cartographic perspectives

journal of the

North American Cartographic Information Society

Number 44, Winter 2003

journal of the North American Cartographic Information Society

cartographic perspectives

Number 44, Winter 2003

in this issue

(*continued on page 3*)

Letter from the Editors

The Changing Face of Atlases

Scott Bell
Scott Freundschuh

Maps hold the fascination of many. Always have. As a collection of maps, Atlases represent a treasure for both the map connoisseur, and the stop-and-look-at-those-really-neat-maps Barnes & Noble shopper. We theorize that the lay public can be divided into two broad groups (of course, we only have anecdotal evidence for this classification, so use caution if you cite us). The first group is those that believe geography is nothing more than pieces of trivia associated with places (e.g., where is the longest river). These are the folks who expect "us" to perform well when "our category" comes up in Trivial Pursuit, or on Jeopardy. If they only knew "our" secret... The second group is those who, when learning that we are geographers, more specifically mapmakers,

(*continued on page 3*)

NACIS WEB SITE
www.nacis.org

Editor
Scott M. Freundschuh
Department of Geography
University of Minnesota
Duluth, MN 55812
(218) 726-6226
fax: (218) 726-6386
sfreunds@d.umn.edu

cartographic perspectives

journal of the
North American Cartographic Information Society

ISSN 1048-9085
Cartographic Perspectives is published triannually

Assistant Editor
James R. Anderson, Jr.
FREAC
Florida State University
Tallahassee, FL 32306-2641
(850) 644-2883
fax: (850) 644-7360
janderson@admin.fsu.edu

Cartographic Techniques Editor
Charlie Frye
ESRI
380 New York Street
Redlands, CA 92373
(909) 793-2853
cfrye@esri.com

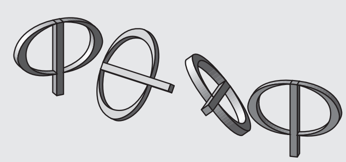
Map Library Bulletin Board Editor
Melissa Lamont
Data Library, McLean Laboratory
Woods Hole Oceanographic
Institution
WHOI Mail Stop 8
Woods Hole, MA 02543
(508)289-3396 fax: (508)457-2183
mlamont@whoi.edu

Book Review Editor
Ren Vasiliev
Department of Geography
SUNY @ Geneseo
Geneseo, NY 14454
(585) 245-5297
vasiliev@geneseo.edu

Essay Section Editor
Matthew McGranaghan
Department of Geography
445 Social Sciences Building
University of Hawaii at Manoa
Honolulu, HI 96822
(808) 956-7092
matt@uhunix2.its.hawaii.edu

Online Mapping Editor
Jeremy W. Crampton
Dept. of Anthropology & Geography
Georgia State University
Atlanta, GA 30303
(404) 651-1763
jcrampton@gsu.edu

about the cover



The cover image, titled *Map Mandala* was created by Matt Knutzen, artist, cartographer and Assistant Chief Librarian of the Map Division of the New York Public Library.

The mandala has long been employed by spiritual traditions in both the process of meditation and also as it's object. According to Carl Jung, "[it] is the exponent of all paths . . . the path to the centre, to individuation." In *Map Mandala,* the functional language of mapmaking (finding one's way) metaphorically reinforces the mandala as a way finding device, a guide to a path (life/spiritual) towards self-understanding and knowledge.

express a shared affection for maps and other representations of the world. As such, an atlas would be a superb gift for these folks who share our passion for geography and maps.

Contemporary atlases are pushing the boundaries of cartography and geography, as well as how map-readers view and use map collections. Cartography relies on both science and art to produce accurate and functional representations of the world. In addition, there is an important need to conform to standards of practice while introducing new innovations to improve the ability of maps to communicate, and to store information and to provide tools for analysis (both spatial and non-spatial). Cartography relies increasingly so on the development of new tools for the storage, analysis, and communication of spatial information. Geographic Information Systems (GIS) software, initially developed as a storage and analysis tool for governments, geographers, and industry, is fast developing tools for the communication and visualization of spatial data. Furthermore, cartographers are quickly assimilating emerging technologies, and building their own, to enhance the cartographic products they are delivering. This includes, but is not limited to, Internet publication and animation software, statistical software, and analytical tools. This development and adaptation has provided today's mapmakers with the ability to live up to, and beyond, the traditional expectations of cartography.

In this focus issue of *Cartographic Perspectives*, we see exemplary map products in the form of traditional and non-traditional map atlases. As cartographers continue to explore new topics in the realm of map-making, we are seeing an expansion of what has traditionally been classified as a map, as well as a resurgence of traditional cartographic elements that might have lately become more closely associated with other geographic techniques (analysis, storage, etc.). With the continued improvement in software designed for developing and delivering content via multi-media (CDROMs, the Internet, digital images, digital line drawing, dynamic authoring, etc.), the decisions for which a cartographer is responsible are increasing rapidly. With these new tools, the line between cartography and related geographic techniques is further blurred. Contemporary atlas developers are creating collections of maps that provide an increasingly flexible experience to the map-reader.

Users of modern digital and multi-media atlases can create "on the fly" maps that are the product of mixing data; these maps represent relatively novel spatial representations, and in many respects represent geo-visualization and spatial analysis. Such maps are just one of the unique features of the online version of the *Atlas of Canada* (Natural Resources Canada, 2002), the country's official atlas, and the sixth edition of an atlas that was first published in 1906 (the preceding 5 editions were traditional paper atlases). While conveying an immense amount of data, the atlas offers a flexible, user-centered approach to map production, but structures the presentation of information so that map appearance is not compromised by non-cartographically trained users of the site. Giving the atlas user the opportunity to determine what is mapped allows for the potential production of representations that the cartographer who developed the atlas may never have seen or anticipated. In more traditional situations, the cartographer can use dynamic mapping and media production tools to produce engaging maps that display time and space in a way that static maps simply cannot.

Two contributions to this issue consider design issues associated with developing regional (sub-national) atlases. The *Atlas of Saskatchewan (CD-ROM Edition)* (Martz 2000) and the *Atlas of Oregon, Second Edition* (Loy, Allan et al. 2001) both take advantage of emerging technology to support the presentation of maps while adhering to the standards and principles of cartographic and information design. The bases for both atlases lie in earlier offerings and specific decisions related to graphic communication and cartographic design. Martz and Pietroniro (this volume) describe how traditional cartographic principles guided their initial decisions, while considering the limitations of these principles given the dynamic nature of the

in this issue

(*continued from page 1*)

medium through which they were communicating. It would be a reasonable suggestion, as alluded to by Martz and Peitroniro, that the cartographic community examine the work of Marshall McLuhan's more closely to understand better how cartography can take advantage of new and emerging media. Others in geography, particularly in GIScience, have already picked up on this theme and are considering some of the ramifications of how technology shapes our view of the world and GSI as a tool (Sui and Goodchild 2001; Sui and Goodchild 2003).

The fourth contribution (Lobben and Patton, this volume) concerns an important step towards the development of a set of guidelines for digital atlases. The guidelines are based on examining the standards for effective communication in a variety of media, including printed atlases, digital cartography, graphic communication via the Internet, and digital atlases delivered via the Internet (WWW). In summary this article provides a set of guidelines for WWW published digital atlases; a unique and valuable tool for those interested in taking advantage of this powerful medium.

As students of cartography develop into mapmakers they are doing so in a changing world, both in respect to the reality that surrounds them and the tools at their disposal. The fact that so many contemporary cartographers have adapted to these changes is a testament to the nature of cartography and the people who practice it. Cartography is defined not only by its past and the work that has established the practice of mapmaking, but also by its continued search for new modes of expression and new tools for spatial communication. We hope the readers of this volume will find something of value that can contribute to their own work, just as the atlases and maps discussed here have been, and will continue to be, valued by the public.

Loy, W. G. and Allan, S. (Eds.), 2001. *Atlas of Oregon, Second Edition*. Eugene, Oregon: University of Oregon Press.

Martz, L. W., (Ed.), 2000. *Atlas of Saskatchewan, CD-ROM Edition*. Saskatoon, Canada: University of Saskatchewan.

Natural Resources Canada, 2002. Atlas of Canada. URL (most recent update 8/6/2003), http://atlas.gc.ca/site/english/index.html

Sui, D. Z. and Goodchild M. F., 2001. "GIS as media?" *International Journal of Geographical Information Science* **15**(5):387-390.

Sui, D. Z. and Goodchild, M. F., 2003. "A tetradic analysis of GIS and society using McLuhan's law of the media." *Canadian Geographer-Geographe Canadien* **47**(1):5-17.

Correction:

Figure 4 in "Earle Birney's *Mappemounde*: Visualizing Poetry with Maps" was inadvertently printed upside down (*Cartographic Perspectives* 43, Fall 2002, p. 68). The author, Adele Haft, apologizes for this error.

Letter from the President

Gordon Kennedy
Washington State Department of Transportation
P.O. Box 47430
Olympia, WA 98540-7430
(360) 705-7641
prez@nacis.org

NACIS is a fascinating community. I know the word "community" is overused, but I choose the term deliberately here. We share many common interests, we constructively interact with each other, and we want to preserve the group's identity and integrity: we are a kind of community. About one third of our members attend the annual meeting, a high level of active participation. At those meetings I see an exceptional degree of cooperation, earnest engagement, and mutual respect among attendees representing a wide variety of interests within and close to cartography.

One shared interest is an appreciation of map design both as a craft one practices and as a subject of intellectual study. NACIS provides a crossroads where cartographers faced with practical challenges of map production intersect with scholars studying the theoretical foundations of cartography. Over the years that I have been involved in the Society, an idea has repeatedly arisen for a conference paper session on map design in which one presents examples of design failures, bad taste and generally weird attempts at the cartographer's art. The idea is to explain and reinforce the design principles that trained cartographers promote by examining the consequences of casual or uninformed design. No one has yet (so far as I know) attempted such a session, probably because to write the abstract would be a very delicate matter. How do you express the idea as a sincere endeavor not intended to insult well-intentioned, amateur mapmakers?

That such an idea should arise and be cheerfully discussed with equal relish by both academics and practitioners speaks of the famously congenial atmosphere of NACIS. When I hear Charlie Rader (University of Wisconsin—River Falls) coin the marvelous term "cartastrophies," and John Krygier (Ohio Wesleyan University) suggest a session entitled "My Worst Map," I remember how important it is that NACIS provides that congenial atmosphere enabling forthright discussion of all matters cartographic: a "safe venue," as Alex Tait, of International Mapping Associates, puts it. Many of us share an enduring fascination with map design, either as a practiced craft or as an intellectual problem. Mark Denil (Conservation International) describes professional cartography as "…a body of informed practice" and I think this phrase succinctly captures something of the source of our interdisciplinary interest. As a "body," cartography is a collection of related elements; as "practice," cartography is the skilled performance of disciplined work; as an "informed practice," cartographic work is subjected to analysis and criticism, and its problems are matters for contemplation and research.

NACIS offers us the venue for discussing this practice with those performing the work, those inventing new methods and those who critique, analyze and contemplate the practice.

Another shared interest within the NACIS community is one of our middle names: *information*. It is for some constructive purpose that we create maps, even those that are more **art**ographic than cartographic. Maps and map-like artifacts are created with intention, and I think this intention generally has to do with the representation of concepts. As artifacts of concept representation, all maps contain information. Here is another crossroads provided by NACIS: cartographic information is at the intersection of geographic information analysis and artifact stewardship. People in these professions love information and are eager to guide us toward the knowledge we can derive from it. Map librarians and GIS analysts are guides who point us to knowledge by providing and analyzing geographic data.

In conventional map-making, the information content is an assertion of facts about the world, and the usual intention is to explain or persuade. In artistic, personal cartographies, the map artifact may be no more than the remaining evidence of the artist's process of becoming informed. NACIS members value the refreshing perspectives on mapping provided by colleagues like Adele Haft (City University of New York), who explains cartographic references found in literature, and Karen Cook (University of Kansas), who deciphers 15th-century cartographic documents for us. NACIS offers a meeting ground for the study and discussion of the informational intent of cartography, from the conservation of data and artifacts to the methods of spatial data analysis to personal expressions utilizing cartographic references. This again reminds me of the important role NACIS plays in providing a rigorous, respectful forum for all thoughts cartographic.

My recent work in information technology has revolved around the planning and design of databases, and the effective use of data for organizational benefit. "Information," in a contemporary technological sense, is data presented in a context useful to people. The information technology (IT) profession has been increasingly interested in recent years in assuming the role of *information* and *knowledge* managers. *Business intelligence*, *data warehousing*, *data mining*, *knowledge management* and *decision-support* are some of the popular phrases in contemporary IT. All of these concepts, when reduced to their essential ideas, are familiar to cartographers. A *data warehouse* is a database designed for analysis and decision-making, rather than for simply recording operational transactions. The principles of cartographic generalization are strikingly similar to the principles of data warehouse design: the designer determines the kinds of information the user wants to have and then selects, simplifies and summarizes source data to make the resulting derivative accessible to the user.

Sophisticated design methods and complex software have been developed to support data warehouses so that they import and present the right data in the right way for decision-makers. The IT industry has discovered what cartographers have known for decades—people perform best when just the right amount of information, rather than all the information available, is organized and presented to them clearly. Much art and science is deployed in finding that "right amount" of information and in presenting it "clearly." Whether this is for tabular or spatial data, many of the concepts are fundamentally the same. We trade precision and completeness for manageability and clarity. Such thinking is inherently cartographic and it is becoming the kind of thinking required to manage tabular data well for analysis and decision support. I find it intriguing that these apparently diverse disciplines—cartography and data warehousing—have much in common.

The applications of information technology are continually expanding—we use or are experimenting with the use of electronic data gadgetry for more and more aspects of our professional and personal lives. Cartographic methodologies are now dominated by information technology, from data collection and analysis through graphic design and publishing. Invention and innovation with IT hardware and software show no sign of waning. The interests of NACIS are starting to look much like some of the interests within the IT professions: data and information and their representation through media aimed at one or more of our senses.

As IT discovers the need for presenting data creatively and effectively, and develops software to service this need, it will inevitably meet up with cartography. I believe many GIS professionals are recognizing their inevitable merger with mainstream IT, and IT is gradually becoming more spatially and geographically savvy ("location-based services" is a new IT buzzword). Where the visual, tactile, audio or other sensory presentation of geography is the problem, cartography will be the discipline to go to.

Cartography's conceptual foundations remain solid and relevant: how does one produce the most effective sensory presentation of geographically based data? How does one acquire, store, conserve and present those artifacts for subsequent users? How does one teach the techniques of map production and the skills of map use? GIS is already an ally in the cartographer's quest for a wide selection of data sources and for data sources that are reliably maintained. IT's increasing interest in data presentation directly relates to cartography. This, to me, presents a bright and exciting future for NACIS. We have vast information resources readily available and usable, great graphic arts technologies, and fascinating new media for publishing cartographic works. There are plenty of intriguing maps, and new forms of maps, to create and many intriguing and rewarding things to talk about.

The Atlas of Canada Web Mapping: The User Counts

Donna Williams,
Douglas O'Brien,
Eric Kramers
The Atlas of Canada
Natural Resources Canada
650 – 615 Booth Street
Ottawa, Canada
K1A 0E9
dwilliam@nrcan.gc.ca
obrien@nrcan.gc.ca
kramers@nrcan.gc.ca
http://atlas.gc.ca

Imagine if…

A student searches the Internet to get information for a project on Victoria for a grade nine geography class. He uses Google to search for "Victoria" and "geography". First on the list of search results is The Atlas of Canada. He quickly selects this and arrives at the home page of the Atlas. He sees that he can search for a place and he does so for Victoria. He finds there are many places named Victoria in Canada and is able to find the one in British Columbia for which he is looking. He then sees that he can link from the location map to combine themes with the place. The thematic material includes all the types of information he is required to put into his project. Not only can he see the maps, which he decides to use as the basis for his project, but also the background data used to make the map. He notices an audio button that he clicks on to get a description of the map and a video button, which brings up an interesting video clip. He then finds that a full description is available that also provides links to other sites that may be of interest. Everything he needs is in this one great Web site. From now on, The Atlas of Canada is where he will start all his assignments.

INTRODUCTION

The advent of the Internet has broadened the scope of The Atlas of Canada. An atlas has traditionally been seen as a collection of maps and has been described by Kraak and Ormeling as maps related to one another that achieve specific objectives (1996:183). The atlas on the Internet can do much more. Web-based systems for mapping are powerful tools for providing public access and visualization of complex information (Warren and Bonaguro, 2000).

The Atlas of Canada's goal in mapping on the Internet is to provide the most interesting, dynamic and comprehensive collection of maps and related information about Canada with effective and intuitive tools to the general public. To accomplish this goal, the Atlas of Canada must provide authoritative, current and accessible geographic information and tools that users want and are able to use. This has resulted in the Atlas being available on the Internet.

"The Atlas of Canada's goal in mapping on the Internet is to provide the most interesting, dynamic and comprehensive collection of maps and related information about Canada with effective and intuitive tools to the general public."

Being available on the Internet, indeed in any electronic environment, demands that the user have a level of technical proficiency. To use any atlas the user must be able to, "…have a clear idea of its overall possibilities and structure, of the way to access the information they want and of the way to get back to the starting point (Kraak and Ormeling, 1996:186). The complexity of the systems used to visualize the information can create a barrier to access to information rather than enhance it (Warren and Bonaguro, 2002). User-centered design and testing engages the user in the process of development, leading to more useful mapping.

This paper will provide a brief description of the history of the Atlas of Canada. The methodology and results of a user-centered design process is then described, and the resulting Web site outlined. The importance of this work and its continuation in the development of the Atlas is explored in the concluding section.

Era of Assumptions and the Lure of Technology

The Atlas of Canada has published five printed editions since 1906 (http://atlas.gc.ca/site/english/about_us/). Each volume represents an evolution of information, format and media. The five printed editions of the Atlas are collections of maps, graphs and tables that provide an overview of the geography of Canada at a given time.

The printed editions were produced without significant consultation from users. For example, map librarians disliked the Fifth edition of the Atlas because the sheets were loose leaf and disappeared from their collections. Decreasing sales indicated that users' needs were not being met. As a result of the low sales and the high cost of printing, the decision was made to end the paper editions of the Atlas and move towards digital solutions.

"The printed editions were produced without significant consultation from users."

Early prototypes included an Atlas on CDROM. Users were required to purchase additional software to view the maps, so the product was not popular. With the Internet gaining acceptance, Atlas staff recognized the power of an Internet solution. The Atlas of Canada moved to the Internet and the journey towards today's on-line version of the Atlas began.

Atlas staff created The National Atlas on the Net in 1994, one of the first instances of using the Web for interactive maps. After proving the concept of interactive mapping on the Internet, the Atlas was contracted to develop geography content for the Industry Canada initiative, SchoolNet (http://www.schoolnet.ca/). This Atlas evolved from having the few layers of data needed to prove that the technology worked, to having hundreds of available layers.

Content and information access tools were developed in consultation with the educational community through a Teacher Advisory Group, representing teachers from across Canada. This group provided invaluable insight into what teachers needed in the site. This was the first real attempt to gather direct feedback in an organized fashion. As a result the Atlas site soon included a quiz about Canadian geography, a resource section for teachers, and much more textual background information on the maps. The seeds of the idea of user feedback may well have been sown through these interactions.

Despite the teachers' feedback, the traditional attitudes of "government knows best" and "if we build it, they will come" still prevailed. The creation of tools during this period was dependent on the developer's insights and data providers' comments. The general feeling was that since we were the developers and cartographers, we knew what would be best.

". . . the Atlas was still attempting to focus on the very broadest audience, trying to serve all needs with a single window."

In 1998, the Government of Canada authorized an ongoing program for an Internet-based National Atlas. This led to the launch of the sixth edition of the Atlas of Canada at the International Cartographic Association (http://www.icaci.org/) conference in Ottawa, in August 1999. This new on-line edition offered the very latest interactive mapping technology on the Internet. Users could browse interpreted information and interact with the data being made available through the Atlas, as well as access the data sources.

The Atlas staff recognized that on-line mapping technology had matured. The focus, therefore, shifted to content and development of the information for the user. To achieve this, the Atlas looked to commercial, off-the-shelf software to provide an "out-of-the-box" solution. However, the Atlas was still attempting to focus on the very broadest audience, trying to serve all needs with a single window.

The great error in this phase of development was not asking users what they really needed. There was little understanding of the how users interacted with the Atlas and the importance of understanding what types of tasks they perform (Scanlon and Percival, 2002). Earlier feedback from the Teacher Advisory Group had provided the insight to focus the development of the Atlas on Canadian issues, but further user testing was not explored. Since the site was trying to address the needs of the basic user (access to general information) and the sophisticated user (cartographic manipulation and database queries) at the same time, the challenge of providing simple access to complex information was not met.

Introduction of the User

". . . the answer was to better understand the Atlas users."

Many of the attempted modifications to the site were based on what was thought to be user input. Since the birth of the Atlas on the Internet, user input had been sought and received through e-mail via the site. This input was the basis of many changes following the Sixth Edition launch but it was never really known how representative this feedback was. For example, feedback indicated that the table of contents was difficult to use. Several changes were introduced, but these did not improve the situation. The Atlas staff was at a stand still, no longer sure of what changes could be implemented to improve the site.

Internal discussions revealed the answer was to better understand the Atlas users. Many questions arose as to who the users were, what they were coming to the site to find and whether they found what they wanted. The users could only provide answers to these questions. This lead to a new era of user-centred design. At the outset, the immense difference that this paradigm shift would make was barely conceived. Today, user consultation is deemed essential in the development of the Atlas.

The user-centred process, adopted by the Atlas, consists of three main stages prior to launching a new or revised product. The first two stages include an examination of the Atlas' business needs and the users' requirements. This is followed by a series of usability tests where the product is refined. The value of this approach is one that saves effort and cost due to the quality of the end result and the reduction of design errors (Nielson, 1994).

"The value of this approach is one that saves effort and cost due to the quality of the end result and the reduction of design errors."

To analyze the issues and problems with the Atlas, site comprehensive research encompassing both design and functionality, was conducted. The high-level objectives were:

1. Identify and profile the Atlas of Canada's user community,
2. Measure overall satisfaction with the site, focusing on the interactive and static mapping,
3. Assess the content, functionality, structure and usability of the site,
4. Understand users' behaviour when interacting with the site,
5. Determine the users' needs not being met with the existing site.

A contractor, that satisfied the Atlas team's requirements, proposed an integrated research methodology. It proposed a review of existing server log analysis reports, a quantitative on-line survey of a minimum of 1,000 visitors to the Web site; four follow-up focus groups and 12 in-depth observational interviews with members of selected user groups. The research would identify successes, problems, concerns and users suggested solutions, using both quantitative and qualitative research.

The purpose of the server log analysis review was to obtain an understanding of visitor behaviour to help form research hypotheses and online surveying strategies. Specifically, the findings outlined usage volume, traffic patterns, entry points and referring pages. This assisted in the on-line survey placement and timing, as well as aided in developing hypotheses around use and preferences.

The on-line survey resulted in 1,059 respondents. The invitation to complete the survey was programmed so that every fifth visitor, to one of 16 entry points within the site, would receive it. These entry points were selected based on the analysis of server log data and in consultation with the Atlas project team. To encourage response, survey participants were eligible to enter a draw for one of ten map sets, each containing nine thematic maps of Canada.

In order to maximize the number of completed surveys, respondents were asked to answer questions about their overall experience with the Atlas site and on one randomly selected area of the site, based on where they spent time. The contractor designed the survey in full consultation with the Atlas team and ensured that it was thoroughly pretested. The survey was branded with the contractor's logo and was located on their Web server. This ensured that those taking the survey knew the research was being conducted independently and with complete confidentiality.

". . . respondents were asked to answer questions about their overall experience with the Atlas site . . ."

The final stage of the study consisted of four focus groups and 12 in-depth usability interviews with site users. The purpose of the groups and interviews was to gain insight into navigation and usability issues identified with on-line survey, as well as to understand in detail the content needs of users and related improvements and additions to the site. Participants who used the site primarily for personal reasons were recruited into sessions that were separate from those who used the site primarily for educational purposes. The students for the in-depth interviews were recruited from local schools and had experience using maps and/or related materials for school.

What Did We Learn? The Quantitative Results

Little previous research, in general, had been done on how Web-maps are accessed and used, how they should be organized, how efficient and useable they are and for what purpose they are being used (van Elzakker, 2000; Harrower, Keller and Hocking, 1997). The results of the research were revealing and illuminating to say the least. The research results that follow will focus on the site as an atlas product and do not deal with content or the particulars of the content in The Atlas of Canada.

User Profile

The user profile offered, for the first time, a quantitative view of the Atlas' user audience. Visitors were evenly distributed among age groups, with the exception of those 55 or older. They represented only 10% of visitors, compared to all other age groups where proportions of visitors ranged from 18% to 24%.

". . . the educational sector represented 32% of visitors . . ."

Table 1 compares the demographic distribution of visitors to the site with the overall distribution of Canada's population, based on Statistics Canada's population data for the year 2000 (http://www.statcan.ca/english/Pgdb/demo02.htm).

Seventy-three percent of visitors were from Canada, followed by 16% from the U.S.A. The remaining 11% were other international visitors.

The largest proportion of visitors to the site was employed in professional services (consultants, engineers, marketing, etc) at 40%. Following this, the educational sector represented 32% of visitors of which 19% were students and 13% were teachers. There were very few in the elementary

Geographic Area	Proportion From Survey	Proportion of Actual Population for the Year 2000
Eastern Provinces	7%	7%
Quebec	18%	24%
Ontario	39%	39%
Western Provinces & Northern Territories	36%	30%

Table 1. Demographic distribution data is from The Atlas of Canada *Public Opinion Research Report, March 2000 and the Statistics Canada Web site (URL referenced above).*

school grades, one to six. The remaining 28% were visitors that could be identified as the general public.

User Behaviour

The previous figures above are more revealing when compared with reasons for visiting the site as shown in Table 2.

User Group	Reason for Visiting the Atlas				
	School	Work	Personal	Total	Percentage by User Group
Students	128	9	63	200	19%
Teachers	56	54	30	140	13%
Professional	55	127	244	426	40%
General Public	52	21	220	293	28%
Totals	291	211	557	**1059**	100%
Percentage by Reason	27%	20%	53%	100%	

Table 2. "Reason for visiting the Atlas" data is from The Atlas of Canada Public Opinion Research Report, March 2000.

"Most educational users cited lack of convenience, speed and availability as impediments to accessing the Internet at school."

When asked how they got to the Atlas site, over 68% indicated that they linked to The Atlas of Canada from another site. Interestingly, only 11% indicated that they had used the site in the past and bookmarked it or knew the URL. Sixty-six percent of visitors typically accessed the site from home, followed by 25% who accessed it from work, and 8% who accessed it from a library. Most educational users cited lack of convenience, speed and availability as impediments to accessing the Internet at school. Most users classed as general public participants indicated that they primarily accessed the Internet from work.

