, *Wired,* July, p. 72.

GIS World (1993) Multimedia Public Information System Introduced, p. 11.

Goddard, J. B. and Armstrong, P. (1986) The (1986 Domesday Project, *Transactions of the Institute of British Geographers*, vol. 11, no. 3, pp. 290 - 295.

Green, S. (1996) Compounding the Issue: Multimedia Documents and New Optical Storage Options, *Advanced Imaging*, September, pp. 38 - 40, 73.

Hamit, F. (1996) DVD Technology: Exploding room for images in on-disk multimedia, *Advanced Imaging*, September, pp. 42 - 44.

Hartigan, J.M. (1993) Closing the 'Computer People' vs 'Video People' Mindset Gap, *Advanced Imaging*, January, pp. 69 - 70.

Hunt, K. (1997) All-purpose player does everything competently, *The Age*, December 9, P. E4.

Jacobs, S. (1998) The Voyager Returns, *Wired*, August, p. 58.

Jiang, B., Kainz, W. and Ormeling, F. (1995) Hypermap Techniques in Fuzzy Data Exploration, *proceedings of the 17h ICC*, Barcelona, Spain: ICA, pp. (1923 - (1927.

Kindleberger, C. (1993) Multimedia - The Next Big Wave, *in URISA*,5,1,pp. 122 - 133.

Koop, K. O., and Ormeling, F.J. (1990) New Horizons in Thematic Cartography in the Netherlands. The National Atlas Information System, *Proc. EGIS,*Amsterdam,pp. 614 - 623.

Kraak, M-J. and van Driel, R. (1997) Principles of Hypermaps, *Computers and Geosciences*, vol. 23, no. 4, pp. 457 – 464.

Kruh, M. (1995) Creating a multimedia presentation for Lonely Planet Publications Pty. Ltd., unpublished report, The University of Melbourne.

Kuhn, W. (1992) Paradigms of GIS Use. *Proceedings of the 5th International Symposium on Spatial Data Handling*. Ed. P. Bresnahan, E. Corwin and D. Cowen. Charleston: IGU Commission on GIS, vol. 1, pp. 90 – 103

Lauer, B., J. (1991) Mapping Information on CD-ROM, *Technical papers of the (1991 ACSM-ASPRS Annual Convention. Baltimore*: ACSM-ASPRS, vol. 2, pp. 187 - (193.

Laurini, R. and Millert-Raffort, F. (1990) Principles of geomatic hypermaps, *Proceedings 4th Conference on Spatial Data Handling*, Zürich, Switzerland, pp. 642 - 651.

Leutwyler, K. (1995) The Guru of Cyberspace, *Scientific American*, September, pp. 40 - 41.

Liebman, S. (1998) Optical Storage and Recording Systems: Natural Home of the Blues, *Advanced Imaging*, February, pp. 60 – 61.

Lines, J. D., (1982) Maps on microform, *The Globe*, no. 17, pp 11 - (19, Canberra: The Australian Map Curators Circle.

Lynch, M. (1996) Separating the Hype From the Hope, NewMedia, August, p. 18.

Massey, J., (1986) Mapping the past and the future: studies in computer animation, paper presented at the *6th Australian Cartographic Conference*, Melbourne: Australian Institute of Cartographers.

Massey, J., Poliness, J. and O'Shea, B., (1985) Mapping the socio-economic structure of Australia - A microfiche approach, The Globe, no. 23, pp 32 - 38, Melbourne: The Australian Map Circle.

Moellering, H., (1980, The real-time animation of three-dimensional maps. The American Cartographer 7 , (1), 67-75.

Mounsey, H. (1988) Cartography and Interactive Video: Developments and Applications in Britain, *Technical Papers, 7th Australian Cartographic Conf.*, Sydney, pp. 189 - (196.

Multi Media Digest (1994) The Now and Future Markets, vol. 3, no. 5, September, p. 2.

Negroponte, N. (1995a) Digital Videodiscs: Either Format Is Wrong, *Wired*, June, p. 222.

Negroponte, N. (1995b) Affordable Computing, *Wired*, July, p. (192.

Negroponte, N.,(1995c) *Being Digital*, Rydalmere: Hodder and Stoughton.

Negroponte, N., (1996) Object-Oriented Television, Wired, July, p. 188.

Nelson, T.H. (1965) A file structure for the complex, the changing and the indeterminate, *proceedings of the 20th National ACM Conference*, pp. 84 - 100.

Nelson, T. (1974, *Computer Lib: Dream Machine*,

Nelson, T. (1981, *Literary Machines*, Swarthmore, PA, self-published.

Nelson, T. (1987, *Computer Lib: Dream Machine* (2nd ed), Redmond: Tempus/Microsoft Press.

Nelson, T. H. (1990) On the Xanadu Project, *Byte*, September, pp. 298 - 289.

Nelson, T. (1995) Software’s New Clothes, *NewMedia*, February, p. 18.

New Media (1995) You Can Get There From Here, March, p. 57.

Ögren, P. (1997) The New PC-Atlas of Sweden, *proc.18.ICC,* Stockholm: ICA,4,pp.2252-2266.

Openshaw, S. and Mounsey, H. (1986) Geographic information systems and the BBC’s Domesday interactive videodisk, *proceedings Auto Carto London*, vol. 2, pp. 539 - 546.

Openshaw, S., and Mounsey, H. (1987) Geographic information systems and the BBC’s Domesday interactive videodisk, *Internat. Journal of GIS,* vol. 1, no. 2, pp. 173 - 179.

Openshaw, S., Wymer, C. and Charlton, M. (1986) A geographical information and mapping system for the BBC Domesday optical discs, *Transactions of the Institute of British Geographers*, vol. 11, no. 3, pp. 296 - 304.

Owen, D. W., Green, A. E. and Coombes, M. G. (1986) Using the social and economic data on the BBC Domesday disk, *Transactions of the Inst. of British Geographers*,11,3,pp. 305-314.

Parsons, E. (1994a) Virtual worlds technology: The ultimate GIS visualisation tool, *Proceedings of AGI ’94*, Birmingham, UK: Association for Geographic Information.

Parsons, E. (1994b, Visualisation techniques for qualitative spatial information. *Proceedings of EGIS ‘94*. Paris: EGIS Foundation, vol. 1, pp. 407 - 415.

Parsons, E. (1995) GIS visualisation tools for qualitative spatial information, *Innovations in GIS 2*, Ed. Peter Fisher, London: Taylor and Francis, pp. 201 - 210.

Pixel Vision, 1991, "IBM 'Ultimedia'", No6, December.

Pournelle, J. (1993) The State of Multimedia, *Byte*, October, pp. 217 - 234.

Raper, J. (1991) Spatial Data Exploration Using Hypertext Techniques, in *proceedings of EGIS ‘91, Second European Conference on GIS,* Brussels, Belgium, pp. 920 - 928.

Raveneau, J-L, Miller, M., Brousseau, Y and Dufour, C. (1991) Micro-Atlases and the Diffusion of Geographic Information: An Experiment with Hypercard, *GIS: The Microcomputer and Modern Cartography,* Ed. D. R. Fraser Taylor. Oxford: Pergamon Press, pp. 201 - 224.

Reynolds, L.R. and Derose, S.J. (1992) Electronic Books, *Byte*, June, pp. 263 - 268.

Rhind, D. W. and Mounsey H. M., (1986) The land and people of Britain, *Transactions of the Institute of British Geographers*, vol. 11, no. 3, pp. 315 - 326.

Rhind, D.W., Armstrong, P. and Openshaw, S. (1988) The Domesday Machine: A Nationwide Geographical Information System, *The Geographical Journal*, vol. 154, no. 1, pp. 56 - 68.

Rhind, D.W. and Openshaw, S. (1987) The BBC Domesday System: A Nationwide GIS for $4448, *proceedings of AutoCarto 8,* Baltimore, Maryland: ASPRS/ACSM, pp. 595 - 603.

Rheingold H. (1996) The Man Who Invented the Present is Still Working on the Future, *The Publishing Resource Services*, http://www.soberanis.com/services/doughlr.html,acces. Nov.9

Rystedt, B. (1987) Compact Disks for Distribution of Maps and Other Geographic Information, *proceedings 13th ICC,* Morelia, Mexico: ICA, vol. IV, pp. 479 - 484.

Sanders, C. (1997) Xanadu - more than just electronic publishing and document storage, Web page accessed March 16, http://xanadu.com.au/xanadu/desktop.html.

Sargent, W. (1994) Road Warrior, *Multimedia and CD-ROM Now*, September, pp. 56 - 60.

Sculley, J. (1989) The relationship between business and higher education: A perspective on the 21st century, *Communications of the ACM*, vol. 32, no. 9, September, pp. 1056 - 1061.

Siekierska, E. M. and Palko, S. (1986) Canada's Electronic Atlas, *proceedings AutoCarto*, London: International Cartographic Association, vol. 2, pp. 409 - 417.

Storey, R., (1996) The dawn of a new 3D era on television, The Age, p. C10.

Sparacino, F. (1996) The Hyperplex, http:www.white.media.mit.edu/ ~fl...1.html# SECTION00010000000000000000, Web page accessed June 17, (1996.

Swerdlow, J.L. (1995) Information Revolution, *Nat. Geographic*, Oct., 188, 4, pp. 5 - 37.

Tanner, M. (1997) TEN Offers gamers Email and Net Access. *HotWired*, http://www.wired.com/news/,accessed January 13 , 1997.

Taylor, D. R. F. (1994) Cartographic visualization and spatial data handling. *Advances in GIS Research*, eds. T.C. Waugh and R.G. Healey, London: Taylor and Francis, vol. 1, pp. 16 - 28.

Taylor, D. R. F. (1996) CD-ROM on Chinese Population Censuses & Electronic Maps of Population, *paper at the ICA Seminar Electronic Atlases*. The Hague, IGU.

The Age (1997a) In every way better or equal to laser, December 9, p. E4.

The Age (1997b) DVD set to be the next format, December 9, p. E4.

The Age (1998) DVD Anywhere, January 20, p. D14.

The Media History Project (1998) http://www.media history.com/time/, Web page acces. Nov. 8.

3AW radio news, 2005, reporting from the E3 conference in Los Angeles, 17/5/05

Uhler, G., Flanagan, D. and Schoenfein, K.J. (1993) Compressed Video for Real Multimedia Products: Cross-Platform, Advanced Imaging, May, pp. 45 - 46.

Wallin, E. (1990) The map as Hypertext: on knowledge support systems for the territorial concern, *Proc. European meeting on GIS*, Amsterdam 10-13/4/90, pp. 1125-1134.

Waring, B. (1997) Rewriting the future, *NewMedia*, p. 18.

Wastenson, L. and Arnberg, W. (1997) The New National Atlas of Sweden Completed: Seventeen Books and an Electronic Atlas, *proc. 18. ICC*, Stockholm: ICA,4,pp.2162 - 2169.

Wired (1998) Tomorrow Today, May, p. 72

Yates, D. (1998) DVD-RAM drive is on the way, *The Age*, February 3, p. E3.

Zachary, G. B. (1997) The Godfather, *Wired*, November, pp. 152+.

3 The Internet and Multimedia Cartography

Michael P. Peterson

Department of Geography, University of Nebraska at Omaha, Omaha, USA

3.1 Introduction

Although the Internet has been in existence in some form since 1969, only since the mid-1990's, with the widespread use of the World Wide Web, has the Internet became a major medium for cartography. Within a matter of years, millions of maps were being delivered to users through this new medium, and cartography was freed of its dependence on a physical medium for the exchange of geographical information. The image search option in most search engines makes it possible to quickly find a large number of maps in the GIF, JPEG and PNG raster formats. Although many are of poor quality and some are even illegible, static maps in the raster format persist despite the availability of more advanced and interactive products. The ease with which such static maps can be placed on the Web and how quickly they can be found still makes such maps a mainstay for the Internet map user. This chapter examines the Internet phenomenon, particularly the current status of the Internet, Internet map use, and contemporary research related to maps and the Internet.

3.2 Internet development

From its beginnings in 1969 up until the mid-1990s, the Internet was used almost solely by academic research scientists and the military. Besides being restricted to specific users, the system was difficult to use. The simple process of sending and receiving files required memorizing arcane text commands. At the beginning of the 1990s, in a research laboratory in Switzerland, Tim Berners-Lee created the hypertext Internet links that formed the basis of the World Wide Web. But, the initial version consisted only of text. Making the Web mainstream would take until the middle of the decade and require the implementation of a graphical browser. The first such browser was made freely available on March 14, 1993 and called Mosaic. The program was written by Marc Andreesen and Eric Bina at the University of Illinois' National Center for Supercomputer Applications (NCSA). They introduced the program as a "consistent and easy-to-use hypermedia-based interface into a wide variety of information sources." The concept, Andreessen says, "was just there, waiting for somebody to actually do it."

NCSA Mosaic enjoyed almost immediate success. Within weeks it was the browser of choice for the majority of Internet users. More Mosaic users meant a bigger Web audience. The bigger audiences spurred the creation of new content, which in turn further increased the audience on the Web and the demand for Mosaic. Not everyone was pleased with Mosaic. Tim Berners-Lee, who designed the Web only a few years before, lashed out at Andreesen at a public meeting by telling him that adding images to the Web was going to bring in a flood of new users who would do things like post photos of nude women. Andreesen later admitted that Berners-Lee was right on both counts.

The success of Mosaic led to the release of a re-written and faster commercial version called Netscape in October of 1994. It became the pre-eminent 'browser' software until rivaled by Microsoft's *Internet Explorer* when it was introduced in 1996, leading to the "browser war" of the late 1990s. Standards were developed for HyperText Mark-up Language (HTML) by the WWW Consortium (W3C). Further work led to a standard for Dynamic HyperText Mark-up Language (DHTML for Netscape) and dHTML (for Microsoft), VRML (Virtual Reality Mark-up Language) authoring (Murie 1996), XML and a variety of derivatives – including Scaleable Vector Graphics (SVG).

At the end of 1994 there were only 13 million users of the Internet. By late 1995 this number had risen to 23 million, plus an additional 12 million using electronic mail of various kinds (Parker 1995). The Web grew one home page every four seconds and doubled every 40 days. It had over 40 million users worldwide in early 1996 (van Niekerk 1996). There were only 200 million Internet users at year-end 1998. It grew to 533 million at year-end 2001. The figure was 935 million in 2004 and. reached 1 billion sometime during 2005. In terms of Web servers, the Internet grew from 130 in 1993 to an estimated 660,000 in early 1997 (Peterson 1997) and by late 1998 servers numbered over a staggering 3.5 million (The Netcraft Web Server Survey 1998). It is clear that the Internet and its use have grown very quickly and now represents the major form of information distribution for a large portion of the world's population.

3.3 Maps and the Internet

The development of map distribution through the Internet was affected by general trends that influence the spread and adoption of the technology. Three major eras in the development of the Internet can be identified that influenced the development of the Internet as a medium for cartography. In the first stage, the distribution of maps via the Internet was a novelty with no specific purpose other than to demonstrate that maps could be quickly distributed in this way. In the second stage, beginning in about 1997, the Web emerged as a major form of delivery for certain types of maps, particularly for interactive street maps. In the current third stage, various forms of user input to maps, including *community mapping*, are being developed. The continued development of the Internet for map delivery is dependent on solving specific problems. Solutions to these problems are both technical and philosophical and will have a major influence on how cartography as a whole develops in the future.

Formal research in cartography related to the Internet began in about 1995. The North American Cartographic Information Society (NACIS) dedicated its annual meeting to the Internet in 1996. The international dimension to this research was aided by the creation of the ICA *Maps and the Internet* Commission in 1999. Meetings of this international body were held in 2000, 2001, and 2002, 2003, 2004, 2005, in the United States, China, Germany, South Africa, Japan, and Spain respectively. These meetings have addressed issues of Internet map use and Internet map delivery. These areas of research are represented in the 2003 publication *Maps and the Internet*, a publication of the International Cartographic Association. The purpose here is to outline each of these areas and present the major focus of each. We first examine the growth of the Internet and the growth of Internet map use.

3.4 Internet use and Internet Map Use

The development of map distribution through the Web is largely dependent on the growth and expansion of the Internet as a medium of communication. According to the Computer Industry Almanac (2004), there are 935 million Internet users or nearly 16% of the world's population (see Table 1). This is up from 533 million Internet users worldwide at year-end 2001 which at that time represented only 8.7% of the world's population (see Table 2). There were only 200 million Internet users at year-end 1998. It is expected that this figure will reach 1 billion by mid-2005 and

1.46 billion by 2007. Most of the current 935 million Internet users, are located in the top 15 countries (see Table 1). The major growth in the use of the Internet is coming from the East and South Asia, Latin America, and Eastern Europe. India is now ranked 5th in terms of the share of world Internet users. In 2001, India was not even in the top 15. The rate of usage and growth in usage is remarkable considering the complexity of the required computing and communications infrastructure.

The growth in the use of wireless Internet via cell phones is especially strong. The wireless Internet share is currently 16% or 85 million people. This is expected to rise to 42% in 2004 and 57% in 2007. This means that by 2007, there will be 829 million users of wireless Internet. The number of wired Internet users will only be 632 million – an increase of only 184 million. These figures indicate that most of the growth in the use of the Internet will come from the wireless sector. However, it is likely that a wireless Internet user will also use a wired network.

Table 1. Top 15 nations in Internet use at year-end 2004. The last column indicates the percent of the world total. Data for some countries are not available.

0Rank	**Nation**	**Internet Users 2004** (millions)	**1Share of World Users**
1	United States	186	19.86%
2	China	100	10.68%
3	Japan	78	8.35%
4	Germany	42	4.48%
5	India	37	3.96%
6	UK	33	3.54%
7	South Korea	32	3.39%
8	Italy	26	2.73%
9	France	25	2.72%
10	Brazil	22	2.39%
11	Russia	21	2.27%
12	Canada	20	2.19%
13	Mexico	14	1.49%
14	Spain	13	1.44%
15	Australia	13	1.39%

Source: Computer Industry Almanac (2004)

Table 2. Top 15 nations in Internet use at year-end 2001. The last column indicates the percent of the world total. Data for some countries are not available.

2Rank	Nation	Internet Users 2001 (millions)	3Share of World Users
1	United States	149	41.92%
2	China	33.7	9.48%
3	UK	33	9.29%
4	Germany	26	7.32%
5	Japan	22	6.19%
6	South Korea	16.7	4.70%
7	Canada	14.2	4.00%
8	Italy	11	3.10%
9	France	11	3.10%
10	Russia	7.5	2.11%
11	Spain	7	1.97%
12	Netherlands	6.8	1.91%
13	Taiwan	6.4	1.80%
14	Brazil	6.1	1.72%
15	Australia	5	1.41%

Source: Computer Industry Almanac (2001)

Another trend in Internet usage is the return of a browser war. All of the major browsers, especially Microsoft's Internet Explorer, are losing ground to upstart Firefox which now accounts for nearly a fourth of all web browser activity (see Table 3). Firefox is viewed as a faster, trimmer Web browser that isn't subject to the crashes and security gaps that afflict the market-leading Microsoft Internet Explorer. Table 4 shows the market share of each operating system.

Table 3. Browser market share in the last four months of 2005. Explorer is losing market share to Firefox.

2005	IE 6	IE 5	Ffox	Moz	NN 7	O 8	O 7
December	61.5%	6.5%	24.0%	2.7%	0.4%	1.3%	0.2%
November	62.7%	6.2%	23.6%	2.8%	0.4%	1.3%	0.2%
October	67.5%	6.0%	19.6%	2.6%	0.4%	1.2%	0.2%
September	69.8%	5.7%	18.0%	2.5%	0.4%	1.0%	0.2%

IE	Internet Explorer
Ffox	Firefox (identified as Mozilla before 2005)
Moz	Mozilla
O	Opera
NN	Netscape

Source: http://www.w3schools.com/browsers/browsers_stats.asp

Table 4. Operating system market share in the last months of 2005.

2005	Win XP	W2000	Win 98	Win NT	Win .NET	Linux	Mac
December	71.6%	13.6%	2.6%	0.3%	1.7%	3.2%	3.3%
November	71.0%	14.6%	2.7%	0.4%	1.7%	3.3%	3.3%
October	70.2%	15.0%	2.8%	0.4%	1.6%	3.3%	3.2%
September	69.2%	15.8%	3.2%	0.5%	1.7%	3.3%	3.1%
December	71.6%	13.6%	2.6%	0.3%	1.7%	3.2%	3.3%
Source: http://www.w3schools.com/browsers/browsers_stats.asp							

An interesting aspect of Internet use is the disparity in the number of male and female users, particularly in certain countries. In 2000, male-female ratio ranged from 94:6 in Middle East to 78:22 in Asia, 75:25 in Western Europe, 62:38 in Latin America, and finally 50:50 in USA (Dholakia, et.al, 2003). Updated data are presented in Table 5. In many European countries, local telephone calls are metered. This means that the home user of the Internet would pay a telephone fee for every minute of connection time. This cost structure would limit home use of the Internet, which may affect women more than men.

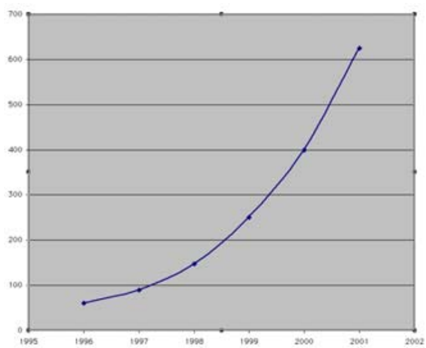
Table 5. Internet use gender differences by country ranked by disparity in male usage.

Internet Users by Gender		
Country	**Male %**	**Female %**
Germany	63.4	36.6
France	61.9	38.1
Italy	60.9	39.1
Spain	60.9	39.1
Belgium	60.6	39.4
Netherlands	59.8	40.2
Brazil	59.7	40.3
Switzerland	58.7	41.3
Japan	58.4	41.4
Austria	58.1	41.9
Norway	58.0	42.1
UK	57.2	42.8
Israel	57.1	42.9
Hong Kong	56.6	43.4
Singapore	56.5	43.5
Denmark	55.9	44.1
Taiwan	55.8	44.2
Ireland	54.8	45.2

Sweden	54.8	45.2
South Korea	54.4	45.7
Mexico	54.0	46.0
Finland	53.9	46.1
New Zealand	52.5	47.5
Australia	51.6	48.4
Canada	49.0	51.0
United States	47.3	52.2

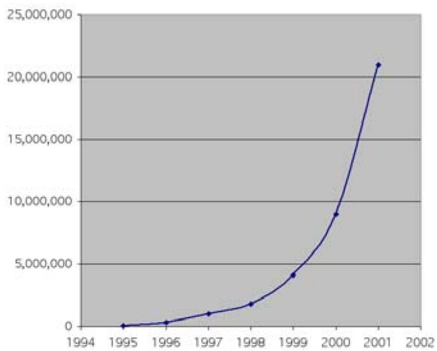
Source: Nielsen/NetRatings, 2003.

The number of maps that are distributed through the Web was tracked at four major sites since 1997 (Peterson 2003a). The results indicate that usage grew rapidly, particularly at commercial sites. Figure 1 presents a comparison of the growth in Internet use vs. the growth of Internet map use through 2001. Both growth rates are strongly exponential. It is probably not surprising that the growth in the use of maps through the Internet is exceeding the growth rate for the Internet itself. It is far more difficult for a non-Internet user to get the initial equipment and Internet connection to become an Internet user than it is to get an existing Internet user to access maps through the Internet. It is interesting that people have adapted so easily to using maps through the Internet and that the growth the usage is expanding at such an exponential rate.



Growth in the Use of the Internet in the number of new users per year.

$e^{0.45}$



Growth in Internet Map Use in Number of Maps Distributed per Day

$e^{0.80}$

Fig 1. A comparison between the growth of the Internet and the growth of Internet map use. Both growth rates are exponential. Internet map use is growing at a faster rate, approximated by an exponent of $e^{0.80}$, where e is the base of the natural logarithms.