Table 4 shows the percentage of visitors visiting the various sections of the Atlas Web site.

The Atlas site was not attracting a large proportion of repeat visitors. The majority of visitors to the site (79%) visited it for the first time. Only 18% had visited the site two to nine times in the past year, and only 2% had visited it ten times or more. Table 5 shows the amount of time visitors typically spent on the site.

Type of Information Wanted by Users	Percentage of Respondents
Cities, provinces, political maps, etc.	44%
General facts about Canada	26%
Maps of lakes, rivers, physical regions, geographic formations	14%
Specific geographic information (e.g. latitude/longitude, elevations, etc.)	8%
Road map/directions	6%
Educational material to use in a classroom	6%
Population figures	5%
Aboriginal/Indian map	2%
Interactive maps	1%
Satellite images	1%
Other	8%

Table 3. "Type of information wanted by users" data is from The Atlas of Canada Public Opinion Research Report, March 2000. Users were allowed to select more than one type.

Areas of the Site Visited	Percentage of Respondents
Quick Maps (static maps)	59%
National Atlas Mapping Tool (interactive maps)	53%
Facts about Canada	36%
Quizzes	21%
Teaching Resources	19%
Canadian Communities Atlas (educational project)	15%
Products and Services (paper maps)	12%

Table 4. "Areas of the site visited" data is from the Atlas of Canada *Public Opinion Research Report, March 2000.*

Interestingly, visitors were spending large amounts of time at the site, especially considering that the majority of them were visiting for the first time. Users were sufficiently interested in the site and its content that they were willing to spend the time exploring it. These numbers showed the Atlas team the significant value of the Atlas to its user groups.

Use of Maps and Mapping-Related Information

Teachers typically used maps from the Internet to support their lessons, as well as to supplement the maps found in out-of-date texts. Some used Geographical Information Software (GIS) to manipulate maps, such as adding layers to create a complete picture of a region. High school students used maps that their teachers gave or referred them to, for classroom work. The general public used maps for a wide range of reasons, mostly travel/interest, locating specific locations for a wide variety of reasons, and some thematic (e.g. topographic maps for personal interest)

"Teachers typically used maps from the Internet to support their lessons, as well as to supplement the maps found in out-of-date texts."

Length of Visit on the Site	Percentage of Visitors
Under 1 minute	3%
1 to 5 minutes	27%
6 to 10 minutes	33%
11 to 20 minutes	21%
Over 20 minutes	16%

Table 5. "Length of visit" data is from the Atlas of Canada *Public Opinion Research Report, March 2000.*

maps. This lead the Atlas team to develop specific parts of the site for different user groups.

What Did We Learn? The Qualitative Results

The overall role and user audience of the site was not clear to visitors. To clarify this, it was necessary to identify the primary user groups and their needs. The original design and content of the site had not been designed with specific audiences in mind. The site design and style was inconsistent, the graphics were too large and did not always serve a purpose. The inconsistent menus and style of navigational aids made moving around the site difficult because users did not know if they were in the appropriate section for their information needs. The site pages were generally slow to load.

"The overall role and user audience of the site was not clear to visitors."

The overall organization of the site was complicated and confusing, and led to user frustration. The organization of the home page was a key problem. Most felt there was no clear indication of how to navigate the site or what would be found behind each label. One of the fundamental problems was that there were four mapping related labels on the home page. For example, if a user was looking for a relief map, he or she would have to go to three different sections to find the three relief maps. This caused considerable confusion as users had to explore each of these areas in order to understand what they contained. In many cases a user would review and exit an area of the site, and still not appreciate what the area contained.

"The overall organization of the site was complicated and confusing, and led to user frustration."

The vast majority of the static maps were contained in a section called "Quick Maps". The intention of this section was to offer these maps quickly and easily. As with other parts of the site, the labels did not accurately describe the contents within each section of Quick Maps and visitors had to visit numerous subsections to determine if the contents were appropriate for their needs. There was also confusion about the difference in the content of this section and the interactive map section, "Make a map".

The Interactive Maps' Table of Contents

Most users were unable to find or access what they were looking for in the interactive mapping table of contents. Selecting maps was a time consuming process. It was designed to emulate Windows Explorer but did not have all of its elements. They did not find it intuitive to click on the 'plus' boxes to "drill down" deeper. The maps and their related textual information were not differentiated; they both appeared as underlined labels. Users expected to click on an underlined word and get a map. When they

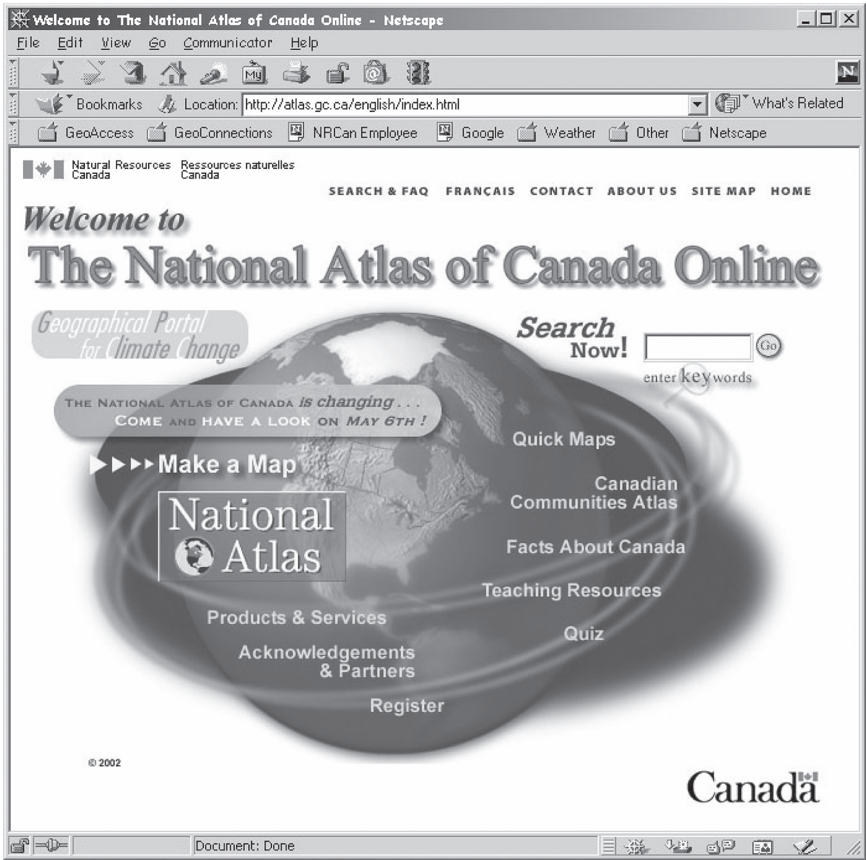


Figure 1. The home page of the Sixth Edition of the Atlas of Canada*, Version 1.*

selected one and was presented with text, they thought that was all there was, text and no maps.

The Mapping User Interface

The initial map displayed was at scale of 1:60 M. Users could not see the entire map, tool bar and legend at the same time. Users typically scrolled down to see the entire legend and the bottom of the map. When this was done, the tool bar was forced upwards and when out of view, it was forgotten. With the apparent absence of the tool bar, users did not realize they could zoom in and would think that the very generalized national view was all there was to see. Due to this, users did not realize they could manipulate maps. The mapping user interface's (UI) tools were shown as buttons with an unselected and selected state and used standard GIS icons. Many users did not understand what most icons meant and how to use the tools.

The links to maps' related text, its subtopic and overall topic were not seen in the upper left corner. Only the primary thematic and relevant base layers were shown in the legend. The others were behind the main legend and were accessible using a tab. This was not intuitive.

"Many users did not understand what most icons meant and how to use the tools."

Responding to the User – A New Atlas Web Site

The need to redesign the Atlas of Canada was clear based on the research and recommendations. A first and most important step was to define the primary user groups (Scanlon and Percival 2002). Based on the results of

"The need to redesign the Atlas of Canada was clear based on the research and recommendations."

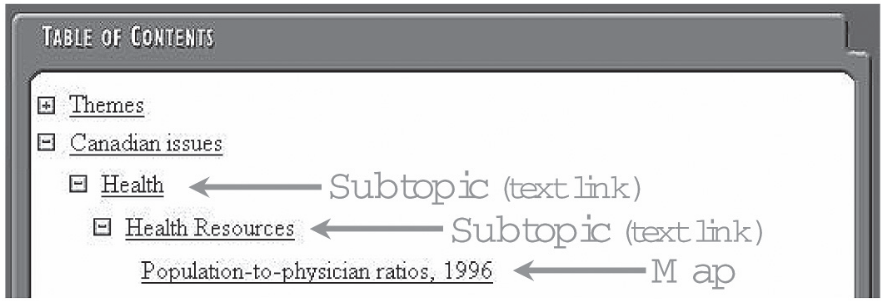


Figure 2. The interactive mapping table of contents of the Sixth Edition of the Atlas of Canada, *Version 1.*

Figure 3. The interactive mapping user interface of the Sixth Edition of the Atlas of Canada, *Version 1.*

the research, they were found to be the general public, teachers and students in their late elementary and high school years.

The role of the Web site required clarification. The selected user audiences identified who the site would be designed for but did not identify what it would contain. Poor and inaccurate labelling, throughout the site, and inappropriate supporting graphics caused confusion about the previous site's role and contents. The project team decided that the role of the site would be to "Discover Canada Through Maps and Facts" and that this would be reflected in all new labels and graphics.

"The new site was designed using iterative user testing."

The new site was designed using iterative user testing. A redesign based only on the results of the initial study would have resulted in some improvements, but not many. To ensure real and validated improvements, the site redesign would include a contract for three iterative usability-testing stages, based on time and budgetary considerations. This approach was used for a companion program developed in the GeoAccess Division. Using simple mock-ups, representative tasks with small numbers of users were key to the testing success of this program (Szeredi and McLeod, 2000). The objectives of the site redesign were to:

1. Develop new site architecture and improved navigation,
2. Develop a new site design and style with consistently applied specifications,
3. Apply the Government of Canada's Common Look and Feel requirements,
4. Implement a gazetteer service,
5. Assess the Atlas' interactive mapping user interface (UI) requirements and implement a new UI,
6. Deliver all maps faster,
7. Improve the site's search functionality,
8. Assess and implement content management software,
9. Assess map server requirements, and implement a replacement.

The interactive maps' textual and ancillary documents were not tested due to time constraints. This component has been undertaken in a different phase of development.

Methodology

The three user-testing sessions were composed of 12 observational usability interviews. Conducting research at three separate stages throughout the re-design process ensured that changes accurately reflected user needs. The user-testing sessions were equally divided between students, teachers and the general public. The number of users required for usability testing was minimal. Typically four to six users per user audience is sufficient to reveal usability issues or provide proof of success (Nielson, 1994).

"Using simple mock-ups, representative tasks with small numbers of users were key to the testing success of this program."

The usability interview approach was well suited to collecting information on users needs and navigation related the Atlas Web site. The interviews were conducted using a think-aloud, task-based testing methodology (Szeredi and McLeod, 2000). It required participants to interact with the Atlas site and conveyed a user's detailed impressions and reactions to the site, navigational behaviour, search strategies and issues with the user interface.

The research in the first testing session focused on identifying the role of the site and the design and labelling of the homepage and second level pages. This was based on two site architecture models reflected in the two functional prototypes. It did not specifically probe on the interactive mapping tool, but participants were asked about the features they expected. Organization of content was tested as well as variations of design and labelling. Participants were asked to find content based on several retrieval scenarios.

The second testing session focused on a single prototype, which included a combination of elements from the two prototypes tested in the first session. The research in this stage included an overview of the homepage, probing comments on its design, labelling and organization. A number of scenarios were conducted to fine tune navigation. The interactive mapping tool was tested to evaluate the appearance and layout of selected features. A new gazetteer section was introduced in this stage, focusing on how users would navigate through a place name search and what they expected to find.

Building on the recommendations from the second stage of research, the third testing session focused on fine tuning specific elements of the homepage design and labelling. Navigation was refined. Further usability issues with the interactive mapping and the gazetteer sections were dealt with. Some home page labels and some features of the interactive mapping user interface still proved to be problematic. These issues will be addressed in future usability testing sessions.

It is worthwhile to examine some of the specific solutions found during the iterative usability testing. In the section that follows, specific findings dealing with site design, labelling, navigation and architecture and the mapping user interface are presented.

"Easily readable pages . . . were found to be more important than the colours used."

Site architecture and design

A new site architecture was developed to offer consistency missing from the previous site. It separated maps and their related textual resources from other textual content. The interactive and static maps, along with their related textual resources, are the Atlas' primary content and they were combined into a single mapping section. This section also included a new gazetteer service titled "Find a Place". The remainder of the site's content was combined in a new secondary section called "More Than Maps", which contains: "Facts about Canada", "Quizzes", "Learning Resources", "Glossary", "Data and Services" and "Useful Links".

Consistency was introduced to the mapping user interface as well. In the previous version of the Atlas, up to four different mapping UI's were used with up to three different map servers. Iterative testing demonstrated that users experienced a great deal of difficulty understanding and using the most basic interface tools. The new Web site used variations of the same interface to avoid confusion for the user.

The format of the site's pages was mainly formulated by following the specifications in the Government of Canada's Common Look and Feel (CLF) standards (http://www.cio-dpi.gc.ca/clf-upe/index_e.asp). Specific higher-level navigation that appears across the top of each page was required to comply with this standard. A vertical navigational panel was also required to appear along the left side of every site page. The remainder of the page was available for site content. The CLF guidelines were followed with the exception of the width of the mapping user interface, which extends slightly beyond the designated right margin. Easily readable pages, with high levels of contrast between the text and the background, were found to be more important than the colours used.

". . . most users wanted descriptive but simple labels . . ."

Navigation – Labelling

Labels used on the home page and within the site are important to help users identify the content within various sections of the site. When deciding on labels or categories for maps, terminology that is easily understood by users is essential. The previous table of contents, shown in Figure 2, initially grouped all interactive maps in one of two categories, themes or issues. Below these, the Atlas used category names such as physical, economic and human. Many of these labels performed poorly with all three user groups involved in the testing. The images in Figure 5 show the evolution of the left navigational panel labelling through the three testing iterations to the final menu.

The process revealed that most users wanted descriptive but simple labels identifying the content within. Categories that had meaning to the Atlas team were in many cases meaningless to those tested. When a user

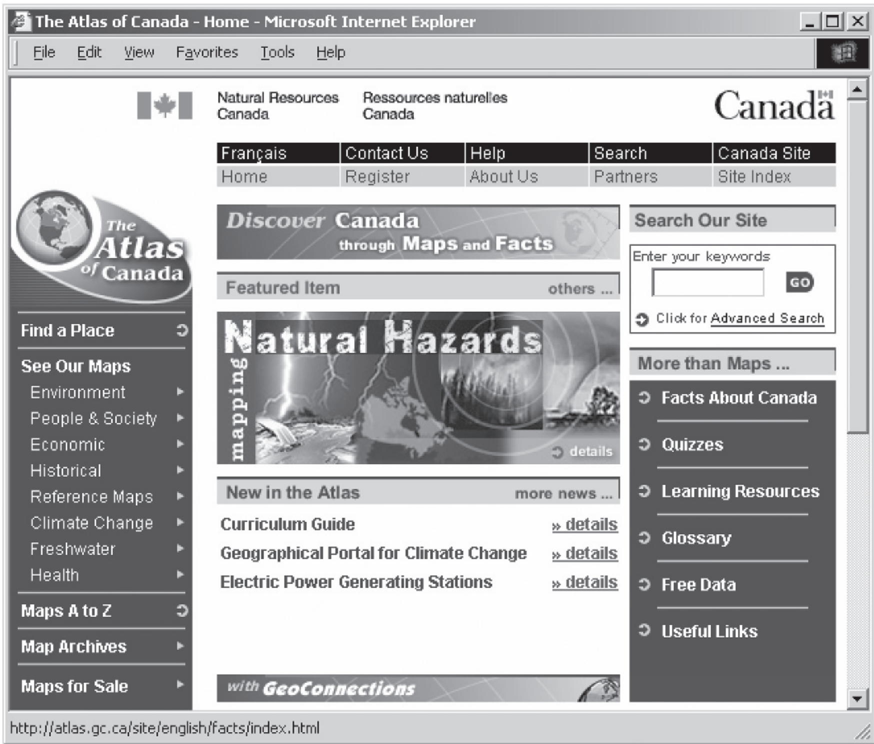


Figure 4. The home page of the Sixth Edition of the Atlas of Canada*, Version 2.*

Session 1 | **Session 2** | **Session 3** | **Final Menu**

Mock-up 1 | **Mock-up 2** | **Mock-up 3** | **Mock-up 4**

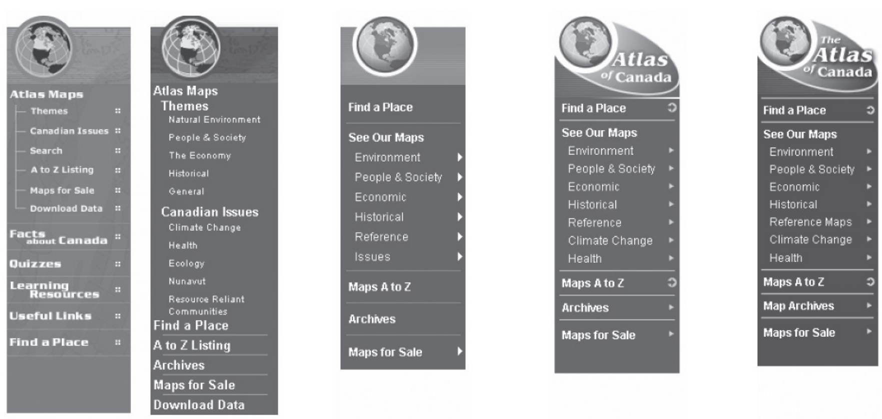


Figure 5. The iterative stages of the pop-out menus developed for the Sixth Edition of the Atlas of Canada*, Version 2.*

did not know what to expect with a particular label, effective navigation working together with the labels assisted users to easily discover what was contained in each section. A complete consensus was never achieved. The practical solution was to get the "best possible fit".

"A complete consensus was never achieved. The practical solution was to get the 'best possible fit'."

Navigation – Finding Maps

Testing revealed that users expected easy and consistent navigational aids allowing them to move effectively through the site. As previously mentioned, some of this was addressed by implementing the Government of Canada's Common Look and Feel standards. However, access to content is not covered in these guidelines. The architecture models regrouped the Atlas map content by theme, such as "Historical", rather than by type, such as static or interactive. Maps are accessible through the left navigation panel and secondary, textual content is made accessible from the home page in a panel on the right side.

A vital user preference was the ability to find and display a map quickly. With about 250 interactive and 70 static maps to choose from, a solution was needed to provide this access. It was found by using mouse-over activated pop-out menus.

"A vital user preference was the ability to find and display a map quickly."

Two mock-ups were used in the first testing session. They offered the user two options (Figure 5). The first mock-up displayed map categories, such as "Themes" on the home page, and pop-out menus of topics, such as "People and Society", and sub-topics, such as "Population". The user would click a sub-topic name and then a list of all the maps in the sub-topic would be displayed in a refreshed window. The second mock-up displayed both map categories and topics on the home page. The pop-out menus listed the subtopics only. From the sub-topic list, offered in both options, the user would select a map or its supporting textual documentation and the window would be refreshed with the selection.

Those tested preferred the second mock-up since the map topic names on the home page offered more upfront navigational information. The grouping of maps in to "Themes" and "Canadian Issues" was confusing; the preference was for all maps to be grouped under descriptive topic names. Those tested also found the sub-topic lists of maps useful but indicated a preference to go directly to a map or a page with more information about the map.

The second testing session used a third prototype that offered the user a revised list of topic names on the home page and pop-out menus of sub topics and map titles. When a map title was selected, a preview map would appear in a refreshed window with a number of viewing options. These options included, as before, the interactive or static map and the supporting textual documentation. Most tested preferred this but some issues remained over users clicking on the preview map image expecting to see a larger version.

The third testing session explored providing the same level of pop-out menus to a map title, but instead of giving the user a new page with a preview map and viewing options, they were given the interactive map. This solution resulted in the most positive responses from all three testing sessions and was incorporated into the final product. The static maps continued to use the viewing options page since they have a number of file format viewing options.

"The iterative testing process allowed the Atlas to do some testing on every component: the legend, map window, access to related text and tools."

The pop-out menus proved to be an intuitive and easy to use method and the response to them was overwhelmingly positive in all three testing sessions. The current pop-out menus require an initial, one time, download of about 300Kb. This is slightly high but the benefits of navigational ease outweigh the download time.

Mapping User Interface

The fault of previous mapping user interfaces, as discovered in the initial usability testing, was that they were not very usable. The usability issues that were uncovered showed the importance of a user-centred approach in interface design (Miller and Pupedis 2002). The iterative testing process allowed the Atlas to do some testing on every component: the legend,

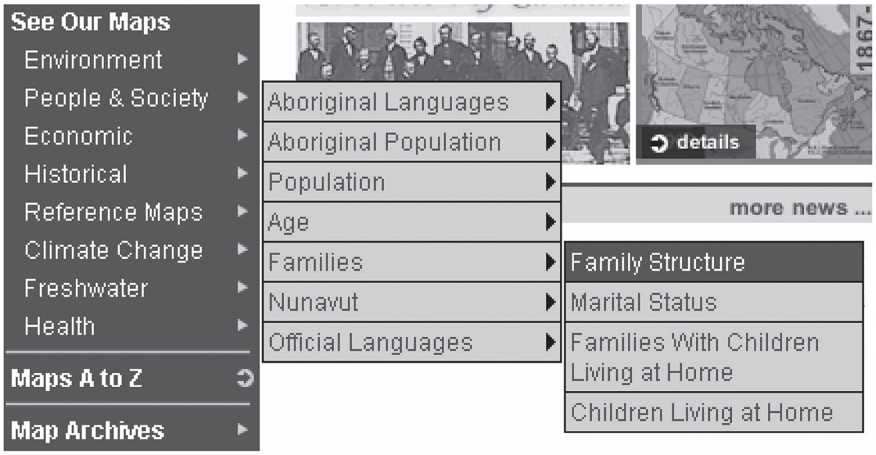


Figure 6. The pop-out menus of the Sixth Edition of the Atlas of Canada, *Version 2.*

map window, access to related text and tools. The results allowed the Atlas to develop its first mapping user interface that users could adequately relate to and use with greater ease. In the first iterative testing session, users were asked what features or functions they expected to be available with maps on the Atlas site. In order of priority they expressed the following:

- Zoom in and out;
- Print a map;
- View a legend (overwhelming consensus to view the entire legend with the map);
- Move about; and
- Select a specific feature and get information on it.

The second testing session focused on two interactive mock-ups to compare preferences for the presentation of various features and functions within the mapping user interface. The information retrieval exercises directed participants to the two interactive mock-ups and required them to use only the zoom and panning tools. Due to time constraints, the rest of the tools were only discussed. These would be tested in the third session.

"The participants intuitively clicked on the map to zoom in . . ."

The participants intuitively clicked on the map to zoom in without making reference to the zoom tool and did not notice that it was highlighted indicating it was active. The "Zoom Out" tool worked in a standard two-step operation, one step to select the tool and a second to click on the map invoking the zoom out action. Participants, however, expected it to work in a one step operation, invoking the zoom out action immediately upon clicking on the tool icon.

The "Pan" tool was less understood. When asked, participants preferred the icon in mock-up two. When required to perform a panning action in the exercises they intuitively clicked the "arrows" surrounding the map.

When participants were required to move from one zoomed in location to another, they did not find or think of using the "Reset Map" tool. They would either pan using the arrows surrounding the map or want to zoom out and then zoom in. The confusion over a two-step zoom out remained and the participants required instruction on how it worked. When the "Reset Map" tool was described, participants felt it would be good to keep

Mock-up One **Mock-up Two**

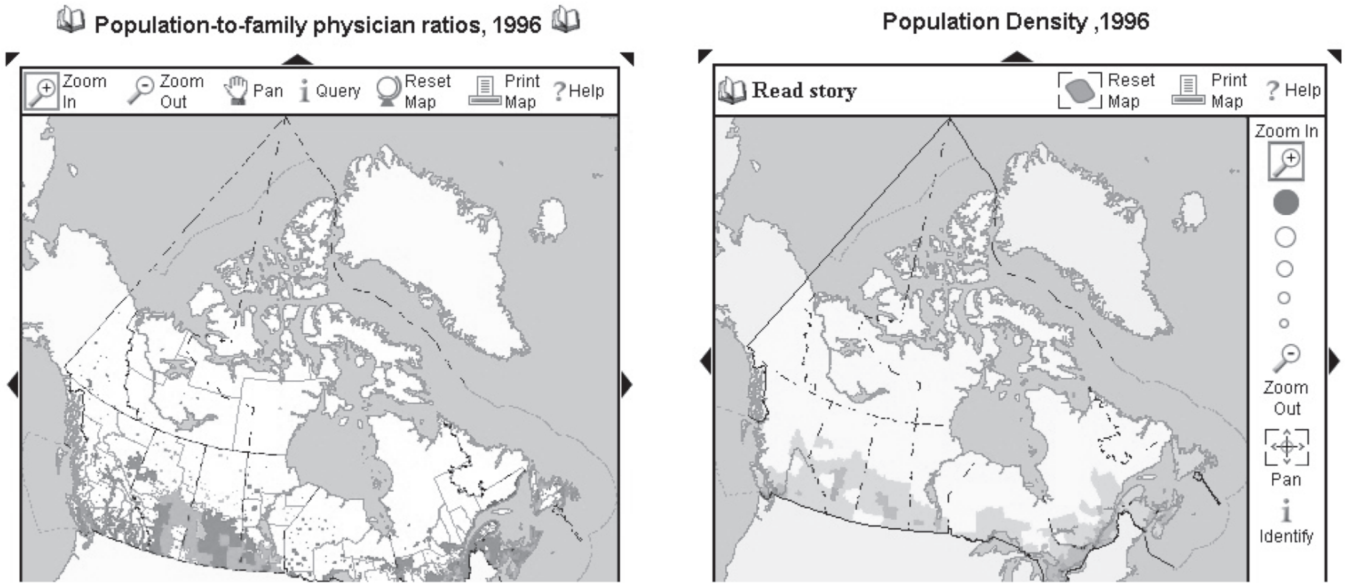


Figure 7. The prototype interactive mapping user interface used during the second iterative testing session of the Sixth Edition of the Atlas of Canada, *Version 2.*

even though they did not use it. The icon of choice was the globe in mock-up one. Another unexpected option to fully zoom out to a full extent was the use of the menus to redisplay the map. The main pop-out menus were so intuitive and easy to use that some used them to reselect the map and get back to the full extent zoom level and they would then zoom into the new location.

"The zoom level indicator in mock-up two . . . was not used by any of the participants."

The zoom level indicator in mock-up two, which used five different sized circles, was not used by any of the participants. Several printed mock-ups, using other shapes such as thin rectangles, were shown to those tested. Most indicated that the shape made no difference in their decision not to use it. This was surprising as this type of feature is commonly used by some well-known commercial Web mapping sites.

The "Query"/"Identify" tool was discussed and most participants felt that it would be useful feature to have. The icon of choice was the arrow icon in mock-up two.

". . . text pages should appear in a separate window so that it could be read while viewing the map."

An important component of every interactive map is the supporting textual documentation. This material describes the map's theme and interprets the patterns appearing on it. Mock-up one provided a link to this material via the map's title and mock-up two via an icon with a "Read story" label on the left side of the upper tool bar. Both were intended to be more prominent than the other tools. Most users did not easily find this tool as it was presented. In probing for further feedback, it was found that users preferred that it appear in the menu bar with a book icon. Also, it was suggested that the label be changed to "Read about the map". Participants also felt that the text pages should appear in a separate window so that it could be read while viewing the map.

All participants felt that the toolbar in mock-up one was more visually appealing as it was cleaner and less cluttered; the split toolbar did not appeal to anyone.

The third and final testing session used a single mock-up with the icons representing the tools as previously described. When all the tools were placed on a single row, it was too crowded to also place labels with the icons. Since the supporting textual documents are important for interpreting the map, its icon was the only one to have text beside it. The tool bar for the fourth mock-up appears in figure 8.

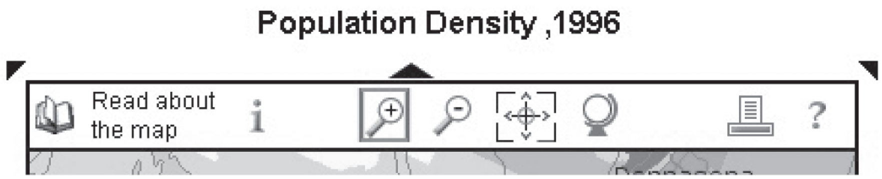


Figure 8. The prototype interactive mapping tool bar used during the third iterative testing session of the Sixth Edition of the Atlas of Canada*, Version 2.*

Many participants commented that the toolbar was not eye-catching or visually appealing. In addition, as soon as participants began to scroll down to see the entire legend, the toolbar disappeared from their view. This coupled with the fact that the toolbar was not eye-catching caused some to give it less attention and subsequently miss the available interactive features.

". . . zoom in was active by default when a map appeared."

Further modifications were required with the "Query"/"Identify" tool represented by the "globe" icon. Participants did not notice it in the tool bar and were confused about what it offered. The "i" symbol was interpreted as a help symbol as in a visitor information centre on a paper road map. The process of selecting the tool and then selecting a feature on the maps caused confusion, as it did initially with the "Zoom Out" tool. The "Query"/"Identify" tool, however, could not be converted to a single step tool. Even so, most participants felt that it was a useful feature. A clearer icon and label were needed as well as visible instructions to help users.

The "Zoom In" and "Zoom Out" tools worked very well. They were modified so that zoom in was active by default when a map appeared. The "Zoom Out" tool was changed to a one step operation so that when it was selected, the map would automatically zoom out one level, keeping the same map centre.

Since most participants used only the side navigational arrows to "pan" to different areas of the map. The "Pan" tool was removed from the tool bar.

The "Reset Map" tool was not intuitive to users. Most associated the globe icon with international maps and did not immediately connect the globe with resetting the map to the national level. It was removed from the tool bar and a "Zoom to Place" feature was added. The "Zoom to Pace" has a drop-down menu that includes Canada, the provinces and territories, and major cities. While this was not tested, it was successfully used on other mapping UIs developed for the Atlas' federal election results maps and the Canadian Communities Atlas project database search results (http://www.atlas.gc.ca/site/english/learning_resources/ccatlas/ccgallery/).

"The 'Pan' tool was removed from the tool bar."

All participants, regardless of audience group felt that a textual description should accompany an icon. They also indicated that some form of explanation must appear (e.g. a mouse-over). Consequently the mapping UI icons have a label as well as an instruction for their use in the form of a small mouse-over window. This was the final testing session so other options for the tools were not tested.

Participants preferred legends that showed only the thematic layers. The shorter legend prevented users from scrolling down a long legend resulting in the disappearance of the tool bar.

The current tool bar incorporates all the refinements resulting from the usability research and is shown in Figure 9.

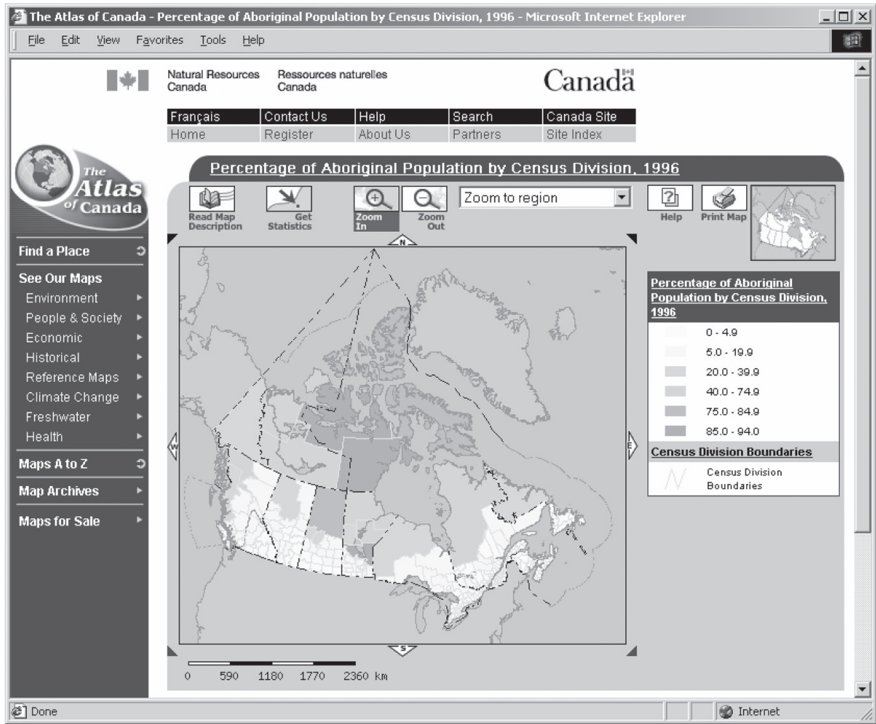


Figure 9. The current interactive mapping user interface of the Sixth Edition of the Atlas of Canada, Version 2.

The impact of a user-centered approach has been an unqualified success for The Atlas of Canada. The result is an Atlas Web site where users can find and use what they want easily and quickly. The Atlas team would have been unable to solve the issues identified in the initial research as effectively without focused and well-planned usability testing. Usability testing does require some additional cost and time but the return on the investment makes it worthwhile (Souza, 2001). However, similar time and money would have been spent on the less valuable approach of untested assumptions.

"The impact of a user-centered approach has been an unqualified success for The Atlas of Canada."

The following are some recommendations to those interested in user-centred Web site development:

"Usability testing does require some additional cost and time but the return on the investment makes it worthwhile."

- Define the audience and mission,
- Never assume anything about your users, let them tell you and test, test, test,
- Do as many iterations as time and money allow,
- Remove everything that is not needed,
- Function is more important than aesthetics,
- Page layout is more important than aesthetics,
- Clean, clear, uncluttered aesthetics are essential,
- Fast direct access to primary content is paramount,
- Have a clear hierarchy of content,
- Users easily default to site search engines, so it better be good,
- Spend time, but not too much, on labels: you cannot please everyone.

- Don't assume users know what you mean - avoid jargon, select words users would understand,
- Make the site usably dynamic.

What's Next – The Immediate Future

The lessons learned from iterative testing and development are demonstrated in the plans for the Atlas. A series of improvements are foreseen that extend over the coming months and years. These include content updates, efficient production processes, revised navigation and new functionality, which will be supported by ongoing user research and testing.

Other components are being updated because of the new Web site and related tools. The new web mapping server software requires the use of different tools for the map authoring and publishing process. This in turn necessitates a new production process involving the proper checks and controls. These requirements have been identified and further refinements and enhancements will be identified as the first maps are produced using the new tools and process.

". . . menus may need to be adapted to support more than just maps if a map-centric approach cannot be found."

Map production was interrupted during the redesign as all resources were brought to bear on that challenge. Following the redesign and launch, map production is slow as the new tools and processes are put into place.

There are several known issues with the new pop-out menu navigation, despite the fact that they work well and are a central component of the users' goal to go immediately to a map. These issues are in the areas of accessibility, scalability and maintenance. The implementation of the menus does not allow universal accessibility to serve the broadest possible audience. This ranges from access technology to assistive devices and emerging technologies according to the Government of Canada's Common Look and Feel requirements. The scalability of the menu system is also a concern as the number of interactive and static maps grow from the current 320 at a rate of 100 new maps every year. Finally, initial user testing involving text and other content associated with interactive maps indicate that a complete navigation paradigm for maps, text and other content must be consistent. This suggests that the menus may need to be adapted to support more than just maps if a map-centric approach cannot be found.

As known concerns of the current Web site are addressed, the Atlas can also start looking forward to new features and functionality. Having an established structure to the Web site allows the Atlas to add new features such as multimedia. This will also contribute to the objective of increasing the percentage of repeat users to the Atlas. With an established base of users, it will be possible to begin introducing increasingly complex concepts and tools. An example of more advanced concepts is the ability for the user to create or customize maps by selecting layers and choosing symbology. This capability was removed during the Web site redesign because not enough was understood about the user needs. This capability can now be reintroduced in a way that is suitable for specific users. It is not yet predetermined how this capability will work, but it is thought that a step-by-step user interface may be best.

"All future changes will be supported by ongoing testing."

All future changes will be supported by ongoing testing. As mentioned, initial testing revealed problems with the discovery and navigation of map texts. All solutions must be proven by testing to ensure an improvement over past approaches. In addition to conducting user testing for specific aspects of the web site, the Atlas will re-conduct user research to gauge overall reaction to the new Web site and to update the user profile.

Reaching the Vision

The overall vision for The Atlas of Canada is more than simply a Web site. It also encompasses the underlying data, information and services. The Atlas currently focuses on map visualization. There will be new and different challenges associated with navigating large amounts of cartographic, textual, attribute data and other content as the number of maps and the amount of information made available through the Atlas grows. Other issues to be faced are associated with a distributed system where individual maps or layers may be drawn from remote partners' web applications to be viewed within, and as part of, the Atlas. The availability and presentation of data and information and the overall performance of the application in a distributed Web environment will add extra challenges in providing a high performance, usable service to users.

"Increasingly, on-line services will provide maps and data directly into other Web based applications."

The vision also supports the Atlas reaching its users through more than just The Atlas of Canada Web site. Currently, the Atlas acts as a service for several other Government of Canada Web sites that link to specific Atlas maps relevant to their subject area. Increasingly, on-line services will provide maps and data directly into other Web based applications. In this context, the Atlas becomes a "back office" service that provides information through other Web sites. A current example of this is the Find a Place capability on the Atlas Web site. It can be reused by other Web sites, as can the underlying Gazetteer service that provides structured data to Web application developers. The Atlas will become an integral part of the Canadian Geospatial Data Infrastructure by using open, accepted standards and specifications such as the OpenGIS Consortium's Web Mapping Service and Web Feature Service (http://www.opengis.org/). In this way, the scope and influence of the Atlas will extend well beyond that of a simple Web site.

In the long run, a usable, relevant and well visited Web site along with a corresponding set of services for partners, will help the Atlas fulfill its role. Within the Government of Canada, this role is as a key communications vehicle for government science and policy, and within the Canadian Geospatial Data Infrastructure, it will be the most public window into the geography of Canada.

CONCLUSION

Imagine if… all students now start at The Atlas of Canada for their geography, history and social studies assignments on Canada. These students search for places and link off to a wealth of related information. They view maps, texts and other multimedia related to a wide range of issues important to Canadians. They visualize and download all the information that they need.

*"The Atlas of Canada is now in a position to begin supporting this '*imagine if…*' scenario."*

The Atlas of Canada is now in a position to begin supporting this "*imagine if…*" scenario. The Web site is focused on its target audience of the general public, teachers and students. Tools and functionality are in place to support their requirements, while superfluous and confusing tools were eliminated. The Atlas is usable, which means that users can now exploit its potential and receive the results that they want and need. This functionality is supported by rich and continuously expanding sets of maps, texts and other information.

Several specific lessons have been learned during the process of user research, focus groups and usability testing. User expectations of The Atlas of Canada may differ from the original ideas of the developers. In the case of the Atlas, the desire of users to find information about specific locations was not planned, but the Atlas was able to respond to this need. The site architecture or the structuring of information is very important. Often developers separate things into unique sections that hold little meaning for a user. For example, the user research found that maps are maps, not interactive maps, static maps, quick maps or archive maps. Within an overall consistent architecture, the information must also be presented in a consistent fashion. Differing terminology, labels and presentation between different sections of a Web site merely cause confusion. The labelling of selections and links is very important. Labels must be presented in simple language, avoiding jargon, and ambiguity.

"The lessons that the Atlas has learned on how to involve users . . . are . . . more important than the specific results . . . learned . . ."

Several interesting lessons were learned with respect to the mapping user interface. In general, the tools represented by icons, which are generally familiar to the GIS community, are not well understood. When they are not understood, they are not used, as in the "Reset Map" tool and the "Pan" tool. These were removed from the mapping user interface. The remaining tools must be supported by help information. Finally, interactions with maps should be a one-step, or one-click operation, whenever possible. When two steps are required, there is uncertainty and what the user expects may not happen when they make a selection.

The lessons that the Atlas has learned on how to involve users in determining requirements and testing are, in the long run, more important than the specific results that we have learned to date. First, a clear understanding of who the target audience is and what they want from the Web site is needed. This then leads to a clear definition of what the Web site can do to support these users. Since it is impossible to do all things, it is recommended to concentrate on specific high priority objectives first.

"Without testing, any assumptions, whether they deal with site organization, labelling or functionality, are nothing more than assumptions."

Once the goals and objectives are known, then the testing begins. Without testing, any assumptions, whether they deal with site organization, labelling or functionality, are nothing more than assumptions. This is not a one-time step as any proposed solution needs to be tested (Daly-Jones, Bevan and Thomas, 1999).

This leads to the concept of iterative research, testing and development. User testing verifies or dismisses solutions that are proposed for an identified problem. In the Internet world, Web sites must continue to evolve or they quickly become stale. Only a certain amount of change can be accomplished in any given development cycle, so priorities must be set. Other changes or enhancements should be left to future development cycles where they can be properly tested. The resulting Web site will be much more effective in achieving its goal.

The Atlas has made significant advancements in recent years by taking users into consideration. This has led to an Atlas that is more useful, more relevant and ultimately more valuable to them. The "government knows best" attitude that existed during the era of the paper Atlas was initially carried forward into the digital era. At first, this took the form of a technology-push approach that led to innovative Web developments, which were feature rich but content and usability poor. Throughout this initial period on the Internet, some user needs were collected and unsuccessful attempts were made to address them. In the end, it took a structured process of research, definition, testing and iteration to be able to understand these requirements and translate them into the new Atlas of Canada Web site. The user does count!

"The user does count!"

URLs CITED

GeoConnections: http://geoconnections.org/

The Atlas of Canada--About the Atlas: http://atlas.gc.ca/site/english/about_us/

Industry Canada SchoolNet: http://www.schoolnet.ca/

International Cartographic Association: http://www.icaci.org/

Statistics Canada: http://www.statcan.ca/english/Pgdb/demo02.htm

Government of Canada Common Look and Feel Guidelines: http://www.cio-dpi.gc.ca/clf-upe/index_e.asp

Canadian Communities Gallery: http://www.atlas.gc.ca/site/english/learning_resources/ccatlas/ccgallery/

Open GIS Consortium: http://www.opengis.org/

REFERENCES

Daly-Jones, N. Bevan and Thomas, C. 1999. Handbook of User-Centred Design. *European Journal of Engineering for Information Society Applications*. http://www.ejeisa.com/nectar/inuse/

van Elzakker, Corné P.J.M. 2000. Use and Users of Maps on the Web. *Cartographic Perspectives,* 37:34-50.

Harrower, M., Keller, C.P. and Hocking, D. 1997. Cartography on the Internet: Thoughts and a Preliminary User Survey. *Cartographic Perspectives*, 26:27-37.

Kraak M.J. and Ormeling, F.J. 1996. Cartography: Visualization of Spatial Data, Addison Wesley Longman Limited, Essex, England.

Miller, S. and Pupedis, G. 2002. Spatial Interface Design for the Web – A Question of Usability. *Cartography, Journal of mapping Sciences Institute, Australia*. 31:2:119-143.

Nielson, J. 1994. Guerilla HCI: Using Discount Usability Engineering to Penetrate the Intimidation Barrier. In Dias, R.G. and Mayhew, D.J. (eds.) Cost Justifying Usability, 245-272.

Scanlon, J. and PercivalL. 2002. UCD for Different Project Types, Part 1: Overview of Core Design Activities. http://www-106.ibm.com/developerworks/web/library/us-ucd/

Souza, R. 2001. Get ROI From Design. *The Forrester Report June 2001,* Forrester Research Inc.

Szeredi, T. and McLeod, B. 2000. Using a Spiral Development Methodology to Successfully Adapt to Change. Earth Observation (EO) & Geo-Spatial (GEO) Web and Internet Workshop 2000, London, England, UK. April 17-19, 2000.

Warren, D. and Bonaguro J. 2003. Usability Testing of Cummunity Data and Mapping Systems, http://www.gnocdc.org/usability/usabilitytesting.html.

Moving the *Atlas of Saskatchewan* from a Hardcopy (Millennium Edition) to a Multi-Media (CD-ROM Edition) Platform

Lawrence Martz
Department of Geography
Univ. of Saskatchewan
9 Campus Drive
Saskatoon, SK
Canada S7N5A5
lawrence.martz@usask.ca

Elise Pietroniro
GIServices
Univ. of Saskatchewan
9 Campus Drive
Saskatoon, SK
Canada S7N5A5
elise.pietroniro@usask.ca

Production of the *Atlas of Saskatchewan (CD-ROM Edition)* required a synthesis of skills including technical expertise in the fields of digital multimedia technology, geographic information systems technology and cartography. Recent advances in electronic media based technology have had a substantial impact on certain aspects of cartography in recent years. Some of these advances include the use of multimedia tools for map design and production, presentation and interactivity. CD-ROM atlases, in particular, have become extremely popular and have been produced in increasing numbers in recent years. According to the literature, advances in electronic technology render electronic atlases more effective in communicating geographic information than those in a paper medium. The former can combine multimedia elements such as sound and motion that cannot be incorporated in a printed atlas. The effects of these advances on cartographic information processing (cartographic communication) forces cartographers to re-examine the way they design maps. Layout, screen real estate, image resolution and colour are among some of the design features that will differ in an electronic medium.

The development of the *Atlas of Saskatchewan (CD-ROM Edition)*, an electronic version of the existing hard-copy *Atlas of Saskatchewan (Millennium Edition)* incorporated many of these new multi-media features and tackled a number of issues associated with the implementation of new technology. These issued included; generalization, legibility, speed, screen resolution and color, as well as software capabilities, hardware requirements, cross platform and file size issues. The fact that this CD-ROM atlas was generated from the transformation of an existing paper version did not make the production any less complex. Issues of consistency, continuity, layout and design had to be considered for the electronic medium. This paper discusses these issues and the ensuing stages in the development of the *Atlas of Saskatchewan (CD-ROM Edition)* in the context of cartographic communication. It also looks at various techniques employed and the multi-disciplinary nature of the development of the interactive CD-ROM Atlas, as well as some of the issues that surfaced in the production process.

INTRODUCTION

The University of Saskatchewan initiated the *Atlas of Saskatchewan* Project in 1996. It was a partnership between the university, the government and the private sector that was formed to collect, analyze, interpret, distribute and communicate geographical data about Saskatchewan. The first phase of the project was completed with the publication of the hardcopy *Atlas of Saskatchewan (Millennium Edition)* in November 1999 (Fung 1999). This edition was produced using computer graphics and geographic information system (GIS) technology and resulted in the compilation of a comprehensive, provincial-scale digital geographic database. This database was the foundation of Phase II of the project; namely, the production of an interactive, multimedia *Atlas of Saskatchewan (CD-ROM Edition)* that was released in November 2000 (Martz and Fung 2000).

". . . its major contribution was the design and implementation of a new, innovative, multi-media framework for the communication of geographical information."

The *CD-ROM Edition* of the *Atlas of Saskatchewan* is the first provincial atlas produced and published in Canada in digital format. It was derived from the hard-copy *Atlas* and is perhaps best viewed as a very large, complex and intellectually demanding work of translation. While the CD-ROM Edition did introduce some important new material, its major contribution was the design and implementation of a new, innovative, multi-media framework for the communication of geographical information. Its production was far from a straight-forward transcription process and presented a number of significant conceptual and technical challenges. All 340 pages of the hard-copy *Atlas* had to be redesigned to fit the size and orientation of a computer monitor while insuring that all elements were legible, visually appealing and concise. Many of the pages had to be re-organized, new layouts had to be designed and each element had to be converted from vector to raster format. One of the principal design objectives was to take advantage of the presentation, interaction and navigation possibilities of the new publication format.

"The ultimate purpose, as with the hard copy edition, was to effectively communicate spatial information to the map user."

Innovative solutions to technical issues related to map generalization, text legibility, product performance, color management, hardware support and data management were required. Even more important were the responses to intellectual challenges that led, ultimately, to a new conceptual model of a "geographical information design unit" to replace the traditional two-dimensional unit of the "page" that was unsuitable to the multi-dimensional organization of information in digital media. An "*Atlas*-wide" navigation system was designed and then implemented in software. A suite of new navigation tools (i.e. "pan and scan" maps) were developed to allow users to explore the rich body of information in the *Atlas*. The *CD-ROM Edition* also introduced the use of animation and sound to communicate geographical information in ways that had not previously been possible in an Atlas context. The ultimate purpose, as with the hard copy edition, was to effectively communicate spatial information to the map user.

CARTOGRAPHIC COMMUNICATION

Cartographic communication is a process of transmitting geographic information (Salichtchev, 1983). The ability of a map to communicate geographic information is the primary concern of the cartographer and the ultimate determinant of design choices. While communication failures are often blamed on the inability of the user to read a map, in most cases it should probably be directed at the map itself (Fairburn, 1994). Unlike a novel or an instruction manual, a map must guide the user by wide variety of visual means to help them understand and interpret the geographic data embedded within it. Cartographers reduce real-world features and represent them by means of symbols. They also apply established mapping conventions (i.e. blue for water) to help the user grasp the meaning of the map. Furthermore, the organization of a series of maps in a manner that is consistent and logical, as in an atlas, is important in guiding the user.

"The implementation of multimedia features provides access to a much greater range of communication tools and, perhaps most importantly, allow the user to play a more active role in exploring geographic data."

These principles are equally important to cartographic design in a multimedia (usually digitally-based) framework. The implementation of multimedia features provides access to a much greater range of communication tools and, perhaps most importantly, allow the user to play a more active role in exploring geographic data. Citing Marshall McLuhan's well-known observation that "the medium is the message", Peterson (1995) emphasizes the effect of the choice of medium on the ability of a map to transmit geographic information. McLuhan (1967) suggested that technology such as electronic media affect the message being communicated and that dependence on traditional print media has impaired our visual communication skills. Peterson (1995) suggests that like McLuhan's view of the printed word, printed maps may have closed our minds to imaginative expression and communication of spatial information.

The Muehrcke (1980) model of the cartographic process (Figure 1), while adequate for describing traditional mapping, can no longer be applied without considering the use of real-time, interactive cartographic technology (Moellering, 1980; 1984). Real-time, interactive cartography is employed in *Atlas of Saskatchewan (CD-ROM Edition)* as well as in many other web and CD based map products. This provides enhanced user interactivity with geographic data and allows access to a wider range of cartographic output including that of Geographic Information Systems (GIS) and map images of various formats, both virtual and real. It is at the output stage where the user interacts most with the map and the choice of output media will probably have the greatest impact on the ability of a map to communicate. It is here that the map user responds to the image. Different output media may entail the use of different communication and design strategies (Leshin et al., 1992).

"It is at the output stage where the user interacts most with the map and the choice of output media will probably have the greatest impact on the ability of a map to communicate."

Moellering (1984) pointed out that the communication between person and machine allows for the flow of map displays, keyboard interaction, function buttons, bell signals and other more esoteric forms of communication which provide a much richer communication channel than traditional cartographic communication. These enhancements can often heighten the ability of a map to communicate and, therefore, were all considered in the design of the *Atlas of Saskatchewan, CD-ROM edition*.

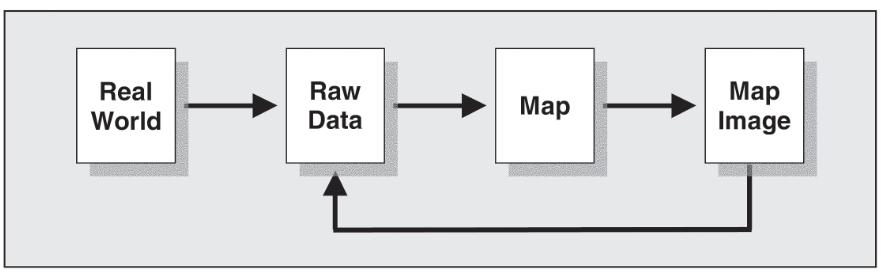


Figure 1. Muehrcke model of cartographic communication (Moellering, 1980) in which map contents are abstracted from real world information through the manipulation of raw data to a mapped image.

MULTIMEDIA AND MAPPING

Multimedia technology provides new visual tools that can be added to the cartographer's repertoire (Hatch, 1995). It provides a tool to communicate information through the integration of variety of media types and formats including text, diagrams, graphics, images, sound, video etc. In mapping technology, multimedia tools include the use of animation, dynamic variables, sound, three-dimensional views and hypermedia (Fisher et al., 1993). There is great potential in the use of multimedia tools and displays in cartography. For example, the use of multimedia technology in a GIS is an ideal tool for the analysis of environmental problems and contributes to a decision support system that is more realistic (Fonseca and Gouveia, 1994). Baldwin et al. (1998) suggest that an enhanced aesthetic experience can increase the accuracy of analysis within a GIS. Electronic atlases seem to provide a natural platform for interactive educational graphics (Campbell and Egbert, 1990).

"Multimedia technology provides new visual tools that can be added to the cartographer's repertoire."