3.5 Research in Internet Cartography

The Maps and the Internet commission of the International Cartographic Association have identified a number of areas of research. These areas are:

Internet Map Use – The purpose of this research is to investigate the growth in the use of the Internet, the growth in Internet map use, methods of Internet map use, and approaches of improving Internet map use.

Internet Map Delivery – The purpose here is to find better methods of transmitting maps through the Internet. Research involves exploring new Internet protocols and graphic file formats for cartographic applications.

Internet Multimedia Mapping –This area of research attempts to integrate multimedia elements with maps and make them available in an efficient and educational manner through the Internet.

Internet Mobile Mapping – This direction examines the use of mobile phones for map delivery and display. The major challenges are to reduce the map to a small display and update the map relative to the position of the user.

3.6 Theory to support Internet Cartography

3.6.1 Dimensions of internet map use

A number of chapters in the Maps and the Internet (Peterson 2003) volume address different aspects of Internet map use. Krygier and Peoples (2003) describe the integration of the Internet in a college-level course to create a basic geographic information literacy. The course attempts to engage "students (who are mostly non-geography majors) in active learning about mapping, but also critical thinking about the nature of maps and mapping sites on the WWW (World Wide Web), a skill that is more necessary than ever." (Krygier & Peoples, p. 17).

Richmond and Keller (2003) explore Internet maps and their use in web-based tourism destination marketing. They examine 181 "maps within 40 official national tourism destination websites" (p.77). They conclude that the "designers of tourism websites need to put more thought into the location of maps within their sites" (p. 94) because the maps are often very hard to find.

Mooney and Winstanley (2003) look at the publishing of public transportation maps and the cognitive processes involved in understanding these maps within the medium of the Web browser. They found that "computer generated route maps often disregard many of the techniques and principles that guide cartographers" (p. 306). Among other things, they argue that transportation maps need to be more up-to-date because over a given day many changes occur on a public transportation network. The Internet can help deliver more current transportation maps to the Internet map user.

Monmonier (2003) examines how online maps are being used to invade privacy. He points out that: "Web cartography" is especially valuable—and potentially threatening—because it not only greatly expands the audience of potential watchers (Peterson, 2000) but also allows for unprecedented customization of maps that describe local crime patterns, warn of traffic congestion and inclement weather, disclose housing values, or - thanks to the Global Positioning System (GPS) and the new marketplace for "location-based services" - track wayward pets, aging parents, errant teenagers, or unreliable employees" (p. 98). He concludes that: "As society and government work through the significance of locational privacy and decide what legal limitations, if any, are appropriate and permissible, the debate will turn to possible restrictions on Internet cartography, which many consider invasive because of the increased accessibility of information about where we live, the size and condition of our homes and real property, and the quality and safety of our neighborhoods" (p. 111).

3.6.2 Internet map delivery

The purpose of this line of research is to find better and more efficient ways of distributing maps through the Internet. This work is influenced by the open source movement that seeks to maintain a body of software through a combined effort of numerous, independent individuals.

Herzog (2003) describes the freely available Mapresso software for choropleth and cartogram mapping. He points out that the "World Wide Web offers cartography an ideal platform for making communication with maps more feasible" (p. 117). He argues that cartography "has not taken sufficient advantage of the Internet" (p. 129). He concludes by arguing for a different model for how software is developed for Internet mapping:

Considering a broader model of cartographic development on the Internet, small applets, as the one presented here, could be the result of a common effort of different actors in this area – from writers of the code for basic utility classes and for applets and related products to compilers of the geodata and finally to Web publishers with special thematic concerns. Such a community would help to exploit the constantly increasing technical opportunities for the diffusion of cartographic products and ideas (p. 129).

Neumann and Winter (2003) describe the advantages of a vector format called SVG. Andrienko, et.al. (2003) relate the experience of developing and evaluating an open source GIS program. Zazlavsky (2003) looks at the cartographic potential of XML, a new mark-up language for the Web.

Elzakker, et.al, (2003) review worldwide progress in the dissemination of census data in the form of maps. Elzakker, et.al, (2003) state that the advantages of web mapping "may be summarized under the headings of accessibility and actuality. Accessibility means convenience in accessing data anytime and from anywhere (as long as there is Internet access). Actuality refers to the potential of making the data available to the user immediately after their collection" (p. 58). In their review, 126 national statistical organizations (NSO's) were identified and analyzed. They point out that if "NSOs (National Statistical Organisations) wish to enable further possibilities to interact with maps, some kind of *mapping application* is needed that dynamically constructs maps out of the available data according to the user's specifications" (Elzakker, et.al, 2003, p. 74). Many possibilities are available, some open source, that would make this possible.

Cartwright (2003) "addresses the new area of Web mapping and covers why maps delivered through the Web are different, what constitutes effective Web map design, and the criteria by which they should be evaluated." (p. 35). He concludes that: "Proper design and evaluation procedures are essential if usable Web-delivered geovisualizations are to be provided and effectively exploited" (Cartwright 2003, p. 55).

Andrienko, et al. (2003) develop and test a general purpose GIS program called CommonGIS. The objective is to incorporate exploratory data analysis with online maps. CommonGIS is implemented in the Java language and can be used in two ways: as an applet running in a standard Java-enabled Web browser and as a local application, after being installed on a user's computer.

Jiang (2003) examines the potential of developing an analytical online cartography. He argues that "more and more users would like to query maps or geographic information for various purposes" (p. 147). Seeing limitations in the server-client model, he sees the potential of P2P for developing and distributing Geographic Information Services (GIServices).

Li (2003) examines point-to-point protocols (P2P) that are used for the exchange of music files and movies. He shows how a "node-hub P2P system enables individual users to form a cartographic data network where cartographic data are packaged, published, registered, searched, and transported over the Internet" (p. 159).

Zazlavsky (2003) introduces XML and outlines its potential for online cartography. Through an application called AxioMap, he shows how data and instructions can be downloaded and processed on a local computer. He concludes by pointing out that XML makes it possible to perform many spatial data integration and dynamic mapping tasks that could not be addressed before (p. 194).

Newmann and Winter (2003) describe the advantages of Scalable Vector Graphics (SVG), a vector graphics standard based on XML. They describe it as the first "vendor neutral vector graphics standard that integrates vector graphics, raster graphics, text, scripting, interactivity and animation while also being fully extensible, open to metadata and internationalization" (p. 217). They argue that SVG will reach its full potential when it is fully integrated with other XML standards (p. 218).

Lehto (2003) views the Web as a new publishing platform, similar to traditional print media. The challenge is to publish maps in multiple formats. He describes a mechanism for transforming XML-encoded data, the Extensible Stylesheet Language Transformation (XSLT) specification, and explains its use as a tool to provide multi-purpose publishing functionality for the Web and the Mobile Internet-based spatial services (p. 221).

Tsou (2003) envisions software agents that reside on the Internet and handle map related functions, such as map design. He argues that: "Software agent-based communication mechanisms can facilitate the dynamic integration of geospatial data, GIS programs, and cartographic rules and knowledge bases in distributed network environments (p. 242).

Torguson & Blinnikov (2003) show that an online atlas can be made by combining the efforts of students and Internet data sources. The project brought students from several different classes together to work in a team-building work experience (p. 312).

3.6.3 Internet multimedia mapping

A particular form of map delivery research attempts to exploit the potential of the Internet for combining multimedia content with maps. For example, Hu (2003) describes the creation of a web-based multimedia GIS. According to Hu, "web-based multimedia GIS is based upon interactions between three components: 1) a web-based GIS application developed to manipulate digital maps; 2) a web-based interactive multimedia application designed to manipulate multimedia information including hypertext, hyperlinks, graphics, photographs, digital video and sound; and 3) a mechanism linking the web-based GIS application and the interactive multimedia application" (p. 336). He argues that the "integrated multimedia-GIS approach provides a multi-sensory learning environment" (p. 341)

Caquard (2003) evaluates the potential of Internet maps to serve a role in a public participation decision-making setting. He argues that the dynamic maps that he studied are better suited to improve public participationby reducing the influence of the mapmaker and supporting the user's participation in the map-making process (p. 355).

Cammack (2003) uses a sense of virtual reality immersion with a map so the map-reader can experience the complexity of the virtual reality scene and abstraction of the map at the same time. He explains that spatial information can be represented in an extremely abstract or nearly realistic way (p. 361) and that there is a relationship between the level of abstraction and map use. "One aspect of this relationship is that spatial representations at different levels of abstraction can have the same map use" (p. 361). He proceeds to develop a multimedia-map environment using QuickTime VR that helps users understand water quality issues in a particular drainage basin.

Schwertley (2003) also uses QuickTime VR to create an online virtual landscape of a small city in Iowa. The individual virtual reality scenes are linked to a map and to each other. He concludes that "QuickTime VR can enhance spatial understanding and provide a better sense of place by combining virtual realitywith geographical information in the form of maps" (p. 381).

Giordano (2003) describes an application to distribute historical maps through the Internet with a GIS. As he states, the study "exemplifies the difficulties of using geographic information technologies with historical data (p. 321). His study showed that it is possible to integrate the traditional tools of GIS with computer cartography and multimedia. Together, "they provide a formidable suite of tools. The geographic query capabilities of the GIS, coupled with cartographic animations, images, pictures, and videos that can help a researcher gain additional insights into the study of historical databases. On a negative note, however, the integration must be done totally from scratch. Today's GIS is too immature to integrate multimedia applications" (p. 331).

Fuhrmann (2003) examines use of a geovirtual environment to support wayfinding. The research looks at how an egocentric frame of reference is best extended for navigation purposes with an exocentric map view and whether adding such a frame of reference significantly reduces navigation and wayfinding problems within the virtual environment.

Ottoson (2003) looks at the use of the Internet for three dimensional visualization, mostly in reference to the Virtual Reality Modeling Language (VRML). The advantage of VRML files is that they can be downloaded and executed on a standalone computer but the format has suffered from a lack of a widely available plug-in. He concludes that there are a large number of 3-D map applications particularly with small mobile devices.

3.6.4 Internet mobile mapping

Gartner (2003) defines mobile mapping as an extension of Internet mapping through the distribution of cartographic presentation forms via wireless air data transfer interfaces and mobile devices. One potential application of this technology is Location Based Services (LBS) in which the location of the map user is identified. He sees the use of multimedia as both a "necessity in the context of small displays and special usage conditions of mobile users and a benefit for the cartographic information transmission (p. 392).

Wintges (2003) tackles map design issues on a PDA display. The purpose of this his research is to design a "satisfactory user interface and a method for navigation and interaction with a personal digital assistant" (p. 397). In the PDA user interface that he proposes, to "compensate for the absence of scrolling and to guarantee the largest display area possible, pop-up menus and information frames which fall back on a structured layer-model were integrated" (p. 402).

Interest in mobile mapping has led to a series of conferences held at the Technical University o Vienna in Austria. These meetings, entitled *LBS and Telecartography* have helped define this new area of study.

3.6.5 Theoretical development

Taylor (2003) argues that the increasing use of maps and the Internet requires a new paradigm for cartography. He proposes the concept of Cybercartography which he defines as: "The organization, presentation, analysis and communication of spatially referenced information on a wide variety of topics of interest and use to society in an interactive, dynamic, multimedia, multisensory and multidisciplinary format" (p. 406).

Brodersen (2003) attempts modeling the visualization of Internet maps. He argues that despite "the changes in the process of geo-communication through Internet maps, communication is still the purpose" (p. 434). The "content of a communication is media-independent" and the ultimate aim is that the map affords the user the possibility of *quickly* and *safely* getting *correct* answers to *relevant questions*.

Peterson (2003) identifies the four paradigms that have guided cartography over the past half-century that have had an influence on the development of cartographic research related to the Internet. These four paradigms include cartographic communication, analytical cartography, cartographic visualization, and maps as power. For example, the latter paradigm argues that "the technological dimension of cartography has managed to overwhelmingly dominate the discourse in the field" (p. 443). It was pointed out by Harley "that under the influence of the computer, cartographers are more interested in technological questions rather than in the social consequences of what they represent" (p. 443).

3.7 Summary and suggestions

Cartography has always been subject to changes in technology. The particular change in the way maps are delivered to map user that began about a decade ago can be seen as a revolution. We are still adjusting to this rapid change. The research that is summarized here reflects this adaptation to a new medium. Clearly, there is much research yet to accomplish before the use of the Internet can be mastered by cartographers.

The *Maps and the Internet* commission of ICA has taken a leading role in spurring discussion and research about this new medium. Additional international efforts need to be focused on encouraging individual map suppliers and government agencies to take a greater role in improving the creation and use of maps through the Internet.

References

Andrienko, Gennady, Natalia Andrienko & Hans Voss (2003) GIS for Everyone: The CommonGIS Project and Beyond. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Brodersen, Lars (2003) Modelling the Visualization of Internet Maps. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Cammack, Rex G. (2003) Cartography, Virtual Reality, and the Internet: Integrating Abstract Models of the Environment Via the Internet. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Cartwight, William. (2003) Maps on the web. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Caquard, Sébastien (2003) Internet, Maps and Public Participation: Contemporary Limits and Possibilities. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Computer Industry Almanac (2004) Worldwide Internet Users will Top 1 Billion in 2005, http://www.c-i-a.com/200010iuc.htm

Cyberatlas. (2002) European Women Surf to a Different Drum. http://cyberatlas.internet.com/big_picture/demographics/

Dholakia, Ruby Roy & Dholakia Nikhilesh, Kshetri, Nir (2003) Gender and Internet Usage in Bidgoli, Hossein (ed.) *The Internet Encyclopedia*, New York: Wiley.

Elzakker, C.P.J.M., Ferjan Ormeling, Barend J. Köbben & Daisy Cusi (2003) Dissemination of census and other statistical data through web maps. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Fuhrmann, Sven (2003) Supporting Wayfinding in Desktop Geovirtual Environments. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Gartner, Georg (2003) Telecartography: Maps, Multimedia and the mobile Internet. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Giordano, Alberto (2003) Historical Geoinformation on the Web: Lessons Learned from the Chapter 91 Pilot Project. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Herzog, Adrian (2003) Developing Cartographic Applets for the Internet in Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Hu, Shunfu (2003) Web-based Multimedia GIS: Exploring Interactive Maps and Associated Multimedia Information on the Internet. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Jiang, Bin (2003) Beyond Serving Maps: Serving GIS Functionality over the Internet. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Krygier, J. & D. Peoples (2003) Geographic information literacy and the world wide web in Peterson, M. (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Lehto, Lassi (2003) A Standards-Based Architecture for Multi-purpose Publishing of Geodata on the Web. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Li, Bin (2003) Peer-to-Peer Sharing of Cartographic Data and Software. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Monmonier, Mark (2003) The Internet, Cartographic Surveillance, and Locational Privacy. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Mooney, Peter & Adam C. Winstanley (2003) Mapping and Internet Based Public Transportation Journey Planning and Information Systems. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Murie, M. D. 1996, “New Dimensions in VRML Authoring”, *NewMedia*, Dec.9, pp. 73 - 78.

Netcraft Web Server Survey (1998) http:77www.netcraft.com/survey/, page accessed. Nov. 25, 1998.

Neumann, Andreas & André M. Winter (2003) Webmapping with Scalable Vector Graphics (SVG): Delivering the promise of high quality and interactive web maps. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Ottoson, Patrick (2003) Three-dimensional Visualisation on the Internet. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Parker, H. D. (1995) “What Does the Internet’s Future Hold?”, *GIS World*, November, p. 118.

Peterson, Michael (1997) “Trends in Internet map use”,*proc.18.ICC*,Stockholm:ICA,3,pp.1635-1642.

Peterson, Michael (ed.) (2003) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Peterson, Michael (2003a) Maps and the internet: An introduction. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Peterson, Michael (2003b) Foundations of Research in Internet Cartography. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Richmond, Erin R. & C. Peter Keller (2003) Internet Cartography and Official Tourism Destination Web Sites. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Schwertley, William (2003) QuickTime Virtual Reality Maps for the Web. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Taylor, D. R. Fraser (2003) The Concept of Cybercartography. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Torguson, Jeffrey S. & Mikhail M. Blinnikov (2003) From maps to student interaction: creating a web-based student Atlas of Russia. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Tsou, Ming-Hsiang (2003) An Intelligent Software Agent Architecture for Distributed Cartographic Knowledge Bases and Internet Mapping Services. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

van Niekerk, M. (1996) “Money on the Net, but not yet.” *The Age*, February 17, pp. B1 and B6.

Wintges, Theodor (2003) Geodata Communication on Personal Digital Assistants (PDA). In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

Xerox Parc Map Site. (2001). Parc Map Site FAQ, http://pubweb.parc.xerox.com (de-activated in 2002).

Zaslavsky, Ilya (2003) Online Cartography with XML. In Peterson, Michael (ed.) *Maps and the Internet.* Amsterdam, Cambridge: Elsevier Press.

4 Development of Multimedia - Mobile and Ubiquitous

Georg Gartner

Institute of Geoinformation and Cartography, Vienna University of Technology

4.1 Introduction

Telecommunication infrastructure (mobile network), positioning methods, mobile in- and output devices and multimedia cartographic information systems are prerequisites for developing applications, which incorporate the user's position as a variable of an information system. Integrating geospatial information into such a system, normally cartographic presentation forms are involved. Thus, the resulting system can be called a 'map-based location based service' (LBS). This chapter discusses the elements of a map-based LBS, outlines main research topics and describes some experiences in the context of conceptual design and developing map-based LBS.

This chapter deals with location-based services and maps. It analyses the basic elements such as positioning, information modelling and presentation as the main fields of research, and the state of the art of currently used location-based systems. It presents selected research experiences such as the potential of cartographic presentation forms, positioning of active landmarks, modelling and visualization of guiding and navigation for pedestrians. TeleCartography is the distribution of cartographic presentation forms via wireless data transfer interfaces and mobile devices.

4.2 Elements of Cartographic LBS

A system can be called a Location Based Service (LBS), when the position of a mobile device – and therefore the position of the user - is somehow part of an information system. The derivable types of applications in this context can be stated as heterogeneous and include simple and text-based applications, which use the 'cell' (unique identification of the cell of a telecommunication network) for a rough positioning ("Which petrol stations are there around me?") to map-based multimedia applications including routing functionalities. In this context, different names for the context of telecommunication infrastructure, location-based applications and cartography are used. Beneath 'mobile cartography', 'ubiquitious cartography' the author proposes the term 'TeleCartography', to be understand as issues involved by the distribution of cartographic presentation forms via wireless data transfer interfaces and mobile devices

Independent from the level of complexity of the system architecture every map-based LBS needs some basic elements to handle the main tasks of positioning, data modelling and information presentation.

4.2.1 Positioning

The determination of the position of a mobile in/output device is a direct requirement for every system to be called LBS. Positioning has to be adequate to the service in terms of a dependent relationship and adapted to the tasks. For various applications the necessary level of accuracy needed can be served by the cell-ID of a telecommunication network and the thus derivable position, which gives an accuracy of positioning between 50 and 100 meters in urban areas (see Retscher 2002). For navigation purposes – in particular in the context of pedestrian navigation – the accuracy demands increases to values of at least 25 meters and less (Retscher 2002, Gartner & Uhlirz 2001). For indoor navigation, the requirements for the position determination are even more increased (Gartner et al. 2003).

Various methods of positioning are available for different levels of accuracy:

- satellite-based positioning,
- positioning by radio network,
- alternative methods,
- combinations.

Nowadays for outdoor navigation, satellite-positioning technologies (GPS) are most commonly employed. GPS provides accuracies on the few meters to 10 m level in standalone mode or sub-meter to few meter levels in differential mode (DGPS). If an insufficient number of satellites is available for a short period of time due to obstructions, then in a conventional approach observations of additional sensors are employed to bridge the loss of lock of satellite signals. This is particularly necessary for areas where the satellite signals are blocked like indoor or underground environments, or generally urban areas.

Deriving information from parameters of a radio network – coordinate cell or base station information – is a further method, but immanently restricted by the cell dimensions. Measuring methods using elapsed time of signals in combination with cell identification, time synchronisation or differences of elapsed time can improve positioning (Retscher 2002).

Alternative methods or improvements of already existing methods are shown by Zlatanova and Verbree (2003). They propose ‘user tracking’ in combination with ‘Augmented Reality’ (AR) to improve positioning in bad conditions (indoor/underground). Kopczynski (2003) describes an approach of using simplified topological relations to determine positions by sketch maps (sketch based input).

4.2.2 Modelling and Presentation of Information

The possibility of transmitting and visualising geospatial information in the context of a determined position is primarily restricted by the limitations of the used mobile device. The basic conditions of the cartographic communication process have to be fulfilled in any way, also when using map-based LBS: The cartographic model has to be clearly perceivable while it is permanently scale-dependent and has to present the task-dependent appropriate geometric and semantic information.

This fact in combination with restrictions in size and format of current mobile devices leads to different levels of solutions for presenting information within map-based LBS:

- Cartographic presentation forms without specific adaptations;
- Cartographic presentation forms adapted to specific requirements of screen display;
- New and adapted cartographic presentation forms; and
- Multimedia add-ons, replacements and alternative presentation forms.

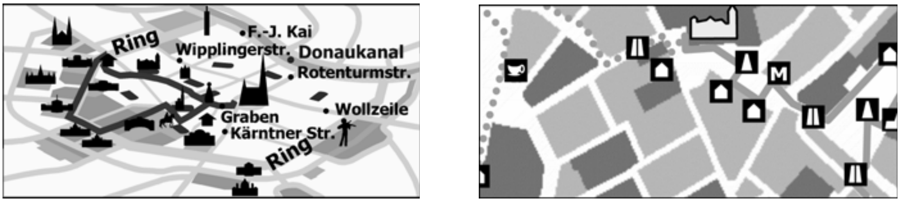


Fig. 1. ‘Look and Feel’ of the *Lol@*-Service

Rules and guidelines have been developed recently to adapt cartographic presentations to the specific requirements of screen displays (Neudeck 2001). A lively discussion about new and special guidelines for map graphics regarding the very restrictive conditions of TeleCartography and mobile internet has brought up various suggestions and proposals (see Reichenbacher 2003, Gartner and Uhlirz 2001). In this discussion the main focus is laid on questions of graphical modelling, visualizations, or generally on questions of usability and application navigation (Meng 2002). First experiences and results have been made e.g. with the prototyping Universal Mobile Telecommunications System (UMTS) application *Local Location Assistant* (*Lol@*) (Gartner & Uhlirz 2001).

Fig 2. Multimedia Content of the *Lol@* Service**.**

Common rules or standards for cartographic presentations on screen displays are not defined yet, due to the permanently changing determining factors. Display size and resolution of state-of-the-art devices are permanently increasing and colour depth is no longer a restricting factor. Parameters of external conditions during the use of the application (weather, daylight) are hard to model. The needs of an interactive system have to be incorporated into the conception of the user interface, which includes soft keys as well as functionalities for various multimedia elements. As a general approach for including the various parameters within a model of map-based LBS the concept of ‘adaptation’ (in terms of user-dependent adaptation of a cartographic communication process) has been brought up (Reichenbacher 2003). The concept is to describe links or mutual dependencies between various parameters and the results are connected to impacts to the data modelling and cartographic visualization. Furthermore, new cartographic presentation forms especially designed for restricted and small screen displays have been developed (see e.g. ‘focus-map’ by Klippel 2003).

For the presentation of geospatial information within LBS and on small displays additional multimedia elements and alternative presentation forms may become potential improvements. Methods of ‘Augmented Reality’ (AR) link cartographic presentation forms (e.g. 3D graphic) to a user’s view of reality, e.g. at applications like navigation systems. Cartographic AR-applications try to create a more intuitive user interface (Reitmayr and Schmalstieg 2003). Kolbe (2003) proposes a combined concept of augmented videos, which realises positioning and information transfer by means of video.

4.2.3 Users and Adaptation

Experiences in LBS developments have led to various suggestions for a more user-adequate system conception. Modelling parameters in the context of the ‘user’ and the ‘usage situation’ are seen as fundaments of more user-adequate attempts, which can be summarized as ‘concepts of adaptation’.