There has been a renewed interest in cartographic technology through the integration of multimedia techniques, as cartographers explore the potential of these techniques to increase the effectiveness of cartographic communication (Taylor, 1994). According to Oz and White (1993), humans learn through a combination of seeing, hearing, touching, smelling and tasting. They retain about 20% of what they hear, 40% of what they see and hear, and 75% of what they see, hear and do. Integration across these senses appears to have the greatest impact in the learning process. Electronic media can, by the use of movement, perspective and sound, stimulate all of these senses simultaneously in ways that a printed image cannot. How well a map communicates can be measured by how much the user learns from the map. The integration of multimedia tools into a cartographic product can enhance the effectiveness of geographic communication in much the same way as the integration of the senses in the learning experience. This is because it provides a much more life-like and vivid presentation of information (Alty, 1991).

"The integration of multimedia tools into a cartographic product can enhance the effectiveness of geographic communication in much the same way as the integration of the senses in the learning experience."

Multimedia technology lets the user interact with a map and become involved in the learning process. This can involve anything from navigating between images, linking text and photographs with maps, to choosing data to be mapped and analyzed. This increases the users' ability to retain information (Oz and White, 1993). The advantages of multimedia approaches in communicating geographic information arise, at least in part, because of the reduced reliance on abstract symbolization. Instead, use is made of realistic images, video and sound to present and augment spatial information (Parsons, 1994). According to Taylor (1994), while the 1980's were the decade of GIS, the 1990's were to be the decade of geographic visualization. The application of multimedia tools for cartographic visualization will certainly extend well into the new millennium.

Some of the visualization tools available through multimedia systems include animation, sound and video. These tools enhance spatial information so it can be communicated more easily to the user. Geographic data is not only spatial, but temporal as well. Cartographic animation is especially useful for the representation of spatial information over time. Thrower (1961) notes the fundamental and substantial limitations of a single illustration for representing change through time since even sequential figures require significant inference of change on the part of the user. He also recognized the tremendous potential of animation for effectively illustrating this 4^{th}, temporal dimension. Where static maps impose restrictions to depicting temporal variation in a spatial context, animation enables the user to visualize the temporal evolution of geographical phenomena (Armenakis, 1996). It permits the cartographer to emphasize change over both space and time (MacEachren and DiBiase, 1991).

"Where static maps impose restrictions to depicting temporal variation in a spatial context, animation enables the user to visualize the temporal evolution of geographical phenomena."

One of the advantages of animated visualization recognized in the earth sciences is as a means of dealing with large volumes of data (DiBiase et al., 1992). Available animation software provides the cartographer with choices in animation type, such as slide presentations or flipbook-style animation (Gersmehl, 1990). Non-temporal uses for animation in cartography also exist, for example, in a variety of statistical maps and classification options of quantitative data (Peterson, 1993). Three-dimensional animation involves making use of movement, perspective, shading and shadows to represent the third dimension on a flat screen (Dorling, 1992). Although using animation introduces new complexity for both the cartographer and the user, it is warranted when the information cannot be represented traditionally or when it has the potential to enliven a presentation in a meaningful way (Dorling, 1992).

Dynamic variables in cartography are necessary in mapping changing phenomena. Maps of duration can better represent the changes or continuance of events (Vasiliev, 1996). Three-dimensional views can be employed as an alternative to traditional maps and is often used to represent terrain and statistical surfaces. It is an impressive visual tool. Sound is also a possible variable in map design and may be used to communicate information. It can be used as background sound to accompany images that appear on a computer monitor, as well as to enhance tasks performed in interactive cartography. It is also a variable in its own right (i.e. bird songs, spoken place names) that can be treated in a spatial framework. The integration of sound and motion (including video) can set information in context and establish relationships among the elements in a map (Hatch, 1995). Multimedia tools and the dynamic nature of sound and motion in cartography produce events that stimulate all of the viewer's information channels (Hatch, 1995). This serves to further enhance the cartographer's ability to communicate information to the user.

"Dynamic variables in cartography are necessary in mapping changing phenomena."

THE ATLAS OF SASKATCHEWAN ON A MULTIMEDIA PLATFORM

The *Atlas of Saskatchewan (CD-ROM Edition)* was conceived as member of a family of Atlas products that was to follow the hard copy *Atlas of Saskatchewan (Millennium Edition)*. As such, it was important to maintain the scope, general appearance and aesthetic quality of the *Millennium Edition* book while exploiting the interactivity and multimedia capabilities of the CD-ROM format to clearly and succinctly convey equivalent content. While the *CD-ROM Edition* introduced some important new material, its content was derived largely from the hard copy *Millennium Edition*. Accessibility, interactivity and enhanced functionality were the primary design objectives for the *Atlas of Saskatchewan (CD-ROM Edition)*. Another important goal of the move to a CD-ROM format was to provide a product that would be less costly both to reproduce and distribute and, therefore, more accessible to everyone.

"Accessibility, interactivity and enhanced functionality were the primary design objectives . . ."

It was also intended to be a useful educational tool from which users could easily extract any relevant information. Toward this end, we were strongly focussed on improving the accuracy and speed of map reading. Dobson (1983, 1985) suggests this is best accomplished by presenting spatial data in a manner well suited to the goals or objectives of potential users. This requires a comprehensive understanding of human visual and information processing capabilities.

A variety of features were made available through multi-media technology to increase the user's ability to interact with the *Atlas of Saskatchewan*. Interactive features included zoom capabilities and navigational links. Interactivity was particularly important in the navigation of the table of contents. It was considered important that users have "random access" to the entire *Atlas* contents; that is, direct access to any section, sub-section or view from anywhere within the *Atlas*, without having to go back through a history of previous views. This was accomplished through a unique design that causes the table of contents to "roll-out" whenever the user moves the mouse cursor over the bar along the left of the screen (Figure 2, see page 74). The table of contents was organized in a logical fashion to facilitate finding the topic of their choice through a hierarchy of "roll-outs" (Figure 3, see page 74).

"The table of contents was organized in a logical fashion to facilitate finding the topic of their choice through a hierarchy of 'roll-outs'."

Navigational links were also incorporated into the content. These links were used when elements from a page had to be broken up and placed on different screen pages, and also provided the CD-ROM version with the ability to link related information form other sections within the chapters. This was necessary because of the need to transform atlas pages designed for a print medium, at 9.5 inches wide by 13.5 inches tall, to fit the format of a monitor that is landscape oriented and typically varies in size from 15 inches to 19 inches on the diagonal. In support of these linking capabilities, a history button was incorporated to allow the user to return to previously viewed screens. It was felt that while it was essential to provide comprehensive "random access" to the entire *Atlas* content from any page, it was also important to allow the user to backtrack through their personal chronology of views. Basically, an effort was made to both preserve the familiarity of sequential book access while taking advantage of the enhanced navigation functionality made available through new technology.

". . . an effort was made to both preserve the familiarity of sequential book access while taking advantage of the enhanced navigation functionality made available through new technology."

Another interactive feature of the CD-ROM was a zoom function. This meant rescaling and resizing images, and developing the zoom feature to allow the user a legible view. This was particularly important for the larger plates in the hard copy *(Millennium Edition)* that extended over two pages (Figure 4, see page 75). No useful detail would have been available had these been simply rescaled to fit a computer monitor. A 'pan and scan' feature was developed that allows the user to move the cursor over a thumbnail version of a map, and simultaneously view an enlarged version of the area bound by a movable cursor (Figure 5, see page 75).

Features such as animation and sound were incorporated to add a multimedia dimension to the CD-ROM. Animation, for example, was a useful solution for transforming time series maps from the paper version of the Atlas. The book contained a number of time series maps that would have been difficult to view all at once, on a single screen. One of the new additions to the *CD-ROM Edition* was a view of the retreat of glacial ice from Saskatchewan and the development of post-glacial drainage (Figure 6, see page 76).

"Interactive links, buttons and animation allowed us to design these pages in a manner whereby the user can see the maps at any period, one at a time, or view the change over time through animation."

Interactive links, buttons and animation allowed us to design these pages in a manner whereby the user can see the maps at any period, one at a time, or view the change over time through animation. Sound was also a useful element in enhancing the content of the CD-ROM. It served to supplement the images and text on screen. For example, sound effects were used in the introduction of each chapter. They were chosen specifically to reflect the characteristics of the content of the chapter.

Sound was also treated directly as a variable with a spatial attribute. For example, sound enhanced the bird section in the Wildlife chapter of the CD-ROM. An opportunity to acquire bird songs presented itself to the project, and the CD-ROM was the ideal platform to incorporate these resources. From the hundreds of bird species mapped in this section of the Atlas, 30 birds with over 100 sounds were chosen to have accompanying songs. Photographs were also added to this section so the user can experience both a visual and audio component of a particular species simultaneously with an illustration of its spatial behavior. Demonstrations of the *CD-ROM Edition* have shown this to be an especially popular section in the *Atlas*, perhaps reflecting that fact that this is the section that probably provides the user with the highest level of cross-sensory stimulation.

TECHNICAL CONSIDERATIONS

The need to incorporate particular functionality and interactivity determined the choice of software for production. An important secondary consideration was the decision that the *CD-ROM Atlas* be available for both PC and Macintosh platforms. It was also recognized that the software chosen could impose minimum hardware requirements on the end user. The production team agreed that the CD-ROM would be more than simply an electronic version of a page turning application. The aim was to find a software program that would be able to incorporate a diverse range of elements in a multimedia environment. The software also had to be resilient enough to handle the large amounts of data that were designated for this project. Consideration was given to producing the *Atlas* as a set of HTML documents or PDF documents. Each of these was felt to have significant limitations with regard to the design objectives. Authoring software proved to be the best solution for integrating the many features and functionalities required for this project. Through consultation and experimentation, Macromedia Director[1] was chosen as the core production software.

"Authoring software proved to be the best solution for integrating the many features and functionalities required for this project."

Macromedia Director[1] is a software product that combines graphics, sound, animation, text and video to create interactive content for CD-ROM, DVD and the Web. The Director software uses a movie metaphor with a stage, cast members and sprites (objects that control when, where, and how cast members appear in a Director movie). Macromedia Flash[1] was also used in the development of the *CD-ROM Edition*. Flash files and Lingo[1] scripting allowed the use of vector based presentations and animations to create applications such as the navigation tools in the Table of Contents of the *CD-ROM Edition*. Other software used in development included, CorelDraw 9.0[1], Corel PhotoPaint 9.0[1], Adobe Illustrator 8.0[1] and Adobe Photoshop 5.5[1]. These products were used in the extraction and development of the various graphic elements for the Director movie. Microsoft Word[11] was used for managing and formatting text.

THE IMPLEMENTATION PROCESS

The *Atlas of Saskatchewan (CD-ROM Edition)* was produced by a team of highly skilled professionals brought together to provide the many capabilities required by the project. The success of the project demanded ongoing and effective communication among production team members and a high degree of organization of the variety of tasks for which they were responsible. Various stages in the implementation process are readily identifiable in which a set of relatively distinct tasks and design issues associated with electronic maps were addressed. Each stage was also associated with some relatively specific technical issues that emerged and had to be addressed. The stages in the implementation process and the relationships between them are illustrated in Figure 7, see page 76.

It is helpful to examine each of these stages in implementation. They can be broadly identified as conceptualization, dissemination of duties, storyboarding, data extraction and transformation, authoring, quality control, and publishing. While these stages provide a useful framework for discussion, it is recognized that there is some overlap between the stages (Martz et al, 2001).

Conceptualization

The first, and probably most critical, stage in the development of the *CD-ROM Edition* was the conceptualization stage. It was at this stage that the general style and functionality of the *Atlas* and its target audience were determined. While the audience would be the general public, emphasis was placed on the development of the *CD-ROM Edition* as an educational tool. The production and publication software was selected on the basis of these decisions.

"The first, and probably most critical, stage in the development of the CD-ROM Edition *was the conceptualization stage."*

Dissemination of Duties

The next stage in the development of the CD-ROM was the dissemination or distribution of duties. This was critical to the success of such a large project. In part, this was driven by the desire to have the various tasks associated with production assigned to those with the most expertise. These tasks included storyboarding, data extraction, data transformation, authoring, quality control and publishing; the remaining stages in the production of the *Atlas*. The distribution and dissemination of tasks was helpful in creating a smooth transition from one task to the next.

Storyboarding

"Storyboarding was the activity that most clearly highlighted the differences between cartographic design for a hard-copy and for a multi-media format."

This stage involved the development of basic design sketches for each page to screen conversion. This was necessary to translate ideas from the conceptualization stage, and from each page of the hard copy edition to the graphical environment of the computer monitor. Storyboarding was also used to make decisions on the dimension and size of graphic elements. Some of the concerns raised at the conceptualization stage were addressed at this stage. These were primarily issues surrounding the incorporation of interactive capabilities and other special multimedia features. The storyboarding process led to the development of page templates; that is, layouts that could be used for pages with similar content. Once these templates were defined, storyboarding became a more straightforward task.

Storyboarding was the activity that most clearly highlighted the differences between cartographic design for a hard-copy and for a multi-media format. In fact, the differences in the design frameworks and available cartographic tools were so marked that the production team quickly began to use the terms "page" and "view" to refer to the design and presentation frameworks of the hard-copy and multi-media versions, respectively.

The basic design element for the book is the page which may occasionally be expanded to allow presentations to extend across two, facing pages. The size of the page and the color presentation of the work are fixed at the time of publication. The resolution with which images are presented is usually unconstrained to the limits of human perception. The presentation of material is limited to two dimensions and access to material is in whole-page increments and is essentially sequential (although it is recognized that the user can jump forward or backward in multiple page increments if they have sufficient familiarity with the content).

Cartographic design for a multi-media format presents a very different situation. The design frame is the computer screen rather than the page. While the aspect ratio of the screen is constrained (although not absolutely specified) by *de facto* industry standards, the actual size of the display and its specific color expression are determined by the user's hardware platform. While the designer can specify image resolution and color depth, they must do so within the constraints of common hardware capabilities.

"The multi-media cartographer has a multi-dimensional space available in design."

The multi-media cartographer has a multi-dimensional space available in design. The design space is multi-dimensional in the sense that individual elements on the page can be changed interactively (i.e. clicking on a photograph can cause it to be replaced by a map etc.) and that the time dimension is indirectly accessible through animation. The designer also has the option to use audible design elements. Access to information still remains essentially sequential in most implementations but the designer has the capacity to provide many sequential pathways along which the user can explore spatial information.

Data Extraction and Transformation

This stage focused on the extraction of each individual page element in a manner appropriate to the storyboards, and its transformation into a format suitable for the production medium. A naming convention scheme was established for storing the various files needed for this project, in order to ensure that all members of the production team could easily recognize individual files. This also facilitated tracing missing or omitted files. The book version of the *Atlas* served as a reference point for the files that represented all elements of the *CD-ROM Atlas*, with exception to new sections that were developed for the electronic version only.

"A great deal of testing was done on each element to determine the optimal method of extraction."

A great deal of testing was done on each element to determine the optimal method of extraction. The goal was to maintain the look, color and integrity of each element from the book. Most graphic elements were converted into a GIF file format to retain full specification of colors. An exception was made for graphic buttons and other user interface elements, which were in JPEG format. Text files were converted into Rich Text Format but much of the editing for text was done in Director.

An interesting interaction between file size and color considerations developed. To meet design objectives, it was determined that the *CD-ROM Edition* should be implemented using a wide, 64K (16-bit) color palette. However, the intensively graphic nature of the *Atlas* made it impossible to store each individual image with a unique 64K color palette and remain within the single CD-ROM (approximately 650 MB) storage limitation accepted for the project. Instead, a 64K Atlas-wide color palette was developed and the majority of individual images were saved as 256 color image optimized within the *Atlas*-wide palette. This allowed the use of a wide color palette while limiting the size of individual images.

"An interesting interaction between file size and color considerations developed."

Authoring

Authoring is the process by which all objects are combined into a software setting and developed into an interactive multimedia presentation. Using the storyboards as a guide, the various elements extracted and transformed at the previous stage were brought into the different casts designated for each of the chapters. Once all cast members were in place, they were manipulated, pending design adjustments, in accordance with the storyboards. The visual authoring of the CD-ROM was simply to follow the storyboards and lay out the elements on the screen. The other facet of the authoring process was to provide the decided functionality. This was accomplished through the use of scripted programming in Lingo, both custom written and Director software provided.

"Authoring is the process by which all objects are combined into a software setting and developed into an interactive multimedia presentation."

Quality Control

As each chapter was developed and authored, production team members reviewed and commented on the various elements and layouts. Suggestions were noted and changes were made accordingly. Quality control was also necessary to ensure that every element was translated to CD-ROM correctly. An important element of quality control was the use of beta version of *CD-ROM Edition* "chapters" by undergraduate students in laboratory exercises.

Publishing

The final stage in the development of the *Atlas* was publishing and packaging the gold master CD-ROM. The master was created as a hybrid to allow cross platform support of both Macintosh and Windows operating systems, and for the ability to share media files.

The publishing of the CD-ROM raised several concerns, including that of providing a cross platform product. An enormous amount of data needed to fit onto a single CD and be read from either a Windows 95/98/NT or Macintosh computer system. A particular attraction of the Macromedia Director software was that it enabled "movie" files (i.e. the *Atlas* sections and chapters) to be read on either platform provided a platform-specific version of the viewing software was available.

Each chapter of the *Atlas* was developed as a separate Director movie. This major division of content allowed for the efficient use of the casts created for each chapter. It also allowed the several people responsible for authoring to work simultaneously on different sections. It is interesting to note that some chapters were authored on a Windows platform while others were authored on a Macintosh. This approach to authoring was helpful in uncovering the small differences that exist between the platforms so that they could be addressed as they appeared.

CONCLUSION

Computer cartography has evolved from a tool to help produce paper maps to an interactive and dynamic medium of communication that presents a tremendous number of opportunities for innovation (Peterson, 1995). During the early development of what is now termed "multi-media technology", Leshin et al. (1992) and Moellering (1984) recognized that this would introduce a set of new design tools and media that provide a much richer channel of communication between the cartographer and the map user.

"Computer cartography has evolved from a tool to help produce paper maps to an interactive and dynamic medium of communication that presents a tremendous number of opportunities for innovation."

The *Atlas of Saskatchewan (CD-ROM Edition)* was the first Canadian provincial atlas to be published in a digital, multi-media format. It has explored a number of the innovative communications made available by this technology including the use of video, sound, animation and hyperlinks between text, images and maps. While it is not possible to present objective, independent, quantitative evaluations of the effectiveness of this technology for geographical communication, we can attest that anecdotal feedback has been extremely positive and that the *Atlas of Saskatchewan (CD-ROM Edition)* is widely used in Saskatchewan schools, has been recognized with a number of communications industry awards and has been selected as a partner for the Western Development Museum special exhibit in celebration of the centennial of Saskatchewan.

The background and design considerations to the *Atlas of Saskatchewan (CD-ROM Edition)* project and some of the major strategies and technologies used in its implementation have been outlined. This is intended to provide some guidance to other who may embark on similar projects. However, as is so often the case in such projects a tremendous wealth of knowledge developed which is still largely embedded in the individuals involved in the project. This is reflected in the fact that several of them were integrated into a new service unit of the University (GIServices) in order to retain access to that expertise. This expertise is still being tapped to generate new, custom materials from the content assembled for the *CD-ROM Edition* and the *Millennium Edition* of the *Atlas of Saskatchewan*.

ACKNOWLEDGMENTS

The authors of this paper wish to acknowledge the financial support of the Government of Saskatchewan and the University of Saskatchewan that made this project possible. Special recognition is given to Dr. Ka-iu Fung who was a contributor to the *CD-ROM Edition* and laid the foundation for this project through his work as Director and Editor of the *Millennium Edition*. Also integral to the production of the *Atlas* were the technical teams from the University of Saskatchewan that helped to bring this project to completion. A special thanks to Keith Bigelow and Gerald Romme, cartographic technicians, Frank Bulk, Sean Zhang and the technical team from the Division of Media and Technology, and Dr. Scott Bell, assistant editor, Department of Geography.

REFERENCES

Alty, J.L., 1991. Multimedia – what is it and how do we exploit it, In *People and Computers VI,* Diaper, D. and N. Hammond (Eds.) 31-44. Cambridge: Cambridge University Press.

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

Baldwin, J., Fisher, P., Wood, J., and M. Langford, 1998. *Modelling Environmental Cognition of the View with GIS.* http://www.ncgia.ucsb.edu/conf/SANTA_FE_CD_ROM/sf_papers/fisher_peter/Baldwin.html (April).

Campbell, C.S. and S. L. Egbert, 1990. Animated cartography/Thirty years of scratching the surface. *Cartographica*, 27(2):24-26.

DiBiase, D., MacEachren, A.M., Krygier, J.B., and C. Reeves, 1992. Animation and the role of map design in scientific visualization. *Cartography and Geographic Information Systems*, 19(4):201-214, 265-266.

Dobson, M.W., 1983. Visual information processing and cartographic communication: The utility of redundant stimulus dimensions, In *Progress in Contemporary Cartography Volume II: Graphic Communication and Design in Contemporary Cartography*, Taylor, D.R.F. (Ed.) 149-175. New York: John Wiley & Sons Ltd.

Dobson, M.W., 1985. The future of perceptual cartography. *Cartographica*, 22(2):27-43.

Dorling, D., 1992. Stretching space and splicing time: From cartographic animation to Interactive Visualization. *Cargtography and Geographic Information Systems*, 19(4):267-270.

Fairburn, D., 1994. Maps for the people. *Geographical Magazine*, 66(December):11.

Fisher, P., Dykes, J. and J. Wood, 1993. Map design and visualization. *The Cartographic Journal*, 30(3):136-142.

Fonseca, A. and C. Gouveia, 1994. Environmental Impact Assessment Using Multimedia GIS. http://www.odyssey.ursus.main.edu/gisweb/spatdb/egis/eg94047.html (March, 1998).

Fung, K.I.. (Ed.), 1999. *Atlas of Saskatchewan – Millennium Edition.* Saskatchewan: University of Saskatchewan.

Gersmehl, P.J., 1990. Choosing tools: Nine metaphors of four-dimensional cartography. *Cartographic Perspective*, 5(Spring):3-17.

Hatch, K.M., 1995. *Cartographic design for multimedia maps*. M.A. Thesis, California State University, Long Beach.

Leshin, C.B., J. Pollock, and C.M. Reigeluth, 1992. *Instructional Design Strategies and Tactics.* New Jersey: Educational Technology Publications, Inc.

MacEachren, A.M. and D. DiBiase, 1991. Animated maps of aggregate data: Conceptual and practical problems. *Cartography and Geographic Information Systems*, 18(4):221-229.

Martz, L.W. (Ed.), 2000. *Atlas of Saskatchewan - CD-ROM Edition*. Saskatchewan: University of Saskatchewan.

Martz, L.W., E. Pietroniro and F. Bulk, 2001. *Translating the Atlas of Saskatchewan from an analog, hard copy format to a digital, CD-ROM format.* Conference Proceedings, Geosask 2001; Spatial Technology, The Route to Better Decisions. Information Services Corporation of Saskatchewan.

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

Moellering, H., 1980. Strategies of real-time cartography. *The Cartographic Journal*, 17(1):12-15.

Moellering, H., 1984. Real maps, virtual maps and interactive cartography, In *Spatial Statistics and Models.* G.L. Gaile and C.J. Willmott (Eds.), 109 – 132. Hingham, Massachusetts: D. Reidel Publishing.

Oz, E. and L.D. White, 1993. Multimedia for better training. *Journal of Systems Management*, 44(5):34-42.

Parsons, E., 1994. *Visualisation techniques for qualitative spatial information*. EGIS Foundation. http://www.odyssey.ursus.main.edu/gisweb/spatdb/egis/eg94046.html (September, 1998).

Peterson, M.P., 1993. Interactive cartographic animation. *Cartography and Geographic Information Systems*, 20(1):40-44.

Peterson, M.P., 1995. *Interactive and Animated Cartography*. New Jersey: Prentice Hall.

Salichtchev, K.A., 1983. Cartographic communication: A theoretical survey, In *Progress in Contemporary Cartography Volume II: Graphic Communication and Design in Contemporary Cartography*, Taylor, D.R.F. (Ed.) 11 - 35. New York: John Wiley & Sons Ltd.

Taylor, D.R.F., 1994. Cartography for knowledge, action and development: Retrospective and perspective. *The Cartographic Journal*,31(1):52-55.

Thrower, N.J.W., 1961. Animated cartography in the United States. *International Yearbook of Cartography*, 1:20-29.

Vasiliev, I. (1996). Design issues to be considered when mapping time, In *Cartographic Design;Theoretical, Practical and Perspective*, Wood, C.H., and C.P. Keller (Eds.) 137-146. West Sussex, England: Wiley.

[1] These refer to copyrighted software products used to produce *Atlas of Saskatchewan (CD-ROM Edition)*

State Atlas Design

James E. Meacham
InfoGraphics Lab
Department of Geography
1251 University of Oregon
Eugene, OR 97403-1251
jmeacham@uoregon.edu

Stuart Allan
Allan Cartography
34 North Central Avenue
Medford, OR 97501
AllanCart@aol.com

This paper covers principles that were useful, and many times essential, in the design and production of the *Atlas of Oregon, Second Edition* (Loy et al., 2001). Design principles and experience guided the creative process from drafting the table of contents to building the final layouts. Key points covered in this paper include: the development of a table of contents; setting up a network of topic experts; data source/compilation and organizational issues; page layout issues; book design issues; choosing type; data classing and quantitative mapping methods; color schemes; prepress issues; and public reaction.

Introduction

After producing the first edition of the *Atlas of Oregon* in the 1970s, Loy (1980) noted "The primary reason for an *Atlas* project should be to depict the geography of a state with the map being the dominant mode of expression." Through this depiction of geography with its dominance of maps, state *Atlas*es are very well suited to promote geographic understanding and communicate fundamental geographic knowledge. *Atlas*es, having maps integrated with other forms of information (graphs, tables, and text), strive to get to the heart of effective, geographically based communication. The *Atlas of Oregon, Second Edition* (Loy et al., 2001) was designed with this goal in mind. Key design principles and practices guided the *Atlas* creation process from drafting the table of contents to building maps, and final page pair layouts. This paper will explain how these principles and practices shaped the second edition of the *Atlas of Oregon*.

"Through this depiction of geography with its dominance of maps, state Atlas*es are very well suited to promote geographic understanding and communicate fundamental geographic knowledge."*

Background

The *Atlas of Oregon* was first published in 1976, and soon became the authoritative reference on the geography of Oregon (Loy, 1980). Since the mid-1980s, funding for an updated edition of the *Atlas* was sought. This funding goal was realized when the University of Oregon administration proposed a new edition of the *Atlas* to help celebrate the University's 125th anniversary. A group consisting of William Loy in the Department of Geography at the University of Oregon, Allan Cartography of Medford, Oregon, the InfoGraphics Lab in the Geography Department at the University of Oregon, and the newly revived University of Oregon Press came together to produce the new edition of the *Atlas*.

Work on the second edition *Atlas* project began in 1999. It was an advantageous time to start a comprehensive state *Atlas* project because of several factors. First, there was a wealth of digital data on Oregon available to produce the *Atlas*, and cartographic tools available to convert this data into effective graphics. Second, the University of Oregon's 125th celebration served as a catalyst to gain administrative and financial support. Third, the project was embraced at the end of a decade of unprecedented growth in the economy, helping set the stage for the half-million dollar fund raising effort. However, it was bad timing in relationship to the release of the 2000 Census demographic data, which came out after our deadline. In lieu of current census data, we needed to use sur-rogate data sources for some of the demographic topics. For example, for "Race and Ethnicity" we relied on recent school district enrollment data.

Atlas Format and Content

The format of the *Atlas of Oregon, Second Edition* is 9.5 in. wide by 13.25 in. tall, 320 pages, bound in both hard and soft cover. The format shifted from the *First Edition* to a slightly smaller format, book-bound (along the long dimension) rather than album-bound (along the short dimension). This shift was suggested by practical considerations: large format album binding is more costly (it doesn't fit into automated bindery lines) and less durable (the shorter binding is subjected to greater shearing forces). Also, album binding makes for awkward handling. At first, a smaller standard base map scale was anticipated as a cost of this format, since the individual pages of the *Second Edition* were slightly smaller than those of the first edition. However, it was soon realized that modern image-setting and press capabilities allowed excellent cross-gutter registration. By extending the maps across the facing pages, the standard base map scale was increased from 1:2M to 1:1.7M.

In the first edition of the *Atlas*, all page layouts were for single pages, with complete borders and neat lines—thus, the page pairs showed two facing sets of borders and neat lines. This approach was dictated by two conditions at the time: not knowing exactly which pages would prove to be executable, and the small format of the photomechanical equipment used. For the *Second Edition*, all designs were for two-page spreads.

The *Second Edition* contains four sections: Human Geography, The Economy, Physical Geography, and Reference Maps. Human Geography begins with locator sections placing Oregon in the world, followed by a series of reproductions of early maps, then another series of thematic maps showing early exploration of the state. After this stage was set, topical page pairs take the reader through American Indian wars and epidemics, pioneer land acquisition, settlement, and growth. The section concludes with a series of socioeconomic topics, for instance politics, health care, and prisons. The Economy section contains 26 topical page pairs on employment, manufacturing, land use, and infrastructure. The Physical Geography chapter includes maps of landforms, vegetation, and climate. The Reference section includes the most detailed maps in two series, one focusing on population centers (scale 1:150,000) and the other a complete reference map coverage (scale 1:500,000) showing land use classes over shaded relief.

"The Second Edition *contains four sections: Human Geography, The Economy, Physical Geography, and Reference Maps."*

Table of Contents *Atlas of Oregon, Second Edition*

The table of contents for the second edition of the *Atlas of Oregon* closely followed the original 1976 edition. The greatest differences between the two editions are the deletion of the wildlife maps as the Oregon State University's authoritative 1997 *Atlas of Oregon Wildlife* made those pages unnecessary, and the expansion of the section on urbanization in the reference chapter (Csuti et. al, 1997:12–54). A complete listing of topics follows.

FRONT MATTER: Foreword; The University of Oregon; Acknowledgments; and Introduction.

HUMAN GEOGRAPHY: Oregon in the World; Location; Maps: 1762–1814; Maps: 1838–1859; Indians; Exploration: 1800–1845; Oregon Trail; Epidemics, Wars and Reservations; Donation Land Claims and Public Land Survey; Political Boundaries; Land Grants; Place Names; County Populations; Cities: 1870–1960; Cities: 1970–2000; Historic Portland;

Willamette Valley Population; Population Growth and Density; Age Structure; Immigration; Race and Ethnicity; Income; Religion; Politics; School Districts; Education; Colleges and Universities; Crime and Prisons; Health Care; and Newspapers and Broadcasting.

THE ECONOMY: Economic Sectors; Labor; Public Employment; Taxation and Revenue; Manufacturing; Lumber and Wood Products; High Technology; Business Activity; International Investments; Public Lands; Land Ownership; Zoning; Minerals and Mining; Fisheries; Timber; Farmlands; Cattle and Crops; Crops and Wine; Energy Sources; Energy Distribution; Development of the Road Network; Highway Traffic; Railroads; Public Transportation and Airports; Ports and Trade; and Tourism and Recreation.

PHYSICAL GEOGRAPHY: Landforms: Elevation; Landforms: Shaded Relief (five page pairs); Cross Sections; Ice Age Lakes and Floods; Ice Age Glaciers; Volcanoes; Earthquakes; Landslides; Geology; Geologic Ages; Geologic Evolution; Soil Orders; Soil Suborders; Soil Interpretations; Annual Precipitation; Precipitation and Seasonality; Temperature and Seasonality; Climate Indicators and Change; Rivers; Stream Flow; Lakes; Drainage Basins; Water Quality and Dams; Ecoregions; Biotic Systems; Vegetation; Wildlife Habitat; Wildlife Habitat Detail; and Protected Areas.

REFERENCE MAPS: Population Centers (13 page pairs); Reference (14 page pairs); USGS Quadrangles; Map Index; Gazetteer; Oregon Place Names Essay; Sources; and Index.

"While every other aspect of the Atlas of Oregon *production was entirely digital, initial page layouts were manually drawn with felt-tipped pens on butcher and tracing paper."*

Design and Compilation

The first steps in the development of the *Atlas* included drafting a table of contents, initially based on the *First Edition*. This list was influenced by the availability of data sets on relevant topics, and the knowledge and expertise of the current staff. Most topics in the table of contents became two-page spreads, though a few lent themselves to multiple spreads. From the start, the table of contents was a tentative and provisional list. As work proceeded on the *Atlas* the table of contents changed. For example, the quality and richness of the data on Population Growth led to our expanding the coverage from one to three page pairs. Similarly, the availability of detailed 10-meter digital elevation model (DEM) data encouraged us to expand the landforms topic. Conversely, we dropped a few topics because of a lack of usable data, e.g., Threatened and Endangered Species and Wireless Communication.

While every other aspect of the *Atlas of Oregon* production was entirely digital, initial page layouts were manually drawn with felt-tipped pens on butcher and tracing paper. The process proved to be a quick and efficient method of getting initial ideas for each topic into an organized format, and it encouraged a fluid approach to page layout. Neighboring page layouts were easily compared, both as overlays, and as side-by-side, full-size comparisons. These manually drafted mockups served as the guide to compiling data sets and working with potential experts on the topics.

Compilation and Organization

The *Atlas* team was able to develop an extensive network of leading experts in government, academia, and private industry because of Loy's long history of atlas and statewide community involvement, and because of the University of Oregon's InfoGraphics Lab's longstanding involvement with state agency mapping projects. The importance of the contributions of participating experts in their fields cannot be overstated. Without those contributions, the *Atlas* would not be nearly the authoritative reference source that it is. The experts helped identify the best way to explain topics and pointed us to the best data sets. They reviewed early drafts of the page pairs and wrote the accompanying text, then often rewrote several versions to accommodate changes to the page content, or changes to the target word count. The *Atlas'* text editor reworked the experts' draft text, insuring a consistent and readable quality to the page pairs both in terms of space considerations on a page, and for syntax and style.

Design Principles

The design principles applicable to any map or book remain basic to a state *Atlas*, but the format involves additional design concerns. Tufte's (1983) information design principles were an important influence. More general graphic design principles helped guide the book and typography design decisions (Williams, 1994). The authors' *Atlas* and map design experience was, of course, fundamental.

The *Atlas of Oregon* paid close attention to several of the design principles laid out by Tufte in *The Visual Display of Quantitative Information* (1983). Examples of Tufte's principles of *graphical excellence and integrity* can be found on nearly every page in the *Atlas*. We tried to make the displays interesting by preparing presentations that communicate the complex nature of a particular subject in a way that was clear, simple, and meaningful to the reader. Much effort went into creating multivariate maps and graphs with a great deal of attention into making the graphics bias-free, well labeled, and contextually appropriate. These representations were designed to reveal spatial patterns of the geographic information at general overview scales, and to show subtle details that allow the user to put his/her nose on the page and see actual data values or detailed feature names. For time-series graphs that contained dollar amounts, the dollar values were adjusted for inflation so that the reader could make useful comparison of historical information. For each page pair layout, diverse forms of page elements—maps, graphs, tables, and copy—were carefully integrated to develop cohesive topic presentations.

"These representations were designed to reveal spatial patterns of the geographic information at general overview scales, and to show subtle details that allow the user to put his/her nose on the page and see actual data values or detailed feature names."

The Highway Traffic page pair (Figure 1, see page 77) is one example of the implementation of many of these principles. The purpose of this pair page is to give the reader a clear idea of traffic volume and flow on the state's highways, and how they have changed over time. The page pair contains a 1:2M scale, statewide flow/volume map. The lines are classed and symbolized according to the volume of average daily traffic. The data for this map came from an Oregon Department of Transportation GIS database file. The statewide map of Oregon's flow lines show the overall pattern of traffic in the state, and includes detailed labels informing the reader of the actual values for more precise comparisons. The map is also labeled with city names and highway numbers. The flow alignments are based on detailed highway centerlines so their spatial accuracy is good and the flow information is detailed enough that the reader can identify where significant changes of traffic volume occur, for instance, at a town or a road junction. The page also provides an enlargement of the Portland metro area, which is difficult to show at a state scale. Multiple small line graphs give a detailed picture of the volume percent increase over the last 40 years at 22 locations keyed to the maps. The graphs all chart percent-ages of change instead of volume, making them easy to compare, and list volume and change rate for 1959 and 1998. An overview graph containing total vehicle miles and vehicle miles traveled per capita is included to help complete the story. The line showing vehicle miles per capita helps give context to the total miles by factoring in population change. A short discussion helps guide the user through the map and graphs. The page pair presents a very extensive transportation dataset in an easily readable form. It can be briefly perused to see general patterns throughout the state, or it can be studied in detail as a reference to compare traffic numbers between locations and over time.

". . . the rise of both GIS technology and GIS data sets. . . accentuates the design challenge of balancing the desire for more data detail while maintaining simple, easily understood maps."

A fundamental change since the production of the *First Edition*—one that is so dominant that many cartographers take it for granted and hardly notice it—is the rise of both GIS technology and GIS data sets. This change accentuates the design challenge of balancing the desire for more data detail while maintaining simple, easily understood maps. In 1976, inked maps were laboriously copied and then generalized for peelcoat color production methods, resulting in over-generalized summaries. Such generalization was an unavoidable necessity of the production technology of the time. For the *Second Edition*, the availability of GIS technology and spatial data enabled us to show extremely intricate detail, for instance, down to the quarter-section level even at 1:3M scale on land-ownership maps, producing more compelling displays (Figure 2, see page 78). The cartographic challenge shifted from production limitations to design issues.

Reference Information and the Virtues of Repetition

The inevitable overlay of successive thematic treatments over the same state base map threatens to make any state *Atlas* boring, no matter how well executed the individual pages are. On the other hand, that same repetition allows the cartographer to presume a depth of background reference that cannot be taken for granted in a single map. Thus, it is no longer essential to name all significant rivers and lakes on every base, when several page pairs are devoted specifically to these features. Highway shields and numbers, an astonishingly time-consuming item of cartographic production and often an intractable design problem, can be blithely disregarded on many maps in which roads are a useful but secondary reference. Built-up area tints may stand in for unnamed towns, reducing type clutter with minimal loss (or even gain) of comprehensibility. And very fine type, or light gray type, may be used much more freely than would be advisable on a stand-alone map.

"The inevitable overlay of successive thematic treatments over the same state base map threatens to make any state Atlas *boring, no matter how well executed the individual pages are."*

Another variation on the virtues of repetition is the *Atlas'* complete 1:500,000 reference map series (Figure 3, see page 79) in 24 pages, and the 54 additional pages at 1:150,000 (Figure 4, see page 79), covering nearly all the cities and towns in the state. Two scales are better than one; we had much greater design freedom for each of these series because the other was there. Reference maps at 1:500,000 could use bolder colors, broader strokes, less comprehensive (and therefore cleaner) type compilation, while the 1:150,000 series relies on subtler color and finer type, and enjoys the freedom of cropping to optimize page layout, without the need to include all of any particular outlying area since it was already covered in the smaller scale reference maps.

These advantages of repetition are important—and liberating to the cartographic designer—but the risk of descending into boredom is significant. The goal of optimal page design poses the danger of an essentially static sequence of pages. Our initial page layout sought to avoid that by continually comparing all neighboring pages, shifting the position of major page elements within the framework of two basic column configurations (two and three columns per page) and a few frequently-used state scales. We used inset maps and graphs liberally to break up the potential monotony of the state base, and varied both scale and style within a single page pair (Figure 5, see page 80). For instance, Health Care includes a small United States state choropleth map, six Oregon county choropleth maps at two scales, two Oregon proportional symbol maps at two scales, two bar charts, two graphs, and a table. The Health Care page pair is an extreme example, and purists might argue that it descends into design cacophony. On the other hand, the reader is certainly aware that this is a new subject, with its own distinct issues.

Data Classification

In early drafts of choropleth maps, the method of natural breaks, a data-classing option in ESRI ArcView GIS software, was used. However, the technique resulted in confusing and counterintuitive class breaks that conflicted with our goal to create an easily understood publication for a general audience. Instead, we used equal-interval class breaks, with the addition of "less than" and "more than" classes when needed. In some cases, where mapping a data set did not lend itself to equal intervals, a variation was applied with generally recognizable benchmark values (for instance 25, 50, 100) as class limits.

Use of Color

"Atlas color, like page layout, must be treated with one eye toward overall book design and the other to the dangers of overuse."

Atlas color, like page layout, must be treated with one eye toward overall book design and the other to the dangers of overuse. There are *Atlas of Oregon* pages built with what many may regard as ugly colors. Ugly is in the eye of the beholder, of course. Functionally, these pages may be described as not the same old comfortable colors, and that is a significant virtue in a 320-page book. For instance, on the Immigration page pair there was a need to display 15 distinct, qualitative categories. A few of the colors that were used disrupt the overall color balance and harmony of the page, but it succeeded in making all the categories distinct, keeping the page readable and, we hope, interesting.

A variety of sequential and divergent color schemes (Brewer, 1994) were employed for the *Atlas'* quantitative maps. Many maps relied on a sequential scheme, increasing value within a single hue to communicate quantity, for instance, *Percentage of Employment Rates* on the Labor page pair. A divergent red-blue scheme was used to symbolize the *Presidential Elections, 1928–2000,* small multiple series with the midpoint data value at 50% for the *Percentage of Two-Party Votes*, showing, in effect, the winning party in each county. On the isometric *Average Annual Precipitation* map (Figure 6, see page 81), an asymmetrical variation on the divergent scheme with a hue and value transition (orange to purple to black) was applied. The scheme is asymmetrical because it adds more classes above the divergent midpoint, the state's average precipitation, because of the wider range of wetter values. Black was used here, and on the *Population Density* map, to emphasize the extreme upper end of the range. The *Atlas* project had the benefit of using the proven and popular *Raven Maps* elevation tint color scheme for the Landforms, Elevation, Landslides, and the Early Exploration maps, among others.

Many maps and graphs were designed with no color fill—that is, white—to enhance the legibility of color point symbols and fine type. To establish figure-ground on these page pairs, a light background tint was applied. Ideally, such a background tint would be applied as a fifth spot ink. To hold down costs, we built the background tint from CMY. That placed unreasonably tight demands on ink fountain controls on the press, and we sometimes had perceptible color shifts in the background tint across page pairs.

Book Design

A book is not merely a collection of pages, but an assemblage of like parts and subparts with attention to the flow throughout. The first decisions to be made were with the subparts—the page grids. We chose to use two- and three-column layouts. All pages stayed within the grid, save the opening spread, "Oregon in the World." The *Atlas* was divided into four chapters, each with a subtle yet unifying color tab-line underling each page title. Sections were separated by simple divider pages, which were aligned with the elements on the title pages. Flow was maintained by adhering to the two- or three-column grid, with no bleed and no distracting flourishes. All pages have strong structure because of the close attention paid to the alignment of page elements. Unlike newspapers and most magazines, the *Atlas* used white space freely. The white space helps keep the pages from feeling crowded. Common page elements are thoughtfully grouped to let the white space flow well through each design, helping to organize the "sometimes overloaded" layouts.

"A book is not merely a collection of pages, but an assemblage of like parts and subparts with attention to the flow throughout."

Typography

Early in the design of the book, we decided to use a classic look, and minimize the use of flashy graphics. The *Atlas of Oregon* would try to look more like an authoritative, even staid, reference work that has a timeless quality. One of the early decisions to be made was the choice of typefaces. There would be latitude for the maps, but the text needed to be consistent throughout the *Atlas*. Heads, subheads, body copy, and sidebars needed to have both harmony and contrast. For contrast, serif and sans serif typefaces needed to be chosen. For harmony, differing weights of the same typeface would be used.

The first edition of the *Atlas of Oregon* set heads in Century and body copy set in Ronaldson. Some charts and graphs used Univers for the sans serif typeface. The look was au courant for the time, but there was a decided lack of contrast between the heads and the text. In the *Second Edition,* contrast would be provided by choosing a serif face for text, heads, and page titles, while choosing a sans serif face for sidebars, graphs, charts, lists, and titles of individual elements on the page. Though not unimportant, the sans serif face was intended to be relatively clear and flavorless. Frutiger, the chosen sans serif face, has a bit more color and flavor than Helvetica or Trade Gothic, but its readability and elegance exceed theirs. We are fairly certain that in 25 years, the authors of the *Third Edition* will consider Frutiger to have been au courant for the time.

In the first edition of the *Atlas*, the maps and text shared nearly equal status. With the changes brought on by the conversion from manual to digital production, the maps for the second edition would gain dominance over the text. The text became subordinate, while the maps, charts, graphs, and tables carried the message. We needed a delicate, classic typeface that would be very readable but not conflict with the more dominant graphics on each layout. A serif face seemed necessary for the text—and thus heads and subheads—to lend a feel and look of classic book design. The typeface needed to be light, to compliment, not dominate, the maps and graphics.

An oldstyle face was preferred. Berkeley Light was chosen for the text because of its nearly diaphanous elegance. Then, Berkeley Bold was a complimentary use for the heads and subheads, as well as the titles for the page pair topics.

Prepress and printing

As most pre-press departments prefer not to work with native files, final FreeHand files were saved as EPS, then placed in QuarkXPress pages. To streamline the work flow, all *Atlas* pages except front matter, chapter dividers, and index pages were prepared as single XPress documents, and prints were made from these XPress files. The final deliverables sent to the printer for each page included (except as noted above) a one-page XPress document, a placed EPS file, and a print of the page. The printer returned a series of color proofs for review and final sign-off.

Public Reaction

Soon after the second edition of the *Atlas* was released it received positive reviews. Book sales were brisk—within the first six months the *Atlas* was in its second printing. Readers and reviewers were pleased by the unexpected amount of thematic information:

"Thousands of coffee tables in Oregon became geographic reference centers, sources that encouraged the understanding of Oregon's diverse geography."

> "The best book on Oregon…This new *Atlas* is much more than a gallery of artful maps. It's an incredibly detailed and wonderfully accessible look at Oregon's human, economic and physical geography."
>
> *Jonathan Nicholas,"PDXtra" columnist*
> The Oregonian*, Portland, October 12, 2001*

> "There's no better snapshot of Oregon in 2001, and none more beautiful…So much information, so intelligently presented…"
>
> *The Best Books of 2001*
> The Oregonian*, Portland, December 30, 2001*

In addition to reference maps, the *Atlas of Oregon* also displays a wide range of topics including where the high traffic flow is and how it has changed over time, where the earthquake epicenters were, where the wettest places in the state are, and, with a graph going back to the 1870s, why there is an endangered salmon problem. Thousands of coffee tables in Oregon became geographic reference centers, sources that encouraged the understanding of Oregon's diverse geography.

CONCLUSION

Designing and producing the *Atlas of Oregon* was a long and complex process that began by thinking about potential geographic topics and how they might best be represented. The lengthy process involved the crucial steps of establishing a network of topic experts, the compilation and definition of page pairs, followed by the design of page layouts, maps, and other page elements. Several established design principles, along with the extensive experience of the *Atlas* team, guided the development of the final designs.

ACKNOWLEDGMENTS

We are indebted to Lawrence Andreas for his contributions to the book design and typography sections, and for taking the time to serve in an editing role. We thank Gene Martin, Erik Steiner, Bill Loy, and Kenneth Kato for their thoughtful comments and edits. In addition, we must express our gratitude to Bill Loy, whose determination and leadership on the *Atlas* was an inspiration, and a necessity for the completion of the project.

The key members of the *Atlas* team included Bill Loy as director; Stuart Allan as co-author and cartographic editor; Aileen R. Buckley (previously Assistant Professor in Geography at the University of Oregon) and InfoGraphics Lab Director James E. Meacham as co-authors; Allan Cartography Production Manager Lawrence J. Andreas and retired Geography Professor Gene E. Martin as contributing editors; and University of Oregon Science Writer Ross West as text editor. The *Atlas* team also included several Allan Cartography cartographers and University of Oregon InfoGraphics Lab staff and students.

REFERENCES

Brewer, C. A., 1994. Color Use Guidelines for Mapping and Visualization, In *Visualization in Modern Cartography,* A.M. MacEachren and D.R.F. Taylor (eds), 123147, Elsevier Science, Tarrytown, NY.

Buckley, A. R., Meacham, J.E. and E. B. Steiner, in-press. Creating a State *Atlas* as an Integrated set of Resources: Book, CD-ROM and Website, *ICC Proceedings*, Durban, South Africa.

Csuti, B., Kimerling, A.J., O'Neil, T., Shaughnessy, M.M., Ganies, E.P. and M. P. Huso, 1997. *Atlas of Oregon Wildlife*, OSU Press, Corvallis.

Loy, W. G., 1980. State *Atlas* Creation, *The American Cartographer*, 7(2):105–121.

Loy, W. G., Allan, S., Patton, C. P. and R. D. Plank, 1976. *Atlas of Oregon, First Edition*, University of Oregon Press, Eugene.

Loy, W.G., Allan, S., Buckley, A. R. and J. E. Meacham, 2001. *Atlas of Oregon, Second Edition*, University of Oregon Press, Eugene.

Nicholas, J., *PDXtra* Column, Oct 12, 2001. The Oregonian, Portland.

Tufte, E. R., 1983. *The Visual Display of Quantitative Information,* Graphics Press, Cheshire, Connecticut.

Williams, R. 1994. *The Non-Designer's Design Book,* Peachpit Press, Berkeley.

Design Guidelines for Digital Atlases

Amy K. Lobben
Department of Geography
Central Michigan Univ.
Mount Pleasant, MI 48859
amy.lobben@cmich.edu

David K. Patton
Department of Geography
Central Michigan Univ.
Mount Pleasant, MI 48859
david.patton@cmich.edu

Interestingly, cartography is one of the oldest disciplines, but it is also continuously in the forefront of disciplines to adopt and adapt current technologies (Koussoulakou 1999).

Introduction

In 1995, *Cartographic Perspectives* put forth an entire volume dealing with the issues of production, dissemination and use as related to electronic atlases. The impetus for the volume came from the success of two special sessions held on the subject: the first being sponsored by the International Cartographic Association (ICA) in 1993 and the second organized at the annual convention of ASPRS / ACSM in 1994 (Trainor, 1995). These papers can now be viewed as a snapshot of the state-of-the-art in electronic atlases in 1995. A review of the articles contained in that special issue reveal several important topics. First, in 1995 the tussle for allegiance to the various computer platforms (Dos, Windows, MacIntosh, Unix) was still an issue (Rystedt, 1995). In 2002, it would appear Windows has won that battle although dissemination across the Internet has made the matter (with regard to digital atlases) less significant. Dissemination, then, was a second major theme in 1995. Electronic atlases were still distributed primarily on digital hardcopies with the CD-ROM being the preferred method. Several of the authors predicted that the Internet had the potential to be as significant as the CD-Rom for sharing electronic atlas data (Keller, 1995; Morrison, 1995; Ormeling, 1995; Rystedt, 1995). Third, several of the authors discussed the potential of electronic atlases to serve different user groups e.g. students, professionals, novices, experts (Dymon, 1995; Keller, 1995; Ormeling, 1995; Rystedt, 1995). User type remains a significant concern when creating a digital atlas. Fourth, the need to make electronic atlases interactive was viewed as critical to meeting the needs and expectations of users (Keller, 1995; Ormeling, 1995; Rystedt, 1995; Smith and Parker, 1995). While the conceptions of "interactivity" have evolved since 1995, this issue remains central to electronic atlas design. Finally, several of the papers dealt with the presentation and navigation of geographic data in an electronic atlas. Ormeling (1995) in particular presented many of the challenges facing the cartographer when creating a digital atlas.

"This paper will . . . discuss design issues as they relate to printed atlases, digital maps, Internet published maps, World Wide Web (WWW) published digital atlases, and finally design guidelines for WWW Published Digital Atlases."

The purpose of this paper is to examine the existing guidelines for printed atlases, digital maps and the Internet with the goal of extracting those design recommendations that can be applied to digital atlases. More specifically, in this paper we will address those design issues that are particular to digital atlases on the Internet. Some of the guidelines may be applied to digital atlases published with other medium, such as CD or DVD. Also, some of the guidelines may be generalized to apply to digital cartography, in general. However, the primary focus of this paper is to present and discuss design guidelines for WWW-published digital atlases. This paper will therefore discuss design issues as they relate to printed atlases, digital maps, Internet published maps, World Wide Web (WWW) published digital atlases, and finally design guidelines for WWW Published Digital Atlases.

In a relatively new and rapidly changing field, such as computer mapping, it is common that many different terminologies evolve. For this discussion, we will use the term "digital" atlas to mean the many presentation types associated with the production of atlases in a computer environment (e.g., multimedia, interactive, dynamic, animated and electronic) and adequately distinguishes them from those associated with static printed atlases.

Design Issues for Printed Atlas

"While there are many new challenges to presenting an atlas in a digital form, much can be directly adopted from the design of effective printed atlases."