The adaptation of cartographic visualisations in this context can be understood as e.g. the automatic selection of adequate scales, algorithms for adequate symbolization, or even the change to text-only output of information in case of inadequate graphic potentials of an output device. Adaptation to the user is for the time being limited to user profiles, selected in advance from a list or entered manually by the user himself to influence the graphical presentation (size of lettering, used colours) or to provide predefined map elements. Adaptation of the visualisation to the situation is including the actual day time (day/night) or considers the actual velocity of the user (this type of adaptation is realised in some actual versions of navigation software like *TomTom*, which adapts automatically the map scale to the current velocity).

Various forms of adaptation are summarised by Reichenbacher (2003) as ‘context-adapted Geovisualisation’, where definitions of methods and algorithms to derive adequate cartographic presentation forms from influencing parameters for various output devices and different users in different situations are aimed at. This approach is challenging not only technical developments but also the questions of how to identify, define and model the main influencing parameters (e.g. ‘user’, ‘user situation’). First attempts of empirical studies in this context have been made (Radoczky 2003), while experiences of implementations are rare.

4.3 Infrastructure Developments: Towards ubiquitous environments

The development of technologies like telecommunication infrastructures, wireless networks, radio frequency identification or innovative displays like electronic paper can all be seen as parts of developing a ubiquitous environment, where location-based services and ubiquitous cartographic applications can be applied.

4.3.1 National telecommunication infrastructure

In Europe, the first generation of mobile telephones appeared in the mid 1970’s in Scandinavia and was based on analogue techniques. The second generation of mobile handheld devices brought digital transfer technologies as the ‘Global System for Mobile Communications’ (GSM) and made the wireless phones a mass market phenomenon. Today, multiple standards are used in worldwide mobile communications. Different standards serve different applications with different levels of mobility, capability, and service area (paging systems, cordless telephone, wireless local loop, private mobile radio, cellular systems, and mobile satellite systems). Many standards are used only in one country or region, and most are incompatible. GSM is the most successful family of cellular standards, supporting some 250 million of the world’s 450 million cellular subscribers with international roaming in approximately 140 countries and 400 networks.

When ‘Wireless application protocol’ (WAP) started some years ago it was for the first time ever that mobile devices have restricted access to the Internet and content that was prepared especially for the use on mobile clients with small displays. Although it does not allow the provision of graphics other than in a very basic presentation, it has been used for first attempts. With 3rd generation technology UMTS it is possible to give continuous access to most of the internet sites, graphical presentations included.

The new so called ‘3rd Generation’ (3G) of mobile phones features not only an IP-based technology but allows also for the first time so called ‘rich calls’ transferring several user data streams simultaneously. This is also often referred to as ‘multimedia calls’. It was a question of data transfer rates which did not allow other than voice calls up to now. But users and developers of wireless devices always had the idea not only to transmit ‘simple’ voice calls but also all other forms of digital data. The new technologies as ‘Global Packet Radio Switch’ (GPRS) and the latest, on air since 2001, ‘Universal Mobile Transmission System’ (UMTS) seem to make this idea become true for first time in mobile communication. This will be possible only with the transmission rates proposed for the third generation of mobile devices as UMTS will be. The difference in speed between GSM and UMTS can be given by factor 50, in rare cases up to a factor of 200. This is a factor of 6 compared to ISDN and enables video transmission as well as audio files. Because UMTS technology enables the transfer of many different data formats in fast growing transmission rates, the development of complete new and attractive applications is initiated. Still, there are only very few ideas, prototypes and even less running applications trying to take advantage of the UMTS possibilities. But due to telecommunication companies this market will grow up and is currently highly focused in research and development.

4.3.2 Electronic Paper

‘Electronic paper’, or e-paper, is a technology that allows the text on a piece of paper to be re-written. The ‘paper’ is actually made of organic electronics that use conductive plastic which contains tiny balls that respond to an electric charge, changing the page in much the same way that pixels change on a computer monitor.

Electronic paper was developed in order to overcome some of the limitations of computer monitors. For example, the backlighting of monitors is hard on the human eye, whereas electronic paper reflects light just like normal paper. It is easier to read at an angle than flat screen monitors. As it is made of plastic, electronic paper has the potential to be flexible. It is light and potentially inexpensive.

Electronic paper was first developed in the 1970s at Xerox's Palo Alto Research Center. The first electronic paper, called ‘Gyricon’, consisted of tiny, statically charged balls that were black on one side and white on the other. The ‘text’ of the paper was altered by the presence of an electric field, which turned the balls up or down.

In the 1990s another type of electronic paper used tiny microcapsules filled with electrically charged white particles suspended in a coloured oil. In early versions, the underlying circuitry controls whether the white particles were at the top of the capsule (so it looked white to the viewer) or at the bottom of the capsule (so the viewer saw the colour of the oil). This was essentially a reintroduction of the well-known 'electrophoretic display technology', but the use of microcapsules allowed the display to be used on flexible plastic sheets instead of glass.

There are many approaches to electronic paper, with many companies developing technology in this area. Other technologies being applied to electronic paper include modifications of liquid crystal displays, electrochromic displays, and the electronic equivalent of an Etch-A-Sketch.

It is obvious, that developments like the combination of wireless networks with such electronic paper devices are of high interest for cartography. The potential of displaying any maps via wireless interfaces on electronic paper devices offers especially innovative map use possibilities. It can be expected, that innovative cartographic applications will be triggered.

In summary it can be stated, that various infrastructure and technology developments are taken place currently. These developments include innovations in terms of new in/output devices, interfaces and telecommunication technologies and can be seen of high interest for cartographic communication processes. As an early field of applications in this context navigation systems are under development currently. In the following chapter some selected aspects will be analyzed.

4.4 Navigation Systems as possible applications of LBS

Guiding instructions for pedestrian navigation consist of geospatially related information. The main elements of guiding instructions for supporting pedestrian navigation are usually resulting from a general routing model, where routing functions and, optionally, guiding functions along predefined routes can be executed. The main elements derivable from such routing models include starting point, target point, decision points, distances and route graphs. In order to communicate the resulting elements they have to be combined and translated into 'communicative guiding instructions'. Such a translation has to be seen in the context of the problem of matching a guiding instruction with the reality by the guided person, which is dependent on various influencing parameters, including:

- the user's task/situation;
- the skills of the guided person;
- the 'quality' of the instruction in terms of semantic, geometric, temporarily correctness or usability;

- the 'potential' of the communication mode to transmit the information needed by the client; and
- the technical restrictions of output devices.

As a research project of the Vienna Telecommunication Research Centre with the Technical University of Vienna, the development of a prototype of a location-based service for a UMTS environment has been done. The application *Lol@*, a guided tour through Vienna's 1st district was designed as a service for foreign tourists. The user is guided along a predefined route or due to individual input to some of the most interesting places in Vienna's city centre, where he can get multimedia (audio and visual) information about the tourist attractions via the Internet portal of the service. The application requires a wireless handheld as input/output device. In order to be able to develop a location based service in a UMTS environment, the project has to deal with four main parts: specifications of technical prerequisites as well as conceptual and method development for localization, positioning and routing, application development and application implementation. The result (cp. Gartner and Uhlirz 2001) is based on the objective to develop a running prototype and therefore lacks usability testing and the testing of additional questions concerning the 'cartographic' communication process, including presentation forms, interface, interactivity tools and design issues.

The objectives of further projects have to be seen as closely adding on / taking advantage of the results of the project *Lol@*. This is seen in the context of applying methodology derived from multimedia cartography research on the transmission of guiding instructions. All this is based on the theory, described in Cartwright et al. (1999), that Multimedia cartography offers various methods and forms of communicating geospatially related information with different potential of information transmission and user interactivity (Gartner and Uhlirz 2001). In this context projects are currently carried out at the Department of Cartography and Geo-Media Techniques of TU Vienna, including issues like the:

- Specification of the applicability of various presentation forms. In this context Reichl (2003) has set up an empirical test with different presentation forms of guiding instructions for pedestrian navigation. Different user 'types' like tourists, locals or business persons have been tested by using different presentation forms including maps, text-visual, text-acoustic, photos, animations with additionally different variables in terms of usability conditions like day/night etc. The result can be interpreted in a way, that in the context of pedestrian situations the presentation form 'map' plays the most important role also when only small displays are available (Reichl 2003, p.75).

- Derivation of route information into guiding instructions in various presentation forms. The output of a routing algorithm consists of metrical and topological information (edges and nodes). This information has to be communicated by using various presentation forms, dependent on user specifications and device restrictions (Klippel 2003). In order to derive semantically acceptable presentations of routing information in various presentation forms, derivation algorithms for various presentation forms (textual, cartographical, acoustic, images) have to be specified. The analysis of the quality and validity of the derived route presentations can be done by comparing metrical and semantic parameters.
- Integration of ubiquitous environments by using active landmarks. The evaluation of integrating landmarks in a multimedia supported cartographic communication process within the context of pedestrian navigation is guided by the hypothesis, that the applying of landmark information on geospatial communication processes is an improvement in terms of the efficiency of information transmission. In the context of pedestrian navigation the appropriate presentation form is dependent on the particular user situations, the user skills and the specification of the user characteristics. It is assumed, that the appropriate form of communicating geospatial guiding instructions will include primarily graphical coding and abstracting, but also other kind of information transmission methods. The special focus on the role of active and/or passive landmarks and their derivation possibilities enables the analysis of more user-centred systems.
- Use of ‘Augmented Reality’ (AR). This can be seen as a form of virtual reality / computer animation, where information is derived into visual displays, e.g. glasses. Whilst in virtual reality applications users ‘move’ through virtual spaces, the user of augmented reality applications move in real spaces. The perception of the reality is additionally overlapped by different layers of information. The main advantage of augmented reality applications in terms of guiding system could be seen in the fact, that all necessary information is displayed in the visual system of the user. The interpretation and comparison of maps with real situations need a lot of ‘mental processing’, including the ‘decoding’ of map objects, the identification of objects in reality and/or maps, the reverse coding of real situation into the ‘abstracted’ graphical representation of the reality. As AR applications need a number of preconditions like precise positioning, precise movement measuring and precise measuring of viewing directions, the availability of ‘running’ systems cannot be expected in the near future.

Fig. 3. Pedestrian Navigation Service TU Vienna – Screenshot (Gartner et al 2003)

4.5 Conclusion

In this chapter the major aspects of conceptualising map-based LBS were discussed: integrative positioning, context-adapted data modelling and multimedia route communication. As a result the pre-requisites for positioning, data modelling and information communication are analyzed. Determining innovations in technologies are described. Findings and results from research projects, accomplished at the University of Technology Vienna, have been presented. Results have been discussed, that lead to further developments and questions concerning the integration of positioning sensors, handing over positions seamless between indoor and outdoor navigation, modelling context-dependent communication forms for route information communication and to enable and to enhance map-based LBS, pedestrian navigation systems in particular.

It can be expected, that further innovations (e.g. e-paper, wireless networks and data transfer standards) will offer additional possibilities to develop new forms of cartographic systems, either for guiding purposes or for collaborative decision support systems or cartographic information systems.

References

Cartwright W. E., Peterson M. P. (1999): Multimedia Cartography. In: Multimedia Cartography, Cartwright, W.E., & M.P. Peterson, G. Gartner (Eds.). Berlin, Heidelberg, New York: Springer-Verlag, pp. 2-10.

Gartner G., Uhlirz S. (2001): Cartographic Concepts for Realizing a Location Based UMTS Service: Vienna City Guide „*Lol@*“. In Mapping the 21st Century - Proceedings of the 20th ICC, Beijing: 2001, pp. 3229-3238

Gartner G., Frank A., Retscher G. (2003): Pedestrian Navigation System for mixed Indoor/Outdoor Environment. In LBS & TeleCartography, Geowissenschaftliche Mitteilungen, vol. 66, 2003, pp. 161-167

Klippel A. (2003): Wayfinding Choremes: Conceptualizing Wayfinding and Route Direction Elements. Doctoral dissertation, University of Bremen, September 2003.

Kolbe T. (2003): Augmented Videos and Panoramas for Pedestrian Navigation. In LBS & TeleCartography, Geowissenschaftliche Mitteilungen,66, 2003,pp.45-52

Kopczynski M. (2003): Localisation with sketch based maps. In LBS & TeleCartography, Geowissenschaftliche Mitteilungen,66,2003, pp.117-123

Meng L. (2002): Zur selbsterklärenden multimedialen Präsentation für mobile Benutzer [About self-explanatory presentations for mobile users]. In TeleKartographie & LBS, Geowissenschaftl.Mittlgn.,58,2002, pp.99-107

Neudeck S. (2001): Gestaltung topographischer Karten für die Bildschirmvisualisierung. [Design of topographic map for screen display]- Schriftenreihe des Studienganges Geodäsie u. Geoinformation der Univ. der Bundeswehr München: 2001, vol. 74

Radoczky V. (2003): Kartographische Unterstützungsmöglichkeiten zur Routenbeschreibung von Fußgängernavigationssystemen im In- und Outdoorbereich. [Cartographic support of route descriptons for pedestrian navigation systems]. Dipl.Th., TU Vienna, 2003.

Reichenbacher T. (2003): Adaptive Methods for mobile Cartography. In Proceedings of the 21th ICC, Durban 2003.

Reichl B. (2003): Kategorisierung des Potentials von kartographischen Präsentationsformen für die Verwendung auf kleinen Displays [Potential of cartographic presentations for small screen displays] DiplTh, TU Wien, 2003

Reitmayr G. and Schmalstieg D. (2003): Collaborative Augmented Reality for Outdoor Navigation and Information Browsing. In LBS & TeleCartography, Geowissenschaftliche Mitteilungen, vol. 66, 2003, pp. 53-59

Retscher G. (2002): Diskussion der Leistungsmerkmale von Systemen zur Positionsbestimmung mit Mobiltelefonen als Basis für LBS. In TeleKartographie & LBS, [Discussion of parameters of positioning with cellular phones], Geowissenschaftl. Mittlg.,58,2002, pp.42-58

Zlatanova S. And Verbree E. (2003): User tracking as an alternative positioning technique for LBS. In LBS & TeleCartography, Geowissenschaftliche Mitteilungen, vol. 66, 2003, pp. 109-117

5 Elements of Multimedia Cartography

Michael P. Peterson

Department of Geography / Geology, University of Nebraska at Omaha, USA

5.1 Introduction

The communication of spatial information in the form of maps is in the midst of a revolution. The origins of this dramatic change can be largely traced to the mid-1980s and the introduction of iconic interfaces on computers that made their use both easier and more widespread. For cartography, this new interface made interaction in the display of maps feasible. Previous to this, computers had been used primarily to help in the process of producing maps on paper. Advances in data storage (CD-ROM / DVD) and the Internet (World Wide Web) during the late 1980's and 1990's contributed to a second wave of cartographic development in the area of multimedia.

It is difficult to overstate the importance of this new medium for cartography. Our conceptions of the world and our actions within it are largely controlled by the depictions that we see. We approach the world with information acquired through models of reality in the form of maps. But, past models have not served us well. Maps on paper could only depict a static and unchanging world and the mental representations that we derived from them limited our interactions with reality. Worst of all, these models could not be used, or used effectively, by most people – leaving a large segment of the population essentially map illiterate.

This chapter examines the meaning of Multimedia Cartography and identifies a set of underlying principles that form the basis of the paradigm. Multimedia Cartography is first viewed in relation to a continuing struggle to represent reality in a meaningful way. Then, the ideas of Kuhn and others are explored that deal with the concept of a paradigm and paradigm shift. Finally, the elements of Multimedia Cartography paradigm are characterised with five basic principles. The overall purpose is to understand the broader meaning of Multimedia Cartography to the development of cartography.

5.2 The Meaning of Multimedia Cartography

5.2.1 Maps, Lies and Abstraction

Multimedia Cartography is based on the compelling notion that combining maps with other media (text, pictures, video, etc.) will lead to more realistic representations of the world. This notion is in contrast to the deeply ingrained idea in cartography that abstraction is the ultimate goal, and that, to some extent; the more abstract the map, the better it works as a functional representation of reality. Indeed, what is the purpose of cartography if it is not to make abstractions of the world that are more useful than looking at reality itself?

Abstraction is a form of lying and artists have long realised that lying through abstraction is art. In *The Decay of Lying*, Oscar Wilde (1913) claims: "The only form of lying that is absolutely beyond reproach is lying for its own sake, and the highest development of this is … Lying in Art." Picasso is quoted to have said that "Art is a lie which makes us realise the truth" and Muehrcke (1978, p. 15) comments that the same can be said of maps. Abstraction in maps is a useful and necessary form of lying.

Artists recognise that different media can be used to create different forms of expression. The differences between static and interactive media has been noted for centuries. Plato, in commenting on a painting, says:

It is the same with written words: they seem to talk to you as though they were intelligent, but if you ask them anything about what they say, from a desire to be instructed, they go on telling you the same thing forever. (Plato's Phaedrus, p. 158)

What Plato is saying is that the quest for truth must be "a joint effort between two minds, the mind of the teacher (or guide) and disciple, whose love for one another is rooted in their common love of truth, beauty, and goodness" (Hackforth 1952, p. 10).

Interactive multimedia may also be seen as a search for "truth, beauty, and goodness." Like a conversation, the interactivity allows lies to be examined, albeit with other lies that may or may not be as insightful as the first. The process is one of discovery as the observer becomes more critical of the information that is presented to them. The same process occurs in a conversation as we "converge" upon a common understanding through a dialog. Plato goes on to say that:

And once a thing is put in writing, the composition, whatever it may be, drifts all over the place, getting into the hands not only of those who understand it, but equally of those who have no business with it, it doesn't know how to address the right people, and not address the wrong. And when it is ill-treated and unfairly abused it always needs its parent to come to its help, being unable to help or defend itself. (Plato's Phaedrus, p. 158)

Plato is referring to the written word, but the same can be said of the printed map. It also cannot adapt itself to the user. In contrast, the "multimedia map" can be constructed in several layers, each addressing the needs of different users. In addition, the multimedia map author, like a parent, can "come to its help," and make the information more understandable and less misleading to an individual user.

5.2.2 Maps and Amusement

Another important aspect of interactive media is enjoyment. People seem to learn things more quickly when the learning process is fun. While "fun" has negative connotations especially in educated circles, 'fun' is essentially an emotion that may be associated with concepts like awareness, excitement, and joy. There is often a physical response, a release and relaxation that accompanies the intense experience of "knowing." Some people experience these sensations when examining a map or an atlas on paper. The feeling can be made more intense and brought to a wider audience through interactive multimedia.

Postman cautions, however, that:

Our politics, religion, news, athletics, education, and commerce have been transformed into congenial adjuncts of show business, largely without protest or even much popular notice. The result is that we are a people on the verge of amusing ourselves to death. (Postman 1986)

Indeed, our lives may be a constant search for amusement. Maps are part of our lives and have a role in amusement as well. They will likely never be as thrilling as a roller coaster ride, but there is a sense of joy when we understand something about the world for the first time – and there is much of the world to learn "for the first time." Multimedia Cartography can contribute to the joy of this discovery.

5.3 The Paradigm of Multimedia Cartography

Multimedia Cartography represents a fundamental change for cartography, analogous to a revolution. In *The Structure of Scientific Revolutions,* Thomas Kuhn (1962) employs the concept of a paradigm to refer to revolutions that inspired such inventions and “unexpected discoveries” as the printing press and electricity.

Scientific revolutions are tradition-shattering complements to the tradition-bound activity of normal science... Major turning points in scientific development are associated with [such] names [as] Copernicus, Newton, Lavoisier, Einstein and Darwin. More clearly than most other episodes in the history of at least the physical sciences, these display what all scientific revolutions are about. Each of them necessitated the community's rejection of one time-honoured scientific theory in favor of another incompatible with it. Each produced a consequent shift in the problems available for scientific scrutiny and in the standards by which the profession determined what should count as a admissible problem or as a legitimate problem-solution. And each transformed the scientific imagination in ways that we will ultimately need to describe as a transformation of the world within which scientific work was done (Kuhn, p. 6).

In Kuhn’s view, no reconciliation of opposing paradigms can be made by some higher authority because each represents both the construct of observation and the higher authority of explanation. The new viewpoint, embodying the paradigm change, wins by gaining the consent of the relevant community. After the paradigm changes, important new lines of work are guided by a new set of generalisations. A paradigm, then, is a widespread, commonly-held set of convictions that takes the form of a firm belief although it’s fundamental elements are not testable in the framework of a hypothesis. While not testable, the tenants of the paradigm are taken to be true by people who would otherwise rely on more rigorous methods to separate fact from fiction. In this sense, the paradigm rests on a “faith” that is similar to that of religion.

Kuhn is describing here a specifically scientific – rather than media-related – paradigmatic shift. However, he goes onto to argue that: “Historians of literature, of music, of the arts, of political development, and of many other human activities have long described their subjects in the same way” (Kuhn, p. 208). Kuhn believes that the process of discovery is not cumulative but cyclical – interrupted and rearranged by new discoveries. “To the extent that this book portrays scientific development as a series of tradition-bound periods punctuated by non-cumulative breaks, its theses are undoubtedly of wide applicability” (Kuhn, p. 209).

Griscom (1996) argues that the concept of a paradigm is germane to changes in communication technology. Marshall McLuhan’s media theory (McLuhan 1967), for example, embraces the Kuhnian notion that human experience will qualitatively evolve under the influence of a new medium. Similar to changes brought by technology, Kuhn’s paradigm shift is a rapid, discontinuous change, in contrast to the traditional view of a slow, step-by-step progression.

The frightening aspect of Kuhn's theory of the paradigm is that, like a revolution, a paradigm shift obviates all prior work. In cartography, this would mean that all work in relation to the print medium – essentially everything we know about maps and their construction – would have to be thrown out. This knowledge would simply not be valid any more. Further, by keeping any of it, we would be corrupting our ability to use the new medium.

Griscom (1996), while embracing the concept of a paradigm shift in communication technology, rejects this basic tenet of Kuhn’s theory. “Whereas Kuhn describes the eradication of past scientific methods as “incompatible” with – and therefore negated by – the new one, revolutions in media do not “prove wrong” the value of its predecessor, but reposition it.” While digital technology is expanding the potential and perceptual scope of humanity, the message of the print medium is not obsolete or untenable, but re-positioned within a broader understanding of reality.

Whether Multimedia Cartography “proves wrong” the previous methods of representation in cartography should not be a major concern. Certainly, there are advantages to representations of reality that use the more portable medium of paper (at least more portable for now). The important point is that Multimedia Cartography is a search for better ways to represent the spatial reality, and that search is somehow predicated on the notion that existing methods are inadequate. It may also be true that there is little that we have learned from print cartography that can be transferred to Multimedia Cartography. In the following sections, each of the five elements of Multimedia Cartography is examined with respect to the concept of a paradigm and the notion that cartography is within a paradigm shift.

5.4 Elements of the Multimedia Cartography Paradigm

Five basic principles can be identified that form the basis of work in Multimedia Cartography. The first of these principles deals with the general inadequacy of maps on paper to represent and convey the spatial environment, especially its multifaceted and dynamic character. The second concerns problems associated with the distribution of maps on paper, both the expense of their production and dissemination. The third deals with differences in map use among individuals, and the troubling but generally accepted notion in cartography that a large percentage of the population do not use maps on paper or cannot use these maps effectively. The fourth principle concerns the intrinsic value of multimedia and the firmly held belief that adding multimedia elements to maps leads to improved information and knowledge transfer. The fifth concerns a general, moral obligation that cartographers have to communicate spatial information in an effective manner to as large an audience as possible. Together, these principles guide and motivate the efforts in Multimedia Cartography.

5.5.1 Inadequacy of the Paper Medium

Paper has two major advantages for cartography over the computer: 1) it is easier to carry, and 2) the medium can support a higher spatial resolution (i.e., display more dots per unit area). In addition, paper may have a greater longevity than electronic media – although both would be less than clay tables on which the first known maps were discovered. Implicit with Multimedia Cartography, however, is the notion that maps on paper cannot adequately represent or communicate the spatial environment. In other words, while paper offers major advantages to cartography, it cannot compete with interactive media in addressing the essence of cartography – the representation and communication of the spatial world.