Atlases are not new to the world of cartography. While there are many new challenges to presenting an atlas in a digital form, much can be directly adopted from the design of effective printed atlases. Two existing studies on the design of printed atlases are particularly informative. Hocking and Keller (1992; 1993) examined atlas design issues through the use of a survey of atlas users, and through a content analysis of atlas reviews written by professional cartographers. The results of the user survey showed that atlas users were concerned with both the content and design of the atlas. In the area of content, users were concerned that data be current and that appropriate metadata such as date, source, scale be present. While the vast majority of the users found the addition of ancillary figures such as photos, text and diagrams useful, there was a concern that the maps not be cluttered or overwhelmed by non-map material. Users also strongly urged for the inclusion of an index of maps that goes beyond the gazetteer. Each of these concerns can and should be addressed in the creation of a digital atlas. With respect to the design of the atlas, users were concerned that the maps remain simple, and not be crowded. Given potential limitations of screen resolution, this concern may be even more critical for digital maps. Two potentially related issues involve the desire of atlas users for maps of various scales for a given geographic area, and their dissatisfaction with maps that span more than one page. The digital atlas provides an ideal means of giving atlas users access to multiple scaled maps, but the inconsistencies of monitor resolutions from one user to another may make the issue of fitting an entire map on a single screen a greater challenge. Finally, the users had several concerns relating to color. They praised the use of color-coding that helped to visually organize sections of the atlas together, but they were critical of maps with too many colors, or colors that differed only slightly. Again, given the capabilities of computer monitors and video drivers, the issue of color differentiation may be even more significant for digital atlases.

"The map user can touch, fold, flip, draw on, and put the printed map in their pocket. The printed map, however, lacks the potential for the multimodal interaction provided by digital maps."

The content analysis of atlas reviews written by professional cartographers had some minor differences in responses, but shared concerns with the 'non-experts'. "Consensus is that simplicity and clarity of communication is desirable. Agreement exists that scales must be rounded and clearly stated. Bold colors tend to be frowned upon, although subdued colors must be clearly separated" (Hocking and Keller, 1993:79).

Design Issues for Digital Maps

Static, printed maps may no longer be the mostly widely produced maps with map engines such as Map Quest or Yahoo Maps, but printed paper maps still outnumber digital atlases. Printed maps allow the reader to physically interact with the map in a manner not currently possible with a digital or virtual map. The map user can touch, fold, flip, draw on, and put the printed map in their pocket. The printed map, however, lacks the potential for the multimodal interaction provided by digital maps. We hesitate to call the digital map interaction deeper, more significant, more profound, or better as the interaction may actually be less personal. But, as

Peterson (1999) states, "it is difficult to overstate the importance of this new medium for cartography (31)." The digital map offers a level of interaction that currently is not possible with a printed map, possibly providing an advantage over traditional printed maps with regard to spatial learning.

The digital map offers a map communication medium that may provide advantages over traditional printed maps. In fact, Peterson (1999) offers several advantages of interactive multimedia over printed maps. One advantage is that multiple media (text, graphics, video, sound, etc.) presented together "will lead to more realistic representations of the world (page 32)." Another advantage is that people enjoy viewing maps as part of multimedia presentations, and therefore may learn more when they are having fun. Research has shown that subjects who have viewed digital maps as well as static map presentations learn more from, and enjoy the presentation of, the dynamic over the static representations (Lobben, 1996; Freundschuh, 1999; Feeney, 2000). A third advantage arises because many people do not know how to adequately read a map—multiple sources of information provided by digital maps may help people gain more understanding of maps. A last advantage is that the exploration of multimedia as an alternative production method for spatial information furthers the theoretical development within cartography.

"The digital map offers a map communication medium that may provide advantages over traditional printed maps."

While cartographic communication may be improved through the use of dynamic multimedia maps (Buziek, 1999), the advent of an alternative production method requires that cartographers explore and identify design guidelines that will help develop digital maps that function as efficient and effective spatial data display and exploration products. Cartographic researchers continue to investigate digital map design issues and several guidelines have already been addressed. While many of the guidelines follow those that have been developed for static, printed maps, the design process associated with digital maps is complicated by the fact that more media as well as potentially more dimensions of data are incorporated into the map display (Miller, 1999). But, guidelines have been suggested and some are included below.

Aesthetics

Monmonier (1991), Robinson *et. al.* (1995), Gartner (1998), and Dent (1999) have addressed the issue of map aesthetics. The overall appearance of a map, including a digital map, is profoundly important in how the map's message is perceived by the reader. In a study performed by Harrower *et. al.* (1997), they found that subjects who identified digital maps that were "the most accurate, ethical and convincing were also the maps that looked the most professional by [the researchers'] standards (33)." As the aesthetics are important for a printed map, it stands to reason that they would be important for a digital map or atlas as well. However, aesthetics is to some degree a matter of personal taste and preference. Developing an eye for cartographic aesthetics is one of the hardest traits to teach (Dent, 1999). Criteria that determines how pleasing a map appears to a reader might include color, line weight, font choices, and simplicity. Though, how should the cartographer control for these choices given the differences and lack of viewing quality control (monitor quality)? Because the specific qualities of each display device are not known to the cartographer, designing for the unknown may be accomplished (or at least simplified) by employing a design that meets minimum display standards. Some of these standards are addressed individually below.

"Developing an eye for cartographic aesthetics is one of the hardest traits to teach."

Text

Most anyone who has ever had to include text on a map (or has taught students how to effectively employ text on a map) knows that dealing with text is a complicated task. Given this, how does the cartographer approach text use on a digital map that has lower resolution relative to the printed map? Harrower *et. al.* (1997) found that illegibility of text on internet maps produced complaints from subjects.

The most legible fonts may be Times, Arial, and Helvetica as these fonts are installed on most computers, lessening the possibility that the fonts will be remapped on the host monitor (Springer, 1999). In addition, these fonts have the advantage of being more legible than other more ornate or complicated fonts, even on the printed map (Dent, 1999).

"How does the cartographer approach text use on a digital map that has lower resolution relative to the printed map?"

Color

Digital map design is hindered by fewer color options than available for printed maps, as modern monitors are less capable than modern printers at creating color depth and variety (Springer, 1999). Also, different monitors may display the same RGB combinations, which may appear slightly (and sometimes drastically) different. Recently, however, the difficult process associated with selecting color for monitor display has been eased. ColorBrewer (http://www.personal.psu.edu/faculty/c/a/cab38/ColorBrewerBeta.html), an online color selection aid for cartography, allows the user to identify color combinations appropriate for a variety of intended audiences and applications including monitor display.

Map Interface

A critical issue in assessing the communicative value of the maps is the interface to the map, which "becomes a significant factor in the use of the map or map sequences" (Torguson, 1997:29). The interface must provide a means of integrating all of the media to provide effective user interaction with the digital map; such effective interaction could include basic functioning of the map presentation as well as map data analysis and manipulation (Miller, 1999). Most maps (both printed and digital) are designed to present spatial data, and care is given to create a design that allows the most direct and effective display of the spatial data. Of course, criteria that define the term *effective* will likely vary from map to map, depending on the map purpose. One goal that may be commonly held in most maps is to direct viewer attention to the data and their symbols on the map, itself. Therefore, the digital map design should, ideally, focus viewer attention on the map and not distract reader's attention to the interface system. As a result, digital map design may benefit by maintaining a structured and consistent interface.

"The interface must provide a means of integrating all of the media to provide effective user interaction with the digital map."

The interface may provide several functions, for example basic interface navigation, direct map access, and peripheral map-related interaction. Many digital maps include *next*, *back*, *home* as well as other basic functions designed to provide navigation within frames, and between sections of the map. Buttons that are common in all frames and screens, or are part of the digital map, can aid communication by maintaining the same pixel location from screen to screen. In cases where a map graphic may overlap the standard buttons, consistency may dictate that the graphic be edited, rather than the navigation buttons. In addition to the standard navigation interface, interactivity may include direct map access. This direct map access can be provided via buttons that are an integral part of the map. For example, both thematic and reference map symbols can be programmed to provide the viewer information about the symbols meaning when selected. This level of interactivity provides the viewer with more detailed information about the elements contained on the map.

The interface may also include interactivity that is not direct, but instead provides peripheral map-related interaction. This type of interaction could include buttons that are programmed to allow the viewer to gain additional information about the map display without clicking directly on the map. This interactivity may not necessarily be designed to further explain characteristics of the map elements, but instead allow the viewer to explore additional possibilities. For example the map user might choose to re-map a choropleth map using a different classification method, or view only certain symbols, or even change the number of classes.

"The interface may also include interactivity that is not direct, but instead provides peripheral map-related interaction."

Legend Design

The digital atlas can utilize both static legends and interactive legends. The static legends will differ little form those associated with printed atlases. If adopting an interactive legend, they may be presented in at least two distinct ways. First, the map may have imbedded self-describing symbols, which when accessed by the map viewer through some sort of interaction such as a roll-over or click provide its own decoding (Miller, 1999). Second, a traditional legend as seen on most printed maps may be displayed. This legend may be static or interactive, which may provide additional information about each symbol when accessed. The legend may also be structured according to hierarchy. For example, upon first observation a legend providing information about a topological map could include only the most general classes of symbols like roads, buildings and soils. However, the viewer could then click on roads revealing a subset of symbols, for instance US highways, state highways, 4-lane, 2-lane, and unpaved.

Intellectual Hierarchy, Visual Hierarchy, and Figure/Ground

The symbols on the static map that are assigned a higher level of informational content should be designed so that they maintain proper visual hierarchy (Dent, 1996). Consequently, higher-order digital map symbols should also be designed to provide maximum visibility (Miller, 1999). The author of the digital map can utilize design techniques that are not available in print-map design. Techniques such as a roll-overs, or animated symbols like blinking, color ramping, and shape changes may provide a visual hierarchy of elements in the digital map.

"The author of the digital map can utilize design techniques that are not available in print-map design. Techniques such as a roll-overs, or animated symbols like blinking, color ramping, and shape changes may provide a visual hierarchy of elements in the digital map."

Graphic Integrity

The problem of screen versus printed page resolution has been well documented and discussed by researchers. While "the visual limitations of the computer monitor [may be] immediately apparent when compared with a finely printed image (Springer, 1999:60), solving the resolution problem requires that the cartographer implement design guidelines for the digital map that may be distinctly different than those adopted for the printed map.

Scanned Images

There are general resolution differences between monitors (lower resolution) and the printed page (higher resolution) that render viewing a digital map, that was created from scanning a printed map, on a computer screen less effective. However, these types of scanned images are commonly found on the Internet. Harrower *et. al.* (1997) observed that digital maps that are scanned from printed maps may have font legibility problems; in particular, they noted that serif and italicized fonts often become illegible due to the scanning process. If possible, cartographers might avoid including scanned printed maps in their digital maps. When the mapping purpose requires that a basic thematic or reference map be included, a new and original map should be designed for the digital display, allowing the cartographer to observe and apply some of the guidelines for designing virtual digital maps. However, new designs may not always be possible.

"If possible, cartographers might avoid including scanned printed maps in their digital maps. When the mapping purpose requires that a basic thematic or reference map be included, a new and original map should be designed for the digital display . . ."

Consider the case of including historical, hand-drawn, paintings, or other original maps created on printed medium; clearly, these maps need be scanned to include in the digital map presentation. In this case, the cartographer needs make one of two design decisions: reduce the size of the map to screen size, or include a large image that requires scrolling to view the entire map. The detail of the original image may help select the method. A scanned map with little detail may be viewed on a single screen without losing any of the graphic integrity of the original map. However, with an original map that contains a great deal of detail, acknowledging that this is a subjective decision, the cartographer may decide to include the image as a scrolling map. With this choice, disadvantages are faced. Harrower *et. al.* (1997) suggest that maps that do not entirely display on the monitor, but instead require scrolling to see the entirety of the map are "difficulty to read, frustrating and confusing" (36).

"Because the cartographer can provide the viewer the option of zooming into the map for a more detailed view, they need not include all map elements when the map is viewed at the smallest scale."

Graphic Simplicity

The limitations imposed by a computer screen display environment will influence the information structure in a multimedia environment and may require that manageable chunks of information are used (Miller, 1999). Digital maps may be more effective if the design is less complex graphically than printed maps (Buziek, 1999; Springer, 1999). Instead of replicating a complex map, a street map or a topographic map, for example, the cartographer could use layers of data. These data layers may be accessible by creating interactivity that allows the map viewer to retrieve the needed information. Also, because the cartographer can provide the viewer the option of zooming into the map for a more detailed view, they need not include all map elements when the map is viewed at the smallest scale.

"... the viewer may benefit from a general overview in the beginning or introductory page of the map."

Content Structure

Ideally, digital map products will provide an overview of the structure and/or content of the map (Miller, 1999). As mentioned above, systematic placement of navigation buttons will aid the map-reader in the exploration of the digital map. But, more than ease of navigation, the viewer may benefit from a general overview in the beginning or introductory page of the map. Following an overview, a general table of contents, which may function as a home page, could provide a grounded organization that the viewer can access from anywhere in the digital map. This access would be via a consistently positioned "Home" button, or similar.

Internet Publishing Issues

Accessibility to the Internet is on the rise (Peterson, 1999) and has become a "major medium for the dissemination of maps and it has a great potential for further growth" (van Elzakker, 2000:34). Publishing on the WWW offers cartographers some spectacular advantages not enjoyed by publishing in permanent tangible medium. Reasons for the popularity abound, but Peterson (1997) succinctly captured the essence of the reasons when he stated that "the internet presents cartographers with a faster method of map distribution, different forms of mapping, and new areas of research." (3). Specifically, internet publishing usually means lower distribution costs, less time spent in the publishing process as it is faster to publish on the internet than on paper or to CD-ROM, and less time spent on distribution and faster up-dates of edited maps.

"Viewers may become frustrated with large, slow loading files."

With these advantages, though, one important issue should be considered in the design process. File Size affects the load time of any digital map viewed over the internet and therefore may inversely affect viewer interactivity (Crampton, 1999). Viewers may become frustrated with large, slow loading files. In addition, delayed load time may impede the entire design purpose as "a slow unresponsive dynamic map interferes with the exploration of the data being presented." (Springer, 1999: 60) Cartographers, therefore, may need to take care of the final file size of the digital map that is published on the Internet.

Aside from file size as a design issue for Internet maps, few design guidelines exist for web-map designers. The lack of guidelines may be due to cartographers knowing little about how people use Web maps (van Elzakker, 2000) as relatively little attention has been paid to WWW and mapping (Crampton, 1999). Additional research on user needs and use of Web maps is needed.

WWW Published Digital Atlases: Examples

As we have seen the WWW continues to grow as a popular dissemination method for maps. Thousands of sites contain maps of many forms, for instance static, multimedia, interactive, and animated maps. Interactive atlases are no exception and many are found on the WWW, as well as on CD-ROM.

"Aside from file size as a design issue for Internet maps, few design guidelines exist for web-map designers. The lack of guidelines may be due to cartographers knowing little about how people use Web maps."

The IMAA (Interactive Multimedia Atlas of Austria) allows users to explore the topographic and socio-economic attributes of Austria through maps, text, photography, and videos (Kelnhofer, Pammer and Schimon, 1999). The planned new edition of the Atlas of Switzerland, which includes both printed as well as multimedia components that may be used in conjunction with each other illustrates the following themes: international relations, natural space and environment, population and society, economy, infrastructure and traffic, and culture and politics (Hurni, Bär, and Sieber, 1999).

The Atlas du Quebec et de ses regions is under production with sections available on the Web at http://www.unites.uqam.ca/atlasQuebec/. The atlas allows the viewer to explore socio-economic data of the Province at three different map scales (Carriere, 1999).

The new Atlas of Florida on CD-Rom represents a project that has been 20 years in development. The digital atlas was created based on previous printed versions of the Atlas, and maintains many of the sections contained in the printed form including topography, geology, geophysics, hydrology, weather and climate, soils, ecosystems, wildlife habitats, Indians, Spanish exploration, the Civil War, cultural landscapes, architecture, the arts, population, economy, and recreation and tourism. The digital version of the atlas was enhanced with more maps, data, and photographs (Anderson, 1999).

Like the Atlas of Switzerland, the Atlas of the Federal Republic of Germany also includes both printed and digital editions that contain dozens of topics intended for a wide audience, from government agencies to the general public (Lambrecht, 1999).

Design Guidelines for WWW Published Digital Atlases

"One of the greatest challenges of creating a digital atlas concerns the overall organization of the atlas components."

In short, an online atlas should contain many of the same features found in a printed atlas (Richard, 1999) but should be designed according to many of the guidelines adopted for digital maps. When designing the digital atlas, the cartographer will apply many of the guidelines for printed atlas production and digital map production as discussed above. However, the design of an effective digital atlas must consider more than those issues associated with the printed atlas and the digital map. The digital atlas has unique design challenges, some of which are addressed below.

Organization

One of the greatest challenges of creating a digital atlas concerns the overall organization of the atlas components. In the printed form, the organization of the atlas is much more apparent to the user. With the digital atlas, the organization is hidden and must be explicitly communicated to the user. As a result, the scope of the interactivity content and navigation should be presented as clearly and simply as possible.

Navigation

"For an atlas it is important to provide the user an effective means to explore the various sections. Therefore an important component of the digital atlas is a table of contents that is available at all times."

Given the random manner in which people explore digital atlases, and because the organizational structure of the atlas is hidden, it is necessary to provide the user with some means to aid in his/her navigation of the atlas. For an atlas it is important to provide the user an effective means to explore the various sections. Therefore an important component of the digital atlas is a table of contents that is available at all times. Whether the atlas provides a clickable table of contents on every page or a permanent link to the table is an individual design choice. In either case, it is important to provide the atlas user a means to manage "where" they are in the atlas. Based on the guidelines for static printed atlases, it is also recommended that a digital atlas provide the user with a gazetteer and an index to the individual maps. The gazetteer and the index can both be presented as hypertext pages and accessed through links in the table of contents.

Minimizing Text

As the printed atlas differs in design and content from a single map (or even a map series) so does the digital atlas differ from the digital map. The atlas provides a collection of maps that share a common theme, and while the maps are still a primary focus in the digital atlas, supporting media also provide a significant amount of information. Effort should be made to transform information into graphic representations (Buziek 1999), but when that conversion is not possible, the cartographer is presented with other options. Auditory narration may be employed in place of paragraphs of text. In addition, a clickable textual graph may be created to allow the map-reader to explore the narrative in his or her own order or format. Finally, sometimes a description of a sound or atmosphere can be replaced by a recording of the actual sound.

Real-Time Data Updating

In most cases, publishing an atlas on the Internet offers many of the advantages offered above, such as real-time data access, frequent updates, broad dissemination. Also, a creative and adept cartographer can add an additional atlas feature that is currently unavailable through traditional printed atlas. Webcams provide streams of image files that can be updated at variable rates of speed. Monmonier (2000) suggests that webcams can function as a mode of "cartographic surveillance" and can provide "qualitative or quantitative information about places" (53). Imagine, for example, an atlas of South America, which devotes a section to Amazonian wildlife. Traditionally, printed atlas maps would likely be enhanced with photographs of flora and fauna. Strategically placed webcams could capture real Amazon scenes, allowing the viewer to glimpse streaming video of life in the Amazon. While actual learning benefits may not be known, webcams at least arguably offer a method of presenting information that is currently not duplicated.

"Traditionally, printed atlas maps would likely be enhanced with photographs of flora and fauna. Strategically placed webcams could capture real Amazon scenes . . ."

Data Accessibility

In the simplest case, the printed atlas may be converted and presented in digital form. An interactive table of contents, structured navigation, clickable thematic and reference maps, interactive legends, photographs, graphs, and any other element included in the printed atlas can be included in the digital atlas. In creating this form of atlas, the design may benefit from applying the guidelines associated with digital maps as well as the organization guidelines presented above.

However, the ability to query information or obtain the relevant data is important in the design single digital maps (Johnson and Gluck, 1997), and the digital atlas as well. The cartographer may choose to include a truly interactive database, allowing the user to carry out remedial GIS querying, or simply include a clickable table of contents.

"The digital atlas need not be constrained to a series of interactive but pre-programmed animated or static maps . . ."

The digital atlas need not be constrained to a series of interactive but pre-programmed animated or static maps—referred to as a closed multimedia atlas where every possibly interactivity is programmed by the author (Borchert, 1999). In other words, the cartographer need not explicitly plan the specific interactivity, and the specific use need not be restricted for the atlas user. In addition to, or instead of creating planned thematic maps, the digital atlas may contain a GIS format of viewing thematic maps. Through this format, atlas users may access the atlas' spatial data sets with which they can perform more personalized functions. Consider again the atlas of South America. Atlas users may choose to create choropleth maps visualizing Amazonian flora or fauna, choosing their classes and their specific themes. In addition, simple GIS functions such as queries and buffering may be accomplished (Gartner, 1999; Swanson 1999; Zaslavsky, 2000; Open GIS Consortium, www.opengis.org).

CONCLUSION

While cartographers benefit from a rich array of sources that provide guidelines for designing static maps, guidelines for digital atlas design are few. Defining or even identifying a digital atlas may be difficult as many presentations on the WWW self-identified as Web atlases consist of only a few html pages with a few maps (Richard, 1999). Do these presentations constitute an atlas? What are the content (qualitative) and the number (quantitative) requirements in order to consider a presentation a digital atlas?

"Design guidelines will evolve as methods for dissemination can display larger images, more detail, higher resolution, and novel media."

The guidelines presented in this paper may not exhaust all of the design concerns that a cartographer might encounter when creating a digital atlas. However, the guidelines presented in this paper may help advance the discussion of designing digital atlases, while keeping in mind that digital map and atlas design guidelines should be dynamic. Design guidelines will evolve as methods for dissemination can display larger images, more detail, higher resolution, and novel media.

REFERENCES

Anderson, J. R. 1999. The Atlas of Florida CD-Rom Experience. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Borchert, A. 1999. Multimedia Atlas Concepts. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Buziek, G. 1999. Dynamic Elements of Multimedia Cartography. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Carrière, J. 1999. Atlas du Québec et de ses regions. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Crampton, J. W. 1999. Online Mapping: Theoretical Context and Practical Applications. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Dent B. 1999. *Cartography: Thematic Map Design*. WCB-McGraw Hill.

Dymon, U. J. 1995. The Potential of Electronic Atlases for Geographic Education. *Cartographic Perspectives*. 20:29-34.

Freundschuh, S. M. and Hellvik, W. 1999. Multimedia Technology in Cartography and Geographic Education. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag, 271-280.

Gartner, G. 1998. About the Quality of Maps. *Cartographic Perspectives*, 30:38-46.

Gartner, G. 1999. Multimedia GIS and the Web. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Harrower, M., Keller, C. P. and Hocking, D. 1997. Cartography on the Internet: Thoughts and a Preliminary User Survey. *Cartographic Perspectives*, 25:27-37.

Hocking, D. and Keller, C. P. 1992. A User Perspective on Atlas Content and Design. *The Cartographic Journal*, 29:109-117.

Hocking, D. and Keller, C. P. 1993. Analysis of State and Provincial Atlas Reviews. *Professional Geographer*, 45:73-83.

Hurni, L., Bär, H-R, and Sieber, R. 1999. The Atlas of Switzerland as an Interactive Multimedia Atlas Information System. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Johnson, D. and Gluck, M. 1997. Geographic Information Retrieval and the World Wide Web: A Match Made in Electronic Space. *Cartographic Perspectives*, 26:13-26.

Keller, C. P. 1995. Visualizing Digital Atlas Information Products and the User Perspective. *Cartographic Perspectives*, 20:21-28.

Kelnhofer, F., Pammer, A. and Schimon, G. 1999. Prototype of an Interactive Multimedia Atlas of Austria. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Koussoulakou, A. 1999. Geographical Reference in Multimedia Cartography. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Lambrecht, C.. 1999. Project “Atlas of the Federal Republic of Germany”. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Lobben, A. 1996. *Qualifying the Effectiveness of Cartographic Animation*. Unpublished Master’s Thesis, Department of Geography, Georgia State University.

Miller, S. 1999. Design of Multimedia Mapping Products. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Monmonier, M. 1996. *How to Lie with Maps*. University of Chicago Press.

Monmonier, M. 2000. Webcams, Interactive Index Maps, and Our Brave New World’s Brave New Globe. *Cartographic Perspectives*, 37:51-64

Morrison, J L. 1995. A Personalized National Atlas of the United States. *Cartographic Perspectives*, 20:40-44.

Ormeling, F. 1995. New Forms, Concepts, and Structures for European National Atlases. *Cartographic Perspectives*, 20:12-20.

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

Peterson, M. P. 1999. Elements of Multimedia Cartography. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Richard, D. 1999. Internet Atlas of Switzerland. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag.

Robinson, A. H., Morrison, J. L., Muehrcke, P., Kimerling, A. J., and Guptill, S. C. 1995. *Elements of Cartography*. John Wiley & Sons.

Rystedt, B. 1995. Current Trends in Electronic Atlas Production. *Cartographic Perspectives*, 20:5-11.

Smith, R. M. and Parker T. 1995. An Electronic Atlas Authoring System. *Cartographic Perspectives,* 20:35-39.

Springer, N. 1999. Designing Dynamic Maps. *Cartographic Perspectives*, 33:60-62.

Swanson, J. 1999. The Cartographic Possibilities of VRML. In Cartwright, W., Peterson, M.P. and Gartner, G. (Eds), *Multimedia Cartography*. Springer-Verlag

Torguson, J. S. 1999. User Interface Studies in the Virtual Map Environment. *Cartographic Perspectives*, 28:29-31.

Trainor, T. 1995. A Forward to Electronic Atlases: National and Regional Applications. *Cartographic Perspectives*, 20:3-4.

van Elzakker, Corné P.J.M. 2000. Use and Users of Maps on the Web. *Cartographic Perspectives*, 37:34-50.

Zaslavsky, I. A New Technology for Interactive Online Mapping with Vector Markup and XML. *Cartographic Perspectives,* 37:65-77.

cartographic techniques

Tips for Designing Effective Animated Maps

Mark Harrower
Department of Geography
University of Wisconsin–Madison
550 North Park Street
Madison, WI 53706
e-mail: maharrower@wisc.edu
web: www.geography.wisc.edu/~harrower/

Introduction

For mapmakers, animating maps presents an amplified cartographic challenge. Because animated maps are difficult and expensive to make—even with today's powerful software and computers—a designer will want to be reasonably confident that their efforts will pay off with a map that is both attractive and informative. There is no shortage of poorly conceived and clumsily executed maps with animated content to be found these days, and many such examples seem made for no other reason than "they look cool" (Campbell and Egbert 1990). In the spirit of Edward Tufte, it is always worth asking *why do I need to animate these data?* Does the animation lend something to the representation that would be difficult or impossible to convey in static form? If the answer is yes, than the added expense and time of creating an animated map may well be justified. Cartographers who want to use animation to make a better map must know the strengths and limitations of animation as a tool, and how map-readers are likely to be impacted by animation.

This article presents suggestions for creating effective animated maps derived from my experiences both as a user and as a creator of animated maps, as well as insights from formal user-testing over the past few years. Below, I offer some solutions to the four major challenges identified by Morrison (2000) with watching and learning from animated graphics: *disappearance, attention, confidence*, and *complexity*.