5.5.2 Problems Associated with Distributing Maps on Paper

Putting maps in front of people is the most important aspect of their use. It wasn’t until a little over 500 years ago that humans discovered a way to accurately and quickly duplicate maps. As late as the mid-1400’s, all maps were still painstakingly reproduced by hand, so there were very few maps in existence. Beginning in the latter part of the Renaissance, maps began to be printed in Europe. The development of printing meant that maps could be easily reproduced while being faithful to the original. It also meant that more people had the opportunity to see and use maps.

The impact of printing on mapping has a good analogy in the present transition to the distribution of maps through computer networks. Like the printing of maps, computer networks have increased the distribution of maps. Printing made it possible to produce thousands of identical maps in a short amount of time. The Internet has made it possible to simultaneously “print” and distribute thousands of maps every second.

In addition, maps on computer networks are delivered in a fraction of the time required to distribute maps on paper. A single network request for a map supersedes the former time-consuming map printing and distribution processes. A process that is analogous to the printing and shipping of maps is done on the Internet in a matter of seconds. Like printing, the Internet, and specifically the World Wide Web, redefines how maps are made and used. They tend to be interactive – often allowing the user to change the perspective, the projection, or the level of detail. They tend also to be more up-to-date. Weather maps, for example, are posted on a hourly basis. Finally, maps are used differently than before. They are accessed through a hyperlinking structure that makes it possible to engage the map user on a higher-level than what is possible with a map on paper (Peterson 1997).

5.5.3 Problems in Map Use

One of the major problems associated with maps is that of map use. Many people have difficulty using maps even within highly educated populations. It has been estimated that more than half of the educated population do not have a basic competency with maps. The reasons for this are not well understood. Some see the problem related to a lack of education specific to map use while others say it is the maps themselves and, more specifically, the medium of paper that is used for their display. But, the result of the map use problem is clear: A large segment of the population have poorly formed mental representations of their local environment and especially the space beyond their direct experience.

A solution to this problem may be interactive multimedia. No longer restricted to the single view offered by maps on paper, the map user is encouraged to explore alternative methods of representation – different views that help shape the user's perspective of the world. The "views" that are presented to people go beyond those offered by the maps in atlases. The maps are more current and targeted to specific users. They can also be more interactive and incorporate animation. The exposure to interactive maps may also lead to better map use skills and both improve and increase the use of maps on paper.

5.5.4 The Intrinsic Value of Multimedia

The fourth principle of Multimedia Cartography that is identified here concerns the intrinsic value of multimedia and the firmly-held belief multimedia leads to improved information and knowledge transfer. Hoogeveen (1997, p. 151) argues that "a strong paradigmatic belief can be noted in the benevolent effects of multimedia for a wide variety of application domains." In many studies the improved learning effectiveness of multimedia in comparison to non-multimedia courses is presumed (Conklin, 1987; Morariu, 1988; Hooper Woolsey, 1991; Marmolin, 1991). Hoogeveen goes on to argue that the true experimental foundation of such assumptions and beliefs is incomplete and often weak (Janda, 1992), and a coherent theoretic basis explaining why multimedia is supposed to work, taking into account the experimental findings, has not yet been established.

A number of studies have been cited to demonstrate that multimedia is not an effective means in improving information and knowledge transfer. For example, Nielsen (1990) reviews a comparative study of Wilkinson and Robinshaw regarding error frequencies of subjects in two test conditions: proof-reading from screen and proof-reading from paper. In the first ten minutes of the experiment, subjects had about the same error rates in the two conditions (25% vs. 22%), but after proof-reading for 50 minutes, the subjects using computer screens did significantly worse with an error rate of 39% vs. 25% for paper. Nielsen concluded from this experiment that users become tired fairly quickly when reading from the current generation of computer screens. According to Nielsen, it is only possible to achieve the same reading speed when the computer screen is high-resolution and uses anti-aliased proportional fonts. It may also be concluded that text needs to be augmented with multimedia elements to achieve the same information and knowledge transfer.

Another example of decreased information and knowledge transfer concerning multimedia involves synthetic speech. It is widely recognised that synthetic speech has a relatively bad quality compared to natural speech and researchers have found that synthetic speech hinders verbal learning (Hapeshi & Jones, 1992). A further argument against interactive multimedia is that of Price (1995) who found that students were more *satisfied* with the passive medium of video than with interactive electronic distance education. However, the quality of the information transfer was not tested.

There are also numerous studies that suggest that multimedia improves information and knowledge transfer. Hapeshi & Jones (1992) note that the presence of moving images can serve to enhance comprehension and learning of spoken material. Marmie & Healy (1995) showed that interactivity improved retention. Fendrich et al. (1995) found the same effects for recognition memory. The importance of congruence, the degree to which different media are used redundantly to express the same ideas, has been demonstrated in several experiments. Marmolin (1991) points to the congruent effect of colour and sound. Bradley & Henderson (1995) report the perceived benefits of a voice-over. Hayes, Kelly & Mandell (1986) found that recall of a visual and auditory presentation was more accurate than only an auditory presentation.

If we follow the arguments of Gibson (1966, 1979), the acquisition of information is an active process. According to Gibson, we do not hear, we listen; we do not see, we look around (Peterson, 1994). Based on this argument, more active environments will lead to better learning environments. Users should be able to explore natural multimedia information in an active way. Marmolin (1991) notes that neither the author of the information or its designer should decide how the information should be processed. Rather, the user should be in control.

5.5.5 The Moral Obligation of Cartographic Communication

Underlying a great deal of research in cartography, especially in recent years, is the idea that we should attempt to improve maps as a form of visualisation for expert map users. Implicit in this argument is that most people don't need maps because they don't perform any kind of spatial analysis. Cartographic research, it is argued, should therefore be oriented toward those few that can actually benefit from this work.

This view, although widely held, is simply inexcusable. Maps help us to understand the world and can provide information to make important decisions. This function of maps is especially important in a democracy where all should participate in the variety of democratic processes. It should also be noted that this "maps for the few" attitude is furthered by Geographic Information Systems that can only be operated by a few, trained individuals. If such systems exist that are only meant for the few then it is naturally easier to put maps in this context as well.

Of course, there are now many efforts outside of cartography to get "maps out," so to speak. Systems for Public Participation GIS are ways to bring interactive map use to a larger audience. Multimedia Cartography has a major role to play in this overall effort.

5.5 Conclusion

Cartography is in the process of change. Like all technological developments, the computer makes our work both easier and more difficult – and multimedia cartography is not *easy*. How must cartography react to these changes? We have to begin using new definitions in cartography. The word "map," for example, should perhaps be redefined to refer to an interactive map display. If the presentation of the information is not controlled by the user - it's not a map. If there is no interaction - it's not a map. If there is no potential for animation - it's not a map. We may eventually realise that what we call maps today are simply static map elements - as much a piece of the puzzle as a single symbol on a map.

It is an exciting time for cartography. We have in Multimedia a new medium. A medium that can lead to a new relationship between maps and people, and ultimately people and the world. But, we have a lot of work ahead of us to make the new medium *work* for cartography.

References

Brady, S. & Henderson, L. (1995) Voice-Overs and Auditory Cues: Their Impact and Role in Learning through IMM. In Maurer, H (Ed.). Educational Multimedia and Hypermedia 1995. Proceedings of ED-MEDIA95. Charlottesville, VA: AACE, pp. 109-115.

Conklin, J. (1987) Hypertext: An Introduction and Survey. IEEE Computer, 2(9), pp. 17-41.

Fendrich, D.W., Gesi, A.T., Healy, A.F. & Bourne, L.E. (1995).The Contribution of Procedural Reinstatement to Implicit and Explicit Memory Effects in a Motor Task. In Healy, A.F. & Bourne, L.E. (Eds.). Learning and Memory of Knowledge and Skills: durability and specificity. Thousand Oaks, CA: Sage Publications, pp. 30-65.

Gibson, J.J. (1966) The Senses Considered as Perceptual Systems. Boston: Houghton Mifflin Co.

Gibson, J.J. (1979) The Ecological Approach to Visual Perception. Boston: Houghton Mifflin Co.

Goodrich, K.H., McManus, J.W., & Chapell, A.R. (1992) A High-Fidelity Batch Simulation Environment for Integrated Batch and Piloted Air Combat Simulation Analysis, 1992 AIAA Flight Simulation Conference, AIAA paper 92-4145.

Griscom, A. (1996) Anarchy and Hierarchy: Comparing the Cultural Repercussions of Print and Digital Media.
http://www.stg.brown.edu/projects/hypertext/landow/cpace/infotech/asg/ag28.html

Hackforth, R. (1952) Plato's Phaedrus. Indianapolis: Bobbs-Merrill, pp. 172

Hapeshi, K., & Jones, D. (1992) Interactive Multimedia for Instruction: A Cognitive Analysis of the Role of Audition and Vision. International Journal of Human-Computer Interaction, 4(1), pp. 79-99.

Hayes, D.S., Kelly, S.B., & Mandel, M. (1986) Incidental Processing of Speaker Characteristics: Voice as Connotative Information. Journal of Verbal Learning, 8, pp. 28-45.

Hooper Woolsey, K. (1991) Multimedia Scouting. IEEE Computer Graphics & Applications, pp. 26-38.

Janda, K. (1992) Multimedia in Political Science: Sobering Lessons from a Teaching Experiment. Journal of Educational Multimedia and Hypermedia, 1, pp. 341-355.

Kuhn, T. (1962). The Structure of Scientific Revolutions. Chicago: The University of Chicago Press.

McLuhan, M. (1967) *The Medium is the Massage.* New York: Bantam.

Markus, M. L., & Robey, D. (1988) Information Technology and Organizational Change: Causal Structure in Theory and Research. Management Science, 34(5), pp. 583-598.

Marmie, W.R., & Healy, A.F. (1995) The Long-Term Retention of a Complex Skill. In Healy, A.F. & Bourne, L.E. (Eds.). Learning and Memory of Knowledge and Skills: durability and specificity. Thousands Oaks, CA: Sage Publications, pp 30-65.

Marmolin, H. (1991) Multimedia from the Perspectives of Psychology. In Kjelldahl, L. (Ed.). Multimedia. Systems, Interactions and Applications. 1st Eurographics Workshop, Stockholm, Sweden April 18-19, 1991. Berlin, Germany: Springer-Verlag.

Morariu, J. (1988, November). Hypermedia in Instruction and Training: The Power and the Promise. Educational Technology. pp. 17-20.

Muehrcke PC (1978) Map Use: Reading, Analysis, and Interpretation. JP Publications, Wisconsin.

Nielsen, J. (1990). Evaluating Hypertext Usability. In D. H. Jonassen, & H. Mandl (Eds.). Designing Hypermedia for Learning. Berlin, Germany: Springer-Verlag, pp 147-168.

Nietzsche, F.W. (1989). Beyond Good and Evil: Prelude to a Philosophy of the Future. Translated by Walter Kaufmann. New York: Vintage Books.

Plato (1952). Phaedrus. Translated by R. Hackforth. Indianapolis: Bobbs-Merrill, pp. 172.

Peterson, M. (1994). *Cognitive Issues in Cartographic Visualization*. In MacEachren, A. and Taylor, D.R.F. edited Visualization in Modern Cartography. Oxford: Pergammon Press.

Peterson, M. (1997). Cartography and the Internet: Introduction and Research Agenda. *Cartographic Perspectives* 26, pp. 3-12.

Postman, Neil. (1986). Amusing Ourselves to Death: Public Discourse in the Age of Show Business. New York: Viking Press.

Price, M.L. (1995). Student Satisfaction with Distance Education and the Medium of Instruction: Is there a Relationship? In Maurer, H (Ed.). Educational Multimedia and Hypermedia 1995. Proceedings of ED-MEDIA95. Charlottesville, VA: AACE, pp. 550-555.

Wilde, Oscar. (1913) The Decay of Lying. London: Methuen & Co., pp. 1-55.

6 Designing Suitable Cartographic Multimedia Presentations

Doris Dransch

GeoForschungsZentrum Potsdam, Helmholtz Association of German Research Centers, Potsdam, Germany

6.1 Introduction

For cartography the predominant medium to present spatial information has been the map. Cartographers have developed suitable methods and theories for map construction and map use. New developments like multimedia presentations or mobile mapping, however, go far beyond a single map. They are highly interactive systems where cartographers and map users can envision geographic information using different media, like sound, video or animation, according to their particular purpose and interest. Multimedia cartography, therefore, requires methods and theoretical principles which concern not only the map but also other media.

The recent developments of multimedia techniques offer a wide range of hard- and software equipment that enables cartographers and map users to create and use cartographic multimedia presentations. To apply the powerful technique in a suitable way it is necessary to choose and combine media which best support the purpose of a multimedia presentation. This chapter focuses on two topics which are fundamental for suitable media application and combination: the function of media and the medium as an artefact. The question addressed is: to what purpose should a particular medium be put and what medium best suits this purpose?

6.2 Media functions and media as artefact

The importance of map functions was emphasised by Papay (1973), Ogrissek (1987) and Freitag (1993) because functions determine both the content and design of a map. In cartographic multimedia presentations attention also needs to be given to the functions that a particular medium has to fulfil, because the function controls the choice of media and how it should be combined with other media.

Functions of media in a cartographic multimedia presentation can be considered from different points of view:

- the function a medium has to fulfil in the perception of information;
- the function a medium has to fulfil in knowledge generation; and
- the function a medium has to fulfil according to the purpose of communication.

The suitability of media to present particular information, for example animations to show processes or diagrams to show relations between values, will not be discussed here as it is widely covered in literature (Schröder 1985; Schnotz 1994; Borchert 1996; Dransch 1997).

A further aspect which determines the choice of media as well as media combination is the task that supported by a multimedia presentation. Media have to be regarded as artefacts which are used to reach a specific goal. For that reason the task and its related activities are of great importance, too, when designing multimedia presentations.

6.3 Functions of media in information perception

A common opinion in the field of multimedia application is that as more media are applied and thus more senses involved, a better presentation results and thus aids the perception of information. This adoption is based on a paper by Dale (1946) where he points out the intensity of information processing according to different forms of information acquisition. A typical breaking up might be hearing causes 20%, seeing 30 %, and hearing and seeing 50% contributing to information acquisition. This ‘summation theory’ was criticised by other researchers (Dwyer 1978; Weidenmann 1995a) and it cannot be naively translated directly to multimedia as acoustic information presentation effects 20%, pictorial information presentation effects 30%, acoustic and pictorial information presentation effects 50% of information acquisition. Multimedia presentations often overwhelm the user as they are constructed according to summation theory and not according to conclusions from perception and cognitive research.

Human perception and cognition are restricted by several constraints (Paivio 1969; Neisser 1974; Kosslyn 1980). In the context of multimedia, particular attention must be given to limited capacity of short-term memory and the overabundance of single senses. Human short-term memory has the ability to retain only a few information units (four to seven units) simultaneously. In the case of information overload short-term memory information process is insufficient. It has been shown that information processing can be improved if information is repeated or elaborated upon and if perception is directed. Information should also be divided into separate visual and acoustic media to relieve single senses.

Considering this perception view, media may have the following functions in cartographic multimedia presentations:

Function of avoiding an overload of information

Media that have to serve this function must prevent information overload. Information overload can occur especially with dynamic media like cartographic animation and video. Text used as an additional medium can avoid the overabundance of dynamic media because it can name presented information and prepare a user for that information (Lurija 1992). The text should be directed to a second sense organ and be presented in an acoustic form to relieve the visual senses from perceptual overload.

Function of increasing important information

Media which have to emphasise important information must repeat and elaborate a particular piece of information. In cartographic multimedia presentations different media like maps, pictures, text and sound can be combined to show various aspects of a spatial object or phenomenon and, in that way, they can increase and accentuate information.

Function of directing perception

Media that have to fulfil this function must direct perception. They have to guide the users' interest and direct their attention to significant information. Written or spoken text like ”compare”, ”take note of” or ”look at first” may help to exploit maps, pictures or cartographic animations.

6.4 Functions of media in knowledge generation

6.4.1 Cognitive approach

According to constructivist theory, knowledge is not objective and cannot be transmitted from one person to another. Knowledge is something very individual which is generated in a personal cognitive process and depends highly on a person's pre-knowledge and on the form and context of its presentation. Pre-knowledge acts as a filter which directs perception as well as enabling the interpretation of new information (Neisser 1974; Antes and Mann 1984; MacEachren 1991). The more pre-knowledge that exists the more new information is activated, and thus more filters can be brought into use, leading to a more comprehensive knowledge processing activity. Presentation form and context also affect the structure of knowledge (Howard 1983). Different presentations give different insights into a phenomenon. They guide the creation of various schemata or mental models, and in this way they support the generation of multifarious knowledge structures.

Cartographic multimedia presentations should offer a generous palette of various media plus flexible media combinations to support the user. This must be characterised by the users' personal pre-knowledge and competence in comprehensive knowledge generation. This is especially true for cartographic multimedia presentations provided via the Internet because they often lack a defined user group. Media may have the following functions in this context:

Function of activating pre-knowledge

Media that have to activate pre-knowledge must present familiar information. They have to support the organisation of new knowledge in such a way that they offer points of contact from existing knowledge to new information. In cartography maps of strange areas are often combined with maps of familiar regions to allow users comparing the new with the familiar. Another example is sound of a particular time period or spatial area that can associate known and unknown information. Not only maps and sound but all media can fulfil this function.

Function of multiple presentations

Media which have to support multiple presentations must show information in various forms to offer the user different decoding schemata. They should display information in several abstraction levels, in different graphical presentations or in acoustic and visual form. All media are able to contribute to this function.

6.4.2 Approach of Erkenntnis theory

A further contemplation to knowledge creation comes from Erkenntnis theory (Keller 1990). This theory is based on the concept that knowledge creation occurs in a hierarchical sequence in different steps of appreciation: *experience*, the direct observation or action in the real world; *abstraction*, the generalisation of information obtained through experience; and *knowledge transfer to the real world*, the setting of knowledge obtained through abstraction in relation to the real world, for example for prediction or planning.

The concept of Erkenntnis theory was transferred to cartography and related to map construction (in the sense of map modelling) and map use by Sališčev (1975), Berlijant (1979), and Ogrissek (1987). According to this approach maps are differentiated according to their different levels of knowledge generation. First level maps show information obtained by direct observation, second level maps show transformed information and third level maps give recommendations for acting in the real world. This diversification can be also transferred to other media. Pictures or natural sound for example are first level media, maps or animations are second level media and a simulation is a third level medium. According to their levels of knowledge generation, media can support the different steps of appreciation - experience, abstraction and knowledge transfer to the real world.

In the field of computer visualization the idea exists that the more realistic a presentation is, the more helpful it is in information presentation. Therefore much research work has been undertaken to develop methods and techniques for creating more realistic presentations. Realistic presentations, however, are, according to Erkenntnis theory, suitable only for certain levels of knowledge generation. Other levels require a higher level of abstraction. In a cartographic multimedia presentation we have to decide which levels of knowledge generation are for support and which media are suitable to be included to show the information. In this context media may have following functions:

Function of supporting direct observation

Media for direct observation have to act as a substitute for the real world. They have to give a vivid impression of a spatial object or phenomenon. 2D-pictures, 3D-hologramms, video, animation in the form of realistic simulation or virtual realities and natural sound can be applied for that function.

Function of supporting abstraction

Media that have to support abstraction must present information in a processed and transformed way. They must be able to convey general concepts that go beyond individual situations. Maps, abstract animations, diagrams, and formal sound used for data exploration are suitable media in this context.

Function of supporting knowledge transfer to the real world

Media that have to support knowledge transfer to the real world should be able to show the effect of human interaction on the environment. They must be able to integrate existing and conceived objects. Suitable media are maps for prediction, virtual realities for decision making in planning and visual and acoustic simulations. An example of this is the simulation of the noise of planned objects like roads or airports.

6.4.3 Didactic approach

A third aspect in knowledge generation comes from didactic research. Didactic science investigates the processes of teaching and learning. A subdivision in didactic science is the didactic of media that focuses on media applications in the teaching and learning process. Issues of research here are the role of media in instruction and the functions of media in the learning process (Schulmeister 2001, Issing and Klimsa 2002).

Cartographic communication (as a dialogue or a monologue) can be regarded as a learning process in which spatial knowledge is created. Therefore principles of media application developed in the didactic can be transferred to cartographic communication and cartographic multimedia presentations.

Didactic science mentions different functions of media in the learning process (Strittmatter and Mauel 1995; Weidenmann 1995b). Some of these functions are significant for cartographic communication and will be elaborated here. They are the informing functions of demonstration, setting in context and construction, and the directing function of motivation.

Function of demonstration

Media for demonstration should help a user to get a suitable ‘picture’ of a phenomenon. For this task pictures, videos, realistic graphic representations and animations as well as virtual realities are suitable. Audio can give a vivid impression about noise and its spatial distribution. Media for demonstration are particularly useful and necessary for people without great knowledge about the topic being presented. (This function correlates closely with the function of supporting immediate observation in Erkenntnis theory).

Function of setting in context

Media that have this function should help a user to set information into a greater context. All media that can give a spatial overview or a thematic integration are suitable for this function. Examples are the traditional overview maps that present a wide spatial area, video that shows the neighbourhood of a spatial object or object group, or sound used to present the typical sound of a particular area or time period.

Function of construction

Media with the function of construction should help the user to create complex mental models. Mental models are constructions of pictorial and propositional knowledge about information units and their relationships. Media for this purpose have to inform about concepts, elements and their relationships. The creation of mental models is highly influenced by applied media. Pictures or realistic presentations are not suitable in this context. On the contrary, this function requires abstract media that show prepared information like text, maps, diagrams, graphs, abstract animations or formal sound. Media for this purpose have to initially give an overview of the complete information structure and subsequently they have to inform about detail.

Function of motivation

Media with motivational function should arouse the user's interest and attention. Knowledge acquisition depends highly on a user's motivation. Motivation can be produced by attraction and by moving and changing media. Therefore attractive pictures, dynamic media like animation and video and sound are best suited for this purpose.

6.5 Functions of media according to the purpose of communication

Functions of media (especially of maps) related to the purpose of communication are a particular point of interest in cartography (Board 1967; Papay 1973; Freitag 1993). The function of a map determines its efficiency in a distinct application and it affects its content, its design and its scale. According to Papay (1973) the primary determinant of a map's function are the users' requirements and interest, their knowledge about the presented subject and their experience in map reading. Later, Freitag (1993) distinguished several functions of maps. In multimedia cartography these functions have to be considered in the context of all available media. The functions are:

Cognitive function

"This function encompasses all processes and operations which generate and enhance spatial knowledge. All processes of ... map analysis, ... transformations, generalisations, animations, etc. should be listed here, if possible in a sequence of operations leading from near reality models to very abstract models of space" (Freitag 1993, p. 4). All media may support this function. Pictures, video, realistic animations like virtual realities or simulations, and natural sound can give a realistic impression of a spatial phenomenon. Maps, abstract animations, and artificial sound are able to present abstract models. The application and combination of different media depends on the users' competence. The higher the competence, the more abstract media can be.

Communication function

"The communication function (including demonstration function) encompasses all processes and operations of spatial knowledge transfer from a map maker to a map user" (Freitag 1993, p. 4). This function can also be performed by all media mentioned in the context of cognitive function. The application of media for communication has to be directed by the users' competence and by the different levels of appreciation distinguished in Erkenntnis theory.

Decision support function

"Decision support function encompasses all processes and operations which -based on evaluation of spatial phenomenon – result in spatial decisions and spatial actions." (Freitag 1993, p.4). Sub functions are navigation, spatial planning and persuasion.

Navigation

Navigation requires media that direct a users' way finding. Route maps or text for example as spoken instruction in a travel pilot may suit this function. Animations in the form of virtual realities and fly- or walk-throughs in combination with landmarks or an overview map might be another possibility. The efficiency of these animated presentations has not investigated comprehensively thus far. Spatial planning demands media that can present existing and conceived objects. Maps, animations, visual and acoustic simulations and virtual realities are suitable media for this function. Persuasion requires media to present information according to a particular interest on one hand or that touch emotions on the other. Suitable media are maps, pictures, video, animation and sound.

Social function

"Social function encompasses all processes and operations which result not in spatial but in social behaviour and actions" (Freitag 1993, p. 4). Examples are media as cultural or prestigious objects as well as media as tools with social power exercised through the access or denial of access of spatial information. The social function can be performed by all media.

6.6 Media as artefacts

Beside this more cognitive and communication oriented functions of media a further aspect has to be considered when choosing media and media combination in multimedia presentations. It is the task which has to be fulfilled, and the goal that has to be reached. A multimedia presentation is not just an information product it is also an artefact that has to support a person to achieve a certain task (Dransch 2001, 2002). Therefore, a cartographic multimedia presentation also has to be designed according to the requirements of the task. Presently, tasks have become more important in cartography. Recent developments in mobile and ubiquitous computing focus on the context in which a cartographic representation is used; beside location the task is a major component of context. A good basis for this task-oriented approach is Activity Theory which offers a suitable framework to model and characterise tasks (Nardi 1996).

A task can be described by different components:

- a goal which has to be reached;
- a sequence of activities (or actions) that has to be performed to achieve the goal;
- an actor in a certain role; and
- rules that have to be considered during the activity.

For cartographic multimedia presentation all these components are of importance. If cartographic presentations are regarded as artefacts it is necessary to know the activities they should support. In a cartographic context two types of activities exist: activities related to the real world, e.g. navigation, and activities related to the cartographic presentation, e.g. detecting location A and B, and finding the best route between them on a map. Both are connected and must be regarded for choosing useful media. A good overview of real world and map activities is given in Heidmann (1999) and Reichenbacher (2004).

The actor and his/her role also influence multimedia design. The map users and their characteristics like age, culture, interest and knowledge have to be considered as well as aspects of perception and cognition. From the perspective of tasks and artefacts a further point is of interest when describing the user or in this case the actor. Activity theory postulates: "You are what you do". According to this, the activity strongly affects the user/actor and characterises him or her. Bearing this in mind, cartographic multimedia presentations should be designed not only for the information processing user but also for *active users* e.g. "children undertaking learning or 'spatial data explorers' or 'spatial navigators'.

Finally, a task-oriented approach has to deal with the rules that are in operation with a certain task. It has to be proven, if the rules can be shown in the multimedia presentation. For example when planning a gas pipeline the acting person has to conform to different rules, e.g. keeping a minimum distance to another pipeline. The minimum distance could be visualized to support the acting person.

A task and its related activities can be seen as the superior criterion when designing a suitable cartographic multimedia presentation. The activity determines which processes are to support and therefore, which media should be selected and combined. Figure 1 depicts this relationship and gives an overview about the different map functions.

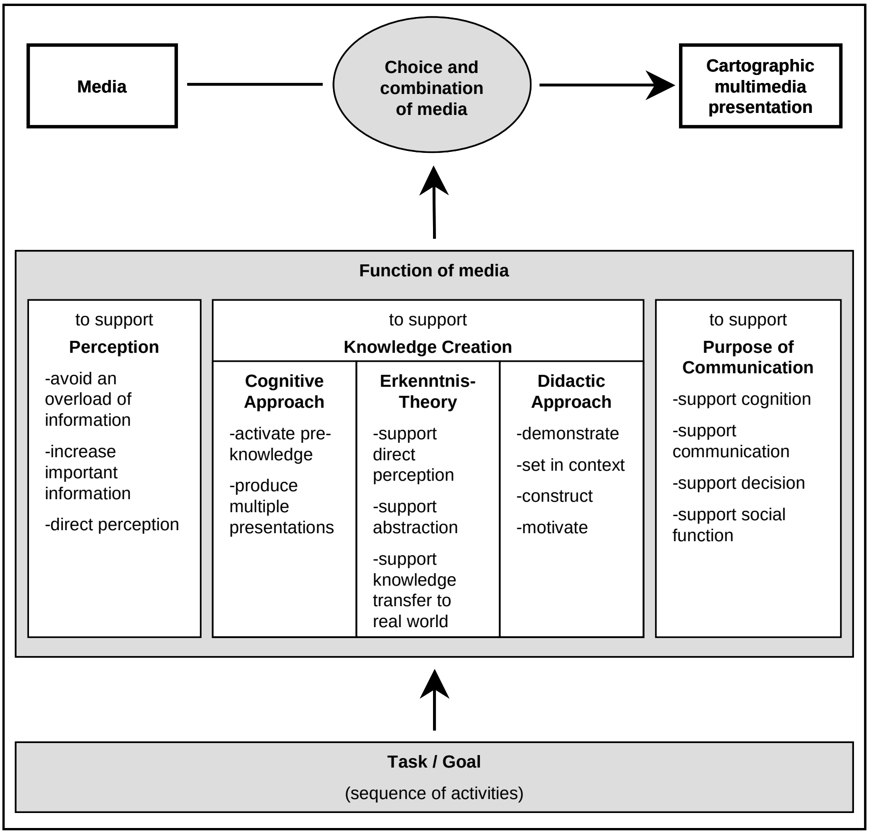


Fig. 1. Task and media function as influencing factors for cartographic multimedia presentations

6.7 Conclusion

The literature of multimedia points out repeatedly that not only the technical dimension of multimedia but also its application dimension needs to be considered. Only the application context accomplishes multimedia *techniques* to real multimedia *systems*. Klimsa (1995) mentions that not any arbitrary combination of media can be labelled as a multimedia system; only the combination of multimedia techniques, application context, and functionality can define actual multimedia systems.

This chapter's discussion of the functions of media and the artefact perspective in cartographic multimedia presentations has been undertaken to contribute to the strengthening of the application dimension of cartographic multimedia presentations. The media functions provided and the task-oriented aspects outlined should help in selecting and combining media in such a way that cartographic multimedia presentations are regarded as more than just a summation of individual media. This approach can contribute a useful application of multimedia to cartography. This is essential if multimedia is used as more than just entertainment and it supports the presentation and exploration of spatial data.

References

Antes JR, Mann SW (1984) Global-local precedence in picture processing. Psychological Review, 46, pp 247-259.

Berlijant AM (1979) Kartograficeskij obraz (Das kartographische Abbild). Izvestija akademii nauk SSSR. Ser. Geograf., Moskva 2, pp. 29-36.

Board C (1967) Maps as models. In: Chorley, R.J., Hagget, P. (eds) Models in Geography. London, pp 671–725.

Borchert A (1996) Zur Normierung des Herstellungsverfahrens hypermedialer Atlanten. Schweizerische Gesellschaft für Kartographie (ed) Kartographie im Umbruch. Tagungsband zum Kartographenkongress Interlaken 1996, pp. 189-202.

Dale E (1946) Audio-visual methods in teaching. New York.

Dransch D (1997) Computer-Animation in der Kartographie: Theorie und Praxis. Heidelberg.

Dransch, D., (2001) User-centered human computer interaction in cartographic information processing. In: Proceedings of the 20th International Cartographic Conference, Beijing 2001, pp 1767-1774

Dransch, D. (2002) Handlungsorientierte Mensch-Computer-Interaktion für die kartographische Informationsverarbeitung mit Geo-Informationssystemen. Habilitationsschrift. In: Berliner Geowissenschaftliche Abhandlungen, Reihe C, Bd. 18

Dwyer FM (1978) Strategies for improving visual learning.Pennsylvania.

Freitag U (1993) Map functions. Five selected main theoretical issues facing cartography. Report of ICA-Working-Group to define the main theoretical issues on cartography. Kanakubo T (ed) pp. 9-19.

Heidmann, F., 1999: Aufgaben- und nutzerorientierte Unterstützung kartographischer Kommunikationsprozesse durch Arbeitsgraphik. GCA-Verlag Herdecke

Howard DV (1983) Cognitive psychology: memory, language and thought. New York.

Keller, A (1990) Allgemeine Erkenntnistheorie. Stuttgart.

Issing, L.J.; P. Klimsa (eds., 2002): Information und Lernen mit Multimedia und Internet. Weinheim.

Klimsa P (1995) Multimedia aus psychologischer und didaktischer Sicht. In: Issing J, Klimsa P (eds) Information und Lernen mit Multimedia. Weinheim, pp. 7-24.

Kosslyn SM (1980) Images and mind. Cambridge.

Lurija AR (1992) Das Gehirn in Aktion. Einführung in die Neuropsychologie. Reinbek bei Hamburg.

MacEachren AM (1991) The role of maps in spatial knowledge acquisition. The Cartographic Journal, 28, pp 152-162.

Nardi, B.A,. (ed), 1996: Context and consciousness: activity theory and human-computer interaction. The MIT Press, Massachusetts

Neisser U (1974) Kognitive Psychologie, Stuttgart.

Ogrissek R (1987) Theoretische Kartographie.Gotha.

Paivio A (1969) Mental imagery in associative learning and memory. Psychological Review, 76: 241-263.

Papay G (1973) Funktionen der kartographischen Darstellungsformen. Petermanns Geographische Mitteilungen 117 /3:234-239.

Reichenbacher, Tumasch (2004) Mobile Cartography - Adaptive Visualisation of Geographic Information on Mobile Devices. Verlag Dr. Hut, München, 2004

Sališcev KA (1975) O kartograficeskom metode poznanija – Analiz nekotorych predstavlenij o kartografii (Über die kartographische Methode der Erkenntnis-Analyse einiger Auffassungen über die Kartographie). Vestnik Mosk. Univ., Ser. Geografija, Moskva, 30/1: 3-12.

Schnotz W (1994) Wissenserwerb mit logischen Bildern. In: Weidenmann B (ed) Wissenserwerb mit Bildern: Instruktionale Bilder in Printmedien, Film/Video und Computerprogrammen. Bern, pp. 95-148

Schröder P (1985) Diagrammdarstellung in Stichworten. Unterägeri.

Schulmeister, Rolf (2001) Grundlagen hypermedialer Lernsysteme. Theorie - Didaktik – Design. Oldenbourg Verlag

Strittmatter P, Mauel D (1995) Einzelmedium, Medienverbund, Multimedia. In: Issing J, Klimsa P (eds.) Information und Lernene mit Multimedia. Weinheim, pp. 47-64.

Weidenmann B (1995a) Multicodierung und Multimodalität im Lernprozeß. In: Issing J, Klimsa P (eds) Information und Lernene mit Multimedia. Weinheim, pp. 65-84.

Weidenmann B (1995b) Abbilder in Multimedia-Anwendungen. In: Issing J, Klimsa P (eds) Information und Lernene mit Multimedia. Weinheim, pp. 107-122.

7 Design of Multimedia Mapping Products

Suzette Miller

Cartographic Consultant, Australia

7.1 Introduction

Design is a complex process. The design of a conventional map-based product involves the cartographic abstraction (Muehrcke 1978) processes of dimensional transformation (scaling and projection), selection and generalisation and various graphic and structural design processes including symbolisation, visual composition, figure-ground and hierarchical organisation and content arrangement (Bertin 1967; Dent 1993; Keates 1973; MacEachren 1995; Robinson *et al.* 1995; Wood 1968). Conventionally, this process also involves a number of compromises due to design constraints such as map scale, presentation format, area coverage and the degree of geographical complexity required in a map-based product. This complex process is made more complex in a multimedia environment by the addition of a greater number of design constraints, a greater and more varied quantity of media with which to work, and the incorporation of tools to enable users to interact directly with maps and map-based information. This chapter aims to simplify this complex process by discussing an approach to designing multimedia map-based products.

The approach to designing multimedia map-based products discussed in this chapter is equally applicable to both discrete (e.g., CD-ROM) and distributed (e.g., WWW) mediums of presentation. At the same time it should be recognised that given the current technological limitations associated with presenting and providing access to content via the WWW (i.e., limited bandwidth and modem speed), much of the design approach discussed in this chapter is far more easily achieved when using discrete media for distribution.

This chapter focuses on the design of discrete multimedia map-based products that communicate spatial, thematic and temporal information about the geographical environment by exploiting maps as the primary, yet not exclusive, source of information. The concept of the map has been extended in more recent years and is approaching a stage of re-evolvement with technologies such as virtual reality and research into visualisation promising new ways of representing information. Despite this, currently the map, as conventionally defined, remains the primary tool for the presentation of spatially definable content, particularly from a publication perspective. It is recognised that this focus on maps as they are more conventionally defined, as graphical representations, and on multimedia map design as an extension of existing map design techniques, is perhaps an interim approach.

7.1.1 Concepts of Map-Based Access

Map-based access enables users to access multimedia content relative to spatial locations via map symbols that have been defined as ‘hotspots’. It is important to make a distinction between two types of map-based access:

1. Map-based access in which maps are used as ‘Content Organisers’. As content organisers, maps visually organise content using a spatial metaphor. Multimedia content is not designed to aid in the decoding and interpretation of maps, rather, maps are used to arrange content in an easily accessible manner. This type of map-based access is intuitive for information systems for such applications as tourism (Mogorovich *et al*. 1992; Panagopoulou *et al*. 1994; Schewe 1993). Map-based access has also been used to organise content that is not conventionally spatial in nature (Hodges and Sasnett 1993). In fact, as a content organiser, map-based access has emerged as a relatively common means of access in multimedia products and web-based sites.
2. Map-based access in which multimedia content is intended to support and enhance map decoding and interpretation. This type of map-based access is less common but it is anticipated that this will change. This is particularly so given the interest of cartographic researchers in finding new ways to use animation, digital and multimedia techniques to increase the ease with which users use maps.

7.1.2 Presentation and Structure Characteristics of the Multimedia Environment

Multimedia products and print-based products use distinctly different information presentation and information structure techniques given the characteristics of each environment of use. Multimedia mapping products are dynamic, interactive, associatively accessed, modifiable and functional products that use a synthesis of audio and visual media for cartographic representation. Product design must take into account the requirement to seamlessly integrate multiple media and to enable direct user interaction with information. Product design must also incorporate the use of dynamic and responsive environments of display and increased functionality enabling analytical and manipulation capabilities. Information structure in a multimedia environment is influenced by the limitations imposed by a computer screen display environment. Restrictions in screen display size and resolution require that manageable chunks of information are used. Since random and associative access are possible, consideration must be given to the manner in which content is arranged in organisational structures, and the way in which access mechanisms are provided. In addition, meaningful relationships between content must be constructed based on information, rather than media, content. This chapter discusses a design approach in accordance with these new information presentation and structure requirements.

7.1.2.1 The Hypermedia Paradigm

The 'hypermedia paradigm' (Maurer and Tomek 1990) refers to the application of the principles of hypermedia to computer applications or product construction. The concept of hypermedia is generally used to refer to the associative linking of chunks of information in large, active, networked systems such as the WWW (Maurer 1993; Parsaye *et al*. 1989). However, its underlying principles are also appropriate for the structure of information in multimedia products that do not necessarily represent large, active databases, and do not always enable entirely flexible access to content (Apple Inc. 1994; Parsaye *et al.*1989). Such products use the 'hypermedia paradigm' rather than the fully-fledged definition of hypermedia.

Hypermedia is an important concept in terms of the structuring of multimedia information. In a hypermedia environment, information is structured as a series of nodes (modules of information) that are connected according to active contextual relationships (associative links). These modules are usually, but not exclusively, complete pieces of information that can be viewed independently of other information (Ambron and Hooper 1988; Jonassen 1989; Shneiderman and Kearsley 1989). Landow (1991) contends that the very existence of links in hypermedia products and systems conditions the user to expect purposeful relationships between connected information. Based on this contention, the spatial environment of access created by using a map as an interface component, conditions the user to expect a purposeful relationship between the map point of access and the information displayed. As such, the hypermedia paradigm is integral to the concept of map-based access.

7.2 Components and Design of Multimedia Map-Based Products

This section provides a brief overview of the main components of multimedia map-based products that are structured according to the hypermedia paradigm. In this chapter, the term 'object' is used to refer to a node in the hypermedia environment of a multimedia map-based product. More correctly, and as part of wider research undertaken by the author of this chapter, the term refers to a node in an object-oriented product construction environment (Miller 1996). The multimedia map-based product is comprised of three primary components:

1. the Graphical User Interface (GUI);
2. a content-set; and
3. object links.

Although each of these components is briefly defined, the focus of this chapter will be on the GUI.

7.2.1 The Multimedia Map-Based Product GUI

The success of a multimedia product is determined primarily by its Graphical User Interface (GUI) (Apple Comp. Inc. 1994). Although content, the contexts within which content is used and the associations between content are also determining factors (Blum 1995), it is the GUI that enables product functionality, navigation and the visual display of content to be realised. The GUI is particularly important in multimedia map-based products given the use of map-based access and the fact that in many instances multimedia content and functionality is intended to support the map content. The multimedia map-based product GUI is comprised of two components: the map object (a responsive display construct that is the primary means of product control and provides direct spatial access to product content); and marginalia objects (referring to those objects that exist outside the bounds of the map object that incorporate display, access, navigation and interaction tools).

Every graphic presentation employs visual hierarchies that aim to guide the viewer's eye across the display in a manner fitting to the content (McCleary 1981). The multimedia map-based product GUI requires a clear visual hierarchy in order to separate its component parts, both visually and conceptually. This can be achieved via the use of structured display viewers, a window or an area of the screen display that is distinct from all other areas (Blum 1995) and/or the use of graphic design variables such as colour. In fact, colour is becoming a ‘pseudo-standard’ for creating distinction between different components and content of multimedia and web-based products (Sather *et al*. 1997).

7.2.1.1 The Map as a Display and Product Control Construct

The map object is the key component of the multimedia map-based product and functions as both a product control and display construct. The map object is a composite object composed of a conceptual framework (‘map object model’) and a number of visual representations of this framework (‘map object displays’). Each map object is defined according to a distinct spatial coverage with its component 'map object model' storing a number of combinations of attribute values according to theme, timeframe and scale. Each combination of attribute values is associated with a ‘map object display.’ In order to construct a multimedia map-based product, each component map object display must represent an individual map (pre-created, dynamically generated or a combination of the two) whose design has been optimised according to a specific theme, timeframe and scale.

In the multimedia map-based product, every object has a relationship with the map object and the map object controls how each object is displayed and behaves. It acts as the product control construct, determining object behaviour in response to user interaction and controlling the relationships between objects in the product. As a visual display construct, the map object uses a ‘symbol-oriented’ structure (see Sect. 7.2.1.2) and a hierarchical arrangement of content to emphasise spatial locations, distributions and relationships. The symbol-oriented structure of the map object enables controlled access to multimedia content to enable the decoding and interpretation of the map object. All access is controlled by the map object relative to a specific spatial context governed by the spatial attributes of individual symbol objects and map object theme and timeframe. The map object and its associated components are displayed in Fig. 7.1.

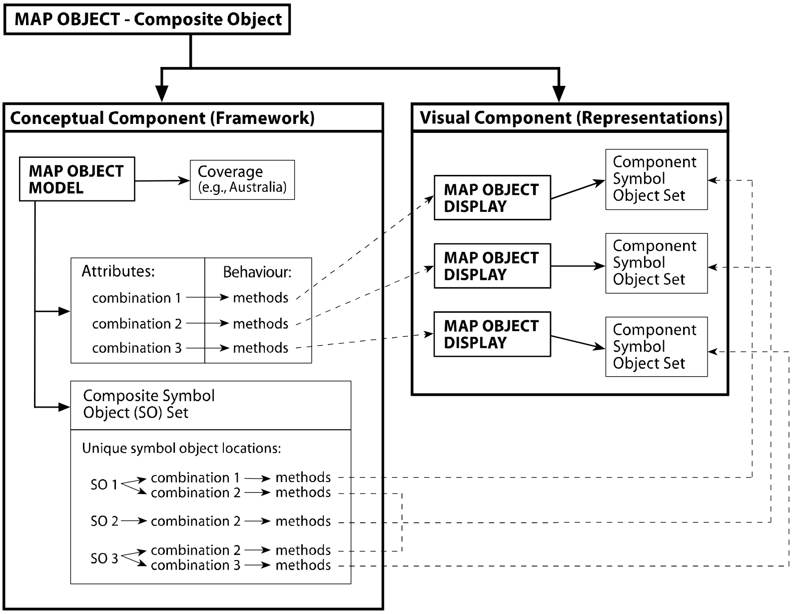


Fig. 1. The Map Object: The relationship between the 'map object model' and the component 'map object displays'.

'Scale-Sets'. Multimedia map-based products are publication quality products whose map content is optimised for display at a specific scale. Generalisation, symbolisation and other design components are specific to a certain scale in both conventional and multimedia map-based products. To avoid destroying map design components, it is not sufficient to merely enlarge or reduce a single map object display in a multimedia product. In order to ensure the map object is optimised for display at all the scales at which it may be displayed, it is necessary to create 'scale-sets' with each map in the scale-set optimised for viewing within a specific 'scale-range'. A 'scale-range' refers to the range of scales at which a map can be optimally displayed (Arnberg 1993).

Coverage Maps. Map object view and map object coverage are distinctly different in a multimedia map-based product. Kuhn (1991) defines view as the visual field that contains what a user sees at a specific point in time. Therefore, map object view refers to the portion of the map object coverage displayed at a point in time. In comparison, the map object coverage refers to the extent of the spatial information contained in the map object. In most instances this will exceed the available map object view area due to the current limitations associated with the environment of display (VDU display and resolution) (Wood 1993).

The synoptic effect is inherent to all conventional map-based products where maps can be viewed in their entirety and compared directly with other maps. The multimedia map-based product can not maintain this synoptic overview in the map object without increasing levels of generalisation in order to maintain legibility, which in many instances renders the map object content largely unusable. The lack of synopticity can be minimised by the use of a coverage map and a flexible map object viewer. To enable the user to locate the map object view with respect to the map object coverage, it is necessary to employ the use of a map that acts as a positional indicator. This is referred to as the coverage map. In addition, in order to provide a flexible map object viewer it must be possible to display multiple views of the map object coverage to enable regional and thematic comparisons.

7.2.1.2 Symbol Objects

Associated with each map object is a composite symbol object set. Each symbol object in this set has a unique location, and a number of associated structures and behaviours depending upon the map object attribute values of theme, timeframe and scale. Each map object display is also comprised of a set of symbols referred to as the component symbol object set, however, these are only visual in nature. The behaviour of each symbol in the map object display is controlled by its corresponding symbol in the composite symbol object set according to the attribute values of the map object. As such, each unique symbol object location has associated with it a number of different visual representations and behaviours according to theme, timeframe and scale (see Fig. 1).

Symbol objects in a map object display are of two types:

1. First Order Symbols – symbol objects that have a direct relevance to the map object theme. Symbols of this type have multimedia content associated with them that is intended to aid in decoding and/or interpretation. Controlled access is provided to this content via the map object. First order symbol objects represent the most visually and intellectually dominant symbol objects.
2. Second Order Symbols – symbol objects that contribute to the overall spatial structure of the map object. They provide the spatial framework necessary for the decoding and/or interpretation of the first order symbology. Whilst second order symbols are defined as objects

and may be responsive to user interaction, they do not have any associated content to which they provide access.

When integrated, first and second order symbol objects create spatial structure via visual hierarchies in the same way as the conventional map.

The visual role of symbology in a multimedia map-based product corresponds to that of the conventional map, however, while symbology in a conventional map is static and a means of display only, in a multimedia product symbology has extended functionality. Each symbol object is responsive to user interaction. In addition, each first order symbol object has associated multimedia content, that may or may not be intended to enhance map object decoding and interpretation. The associated multimedia content is arranged according to an organisational structure (see 7.2.3) based on the map object attributes of theme and timeframe and the specific symbol object location within a coverage. Each first order symbol object represents the parent node in an associative network to which other nodes are cross-referenced.

Each 'map object model' and its associated symbol object set is defined by the attribute of coverage, however, it is the attributes of theme, timeframe and scale that determine the specific visual structure and behaviour of symbol objects that are visible to a user. Each symbol object has an associated state and behaviour. Two mechanisms are used to enable symbol objects to function in the map object:

1. Display Mechanisms – these mechanisms control the visual appearance of a symbol object in response to user interaction and enable the incorporation of ‘self-describing’ symbols.
2. Access Mechanisms – these mechanisms are exclusively associated with first order symbol objects and control the access of multimedia content relative to unique symbol object locations.

Both mechanisms enable the incorporation of ‘user-notification stimuli’.