Challenge #1: Disappearance

By their very nature animated maps change, often quite dramatically from moment to moment. As a result, there is always the potential that the map-reader will miss important information or cues. Because of *disappearance* (i.e., blink and you miss it), many basic map reading tasks can be very difficult, such as: estimating the size of symbols or areas, matching colors to a legend, comparing one symbol to another, or reading text labels. As MacEachren (1995) notes, due to perceptual power of motion we should expect a decrease in the ability of map-readers to notice differences in non-dynamic visual variables on animated maps. As a result, the individual frames of the animation should be relatively simple since small details are unlikely to be noticed. This is true of both the base map and the thematic data. In many cases, a simple base map with a few data classes or features can be highly effective and dramatic. Extra information only competes for the readers' attention and may increase the chances of missing important cues or events.

Solutions to the problem of *disappearance* include letting the viewer (1) watch the animation multiple times (looping), (2) stop the animation and proceed frame-by-frame, and (3) adjust the frame-rate or speed of the animation (see Figure 1, page 82). Testing has shown that map-readers become frustrated with maps they cannot control (Monmonier and Gluck 1994, Koussoulakou and Kraak 1992). More complex solutions include the use of "decay" images where important features linger in the image. For example, a proportional symbol map showing earthquake events over the last 100 years may need to exaggerate the length of each earthquake event (let the symbol fade slowly). In other words, the event is not drawn to its correct temporal scale because a 2-minute event in a 100-year animation would be missed if not exaggerated in time. Temporal exaggeration is analogous to spatial exaggeration on static maps (e.g., exaggerated highway widths on road maps).

Figure 1 (see page 82)**:** Minimize the footprint of the interface and devote as much of your limited screen real estate to the map itself. Do not hide important interface controls (a common mistake) as most people will not try to find them, thinking, what they see is what they get. Standard VCR-style controls (stop, start, etc) are widely understood, and should normally be included since testing has shown users are frustrated by, and perform poorly with, maps they cannot control.

Challenge #2: Attention

The problem of where to look as the animation plays (i.e., attention) is a related to disappearance. I have seen that many map-readers who have limited experience with animated maps do not know *where to look* (a problem with the map) or *what to do* (a problem with the interface). All other things being equal, the less intrusive and demanding the interface, the more time the user can spend looking at the content.

"Sequencing" is one strategy that has proven successful with learning from animated maps (Slocum et al. 1990, Patton and Cammack 1996). By depicting the information in a logic and pre-defined sequence, the cartographer can increase the likelihood that the reader will notice important features or events in the animation. Voice-overs and sound prompts can also be effective in directing the readers' attention. Another strategy is to employ dynamic map symbols at critical moments. For example, flashing or moving symbols are more obvious and ascend the visual hierarchy. Monmonier (1992) was one of the early proponents this strategy. For example, in his Atlas Touring maps individual enumeration units and their corresponding bar chart graphic would blink for a few seconds to focus the users' attention (Figure 2, see page 82). Testing has shown, however, that excessive use of such "attention grabbing" symbols can be annoying and virtually impossible to ignore —hence the abundance of blinking symbols on Web advertisements! (Monmonier and Gluck 1994, Harrower et al. 2000).

Challenge #3: Complexity

Many animated maps try to do too much and end up saying very little. Burdening the user with more information than they can process in real-time undermines the map's design and may confuse or mislead the reader. Effective animated maps are often highly generalized so that only the most important trends or feature emerge. This may take the form of *data filtering* (e.g., presenting only a subset of the data), *data smoothing* (e.g., running average to reduce the variability), or *aggregating the data* into two or three classes. For example, consider using categorical data legends. A legend that depicts "High", "Medium", and "Low" is very easy to understand and colors for those classes should be easy to remember so that the user does not have to divide their attention between the map and the legend. The numerical details of those classes can be given later once the larger patterns have been noticed (e.g., by directly clicking on a symbol/color to retrieve specific rates).

Acevedo and Masuoka (1997) employed a highly simplified and highly interpolated representation of urban growth in Washington, DC (Figure 3, see page 83). Although this growth process is complex, their map is successful because the data are generalized, they used hundreds of individual frames so that the amount of change between frames is small, and the maps have been greatly smoothed. Their animated map consisted of only two classes—urban and non-urban—in order to more clearly show the rapid (and non-linear) urban growth rates of the last 200 years. No attempt is made to characterize differences within the urban class (e.g., retail, residential, industrial). By not depicting changes *within* the city, the reader is free to focus on the relationship *between* the city and the surrounding county and the shape of the urban expansion.

Letting users turn data on and off can help reduce information overload. Changing the tempo of the animation can also help by allowing users to slow down the map during complex periods of change, or speed it up to "blur-out" noise and insignificant events. Giving users the ability to change the tempo of an animation (i.e., change the temporal scale of the map) is analogous to zooming and panning on static maps (i.e., change the spatial scale of the map).

It is my contention that animated maps are better suited to depicting geographic *patterns* (and changes in those patterns) rather than specific *rates*. If retrieval of exact rates is important, provide the numbers (i.e., data) in some other form such as a spreadsheet. With interactive maps, there is no need to burden the reader with trying to rapidly extract specific rates from generalized symbols (a weakness of most thematic maps): have that information appear on demand, when it is needed. One of the cornerstones of today's geographic visualization systems is the use of multiple linked representations—such as a planmetric map, parallel coordinate plot, and 3D block diagram—that each cater to different knowledge construction tasks. Similarly, by using complementary data portrayals, such as histograms or charts that are labeled with the specific rates/values, we may be able to increase either the amount or kinds of information the user can process compared to a solo animated map.

Challenge #4: Confidence

Evidence exists that users, especially children, are less confident of the knowledge they acquire from animation than from static graphics (see Rieber and Parmley 1995, and Morrison 2000). Since people have far more experience visually interpreting static graphics than animated graphics, it is not surprising that without equivalent experience and training, people are less confident with animation.

A strategy that can increase user confidence is to provide a short (e.g., less than 30 seconds) guided introduction to the interface before showing the data, thus breaking the learning curve in two: first learn what the map can do (the tool), then apply that knowledge to learn about the map (the data). Since most animated maps are not meant to be full-fledged GIS viewers, they need significantly simpler interfaces that become transparent to the user as quickly as possible. Otherwise, the user may abandon the map because they become intimidated by the interface not because they were incapable of understanding the map.

In order to make it possible to add animation to a map and make it possible for a broad audience to successfully interpret the map, the basic cartography must become highly focused and quickly readable. While this is the same general guidance that would be given to mapmakers who want to convert a map that was originally intended for paper to be used on a computer screen, the degree that guidance must be followed is considerably higher for animated maps since both the computer medium (at 72-96 dpi) and the ever-changing images limit your design choices. For example, use larger text than you would on paper maps (at least 10 pt), brighter colors, thicker line weights, and less detailed base maps. What you loose due to the display limitations of the medium, you can make-up through interactivity, linked displays, live data delivery, and multimedia possibilities. Digital and Web cartography fail when we try to reproduce paper maps on-screen. New media demand new graphic techniques.

Thinking of the User: "Effort-to-Reward Ratio"

As a rule of thumb, strive to have the time it takes to learn how to use the map be less time than it takes to play the map. This is the *effort-to-reward ratio*: the designer's job is to maximize it. Tapping into existing popular interface metaphors (e.g., pull-down menus) and cartographic techniques (e.g., dark-equals-more color schemes) can accelerate the learning process. One of the best methods for improving your map is to formally test it with potential users (e.g., not other programmers, but members of your target audience). Watch them as they use your maps—often a humbling experience—and ask them questions about both the interface and the map. Discover what is causing them trouble, and never hesitate to incorporate their suggestions. I have come to appreciate how important testing is in the development cycle of dynamic maps.

Acknowledgements

I would like to thank Charlie Frye at ESRI and the director of the NACIS Student Web Mapping Contest for encouraging me to write this, for his skillful eye as an editor, and for helping to generate many of the ideas presented here.

References

Acevedo, W. and P. Masuoka (1997). Time-series animation techniques for visualizing urban growth. *Computers & Geosciences* 23(4): 423-436.

Campbell, C. S. and S. L. Egbert (1990). Animated cartography: Thirty years of scratching the surface. *Cartographica* 27(2): 24-46.

Harrower, M., A. M. MacEachren, and A. Griffin (2000). Developing a Geographic Visualization Tool to Support Earth Science Learning. *Cartography and Geographic Information Science* 27(4): 279-293.

Koussoulakou, A. and M.-J. Kraak (1992). Spatiotemporal maps and cartographic communication. *Cartographic Journal* 29(2): 101-108.

MacEachren, A. M. (1995). *How Maps Work: Representation, Visualization and Design*. New York: Guilford Press.

Monmonier, M. (1992). Authoring Graphics Scripts: Experiences and Principles. *Cartography and Geographic Information Systems* 19(4): 247-260.

Monmonier, M. and M. Gluck (1994). Focus groups for design improvement in dynamic cartography. *Cartography and Geographic Information Systems* 21(1): 37-47.

Morrison, J. B. (2000). *Does animation facilitate learning? An evaluation of the congruence and equivalence hypotheses*. Doctoral Dissertation, Department of Psychology, Stanford University. 161 pp.

Patton, D. K. and R. G. Cammack (1996). An examination of the effects of task type and map complexity on sequenced and static choropleth maps. In Wood and Keller (Eds.) *Cartographic Design: Theoretical and Practical Perspectives*. New York: John Wiley and Sons. p. 237-252.

Rieber, L. P. and M. W. Parmley (1995). To teach of not to teach? Comparing the use of computer-based simulations in deductive versus inductive approaches to learning with adults in science. *Journal of Educational Computing Research* 13: 359-374.

Slocum, T. A., S. H. Robeson, and S. L. Egbert (1990). Traditional versus sequenced choropleth maps: An experimental investigation. *Cartographica* 27(1): 67-88.

reviews

Erikson, Eskimos, and Columbus: Medieval European Knowledge of America.
By James Robert Enterline
Baltimore, Maryland: The Johns Hopkins University Press, 2002. xx, 342 pp., maps, illustrations, notes. $45.00 hardcover, ISBN 0-8018-6660-X.

Reviewed by Russell S. Kirby, University of Alabama at Birmingham

One of the first lectures I attended as a graduate student focusing in historical geography of North America in the mid-1970s was focused on the geographical myths and counterfactual scenarios related to the discovery and settlement of the North American continent. Although the work of James Robert Enterline did not figure in that lecture, his book, *Viking America* (1972) had only recently been published. The notion that Greenland settlers had traveled to the shores of North America, establishing and then abandoning permanent settlements several centuries before Columbus, was accepted as probable. However, no consideration was given to the possibility of a pre-Columbian exchange of cartographic knowledge and detail between the first Native Americans and European cartographers in the 13th to 15th centuries.

In *Erikson, Eskimos and Columbus*, Enterline puts forward a simple hypothesis—that detailed cartographic knowledge of portions of the western hemisphere was accurately transferred from the native peoples of the Arctic regions, via the Greenland settlements, to European mapmakers, several centuries before the fabled voyage of Columbus in 1492. The text is divided into two sections of unequal length. Following a lengthy introduction, Enterline discusses three "outstanding misunderstandings" in separate chapters. The first deals with the work of Claudius Clavus in the 1420s and 1430s, and a controversy, as described by Enterline, as to whether the work of Clavus was the first to show the general outline of Scandinavia. Enterline agrees with other cartographic historians that Clavus's work incorporates the earliest known graphical depiction of the outline of Greenland, but interprets what some have claimed to be representations of Scandinavia as boundaries of islands and physiographic features from several spatially discontinuous areas of Arctic North America, as passed down through rough sketches and oral tradition from contact between Greenland settlers and native peoples of the Arctic and Greenland.

The second "misunderstanding" focuses on the *Inventio Fortunatae*, a lost book thought to be written around 1363. On a map drawn in 1507-8 by Johann Ruysch, the cartographer attributes eighteen highly stylized islands around the North Pole to that source. Cartographic representations of these islands on this map were later incorporated into the work of others, and Enterline surmises that Clavus also incorporated these data into his maps. Enterline again makes the claim that these islands are representations of landforms from locations across the Arctic, the product of knowledge transfer through a pre-Columbian exchange of cartographic information.

And finally, the third of the "misunderstandings" concerns the much debated Yale Vinland Map (circa 1440). While for some the misunderstandings surrounding this map relate to its provenance, in the context of Enterline's discourse the central issue is how the cartographer who drew the Vinland Map knew the general outline of the island of Greenland if it had never before appeared on a medieval European map. In Enterline's view, allowing for some minor rearrangements of islands and other boundaries on the Vinland Map to place them in proper spatial alignment, the only plausible explanation for the curious cartographic misrepresentations he sees in the Vinland Map is a highly imperfect transfer of cartographic knowledge from the native peoples of the Arctic to the cartographic craftsman who ultimately drew the map without any first-hand knowledge of the lands he depicted.

The second section of Enterline's book provides a chronological survey of known maps, atlases, and globes pertinent to the subject of exploration, discovery, and cartography of the northern hemisphere and North America. This material is reviewed with careful consideration to Enterline's main hypothesis, and contains numerous reproductions of portions of maps, atlases, globes, and documents relevant to Enterline's arguments. Many of these illustrations are quite interesting in their own right and are further elucidated through brief discussions of the historical context of each illustration selected. Many of these documents are extremely rare, and it is helpful to see them integrated into the text. The book concludes with an appendix in which the author describes and comments on some of the experiments done to establish the authenticity of the Vinland Map, notes to the preceding chapters, and an index.

Few icons of American history are so sacred that the mere suggestion that they are wrong seems blasphemous. This is not to say that historical geographers and cartographers have not done their level best to reveal as myth a number of sacred "truths." But James Robert Enterline has chosen to tackle the notion that Columbus was the European discoverer of North America. True, Enterline goes to great lengths to preserve much of Columbus's presumed accomplishments, his thesis in *Erikson, Eskimos, and Columbus* is that considerable evidence of European cartographic foreknowledge of North America can be discerned in world maps from the 14th and 15th centuries, and that Columbus's voyage in 1492 was predicated on that knowledge.

Enterline arranges his argument in a crafty manner, first preparing readers for his thesis by describing the "hypothetico-deductive" scientific method he intends to employ as a basis for evaluating and interpreting the evidence and ultimately asserting his thesis to be true. This reviewer is also a practitioner of the scientific method, but generally we start with a null hypothesis, which is the antithesis of the research hypothesis, and seek to refute the null hypothesis in favor of the alternative. Enterline does not follow this approach, but rather works from every possible angle (sometimes literally) to find ways to support his thesis from the existing evidentiary base of maps and globes that survived from the medieval era to the present. This reviewer, while trained as a historical geographer, is not an expert on the history of European cartography from 1000 to 1500 A.D., and lacks the detailed knowledge of the subject matter necessary to fully evaluate Enterline's interpretations of each map, atlas, and globe. However, Enterline does not provide the reader with the reassurance that he has not selected only those documents supporting his argument, and ignored those that do not. In scientific terms, he may be guilty of "publication bias," that is, the publication only of positive findings.

Enterline's book presents an intriguing counterfactual hypothesis, marshalling evidence from rare, archival sources to support the view that the Atlantic Ocean into which Columbus sailed in 1492 was far from the unknown expanse of lore and fable. Though the writing style is tedious, the book makes for interesting reading. The volume is nicely formatted, well copyedited, with illustrations well reproduced (although in some instances the originals have the imperfections of the passing centuries). Although there are many endnotes, the author may again be guilty of selecting felicitously from the body of scholarly work. The gullible or less knowledgeable reader may be convinced by Enterline's arguments; however, it is likely that most cartographic historians may prefer that this book be forgotten by the scientific community, or used as an object lesson in how to misapply the scientific method in historiographic research. The best way, in the end, is for readers to form their own judgment, and that is another part of the scientific method to which this author subscribes.

Maps of **The Queens Jazz Trail, The Harlem Renaissance,** and **The East Village**. Published by Ephemera Press, Brooklyn, NY.

Reviewed by Matt Knutzen, New York Public Library

Ephemera Press, of Brooklyn, NY, has produced three touring maps related to the rich cultural landscape of New York City: The Queens Jazz Trail, The Harlem Renaissance, and The East Village. The following review provides description and analysis of these three titles.

The first, **The Queens Jazz Trail, A Full-Color Illustrated Map**, is in its second edition, with project direction by Marc H. Miller, illustration by Tony Millionaire, and design by Cindy Ho. Copyright by Flushing Town Hall, Flushing Council on Culture and the Arts, 1998. It is 21" x 17" unfolded and retails for $9.95. This map was produced as part of the Queens Jazz Trail guided tour of the borough, a program run by the Flushing Council on Culture and the Arts, Inc.

The front side is an illustrative handdrawn map "poster" depicing famous jazz artists and their homes in Queens while the back has a short essay about the importance of Queens as New York City jazz musician's borough of choice, an address listing of their residences, a short explanation of the Jazz Trail escorted tour and project acknowlegements.

At the very top (north) of the oblique perspective map is blue sky with puffy white clouds, under which sits the nonsubject area boroughs of Manhattan (at top left) and the Bronx (at top center), while Queens, the subject area, takes up the foreground and most of the remaining page. Manhattan and the Bronx appear in a cool lavender evoking mountains of steel and concrete. These are separated from the Queens side by the East River, which perhaps ironically appears in clean blue. The background coloring of Queens is depicted in a fresh shade of light green.

Crisscrossing the map is a network of major roads, highways, and expressways depicted in brick red. Small, tan banners adorn the various neighborhoods, parks, and cemeteries where famous jazz artists lived, performed, and are interred. Some of these have short explanatory text such as "St. Michael's Cemetery: Scott Joplin buried in a pauper's grave, 1917, marker placed, 1985" and "Jamaica: Site of the first jazz community in Queens. Clarence Williams and Eva Taylor, arrive in 1923..." while others simply designate neighborhoods, such as "Hollis." Depictions of apartment buildings, colleges, churches, and houses large and small appear in their approximate relative locations. Small green labels adorn each indicating their significance; e.g. "'Count' William Basie 174-27 Adelaide Rd." and "The Louis Armstrong Archives, Queens College, CUNY." Finally, small portrait vignettes of the jazz legends fill in the remaining space and are sized according to their relative importance.

The alphabetical address list on the back side supplies the reader with the essential information to lead them to the various homes and cemeteries of the musicians depicted and further provides a list of "Places of interest for jazz fans." The latter (mostly jazz concert halls) also includes telephone numbers. Also on the back side is a short history of the development of Queens as the place where it appears that most of New York City's jazz greats were born, raised, eventually settled, or died.

The Queens Jazz Trail map was designed specfically to accompany the guided tour organized by the Flushing Council on Culture and the Arts. While this author admittedtly has not taken the tour himself, it is clearly one that, for the jazz afficionado, would animate the lives of jazz legends, personalizing them in the context present-day Queens. The portraits and the small drawings of buildings give this map a very human touch while the texts, both on the map and on the reverse side are quite informative.

All of the visual elements that rest on top of the background of the map are clearly distinguished from one another in color, shape, size, and content. This diverse symbology and lucid categorization lends itself to a clearly defined visual hierarchy. The portraits, oval with blue outline borders and green backgrounds, rest like bubbles on the surface and are the most eye-catching elements of the design. The text banners used to indicate neighborhoods and buildings are slightly smaller and are behind the portraits but sit on top of roads and buildings. The buildings have no outlines and appear to sprout from the background of the map itself. The overall effect is an easily understood thematic map.

This map, while educational and interesting in its own right, is limited in its usability for the following reasons. The first is related to the nature of the place being mapped. Queens has a highly dense and complicated road infrastructure that is usually depicted on maps twice the size of the Queens Jazz Trail map. Therefore, in order to fit all of the pictorial elements onto this map, the mapmaker has greatly generalized the road network. Because of this, buildings depicted are in their general neighborhood. A reader not on the guided tour would most likely have a very difficult time finding Louis Armstrong's house at 34-56 107th Street knowing only that the nearest cross streets depicted on the map are Northern Boulevard and the Grand Central Parkway. This has limited the use of this map to participants on the guided tour, users who know Queens roads very well, or those who are carrying along a detailed street map of the borough.

These things aside, the Queens Jazz Trail map provides useful information for the jazz lover, historian, and geographer.

The next map is the **Harlem Renaissance Map Poster Guide: One Hundred Years of History, Art and Culture, an Illustrated map: of Homes of musicians, Artists & Writers, Civil Rights Sites and The Legendary Nightclubs**. In its second edition by Ephemera Press with project direction by Marc H. Miller, illustration by Tony Millionaire, and design by Kevin Hein. 2001. The map is 18" x 24" unfolded and retails for $9.95.

On the cover is a short history of the Harlem Renaissance, a walking tour map with 61 points of interest labelled as numbered circles and a corresponding numbered list explaining each stop along the tour. The numbered circles are coded red for existing sites and black for demolished buildings or sites. Some of the explanations are short and to the point, such as "#59, Apartment of Duke Ellington, 935 St Nicholas Ave. Jazz music's leading composer and bandleader, Ellington lived here from 1939 to 1961." Others, such as the Apollo Theater, are lengthier and include some history as well as contact information. These sites are listed in order of the route and fall under various subheadings within the tour, such as "Along 136th St" and "Hamilton Heights and Sugar Hill."

On the other side is a handdrawn pictorial map depicting important historical people and places of the era, including residences of important artists, civil rights figures, and musicians, as well as civil rights sites, night clubs, and art studios. On the right and bottom edges of the map is a small inset area depicting more people and places important to Manhattan's African American history that happen to fall either above 153rd Street or below 115th Street.

The map colors are warm earth tones with brown and orange as background and roads of pale yellow with red casings. Small green banner labels call out neighborhoods such as "Strivers Row" and "Jungle Alley" and white labels accompany small pictures of sites (almost always buildings) and historical figures. Often, the buildings are depicted with the relevant figures standing in front or dancing, as in the case with The Cotton Club, which depicts the club front signage with three dancing figures and the label "Cab Calloway, Ethel Waters and Bill 'Bojangles' Robinson" below. Other labels contain street addresses and appear where the points of interest are located; e.g. "Mt. Morris Fire Watchtower, 1855 Marcus Garvey Park, 122nd St. & Fifth Ave."

The Harlem Renaissance Map Poster Guide is a well organized tool for those interested in touring the sites of the era within present day Harlem. It provides basic information for a large number of sites. The cover, with its locator map and numbered list, allows users to simply either follow along the numbered sequence of points of interest or to create their own self-guided touring route. Thankfully, the author has called out demolished buildings and saved the user from occasional disappointment. The locator map is simple, clear, and very well labelled. For those readers who are visually inclined, there's the pictorial map. The well rendered pictures of people, buildings, and other sites help tie the history of the Harlem Renaissance into the landscape of Harlem, personalizing and humanizing the history and the geography of the area. This work is clearly the result of extensive research, planning, and execution of complex graphic and cartographic design. It will surely help to preserve the historical record for the rapidly changing landscape of Harlem.

The final map is **The East Village, New York City, A Map, guide and wall poster exploring the history of New York City's most creative neighborhood**. By Ephemera Press, text by Marc H. Miller, illustration by James Romberger and Marguerite Van Cook, and design by Kevin Hein. No year listed. The map is 18" x 24" unfolded and retails for $8.95.

The cover contains five distinct elements. The front cover depicts an old tenement in front of which are standing a charicature of the proto punk band The Velvet Underground with Nico. Above, the map title is stylized to appear as graffiti art evoking the rebellious, countercultural East Village. On the back is a brief overview of the significance of the area within the cultural history of New York City as well as an acknowledgment of more recent gentrification. This short text asks us to "Use it [the map] to resurrect the East Village's glorious and romantic past..." The next element is a short historical geography of the area outlining the movement of bohemian New York from its previous nerve center in Greenwich Village eastward to what has come to be known as the East Village. The rest of the page is devoted to an extensive walking tour outlined in a small map as well as a 68-point numbered point of interest list with significant explanatorry text, on average two or three lines of anecdotal information per site. For example, "#66, Nuyorican Poets Cafe, 236 East Third Street, The sucess of Miguel Pinero's play Short Eyes at the Public Theater..." As with the previous map, demolished sites (a dozen here) are called out (this time in red). The page is cast in cool blues and purples.

The poster map side has three separate sections. The first and largest is the main map. This area is bound on the west by Broadway, on the east by the East River, on the north by 14th Street, and south by Houston Street. On the right side of the page is an inset of St. Mark's Place, one of the larger concentrations of radical activity in the area; e.g. "Leon Trotsky works for Bolshevik newspaper (1917) 77 St. Mark's Place" and "Apartment of Abbie Hoffman, 30 St. Mark's Place." Appearing at the bottom of the map is a short timeline with a subtitle "New Clubs, Changing Sounds, 1950-1985," depicting bebop jazz artists of the '50s, psychedelics of the '60s, and progressing to punk in the '70s and '80s. The main map is adorned with drawings of significant cultural figures ranging from William Burroughs to Susan B. Anthony. Often depicted also are their homes, places of work, their galleries, studios, lounges, and murals.

This is a very useful map for those interested in the counterculture as it exists in the East Village. The simplified map provides an easy tour with readily accessable explanatory texts. The area covered is small enough that the user could randomly wander and still make use of it. The pictorial map, as with the other maps reviewed, provides a personal connection between the user and history and geography of the neighborhood. This is quite significant given the extent to which this neighborhood has changed, a fact evidenced by the 12 demolished structures in the self guided tour.

All three of Ephemera Press's maps represent a clearly significant contribution to the historic and geographic record of New York City. As noted above, this is particularly relevant given the rapid pace of change within that environment.

Spying With Maps: Surveillance Technologies and the Future of Privacy.

By Mark Monmonier
Chicago: University of Chicago Press 2002, 239 pages, $25.00 L17.50. ISBN 0-226-53427-8

Reviewed by Barbara P. Buttenfield (Professor), Vanessa Bauman and R.J. Kern (First Year Cartography Graduate Students), Geography Department, University of Colorado-Boulder.

In the current environment stressing homeland security, it is readily forgotten that the machines monitoring for safety are also monitoring daily activities. There exists a delicate balance between protection from crime or terrorism and protection of individual privacy in everyday life. In his newest book, Mark Monmonier makes an articulate and compelling argument for the importance of understanding how, when, and where surveillance technologies operate, from data collection through interpretation; and how their emerging importance to national defense may also infringe on confidentiality. Monmonier explores the power and control of geographic surveillance in an effort to understand the implications of geographic technology. In particular, he focuses attention upon surveillance with maps and locational information, as for example in mapping consumer behavior for marketing purposes, in mapping disease epidemics, in traffic surveillance, satellite data collection, and severe weather broadcasts. As with many of his books, his discussion is interleaved with anecdotes highlighting the development of cognate technologies and the social, economic, and legal consequences that these technologies introduce.

The book contains ten chapters, and an Epilogue arguing for locational privacy as a human right. Bibliographic citations are (unfortunately) embedded within an extensive endnotes section, making it nearly impossible to search for cognate literature. For the popular reader, though, the endnotes are isolated to preserve an otherwise highly readable writing style. The book is indexed by author and by subject. Chapters highlight diverse application domains such as urban traffic patterns, precision agriculture, weather reports, and so forth where surveillance technologies are utilized. In each chapter, he presents multiple perspectives on locational privacy issues, using real-world examples and compelling narrative. Anecdotal reference to his personal experience brings home the point that locational security affects each of us every day, albeit in an often oblique or even covert manner.