Self-Describing Symbols – The Embedded Legend. According to Blum (1995), icons in user interfaces, particularly multimedia interfaces, are not intuitive to every user. In many instances, the same can be said of map symbols. Most maps contain symbology that requires explanation in order to enable decoding and interpretation. Conventionally this has been provided by a legend, part of the map marginalia, requiring a visual comparison with the map content in order to decode the symbology (Robinson *et al*. 1995). In a multimedia map-based product, the symbol-oriented structure of the map object makes possible the concept of ‘self-describing’ symbol objects.

A ‘self-describing’ symbol provides its own descriptive information. As such, each symbol object in the map object has a unique legend associated with it. This legend is a component of the symbol object structure and remains hidden until exposed, if required, by the user. A ‘self-describing’ symbol also alleviates many of the problems associated with the limitations of computer screens as display devices for high resolution map data by enabling identification information to be displayed as needed rather than persistently. The activation of ‘self-describing’ symbols when using a multimedia map-based product can be the result of setting a mode of display (Armenakis 1993). Alternatively, ‘self-describing’ symbols can be an integral and persistent part of symbol object structure (Miller 1996). For example, descriptive information can be accessed by simply moving a mouse cursor over a symbol.

Self-describing symbol objects and the multimedia environment provide an opportunity to increase the detail and specificity of legend material accessible from individual symbol objects. For example, since a symbol object is self-describing, its legend content may be slightly different to that of another symbol object of the same graphic appearance. Therefore, legend content is spatially as well as thematically specific.

User Notification Stimuli. A user notification signal is an aural or visual signal, such as a change in symbol object colour or intensity (brightness). According to Lynch (1994), signals or ‘cues’ are necessary to provide feedback to users and are fundamental design features of graphical user interfaces. A key multimedia component is the ability to enable the dynamic presentation of content. Since symbol objects are dynamic and responsive to user interaction, each symbol object in the multimedia map-based product, encapsulates within its internal structure the ability to provide user notification for the purpose of indicating:

- the presence of an access mechanism or the status of a symbol; and
- a spatial relationship between itself and an information object.

A number of standard multimedia interface techniques have emerged as a means of indicating the presence of embedded content, or an access mechanism. Of these, cursor modifications are the most universally employed means of indicating the existence of ‘hidden’ information in multimedia products (Blum 1995; Michon 1992). Cursor modifications can be further extended to indicate the type of information that can be accessed (Blum 1995). For example, this may involve using a camera icon to indicate the presence of a photograph when moving a mouse cursor over a symbol object.

Modifications to symbol object appearance can be used to indicate both the presence of an access mechanism and a spatial reference between a symbol object and an information object. A direct manipulation interface is one that supports visibility of the object of interest (Shneiderman 1987). Since the multimedia map-based product represents a direct manipulation interface, it is necessary to ensure that symbol objects that have the users attention have greater visibility. This can be achieved by manipulating the conventional visual variables of the symbol object and/or via the use of dynamic visual variables (DiBiase *et al.* 1992; Köbben and Yaman 1995). Several cartographic multimedia products utilise user notification signals. Jiang *et al.* (1995) refer to the use of 'blinking' to attract user attention. Armenakis (1993) alludes to the use of user notification signals with respect to the *1:50,000 Topographic Map Application* in which 'double-clicking' on a road (for example) causes the road to be highlighted and information provided. Ishizaki and Lokuge (1995) refer to the use of opacity and transparency to create hierarchical relationships between symbols in maps based on a context.

User notification stimuli are an inherent component of symbol object structure and are visual and/or aural in nature. From a visual perspective, recent research on dynamic visual variables (Köbben and Yaman 1995; Wang and Ormeling 1996) can be applied to the construction of user notification stimuli. From an aural perspective, cartographic research on sound variables (Krygier 1994), and more generic research on sounds in the user interface (Blattner 1993), suggest that when combined with visual responses, sound can be effectively used as a means of user notification.

7.2.1.3 Marginalia – A Concept Extended

The concept of marginalia is extended in a multimedia map-based product. Conventionally, marginalia refers to information (graphical, image or textual) that exists outside the spatial bounds of a map and whose primary role is to aid in the decoding and interpretation of that map. In the multimedia map-based product, map marginalia shares the same primary aim, however, it is more varied and requires additional capabilities to support the decoding and interpretation of the map object. The multimedia map-based product contains three types of marginalia: spatial, manipulation and navigation marginalia.

Spatial Marginalia. Spatial marginalia are visually dynamic objects that are seamlessly and actively linked to the map object and may include scale, direction, geographic location and legend information. Being actively linked to the map object, any change in, for example, map scale or coverage is reflected in the spatial marginalia while it is also possible for the user to change the scale, orientation and map object view via the direct use of spatial marginalia. Despite the incorporation of ‘self-describing’ symbols, a legend should also be available on request for purposes where symbol object comparisons are necessary to facilitate interpretation.

Manipulation Marginalia. Manipulation marginalia enable direct interaction with the attributes of the map object. Many of these tools prompt a change in the values of map object attributes causing the map object display to respond accordingly. According to Asche and Herrmann (1994), interactive maps should provide zoom and scale controls to enable direct user interaction. Fundamental manipulation marginalia should also include panning functionality, view modification and, depending on the product, layer manipulation and search functions.

Navigation Marginalia. The standard multimedia product contains some sort of reference to the overall product content usually via content listings consisting of subject or theme headings. This provides the upper level structure of the product as well as a means of providing an overview of product content. In the multimedia map-based product, navigation marginalia function as a content overview that is displayed in conjunction with the map object as a component of the GUI. Coverage, theme and timeframe selectors, or navigators, should be persistently available as ‘buttons’, icons or pull-down menu structures to enable a user to change the attribute values (coverage, theme and timeframe) of the map object and therefore the current map object display. The attribute values of the coverage navigator are persistent within the product GUI since the range of coverages available does not change. In comparison, the map object attribute values of theme and timeframe are non-persistent. Different themes may be related to different coverages and different timeframes may be related to different themes. As such the theme and timeframe navigators are active. A sub-theme navigator may also be incorporated; this is controlled by the attribute value of theme and represents a means of content access (in addition to symbol object access to content). This enables the rapid access of specific information of interest, however, it is important that a spatial context is maintained by ensuring the spatial locations, distributions and relationships to which content relate are always visible within the map object itself (see Miller 1996 for a more detailed coverage). Depending upon the required functionality of the product, search tools should also be incorporated to assist user navigation and access.

7.2.2 The Multimedia Content-Set

The multimedia content-set refers to the content objects contained within the multimedia map-based product such as maps, photos, text, video and sound. A multimedia MBIP content-set is comprised of four types of content objects which have distinctly different roles:

- Direct Spatial Objects – referring primarily to map object displays and to other maps used as locality indicators and to illustrate spatial concepts or distributions;
- Information Objects – referring to the multimedia content used to assist in map object decoding and interpretation. Every information object has a spatial context;
- Functional Objects – referring to the visual objects used in the multimedia MBIP GUI. These include marginalia objects and other standard multimedia interface objects; and
- Aesthetic Objects – used only as a means of increasing the aesthetic appeal of a product.

7.2.3 Object Links and Organisational Structures

Object links are used to define relationships between symbol objects and information objects and between individual information objects. There are various types of object links, also referred to as associative links (Bielawski and Lewand 1991; Parsaye *et al*. 1989; Woodhead 1991). Miller (1996) discusses an approach to classifying links and thereby the relationships between information objects and the map object.

Organisational structure refers to both the ‘concept structure’ and ‘content order’ of information objects (Sikillian 1995). Concept structures connect objects according to a common semantic category and in a multimedia map-based product are used to create associations based on spatial context. Concept order refers to the order in which objects are accessed or the arrangement of objects. Therefore, organisational structure refers to the types of information objects to which a symbol object is referenced and the order in which these are presented during content access. Each symbol object in the map object has an associated set of information objects arranged in an organisational structure according to map object theme and timeframe and the unique location of the symbol object. Conceptually, a symbol object with a specific map object location may have a number of organisational structures associated with it according to different map object attribute values.

The organisational structures used in multimedia map-based products are highly structured in nature in order to guide access and user interaction (Asche and Herrmann 1994; Ormeling 1993), however, this does depend upon the requirements of the product. Generally, the aim is to convey a thematic and/or temporal structure, based on a spatial context, between linked symbol objects and information objects (Miller 1996).

7.3 Conclusion

Multimedia is a potentially powerful tool for geographical representation. It enables a greater quantity of a more diverse range of media to be used to increase the potential for the communication of spatial information. It also enables an interactive, dynamic environment in which a user can explore, manipulate and transform spatial information. This ability to incorporate such a wide range of media into map-based products can have a tendency to focus the cartographer's attention on issues other than map design. Map design still remains a primary means of spatial communication in a multimedia environment, particularly in the multimedia map-based product environment discussed in this chapter. Despite the potential that interactive three-dimensional spatial environments, virtual worlds, and the more immersive environments of virtual reality offer for representing spatially definable content (Jacobson 1994; Koop 1995), it can be surmised that the two-dimensional map, whether in hard-copy or multimedia format, will remain a dominant means of spatial representation given its ability to provide a succinct summary of spatial patterns and relationships within a coverage. It is at the development of multimedia products whose primary content is the two-dimensional map that this chapter is aimed. This represents a sub-set of the ever increasing field of multimedia cartographic design.

References

Apple Computer Inc. (1994) Multimedia Demystified. Random House, New York

Armenakis C (1993) Hypermedia: An Information Management Approach for Geographic Data. In: Gis/LIS '93 proceedings, ACSM-ASPRS-URISA-AM/FM, Minneapolis, 1:19-28

Arnberg W (1993) Design Concepts of the National PC-Atlas of Sweden. In: Proceedings of the Seminar on Electronic Atlases, ICA, Visegard, Hungary, pp 113-128

Asche H, Hermann CM (1994) Designing Interactive Maps for Planning and Education. In: MacEachren AM, Taylor DRF (eds) Visualisation in Moderm Cartography, Pergamon, pp 215-243

Bertin J (1967) Graphics and Graphic Information Processing. Translated by Berg WJ, Scott P (1981) Walter de Gruyter and Co., New York

Bielawski L, Lewand, R (1991) Intelligent Systems Design: Integrating Expert Systems, Hypermedia and Database Technologies. John Wiley and Sons Inc., USA

Blattner MM (1993) Sounds in the Multimedia Interface. In: Proceedings of ED-MEDIA 93 – World Conference on Educational Multimedia and Hypermedia, Orlando, Florida, pp 76-82

Blum B (1995) Interactive Media Essentials for Success. Ziff-Davis Press, California

Dent BD (1993) Cartography. Thematic Map Design. Wm. C. Brown Publishers, Melbourne

DiBiase D, MacEachren AM, Krygier JB, Reeves C (1992) Animation and the Role of Map Design in Scientific Visualisation. In: Cartography and GIS, 19:4:201-214

Hodges ME, Sasnett RM (1993) Multimedia Computing. Case Studies from MIT Project Athena. Addison-Wesley Publishing Company, Massachusetts

Ishizaki S, Lokuge I (1995) Intelligent Interactive Dynamic Maps. In: Proceedings of Auto Carto 12, North Carolina, USA, 4:41-48

Jacobson R (1994) Virtual Worlds Capture Spatial Reality. GIS World 26:1:36-39

Jiang B, Kainz W, Ormeling F (1995) Hypermap Techniques in Fuzzy Data Exploration. In: Proceedings of the 17th ICC, Poster Session, Barcelona, pp 1923-1927

Jonassen D.H (1989) Hypertext / Hypermedia. Educational Technology Publications, New Jersey

Keates JS (1973) Cartographic Design and Production. Longman Group Ltd., London

Köbben B, Yaman M (1995) Evaluating Dynamic Visual Variables. In: Proceedings of the Seminar on Teaching Animated Cartography, Madrid, pp 57-65

Koop O (1995) Reality and Realities: A Brief Flight Through the Artificial Landscapes of the Virtual Worlds. In: Proc. Seminar on Teaching Animated Cartography, Madrid, pp 57-65

Krygier JB (1994) Sound and Geographic Visualisation. In: MacEachren AM, Taylor DRF, Visualisation in Modern Cartography, Pergamon Press, UK, pp149-167

Kuhn W (1991) Are Displays Maps or Views? In: Auto Carto 10 Technical Papers, Baltimore 6:261-274

Landow GP (1991) The Rhetoric of Hypermedia: Some Rules for Authors. In: Delany P, Landow GP (eds) Hypermedia and Literary Studies, The MIT Press, Cambridge, pp 81-104

Lynch PJ (1994) Visual Design for the User Interface, Part 1: Design Fundamentals. Journal of Biocommunications 21:1:22-30

MacEachren AM (1995) How Maps Work. Representation, Visualization and Design. The Guildford Press, New York
McCleary GF Jr. (1981) How to Design An Effective Graphics Presentation. In: Moore PA (ed) How to Design an Effective Graphics Presentation. Harvard Library of Computer Graphics / 1981 Mapping Collection, Volume 17, Harvard College, Massachusetts
Maurer H, Tomek I (1990) Broadening the Scope of Hypermedia Principles. Hypermedia 2:3:201-221
Maurer H (1993) An Overview of Hypermedia and Multimedia Systems. In: Magnenat Thalman N, Thalman D (eds) Virtual Worlds and Multimedia. John Wiley & Sons, Chichester, pp 1-12
Michon B (1992) Highly Iconic Interfaces. In: Blattner MM, Dannenberg RB (eds) Multimedia Interface Design, ACM Press, New York, pp 357-372
Miller S (1996) Design Rules for the Construction of Multimedia Map Based Information Products. PhD Thesis, Department of Land Information, RMIT University, Australia
Mogorovich P, Magnarapa C, Masserotti MV, Mazzotta S (1992) Merging GIS with Multimedia Technologies: The Case Study of an Information System for Tourist Applications. In: Proceedings of EGIS '92, 3.European Conf. and Exhibition of GIS, Munich, pp 1085-1094
Muehrcke PC (1978) Map Use: Reading, Analysis, and Interpretation. JP Publications.
Panagopoulou G, Sirmakessis S, Tsakalidids A (1994) Athena: Integrating GIS and Multimedia Technology. The Design of a Tourist Information System for the County of Attica. In: Proceedings of EGIS '94, Vol.1, Paris, pp 391-400
Parsaye K, Chignell M, Khoshafian S, Wong H (1989) Intelligent Data Bases. John Wiley and Sons, New York
Robinson AH, Sale RD, Morrison JL, Muehrcke PC, Kimerling AJ, Guptill SC (1995) Elements of Cartography. John Wiley and Sons, USA
Sather A, Ibanez A, DeChant B, Pascal (1997) Creating Killer Interactive Web Sites. Hayden Books, Indiana
Schewe J (1993) Concept and Structure of a Cartographic Information System for Tourists. In: Proceedings of the 16th International Cartographic Conference, Cologne, pp.1343-1348
Shneiderman B (1987) Designing the User Interface: Strategies for Effective Human-Computer Interaction. Addison-Wesley, Massachusetts, USA
Shneiderman B, Kearsley G (1989) Hypertext Hands-On! An Introduction to a New Way of Organising and Accessing Information. Addison-Wesley, Masachusetts
Sikillian M (1995) A New Model for Developing Complex Hypertexts. Asymetrix Multimedia Conference , Melbourne
Wang Z, Ormeling F (1996) The Representation of Quantitative and Ordinal Information. The Cartographic Journal 33:2:87-91
Wood M (1968) Visual Perception and Map Design. The Cartographic Journal 5:1:57-58

Wood M (1993) Interacting With Maps. In: Medyckyj-Scott D, Hearnshaw HM (eds) Human Factors in Geographical Information Systems, Chapter 9, Belhaven Press, UK, pp 111-123

Woodhead D, Tatnall A (1991) Information Technology: Theory, Application and Impact. Dellasta Pty. Ltd., Australia

8 Map Concepts in Multimedia Products

Ferjan Ormeling

University Utrecht, The Netherlands

8.1 Introduction

This chapter provides some insight into the theoretical issues that relate to the design and production of cartographic multimedia products. The concepts related to Multimedia Cartography are largely derived from cartography itself. Therefore, we will first look at the general contributions of cartographic products (maps and atlases) before we look at the specific cartographic concepts of multimedia products. The latter can be subdivided into 'meta' concepts used for accessing the information contained in the products (navigation, access), and concepts where maps are the means for exploration or information transfer. Consequently we will consider the role played by maps:

- as organisers of the multimedia products;
- as container of links to other multimedia elements;
- as interface to the geographical database; and
- as vehicles for interaction.

Subsequently, the conditions for proper interaction will be discussed.

It is always relevant to realise what concepts the procedures one follows are based on - if only to check whether one has a sufficiently good reason to deviate from them. The concepts described here make us understand why specific approaches have been taken when dealing with maps in multimedia products. If we want maps or atlases to play their expected role in a multimedia environment, we should see that the conditions to play that role are met, and that the (cartographic) interfaces needed are in place. Only then can we ensure proper interaction with the data, and that is what a multimedia approach is all about.

8.2 General Map- and Atlas-related Concepts

Maps as models of spatial reality

Maps serve as scale models of spatial or geographical reality. Because they are rendered to a specific scale, maps provide overviews that are otherwise beyond one's ability to conceive. As these overviews are made to serve specific purposes (game hunting, tax gathering, inventorying resources) these models are also selections of the various possible information layers, containing only the information thought to be relevant for a specific objective.

Maps as providers of spatial insight

What is the advantage of a multimedia atlas? In the first place they provide answers to specific questions. Maps inventorize, and therefore they can answer a question like:What is there? Maps suggest explanations because they show the proximity and interrelationships between the objects depicted. Therefore, they help in answering the question: Why is that there? Because they are generalisations and selections from all the possible data that could have been rendered, maps are able to show overviews. So they would answer the question: Where is that? And, as an answer to that question, spatial patterns can be interpreted from the map.

The number of these map-based questions can be expanded exponentially when we combine maps in an atlas. Besides asking what is there, we can also ask what more is there? Such a combination would allow us to ‘mine’ different data sets in order to find multiple attributes for the same location. These various data sets have all been processed in the same way, in order to have their level of generalisation, and therefore their patterns, comparable at a specific resolution set by the user. So the users would be able to ask for example: What phenomena have the same distribution pattern over this area?

Users would ask all these questions because it would allow them to anticipate spatial phenomena when planning a trip. It would allow them to plan for specific conditions set by climate, altitude, etc. Users would be able to make themselves familiar with the local situation. Few map users can mentally transform the abstract contour-based map images into a fly-through rendering. Analogous to the training of pilots in flight simulators, we can provide this kind of virtual environment as well. That will allow people to visualise space through our multimedia atlases. The armchair travellers of today, in the future can truly become immersed in their multimedia atlases.

Maps as spatial organisers

The map, or its ensemble as an atlas, can act as an organiser of the multimedia product. Atlases consisted of explanatory texts, photographs, graphics, schemes and diagrams even before the digital age, that added sound and video. Because the map defines the area covered, it thereby provides geographical linkage to this set of disparate elements, and holds them together.

There are other means, besides maps, for providing linkages between a variety of datasets. Toponyms can be used, for example, but these geographical names have an unfortunate tendency of referring to different areas over time. Australia would be no problem for this century, but how would the toponym ‘Germany’ be used? Does this name refer to the extent of the area designated by this name before 1918, or before 1939, or before 1989 or after? Geographical names would at least also require a temporal indication in order to make sure of the geographical area referred to. So the map would be a superior spatial organiser, even more so where graphics and logo's are more powerful than alphanumeric cues.

Their role as spatial models, as tools for providing spatial insight and as spatial organisers are traditional strong points of maps and atlases. Now, we add to these, the new potential of the digital environment:

Maps as tools for accessing information elements

Amongst the cartographic concepts that are specific for multimedia products, there are those that relate to exploration and/or information transfer from the maps and those that relate to the role maps play in accessing non-cartographic information elements contained in the multimedia product. We will start here with the latter:

Maps as navigation tools for the multimedia product

The ability of maps to provide overviews and show spatial relationships can also be transferred to other dimensions, for instance to Cyberspace (Jiang and Ormeling 1997). Within multimedia products, the structure of the various elements that together compose the product can be made clear to the user through maps, providing a better understanding of the product. At the same time, this can be used as a way to show users their current position in the product (Where am I in the multimedia atlas, what are my possibilities for navigation from my present position?).

An example of such a map is given in Fig. 1. Here the user has accessed an agricultural map (Banana production) of a specific area (South Asia) in an electronic atlas. As is shown on this map, he can directly access:

a) a map with the same theme for an adjacent area (such as Southwest Asia, East Asia);

b) maps for the same area (South Asia) with different themes (such as coconut production, rice production);

c) a geographical map or a physical map of the same area;

d) zoom out to a world map with the same theme (Banana production).

Such navigation possibilities immediately set the conditions or requirements for the maps that can be accessed. If two maps with the same theme are accessed in sequence, the class boundaries they have in their legends should be similar, as well as the tints rendering these classes, in order to be able to make fruitful comparisons. After all, this is what atlases are for.

Maps as interface to the geographical database

By clicking map elements, the geographical data behind the map may be accessed, such as population numbers or geographical names, for locations or areas, geographical names or (traffic) volumes for linear features, spot heights, co-ordinates, distances, surface areas and even local time for a specific spot, the latter provided the user's real time and co-ordinates have been entered.

The most important contribution of the electronic environment to cartography is that the storage and display functions of maps could be separated. Maps could be customised, visualising only those items that were important for answering a specific question. In traditional cartography, maps had both a storage and communication function. In digital cartography, the map is that visualisation of data from the database that is appropriate for answering a specific question.

Of course, displaying maps on a computer monitor is not ideal. The size of the map is restricted and it therefore does not provide an overview. So, it is a sheer necessity to be able to do away, if even temporarily, with those map elements one does not need at a particular moment. The legend need pop up only when needed, and the same goes for the scale, source data, and all other marginal information. It is not only valid for the elements from the traditional map's margin, but also for the map elements proper: the various layers that together constitute the map can be turned on or off, according to the map user's needs. So we have been able to overcome the restrictions imposed by display of maps on monitor screens by customising the map information and by manipulating the marginal information, only visualising and accessing it when really needed.

In a traditional production process,the office of the atlas editor contained the database with demographic, economic and toponymic data. He would have an image bank as well for his illustrated editions. From this database, the various attributes of the map elements were taken, classified, categorised and symbolised. In an electronic environment it became possible to transfer this database to the product, allowing the user to access it directly instead of going through the editor. The exact population numbers (for example 337,000) of settlements would be available instead of a categorised attribute value (between 250,000 and 500,000 inh.) indicated by a symbol. The geographical names contained in a search engine would allow the user to access a map version where the name entered would be displayed at the largest 'scale'. At the same time it could also store the name's pronunciation and other relevant attribute information.

Maps as multimedia interfaces

The maps in multimedia cartographic products provide - through their hotspots - the actual links to the other multimedia elements, and thereby enable users to access them. The maps are the most obvious carriers of these hotspots as these would immediately indicate the geographical positions (locations, linear objects or areas) the other multimedia elements (texts, diagrams, images, drawings, schemes, videos, sound tracks, etc) refer to.

Maps as vehicles for interaction

Finally, maps can, in this digital environment, play additional roles to those in analogue cartography:

Maps as interface to the cartographic database

In principle, by scrolling and zooming every wished-for area can be accessed at every scale. So, as any frame required could be visualised, each geographical site and situation can be understood. Geographical stepchildren no longer exist. For example middle eastern countries like Lebanon and Israel are such stepchildren: they lie in the margin of the map of Europe as well as of the map of Asia in our traditional school atlases.

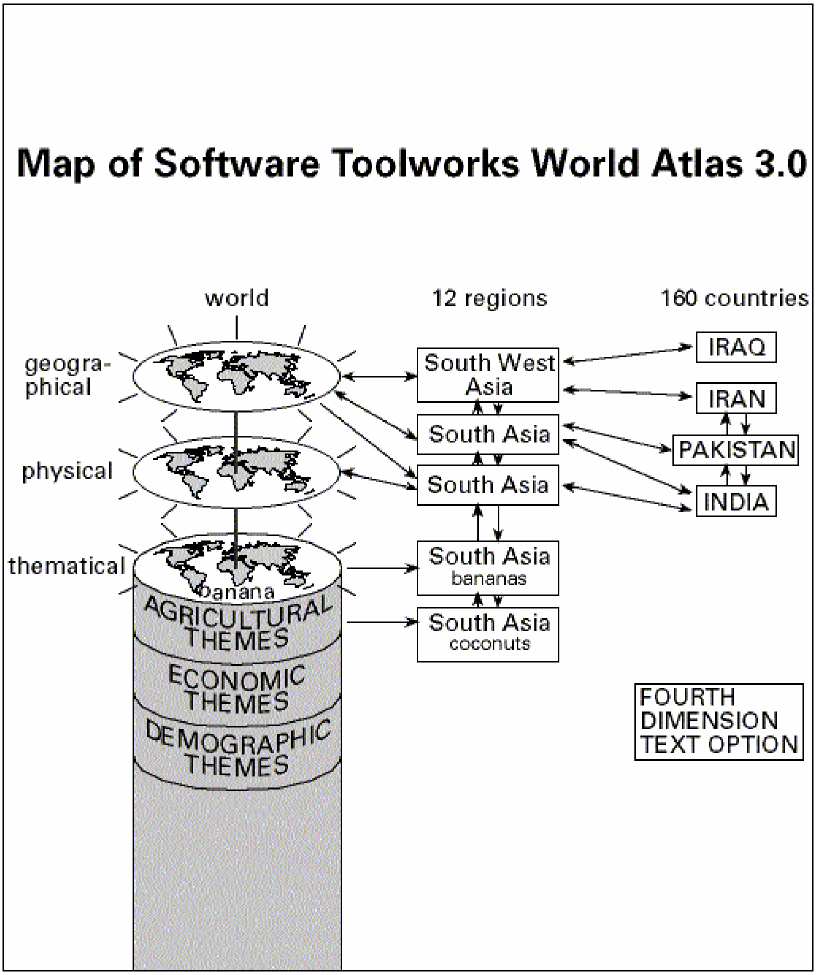


Fig. 1. Map of the navigation possibilities of the Software Toolworks World Atlas 3.0 (Ormeling 1993)

Maps as tools for scientific visualisation

Through maps, cartographers try to transfer images of reality that are as close as possible to the 'true situation'. One single image here could easily be biased, and they come closer to the actual situation by manipulating classification schemes (the number of classes and the classification types), the colours assigned to classes, representation modes, and aggregation levels. It has been said that it is unethical to provide only a single view of specific data (Monmonier 1991). Analogue atlases, with their lack of space, could not escape from the restriction of only providing single views. With multimedia atlases, we are able to break free and provide as many views as we want.

A good example of breaking away from the traditional static cartography is the prototype of the digital Swiss National Atlas (see chapter 9). It contains a digital terrain model (DTM) that allows users to state vertical exaggeration, angles and direction of view and even the time of day and the season. Before this, we were forced to have the relief illuminated from the Northwest, and because of the names rendered, were forced to look northwards. In this new digital representation, one can actually plan the panorama one is going to see at a specific point (provided the weather does not spoil it). Names, when asked for, would follow the orientation rather than be set at a single angle.

Conditions for interaction

Around this conceptual framework provided by maps, other conceptual issues that are to be taken into account in order to set proper conditions for interaction are: modalities, narratives, task situations, and carriers or medium types. Their interrelationships are suggested by Van der Schans (1997) as (see Figure 2):

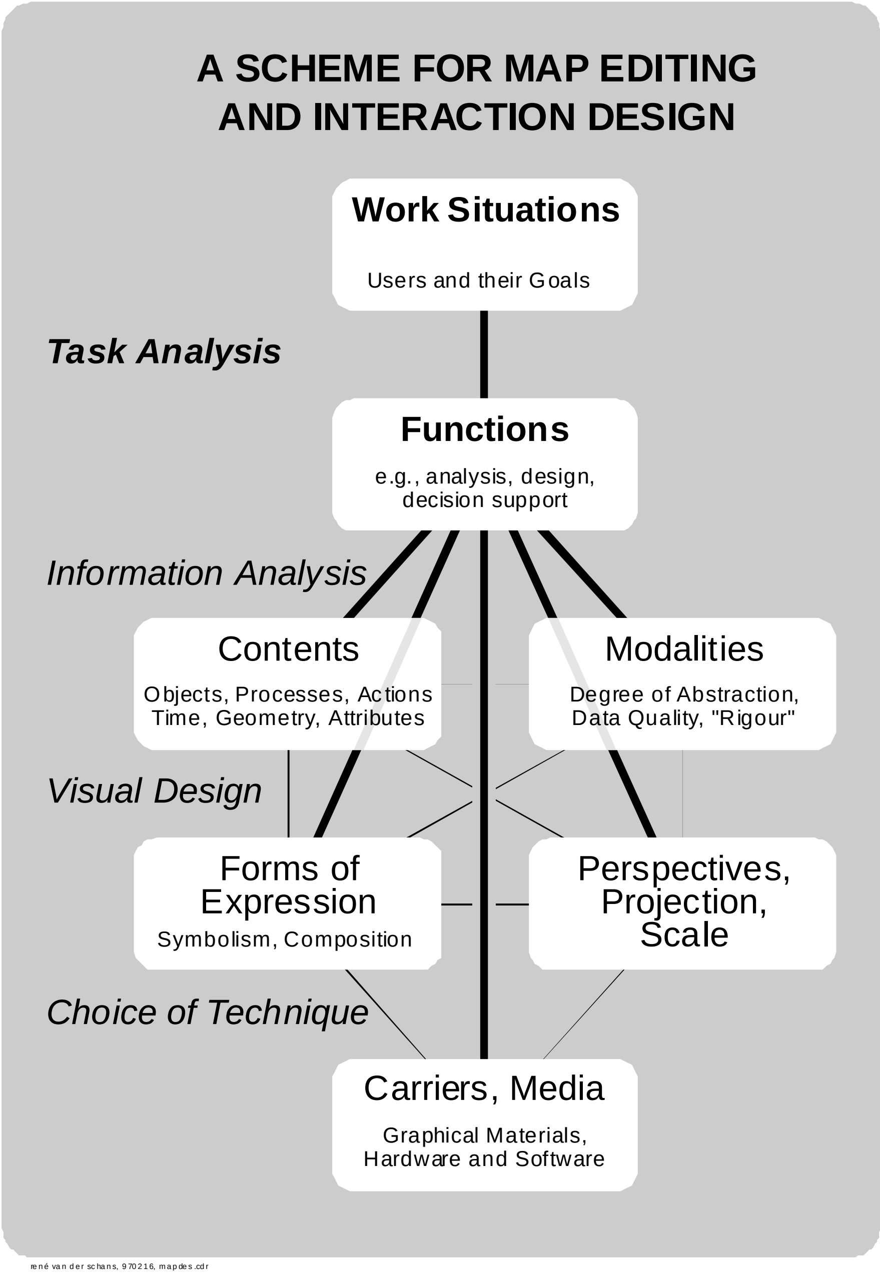


Fig. 2. A scheme for map editing and interaction design, by R. van der Schans (1997).

Users of multimedia atlases can be beginners or be advanced, casual or expert, intermittent or frequent. They can be computer novices or experts and be more or less knowledgeable about the domain depicted (Nielsen 1993). On the basis of the goals users would have when accessing our products, specific work situations should be envisaged. Whould they access the maps or other information elements in the multimedia product to answer any of the questions indicated in the section above (on maps as providers of spatial insight), or even the more complex ones? We can envisage GIS-like situations where questions might involve finding the area where five or six different conditions apply. The goal would be to find those designated areas, visually isolate them from the base map, and transport their outlines to maps with other themes in order to find additional attribute values.

This would be a decision support function that is linked to an extended analysis function. The map, as interface, can have other functions to perform, such as navigation, management, education, reference, recreation or propaganda. Each of these functions would require a specific selection of information layers from the database, a specific degree of generalisation and a specific design. Maps designed for propaganda would render a certain geographical situation or relationship different from a more neutral rendering on a map with a reference function.

The contents to be incorporated are set by the strategy/objective of the multimedia product. The material to be incorporated should allow for a homogeneous coverage answering the conditions that have been set, with a comparable level of generalisation, collected within a comparable timeframe, and with a comparable data quality. In a multimedia product, users would expect the data quality to be homogeneous. If this is not the case, this should somehow be indicated.

Modality as rendered in Figure 2 can be defined as being conscious of the relationship with reality (Van der Schans 1997, Hoye 1997). In physical planning, for instance, a geographical situation can be rendered as it is now, as it should be or as it possibly will be within a given number of years (temporal modality). Modalities can refer to the legal character of planning measures: whether a situation is prescribed by law, or whether more latitude is given. It can refer to geographical modalities: the site of a new building/settlement could be exactly indicated or it could merely refer to a smaller or larger prescribed area. Cartographic modalities could be efficiency of the visualisation (Bertin, 1981), redundancy, perceptibility, accuracy and - for the multimedia product as a whole - its synergy (Maybury and Wahlster 1998): "one channel of communication can help refine imprecision, modify the meaning and/or resolve ambiguities in another."

Perspective, as indicated in Figure 2, can be defined as a conscious orientation to other users (Van der Schans 1997, Simpson 1993). It is our objective to convey information to the users, but in order to let them better understand it, they have to know our standpoint: an American multimedia product meant for the American market will show the world from an American perspective, with the U.S. as a yardstick with which to measure other areas. The product will be focused on those aspects that Americans are thought to be interested in, and it will be based on the peculiarities of their educational system (which seems to be interested in things like: "Which state in the US is first in hog production, or has the highest crime rate?"). When aware of producer's perspectives like this, it will be easier to evaluate the information contained in the multimedia product.

Carriers, of course, will determine the specialisation of the subject matter. Look, for instance, at the National Atlas of Germany that is now being produced (Atlas Bundesrepublik Deutschland 1997) in an analogue version, on CD-ROM, and on the Internet (this is discussed in another chapter in this book by Lambrecht). As seems to be the case at this point (Mayr and Lambrecht, forthcoming; see also the latter's chapter in this book) it is the role of the printed version of the national atlas to interest users in the subject matter and to incite them to use the CD-ROM version, which will be more complete regarding data and possibilities of combining datasets and will allow users to change classifications and legend colours. As opposed to the CD-ROM version, the Internet version will primarily serve to update the material.

8.3 Conclusion

Iterations are not shown in the model depicted in Figure 2, but they are necessary, as all these aspects influence each other. What we want to express would influence the choice of the carrier. But, as indicated with the example of the National Atlas of Germany, the choice of carrier in turn influences the contents. It is a complex environment of construction, in which we will only be able to produce relevant multimedia products when we are able to differentiate between and take into account the various roles played by the maps involved.

As indicated above, these roles are (1) to make the overall multimedia product function properly and (2) to allow users to interact in a relevant way with the cartographic part of the product. While playing the first role, maps function as spatial organizers, as navigation tools and as interfaces to the geographical database contained in the product. Their second role allows users to adapt the maps contained to their requirements, generate the cartographic images they want and manipulate them in such a way that new insight might be gained.

References

Atlas Bundesrepublik Deutschland. Pilotband. Leipzig: Selbstverlag Institut für Landeskunde 1997; Demoversion, Institut für Landeskunde Leipzig 1997; http://www.geographie.de

Bertin J (1981) Semiology of Graphics. Madison: University of Wisconsin Press

Hoye L (1997) Adverbs and modality in English. London: Longman

Jiang B, Ormeling FJ (1997) Cybermap: the map for Cyberspace. The Cartographic Journal 34-2: 111-116.

Hurni L, Bär HR, Sieber R (1999) Atlas of Switzerland. In: Cartwright W., Peterson M., Gartner G. (eds.) Multimedia Cartography. Springer, Berlin Heidelberg New York.

Lambrecht C (1999) Atlas of the Federal Republic of Germany. In: Cartwright W., Peterson M., Gartner G. (eds.) Multimedia Cartography. Springer, Berlin Heidelberg New York.

Maybury MT, Wahlster W (1998) Intelligent user interfaces. San Francisco: Morgan Kaufmann

Mayr A, Lambrecht C (forthcoming) The National Atlas of Germany. In Gylfason A, Ormeling FJ and Trainor T (eds) Proceedings of the Seminar on Electronic Atlases and National Atlases in the Information Age, held in Reykjavik, August 1998. Utrecht: Commission on National and Regional Atlases, International Cartographic Association.

Monmonier M (1991) Ethics and Map Design. Six strategies for confronting the traditional One-Map Solution. Cartographic Perspectives 10: 3-8

Nielsen J (1993) Usability engineering. Cambridge: AP Professional

Ormeling FJ (1993) Ariadne's thread: structure in multimedia atlases. In: Mesenburg P (ed) Proceedings International Cartographic Conference ICA, Köln 1993. Köln: Deutsche Gesellschaft für Kartographie: 1093-1100

Simpson P (1993) Language, ideology and point of view. London: Routledge

Van der Schans R (1997) A quest for optimal expression of objects and actions in GIS. In: Van Arragon J (ed) Proceedings Best-GIS Workshop "GIS-Interfaces for Environmental Control", Utrecht, 19-20 February 1997. Utrecht: NexpRI: 11-20

World Atlas 3.0 (1991) Novato (Cal): Software Toolworks

9 Territorial Evolution of Canada - An Interactive Multimedia Cartographic Presentation

Eva M. Siekierska, Costas Armenakis

Mapping Services Branch, Geomatics Canada, Natural Resources Canada

9.1 Introduction

The numerous changes to boundaries within Canada, which occurred between 1867 and 1949, are difficult to display in classical map forms. A major advantage of electronic mapping over conventional cartographic presentations is the capability to present time-dependent phenomena by the use of animation. The first version of an animated Territorial Evolution map was produced within the Electronic Atlas of Canada prototype system called MARK 2 (Siekierska and Palko 1987; Siekierska 1990; Siekierska and Taylor 1991). A desktop version of the electronic Territorial Evolution map was produced as a stand-alone multimedia mini-atlas first displayed at the 'Canada House' exhibition, which was organized to celebrate the 125 anniversary of Canadian confederation, in 1992. A modified bilingual version of this product was released on a CD-ROM for use by schools and by the general public (Siekierska 1998).

Territorial Evolution consists of a series of Canadian maps at important times in the evolution of the Canadian Confederation with the ability to animate these maps through time. For the purposes of the multimedia version, still and animated graphics or images, text, sound, and video information were included, as well as provincial maps. A hypermedia information management method that connects various types of media in a non-sequential mode was incorporated. The user can access information in a flexible nonlinear fashion by moving from one part of the presentation to another, as long as the associative links mechanism has been created. The links are equivalent to an indexing schema and the established relationships between objects allow browsing within the same object or navigating between multimedia objects containing related information.

This chapter provides a brief description of the main characteristics, information content, cartographic representation, and technical issues of the

CD-ROM and the Internet version of the Territorial Evolution of Canada map. The *Territorial Evolution of Canada* - a multimedia presentation, is one of the earliest examples of cartographic animation of historical data. It has been selected for this publication to exemplify issues, which should be taken into consideration when developing and producing similar products.

9.2 Background of Product Development

The need for a more holistic approach for the interpretation of spatio-temporal data requires new forms of cartographic representations. The implementation of virtual realism in displaying time-dependent data is a step in the creation of maps-in-motion. The creation of virtual reality images for the display of time-dependent geographical information enables us to perform dynamic presentations applicable to mapping (Armenakis 1996). One of the advantages of electronic mapping and dynamic cartography over conventional cartographic presentations is the capability to display motion and changes over time by use of animation (Siekierska 1983). Animation also supports dynamic data exploration and visualization. The evolution of Canadian territory is represented in the ‘hard-copy’ 4th edition of the National Atlas of Canada, published in 1974, as series of maps each showing a distinct period of history. In the 5th edition of the National Atlas the territorial evolution is shown on one map. However, it is a rather complex representation due to the amount of information which had been incorporated, thus map readability and perception of changes of the boundaries is difficult.[1] Therefore, this map became a prime candidate for experimentation with the animation of historical data when the Canadian electronic atlas was being developed (Siekierska and Palko 1987). Animated maps significantly extend the mapping capabilities by including the visual display of time, a variable of an inherently dynamic nature. These maps allow the continuous display of time-dependent data in chronological order, thus adding realism to the display process.

During the course of development, a number of data sets were used to test the functionality of the Electronic Atlas software. Territorial Evolution was originally developed to demonstrate the potential of representing time-dependent data using the cartographic animation capabilities of the Electronic Atlas System. Dates related to the entry of provinces into Confederation and to changes of boundaries throughout the political evolution of Canada were stored as attributes. The data sets used for the Territorial Evolution electronic map were derived from the Fourth and Fifth Editions

---

[1] http://atlas.gc.ca/site/english/maps/historical/territorialevolution/1867-1999

of the National Atlas of Canada. The map on the Electronic Atlas contained additional information, such as a chronology of places.

The animation was based on a time-composite map, linked to time-stamped display parameters. The time-composite map is one map, which contains all the time-maps in a single cartographic layer. Each map can be extracted from the composite-map for display purposes. The elements in each map are linked to time-stamped attributes, which include a series of cartographic display file attributes. The animation is driven by the attributes. As the animation progresses, time-stamped attributes become valid or invalid, and they activate or de-activate, the corresponding graphic display files. The display of the maps in succession gives the idea of movement through time.

The animation of Territorial Evolution is a very effective display of the changes to the boundaries of the Canadian Confederation. The animation of these changes gives a picture of the evolution of the boundaries within Canada, which cannot be easily visualized from a static map. The animated electronic map is potentially a very good teaching tool, and it was thus decided to transfer this data to the widely used desktop computers. The integration of maps-in-motion with other multimedia data was implemented according to hypermedia concepts (Armenakis 1993).

9.3 Example of an Interactive Multimedia Presentation

The combination of the concepts of animated cartography and hypermedia offers an effective tool to design and develop interactive type multimedia cartographic representations (Siekierska 1990, 1993). These electronic maps enhance the cartographic information by providing direct access to multiple sources of information from within the cartographic presentation and by supporting flexible navigation schemas, allowing exploration of possibilities for dynamic presentations. In the Territorial Evolution multimedia presentation (Armenakis 1992, 1993 and 1996; Armenakis et al. 1992), the hypermedia network was built based on predefined links. The nodal information was organized in three levels linked to each other based on pre-established relationships (Fig. 1).

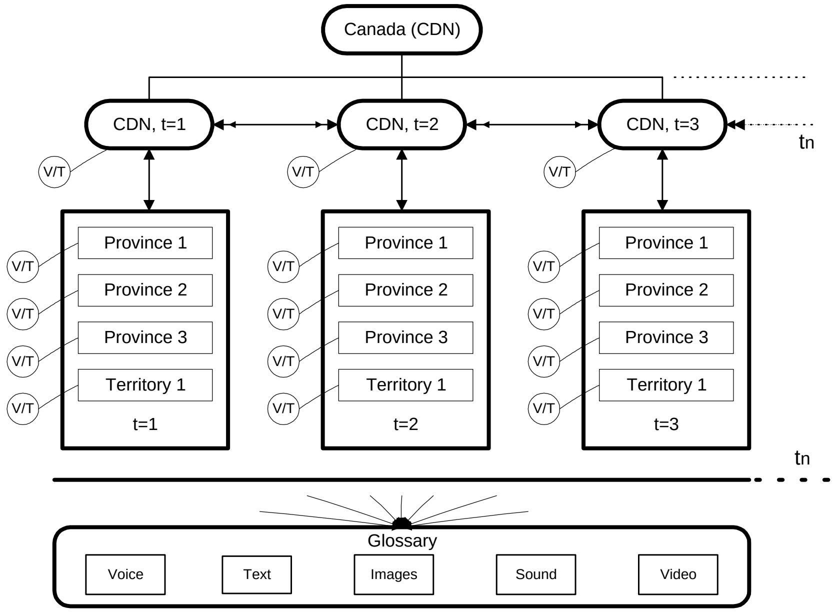


Fig. 1. The hypermedia network of the Territorial Evolution (V:voice; T:text).

9.3.1 Thematic Content

The *Territorial Evolution of Canada* depicts the evolution of Canadian territories since the time of Confederation in 1867, until 1949, when the last province (Newfoundland) joined the Confederation. In 1999 the internal boundaries of Canada will change again as the new territory of Nunavut has been established. The Territorial Evolution product consists of a series of electronic maps, which show the changes in the national and provincial boundaries of Canada. The maps are accompanied by textual information, still and animated images, sounds, music and voice commentaries, which explain and illustrate the historical events that lead to particular changes in the boundaries.

The product is divided into three levels.

1. The first level consists of maps and descriptions of boundary changes at the national level, and includes a series of maps, additional textual information and narration. It contains 20 time-series maps.
2. The second level consists of 28 frames depicting the evolution of the various provinces and territories. They are chronologically attached to the appropriate map of Canada at the national level; the maps and are

also linked to voice and textual information. The access to the evolution of individual provinces is via a map of Canada, and it is possible to explore the provincial evolution from any national level map.

3. The third level, called the ‘glossary’, contains additional illustrations and accompanying text and sound and consists of 13 related topics depicting historical events or people, which are central to understanding boundary changes and are referred to in the previous two levels.

The animation of the evolution of boundaries in Canada is shown at the first and the second levels. It is thus possible to view the evolution of the country through maps showing Canada as a whole, or to follow the evolution of individual provinces and territories. Sound was added as a spoken commentary on the evolution of the country as a whole.[2] The spoken text is shorter than the written textual information. Reference to the text accompanying each map provides the user with additional information.

The Electronic Atlas maps were created from *Arc/Info* files derived from information found in the 4th and 5th Editions of the National Atlas of Canada. This data consisted of a number of *Arc/Info* graphics covers, one for each year in which the boundaries of Canada change. These covers were imported into the Electronic Atlas and attributes were associated with the graphics. Using the time-series display capability of the Electronic Atlas, electronic maps for each year were displayed and screen captured. These Sun raster screen images were saved, converted to .GIF format and transferred to the *Macintosh* computer.

The provincial maps were derived at various scales from the Canadian maps, and the text was written, both in French and in English, to accompany the electronic maps. The bilingual text used in the multimedia version was specifically written for this product to conform with the school curriculum. This text gives information dealing with the boundary changes, namely the reasons why they occurred, and how these changes actually affected the territory. Additional historical information was also given when it was found necessary to explain the context of the changes.

9.3.2 Cartographic Design Issues

The cartographic representation of information follows very closely the conventional cartographic map representation. The approach taken was to replicate the style of the cartographic design of the conventional paper map of the 5th Edition of the National Atlas of Canada. This is particularly noticeable in the selection of colour schema. The variations of hue differentiate the British possessions from the provinces that signed the Canadian

[2] The CD-ROM version has spoken commentary in all three levels.

confederation. The variations of colour value differentiate the stages of development of individual provinces. The same approach is used in all versions of the map, that is the paper copy, the CD-ROM version and the Internet version.

Due to time constraints to produce an electronic version within a short period prior to the anniversary exhibition no efforts were made to prepare digital files appropriate for visualization on smaller size screens. As a consequence, the existing CD-ROM version and Internet product were derived from the graphic files prepared for the production of the 5th Edition of the National Atlases digitized from the 1:7.5 million scale paper map. No generalisation operation was applied to prepare these files for display at the computer monitors, which depending on the size of the screens can correspond to scales varying from 1:15 to 1:60 million The lack of generalization is particularly noticeable at the coast lines.

9.3.3 Authoring Tools

The stand-alone multimedia prototype was built around the first level -the time-series maps of the evolution of Canada and their associated text (Armenakis 1992, 1993). It was developed on a *Macintosh IIci* with the *HyperCard/ HyperTalk* application program using a customized version of the NCSA *HyperCard* Animation Package. A proof-of-concept prototype was developed using the *SuperCard/SuperTalk* software and incorporated the second and third level information (Armenakis 1996). This second prototype also allowed for the juxtaposition of two neighboring temporal maps for visual comparison.

The MacroMind *Director* 3.0 authoring software, created by MacroMind Inc. (now Macromedia), was used to build the multimedia cartographic presentation having all the specified functional requirements of the product, including color, sound, graphics and animation. This software was selected because it is user friendly, it includes examples and tutorials, it has tools for authoring and for creating animation, and creates stand-alone.

There are two integrating modules within MacroMind *Director* – Overview and Studio. The Overview module is used to design presentations and to join documents with the animation created by the software. The second module, Studio, is used to produce the series of still frames for the movies (animation). The objects, such as graphics, sound, text, colour, of each movie are stored in a database called Cast, and all the activity in each frame of the animation is created using a storyboard-like window called Score. Score keeps track of the position of each cast member in each frame and controls the timing of special effects like transitions, tempos, sounds and palettes. The *Lingo* scripting language permits sophisticated interactive control. The presentation is designed through the use of scripts, which can be attached to objects or frames within the animation.

9.3.4 Graphical User Interface

In the first level, where the maps of the country are displayed, the interface metaphors include a text button to display a text window, a sound button that activates an audio playback of the short version of the text, an video-camera button which animates the maps, and a time selection bar which gives the user the opportunity of selecting a specific year in the evolution (Fig. 2).

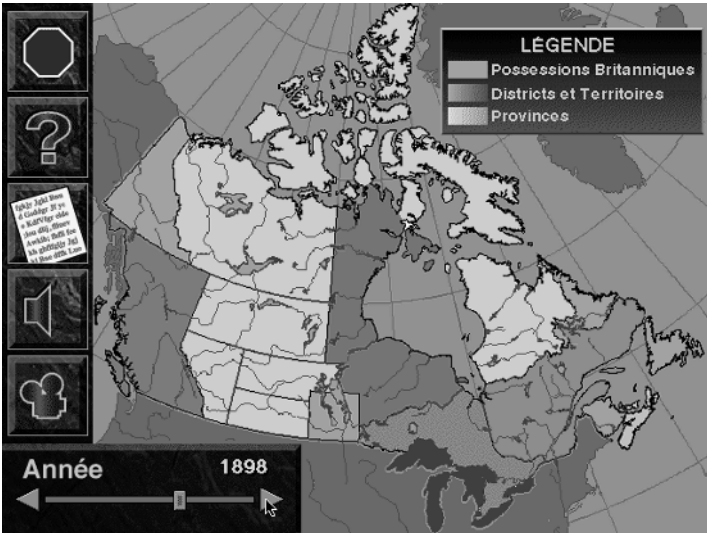


Fig. 2. The user interface, first level.

The second level is reached by selecting the different provinces and territories. When a province or territory is retrieved, the area is highlighted on the screen, then an enlarged view of the area is displayed. In this second level, there are text buttons, a time slide bar to permit an animation of the province or territory, and a return button that brings the user back to the main Canada map. Some of the text windows include hot-spots, which permit access to the third level. These hot-spot buttons are highlighted words in the text, and were chosen to provide additional information on these subjects or people as needed. When the user selects the third level, a graphic background and text are displayed.[3]

9.3.5 Operation

The user can access all three levels and navigate from one level to another. The user can view in motion (reconstruct) the *Territorial Evolution of Canada* using play-back computer animation maps of the whole country. Frame by frame motion and retrieval of the time-series maps at a specific time is also possible with a temporal slide bar. The play-back animation is done through the dissolving of colors which results to a relatively smooth transition between frames. The animation can also be interrupted at any time and restarted at the position where it stopped. At any point, the user can access textual and sound information, or a provincial or territorial map, which is also accompanied by text. In addition, each province or territory is linked to its temporal conjugate, therefore enabling a complete reconstruction of the evolution of each province or territory. The third level is accessed through highlighted hot-spots in the text of the national and provincial and territorial levels. Sound narration is available in all three levels of the final CD-ROM version.

9.3.6 Design Considerations

The Territorial Evolution multimedia presentation operates in an active cartographic environment (Armenakis 1996), where the users view and understand the evolution of temporal patterns, control the motion, study the evolving images at their own pace, interrupt the rolling of images, visually compare multi-temporal images, and consult and integrate various sources of information. The following basic characteristics were considered:

- interactive operations;
- complete control over the animated displayed frames (direction of motion, speed, frame by frame direct access and display, selective retrieval);
- hypermedia links to other information sources, including book-marking of certain nodes/anchors for direct access and return;
- user-friendly interface, with icons and metaphors for intuitive operations, with on-line help and navigation schema for guidance; and

[3] In the final CD-ROM, which was produced for distribution, the hot-spots in the text were replaced by additional buttons for accessing information of the third level.

- good overall performance (e.g., quality, speed, consistency).

Dynamic map production requires well-defined programmable operations. Scripts describing the stages of the dynamic depictions (screen background, features, position, duration, colour, speed, etc.), as well as the links to other multimedia sources, are developed and tested during the design stages. Working in a hypermedia environment it is important to have a good understanding of the subject and the user's level in order to select the appropriate information nodes and their types, and identify the associate relationships to form the hypermedia network.

Other aspects considered were the display speeds, the amount of display information and the continuous changes of map contents. These elements affect the interpretation and understanding process. It is important to know how much time the user will spend viewing the map, and whether the viewer is a novice or an expert.

The animation used in this multimedia cartographic presentation is a play-back animation where maps were created in advance. The computer displays the maps (frames) in chronological order, based on a predetermined sequence. In the case of territorial evolution, this was found to be an acceptable solution, since the contents of maps represent absolute temporal states, as defined by the historical events.

9.4 The Internet Implementation

The multimedia version of the Territorial Evolution of Canada was implemented on the Internet World Wide Web as part of the Geomatics Canada contribution to the SchoolNet project.[4] The relatively early implementation of the Territorial Evolution map within the Internet environment resulted in the relatively static portrayal of this map package (Medaglia 1994). Thus, the dynamic user interface used in the CD-ROM version has been replaced by a table with dates where significant changes to Canadian boundaries occurred. The table provides access to maps corresponding to each date. The commentary explaining the changes is provided only in textual form, as the spoken commentary is time-wise still rather expensive mode to convey this information on the Internet, due to the speed of transmission of voice and music at the time of the implementation (Siekierska and Williams 1996).

4 http://www.pch.gc.ca/special/gouv-gov/section4/sites_e.cfm

9.5 Conclusions

The *Territorial Evolution of Canada* is one of the early examples of multimedia cartographic applications (Siekierska 1996). The animation of the changes of the boundaries gives a complete, easy to comprehend picture of the territorial evolution within Canada, one which could not be easily visualized from a static map in a conventional cartographic presentation. A hypermedia organization of information permits the user to access it in an intuitive way, guided by interests and previous knowledge of the subject. Multimedia, multi-channel communication facilitates the easy assimilation of large amounts of information, making learning with multimedia products an interesting experience.

The cartographic elements of the product such as colours, text placement, frame transition and generalization suitability for smaller size monitors could be further improved, if time allowed. On the other hand, the product is one of the early examples of complete multimedia cartography (with still and animated images, text, sound, video, narration), operates in both stand-alone and interactive mode, provides very intuitive and unrestricted navigation, it has zero learning time, and it is integrated with the school curriculum.

The final version of the product was produced in cooperation with the private sector. The CD-ROM product is currently distributed by the Mapping Services Branch, Geomatics Canada, Ministry of Natural Resources.

References

Armenakis C (1992) Electronic mapping of time-dependent data. In: Proc. of the ASPRS/ACSM/RT'92 Annual Convention, Tech. Papers, Washington DC, vol. 3, pp 445-454

Armenakis C, Lapalme-Roy LA, Medaglia R, Newton G (1992) The Territorial Evolution of Canada - a Hypermedia Map. In: Proceedings of the ICA National and Regional Atlases Commission Meeting, Madrid, Spain, pp 321-325

Armenakis C (1993) Map animation and hypermedia: Tools for understanding changes in spatio-temporal data. In: Proc. of the Canadian Conference on GIS 1993, CIG, Ottawa, pp 859-868

Armenakis C (1996) Mapping of spatio-temporal data in an active cartographic environment. Geomatica, 50(4), 401-413

Medaglia R (1994) Personal communication

Siekierska EM (1983) Towards an Electronic Atlas.In: Proc. AutoCartoVI, Ottawa, II, pp 464-474

Siekierska EM, Palko S (1987) Development of the Electronic Atlas of Canada. In: Computer Handling and Dissemination of Data, (ed) Glaeser, Elsevier Sci-

ence Publishers B.V. (North-Holland), CODATA 10th International Conference, Ottawa, Canada, pp 308-312
Siekierska EM (1990) Electronic Atlas of Canada and Electronic Mapping Projects. In: Proceedings of the ICA National Atlases Commission Meeting, Beijing, China Cartographic Publishing House, pp 45-51
Siekierska EM, Taylor DFR (1991) Electronic Mapping and Electronic Atlases: New Cartographic Products for the Information Era - the Electronic Atlas of Canada. CISM (Geomatica) Journal, Cartography in Canada 1987 to 1991, 45(1), 11-21
Siekierska EM (1993) From the Electronic Atlas System to the Multimedia Mapping Products: the Canadian Experience. In: Proc. of the Seminar on the Electr. Atlases, Visegrad, pp 101-111
Siekierska E, Williams D (1996) National Atlas of Canada on the Internet and the Schoolnet, Electronic Atlases in the New Environments: from CD-ROM to Internet. In: Proceedings of the Seminars on Electronic Atlases Regional Atlases II, Den Hague and Prague, pp 19-25
Siekierska EM (1996) Development of Electronic Atlases - the ICA Perspective. In: Proceedings of the Symposium on 'Information Users and Information Producers', Rio-de-Janeiro, vol. 7, 18p
Siekierska EM (1998) New Canadian Cartographic Products: Animation in the GIS Era. GIM International, (12), 23-25

10 Wula Na Lnuwe'kati: A Digital Multimedia Atlas

Ken Francis

Mapping Services Branch, Geomatics Canada, Department of Natural Resources

10.1 Introduction

The Mi'kmaq Nation is one of North America's aboriginal peoples. The group is part of the north east culture area and speaks an Algonkian language. Our traditional territory covers most of Canada's Maritime Provinces as well as parts of Newfoundland and the Gaspé Penninsula. It is from our eastern geography that we are known as 'Keepers of the Eastern Door'.

Wula Na Lnuwe'kati[1] is a multimedia atlas of the Mi'kmaq Nation. It was developed from 1994 to 1996 as a Master of Arts thesis in geography at Carleton University. The work was intended both as an academic work and an artistic endeavour. The atlas grew out of a personal interest to learn more about the culture and history of the Mi'kmaq people as part of a journey of personal discovery/recovery. Development of the atlas continues to take the project to a publishable form.

10.2 Target Audience

Wula Na Lnuwe'kati will be donated to Mi'kmaq Native Friendship Centres as it is intended to give the work back to the community from where it comes. The atlas will also be commercially available to the general public.

[1] 'Wula Na Lnuwe'kati' can be translated as 'This is Indian Land'. This is best understood as our relationship to the land as a trust given to us by Niskam (the Great Spirit/Creator). As the Mi'kmaq, our identity is distinctly linked to the land we call Mother Earth through our culture, traditions and language. Our culture grows from the land and within the concept of respect for the land, nature, humankind and all living things on earth.

The intended audience is all who are interested in Mi'kmaq geography and history with a focus on senior high school students and university undergraduates. The audience may be Mi'kmaq or of non-native heritage.

10.3 Selection of Chapters

- The 'Place Names' chapter represents a reappropriation of the land. The re-insertion of Mi'kmaq place names into the landscape asserts the fact that this is a territory of Mi'kmaq occupation … past, present and future.
- Stories of how the land was formed is the theme of the 'Legends' chapter. This section was selected for reasons similar to 'Place Names'; it offers the reader the chance to know the Mi'kmaq people as part of the land from time immemorial.
- The 'Geopolitics' chapter was chosen for its potential to instruct the reader on issues concerning the structures of political organization. The chapter examines Mi'kmaq political life in the context of a sovereign nation and in an international context.
- The 'Trade' chapter was selected for reasons similar to 'Geopolitics'. This chapter describes trade with other nations for goods not produced domestically.
- Mi'kmaq population distributions, discussions of forces which shape these distributions, as well as explanations of pressures contributing to population decline are offered in the 'Population' chapter.
- The 'Canoe Routes' chapter was selected to provide an opportunity to use previously learned animation techniques.
- The 'Information' section was included to create a place to give the map reader instructions on the atlas's functions, give an artist's statement and biography, references, acknowledge the contributions of others and to let the reader close the atlas.

A number of possible themes for the chapters of the atlas were considered. Those that were considered, but not selected, were: the geography of resistance, loss of territory due to European expansion, and sacred sites. Noel Knockwood, Elder and Spiritual Leader of the Grand Council of the Mi'kmaq Nation provided significant advice in these decisions. While these themes were not portrayed in the first iteration of Wula Na Lnuwe'kati, they will be represented in future editions of the atlas. The themes that were selected are described above.

10.4 Software

A number of software packages were used in the production of Wula Na Lnuwe'kati. Maps were drawn using Aldus *Freehand* 3.11. Textured map fills, hill shading and special presentation effects were produced using Adobe *Photoshop* 2.5. Digital video clips were compiled with Adobe *Premiere* 3.0. Sounds used in the atlas were sampled and engineered using *SoundEdit Pro*. Type for maps was designed using Adobe *Illustrator* 5.5. Macromedia *Director* 4.0.3 was used to assemble the elements together and to create the interactivity.

10.5 Production of Base Maps

10.5.1 Scanning

The International Map of the World (1:1 000 000) published by Natural Resources Canada served as base maps for this work. These large sheets were scanned in sections on a flat bed scanner. Image integrity and clarity was maintained by balancing brightness and contrast. The distortions introduced through scanning were removed at the same time the sections were joined together with *Photoshop*.

10.5.2 Tracing

In drawing the map, an important consideration was: How well will the linear complexities of the design hold up when converted from a vector drawing to a raster drawing? A 1/2 point line worked well to preserve the integrity of the drawing. The *Photoshop* file was imported into *Freehand* to serve as the template for generalizing and tracing shorelines, watercourses and contours.

10.5.3 Textures

There was a definite need to create maps that are warm, inviting and with rich surface interest. With this accomplished, the information on the maps is more available to the reader because the reader is likely to linger and enjoy the image and therefore pay more attention to it. The maps are presented as both information and image.

Textured fills for the maps are based on the work of a number of Canadian First Nations artists selected by the author. The images, taken from exhibit catalogues, were digitized and imported into *Photoshop*. Sections of an image were isolated and used to build a conglomerate. These were built to serve as both water fill and land fill. Variations of colour were produced for some textures, which together constitute a palette that were applied to the maps as hypsometric tints.

10.5.4 Compilation

A number of steps were needed to take the base map image to its final form. The software used was *Photoshop*. The grey tints were blurred and embossed to reveal hillshading. This was blended with the land texture resulting in the final land fill. The water texture was faded around the coast lines and added to the land fill resulting in the final map image. Experimentation established a formula that would perform consistently to produce images that are similar in style, colour and feel.

10.6 Media Choices

10.6.1 Maps

The variety of maps grew out of the author's need to find different ways of presenting the information in the atlas. The base map, with its hillshading and subtle textures, delivers a sense of permanence, as if the land form was eked out a block of granite, unpolished and rough, inviting the hand to register its topography. Hydrography can be clearly seen but remains damped by the anti-aliasing inherent in the treatment of the land fill.

Water areas in the base map have a rhythmic quality. Colour variations in the water fill call on an abbreviated blue palette while reflecting some of the earth tones of the land. The water fill has been faded along the shorelines as a way to elevate the land mass and establish a figure/ground relationship.

The map in the 'Place Names' chapter serves as the interface for sourcing other information. In the 'Geopolitics' chapter it is the base on which textual and graphic information is layered. This chapter opens with the names of political districts displayed on the map. When the reader moves the cursor over the map, the result is areas of the political districts are shown. These boundaries are generous in their extent, easily flowing into neighbouring districts; the lines fade toward the inside edge of the extent.

This is intended to convey the understanding that the limits of these districts are not sharply demarcated: they are more understood than measured.

The Wabenaki Confederacy map is interesting in the way it is presented. The map is built through a short but effective animation sequence which first shows the cartographic base, then the international boundaries and finally, the names of each member nation. This logical sequence reinforces the message of the map.

The map uses the same texture for its land fill but has been drawn without hillshading. The territory outside the membership of the confederacy is given a less colourful textured fill. While the water has a flat colour, it has been vignetted along the shorelines to contribute to the figure/ground relationship.

The success of this map is due to how it, at once, compliments and contrasts with the base map. The simplicity of its surface moves against the richness of the base: this deflects attention to the new information that is offered within. The similarity in palette and texture reinforces that the two map are part of the same chapter.

'Legends' and 'Canoe Routes' have maps which describe yet another cartographic approach. These maps are energetic with lively colours and smooth textures. The impression is one of fertility, abundant resources and a landscape flooded with sunshine and promise. The hypsometric tints were critical in the discussions of landform creation but also served as an interesting point of departure in the 'Canoe Routes' chapter as well.

The 'Trade' chapter uses as its base a small, unassuming map done in soft shades of yellow and green. The textures are flatter than seen elsewhere. In combination with the restrained palette, the size of the map, and how it is cropped, seems to make the map whisper. This soft quality acts as a foil for the livelier line work with more saturated colours. When examined in terms of tone and feel, the map in the 'Trade' chapter is most closely related to the Wabenaki Confederacy map.

All the maps described above, have been designed specifically for the computer screen. This means working with the screen as a new medium and accepting its limitations. It is impossible to achieve the crisp, sharply delineated line work in a map that is to be displayed on a computer screen that we can in a map on paper. Instead, work with the limitations of the medium by camouflaging stepped line work and jagged looking shorelines with textures and colourisations that suggest the feature's characteristics rather than declaring them. This approach serves to extend the vocabulary of cartographic production.

10.6.2 Typography

When designing type for the maps, the approach was similar to that which would be taken if working on a paper map. Rules of proximity, extent and balance were important in the process. This insured that the composition was readable and attractive. The shape of paths for curved type was carefully drawn and colours used were given special attention.

Palatino 14 point with 10.5 point leading is the most readable typographic configuration for text blocks in Wula Na Lnuwe'kati. Palatino was the best choice to create text that is both attractive and readable. The serifs create fluidity and the clarity of letter forms ensures readability in a raster environment. Inset caps are Lithos Black 36 point and are decorated with strikes of colour that represent the four sacred directions. Chapter titles are Lithos Black in various sizes. Political district names are Lithos Bold, water feature and land feature names are Gill Sans Bold. Some type was designed in colours other than black and blue. Here, attention was paid to compatibility and contrast of type with the map image.

10.6.3 Imagery

Throughout the atlas various images are offered to the user. These images are rooted in Mi'kmaq traditional decorative practices or borrowed from contemporary Mi'kmaq art. The background for type blocks is birch bark selected by the author's father from his wood pile. Birch bark also has been used for many start and end screens for digital video clips in Wula Na Lnuwe'kati. Birch bark is an important material in Mi'kmaq culture. Using the image of birch bark in Wula Na Lnuwe'kati is a link to the more traditional artistic practice of the Mi'kmaq people. Chapter icons are details from a painting by Luke Simon a Mi'kmaq artist. While some icons are borrowed directly, others are created in the same style as Simon's work.

Navigation devices have been carefully designed to be integrated decorative elements in Wula Na Lnuwe'kati and to contribute to the experience of a reader's visit. Paging is done with arrowheads and other navigation buttons are drawn to resemble chips of flint. A smoky field embraces the media elements, suggesting continuity from one form to another.

10.6.4 Audio

Sound in Wula Na Lnuwe'kati is a very important media element. It is used as an interface feedback device, to establish cultural context, to deliver information and to serve as a sound track for video clips.

Every choice made by the reader is met with an auditory response. These audio clues are distinct for each type of interface navigation device helping to distinguish one from another. The response to clicking on section buttons is a guitar lick from a recording by Don Ross, a musician of Mi'kmaq decent. Other audio selections are from The Eagle Call Singers, traditional Mi'kmaq singers. Their version of "Mi'kmaq Honour Song" is part of the animation sequence which opens the atlas, establishing the cultural context of the piece. The beating of a drum has been merged with sounds of the ocean, and songs of whales. This union of sounds assumes physical characteristics of the territory which offers deeper understanding of the nature of the land to a wider audience. It also helps to reinforce the atmosphere established in the opening sequences of the atlas.

The 'Place Names' chapter features pronunciations of Mi'kmaq place names spoken by the author's sister. Here, audio is used to its most powerful effect. The inclusion of these pronunciations has a transformative effect on this map. The cartography moves away from the graphic and embraces an alternate media in a way that extends the traditional cartographic vocabulary. The author's mother also contributes her voice to the atlas with a welcome message at the opening, and at the closing sequence with a final statement.

10.6.5 Video

Digital video easily lends itself to cartographic communication. Motion video can be used cartographically by selecting clips that offer a look at the topography of the land, as in the case of the video of Eskasoni. Video can also continue the discussion of an event at a specific location as in the case of the Grand Entrance of the Feast of St. Ann. The videos have been edited to focus attention on important locations shown on the map or to offer an alternative perspective on the information. In this regard, video has been applied in Wula Na Lnuwe'kati in much the same way that still photography is used in a printed atlas.

Adobe *Premiere* was used to compile and edit the raw digital video footage. All video clips included in Wula Na Lnuwe'kati are set to run at 30 frames per second and are sized to 160 pixels x 120 pixels. They have been saved in Apple *QuickTime* format as this can be played in *Macintosh*, *Windows* and Unix environments.

10.6.6 Atlas Interactivity

The interface for Wula Na Lnuwe'kati is based on an appliance metaphor. Basing the operation of the interface on something familiar has a very important benefit: it helps the user recall actions and reactions that are familiar and comfortable rather than having to re-learn the basics of operation.

Each type of button in the atlas has an 'on' condition signaled by distinct graphic and audio cues. This is important to help the reader learn how each of the different buttons and navigation devices may be used to explore Wula Na Lnuwe'kati.

The chapters are not explicitly named in the interface. The reader is not encumbered by type in the basic interface structure. Instead, chapter titles are available through rollovers of the chapter icons. This is a way to encourage non-linear exploration. Direct naming of the chapters or listing titles would encourage a reader to fall back to a linear approach.

The six chapter buttons operate even while video is playing or several items of information are on the screen; there is no need to close everything down before choosing another section. A reader may move to a different section at any time. Such freedom of movement allows the reader to satisfy curiosities by collecting information of particular interests.

The atlas has been constructed to offer the responsibility of choice to the reader. Explorations in creating Wula Na Lnuwe'kati, are oriented toward action in expanding the roles and responsibilities of reader and map. Wula Na Lnuwe'kati breaks down any formerly established narrative and invites the reader to construct a new, self-directed narrative.

Wula Na Lnuwe'kati has a structural foundation whose role is to serve as the interface's skeletal form. It is to this skeletal structure that information sources are secured. The basis of this structural foundation is several carefully constructed subroutines of code that describe the action/reaction of user interactivity.

10.7 Conclusions

Wula Na Lnuwe'kati is a cartographic product which reintroduces a different type of art into the practice of cartography: maps are more than information sources, they are offered to as images that invite one to linger and enjoy.

In a digital multimedia environment, the atlas redistributes the responsibilities of map maker and map user. Through interactivity, the map user is a participant in the writing of the cartographic narrative. This user engagement is facilitated by an interface that offers many avenues for self-directed exploration through a complex of possibilities.

Media elements compliment each other and are presented as partners in information delivery. Interface devices assume the dual roles of both functional and decorative components. Sound and image are vehicles for information delivery as well as acting to ground the work within its cultural foundation.

What has been achieved in Wula Na Lnuwe'kati is, in part, a result of embracing the possibilities of new technologies while allowing traditional techniques to influence the evolution of the cartographic practice.

While this chapter has let the author dissect his work (not an easy undertaking, but a very valuable exercise), the best way to experience Wula Na Lnuwe'kati is to explore it. If a reader interprets the piece in a way that was not foreseen, the work has not been created as an encapsulated moment: it has achieved a life of its own.

Index