The first two chapters introduce surveillance cartography and answer popular questions about current spatial technologies. He gives an informative overview of basic GIS analysis methods, elaborating a short history on the evolution of remote sensing techniques and platforms. Simple explanations on these topics are supplemented by clear illustrations and provide a solid opening to the book. Ethical issues surrounding the implementation of locational surveillance systems are also addressed.

Subsequent chapters demonstrate how integrated spatial technologies support surveillance in a wide range of common domains. Monmonier describes examples of this technology improving land and hazard management systems, monitoring world agricultural production, managing wildfires, and creating intelligent traffic signals. He imagines a society where rental car companies use satellites to track and fine unsuspecting customers for speeding, and then reminds us this is an attainable reality, cautioning the reader that the "… added cost of the automotive utopia is the privacy lost when computers know who we are and where we've been" (p. 107). GIS management systems for public health and threats of bioterrorism open scenarios that look seriously at the effectiveness of applying spatial technology to the development of disease prevention strategies. In each case the advantages to exploiting locational data are highlighted, but there sincere warnings are also attached.

The reader will learn about the distribution of junk mail in a section on geocoding and "dataveillance," which is characteristic of Monmonier's lighter side. He sheds light on the potential power of geographic voyeurism, where the perceived risk of panoptic surveillance deters street crimes and acts of terrorism alike. In most chapters, he argues the double-edged sword: greater public security and safety carries with it the potential loss of personal privacy, for example offering tongue-in-cheek description of how direct mail advertisers and telemarketers exploit knowledge of where we live to know what we might be willing buy. In another chapter, he notes that surveillance technology can act both as a digital leash and a scarlet letter for sex-offenders, parolees, or spouse abusers.

With this idea in mind, the Epilogue discusses locational privacy as a basic human right. Industrial lobbyists and civil libertarians continue to debate about appropriate uses of surveillance technologies. Opinions differ on what constitutes appropriate regulation where issues of privacy and confidentiality are concerned. It does not appear to be the author's intent to frighten readers when he brings negative aspects of cartographic surveillance to light.

Monmonier maintains a positive tone throughout the book, but also encourages the reader to think about this open controversy and what it could mean for the future of surveillance technology and public privacy. At the end, and throughout the book, Monmonier provokes us (p. 175): "Imagine what Orwell could have done had he foreseen GPS?"

Spying with Maps is a reference volume to be enjoyed equally at the scholarly desktop or at home in front of the fire, with a glass of good red wine. Filled with in-depth content and interesting debate, it is nonetheless an easy book to read. His citations are extensive, although hard to find. More often than not, we reached the end of a chapter without once looking at the endnotes section. This meant we missed a lot of material, since the endnotes make up over 20% of the book volume (50 pages). Figures and diagrams are lucid and spare, comprised mostly of schematics, line drawings, and maps.

We hoped for a more detailed speculative look into the future and a vision where an ethical balance could exist between privacy, safety, and security. What would it take to defend privacy on a global scale? An elaboration of potential political issues of geographic surveillance would shed more light on future consequences. A greater discussion on ethical ambiguities and ramifications would have consolidated chapter endings. Additionally, Monmonier's window of analysis considers only technologically advanced countries. He neglects to address issues of geographic surveillance in places that lack capability to photograph traffic violators with red light cameras, for example.

Monmonier teaches real-world geography lessons about the ability of maps to "know," and often, maps can "know" more effectively than we realize. He is careful to avoid hyperbole and often softens otherwise alarmist viewpoints with humor and grace, but hints nonetheless of the potentially chilling effects of surveillance that are embedded within cartographic and remote sensing practice. One of the strongest points in the book is the implicit demonstration of the increasingly interdisciplinary nature of cartography, giving the book added value as a snapshot in the history of modern cartography (one of Monmonier's areas of academic expertise). Another strength is that the writing style maintains accessibility for a general readership without sacrificing academic interest.

Would the book prove useful for a graduate seminar? Absolutely. In fact, one of us accepted the invitation to review the book as an opportunity to carry on a virtual seminar this spring for two graduate students who could not attend weekly meetings of the departmental graduate reading group. It's fair to say that the three of us could have used a lot more face-to-face discussion, but schedules didn't match up; the book, however, kept us intrigued and collaborating (if asynchronously) for several weeks. We recommend it to mapping science and GIS professionals, to scientists working in any area cognate to public policy, to everyone whose work involves creation or use of representations of spatial information. We also recommend the book to lay readers interested in issues of public and community safety, as well as those concerned about current and future threats of an intrusive Big Brother.

Color Figures

Moving the *Atlas of Saskatchewan* from a Hardcopy (Millenium Edition) to a Multi-Media (CD-ROM Edition) Platform

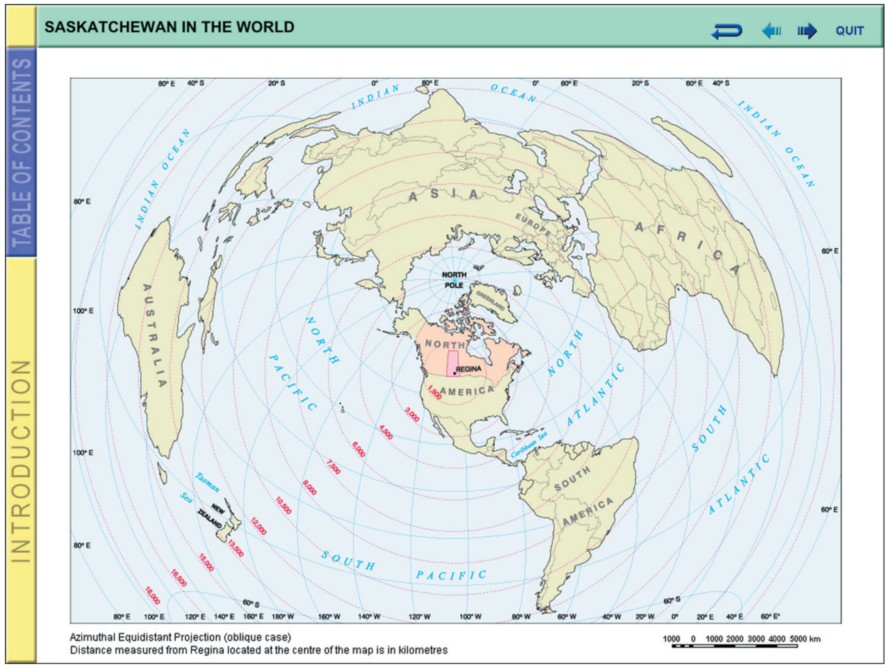


Figure 2. Basic layout showing "Table of Contents" bar to the left and "history" arrows to the upper right.

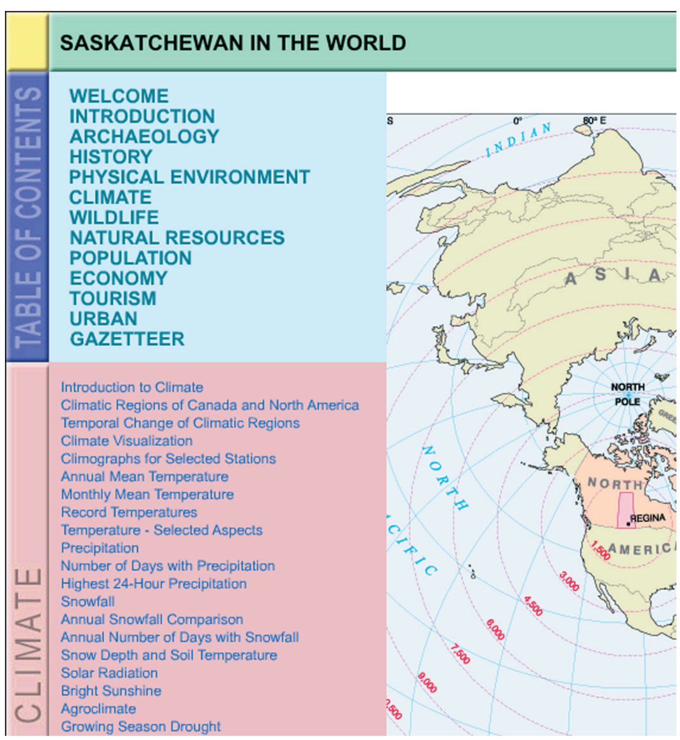


Figure 3. Table of Contents roll-out for the climate section viewed from the introductory page shown in Figure 2.

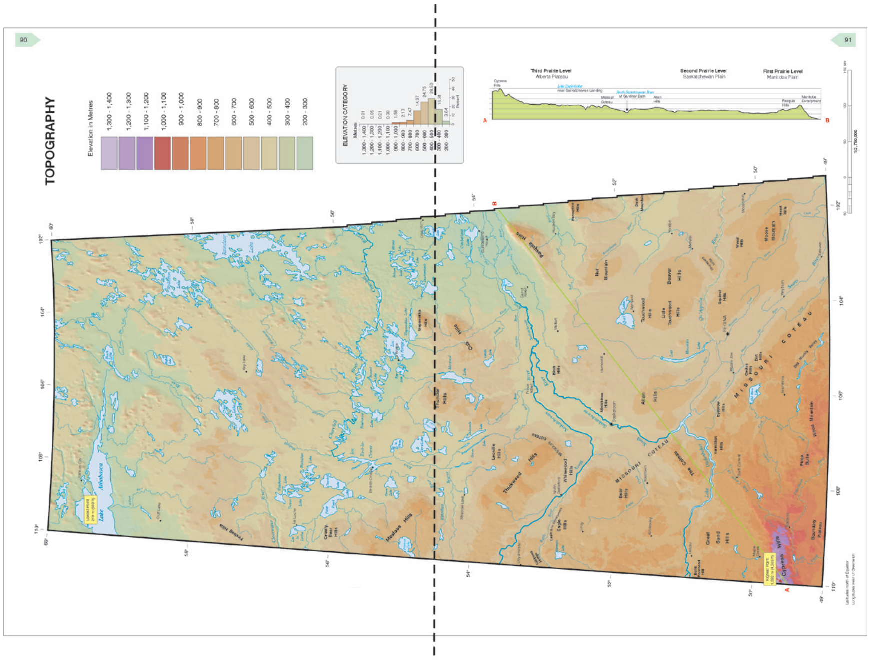


Figure 4. A two-page plate layout of the main topography map from the hard-copy Atlas of Saskatchewan (Millennium Edition).

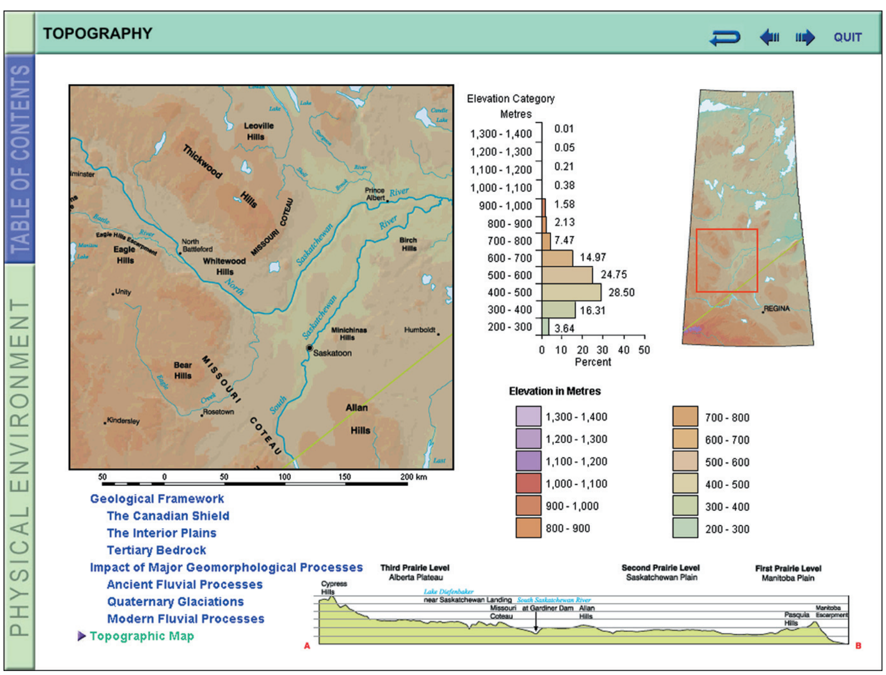


Figure 5. The topographic view from the Atlas of Saskatchewan (CD-ROM Edition). *An index map to the right of the view has a smaller "pan" window which can be moved by the mouse. A larger "scan" display to the left of the view shows an enlarged view from the smaller "pan" window.*

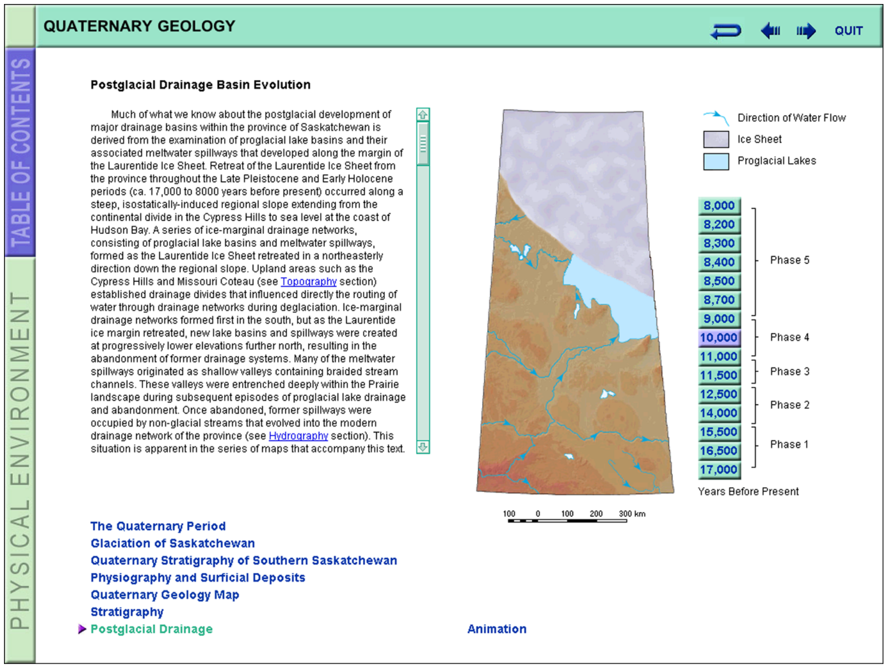


Figure 6. An animation to the right of the screen showing the retreat of glacial ice. The user can also interact with the map by selecting specific times on the scale next to the map.

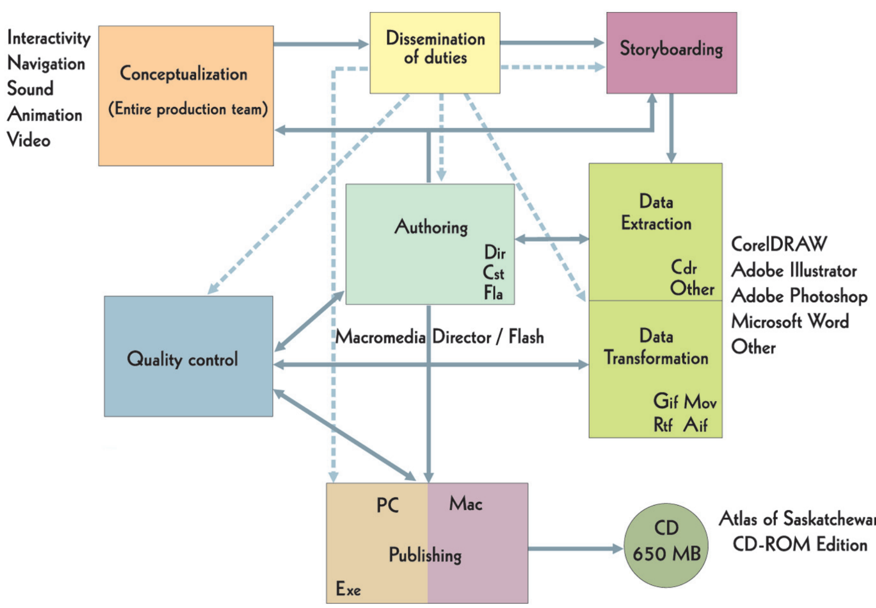


Figure 7. Stages in the production of the Atlas of Saskatchewan (CD-ROM Edition). *(Source: Martz et al., 2001)*

State Atlas Design

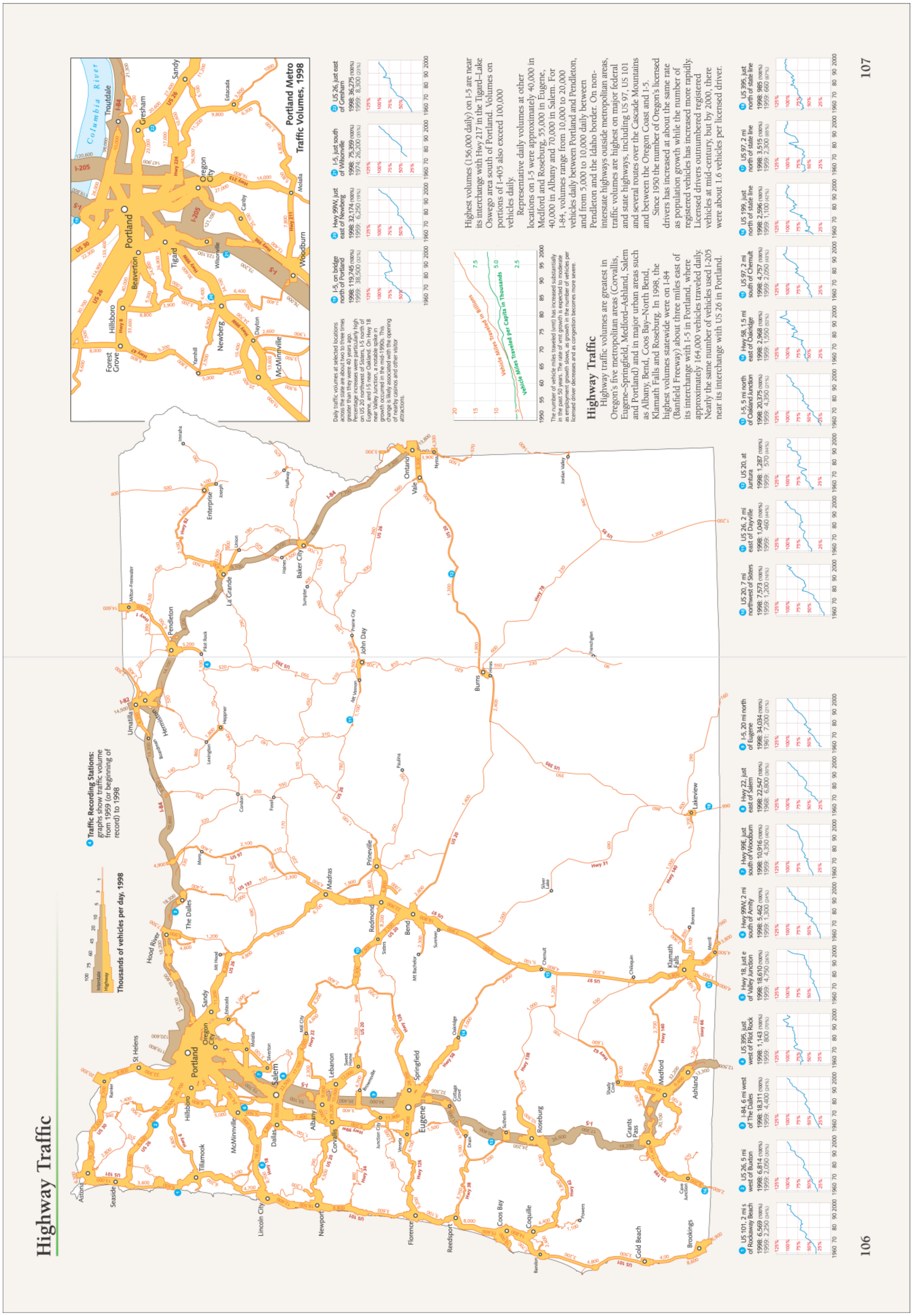


Figure 1. Highway Traffic page pair.

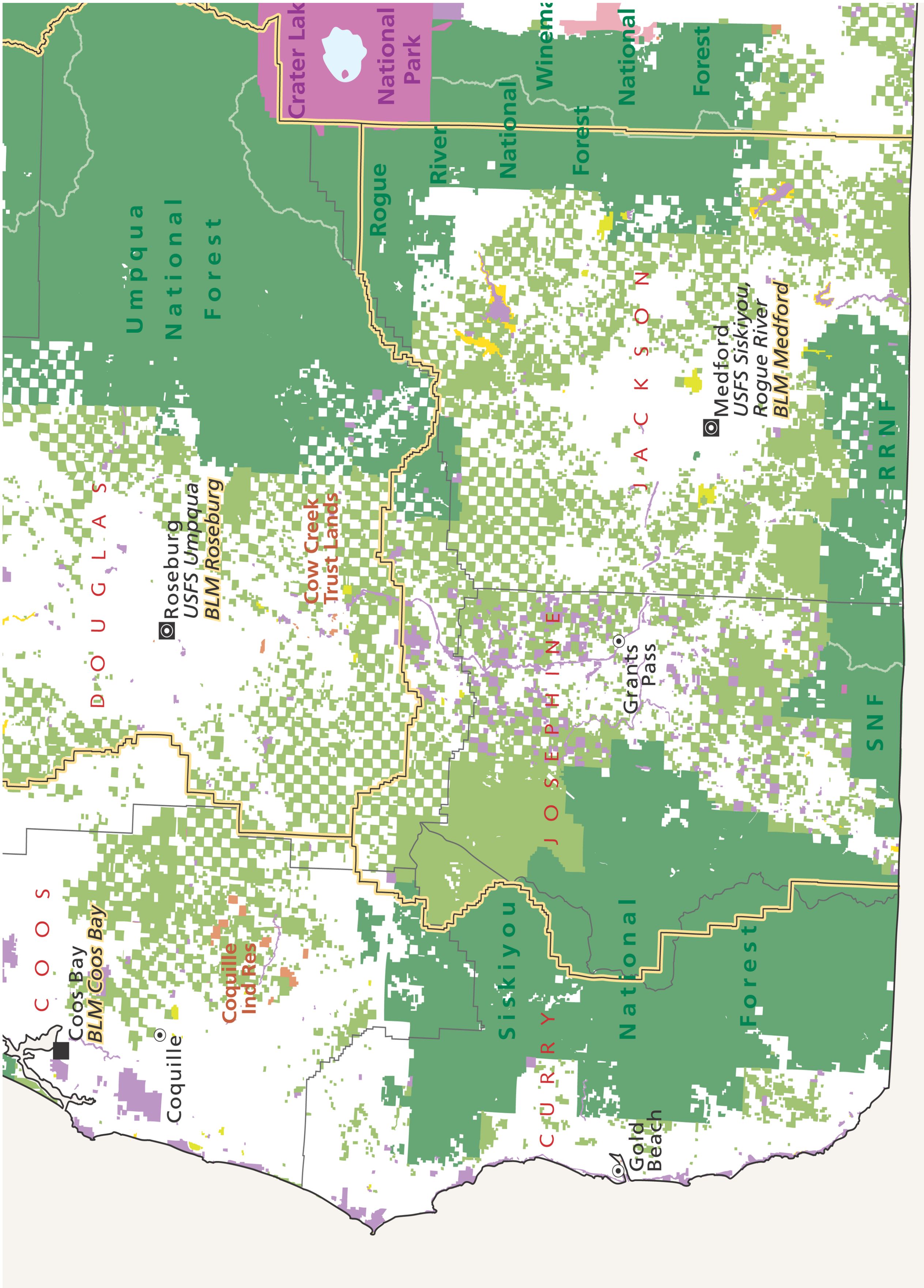


Figure 2. Land Ownership: detail example.

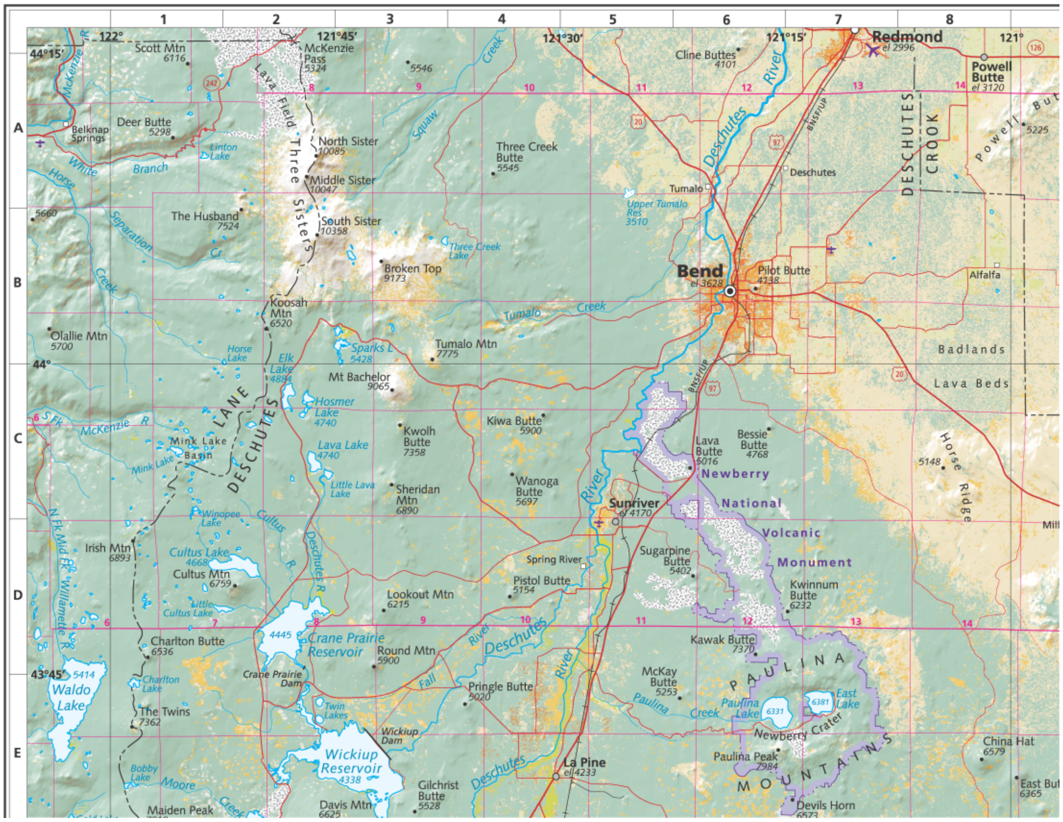


Figure 3. Reference Map Series example (scale 1:500,000).

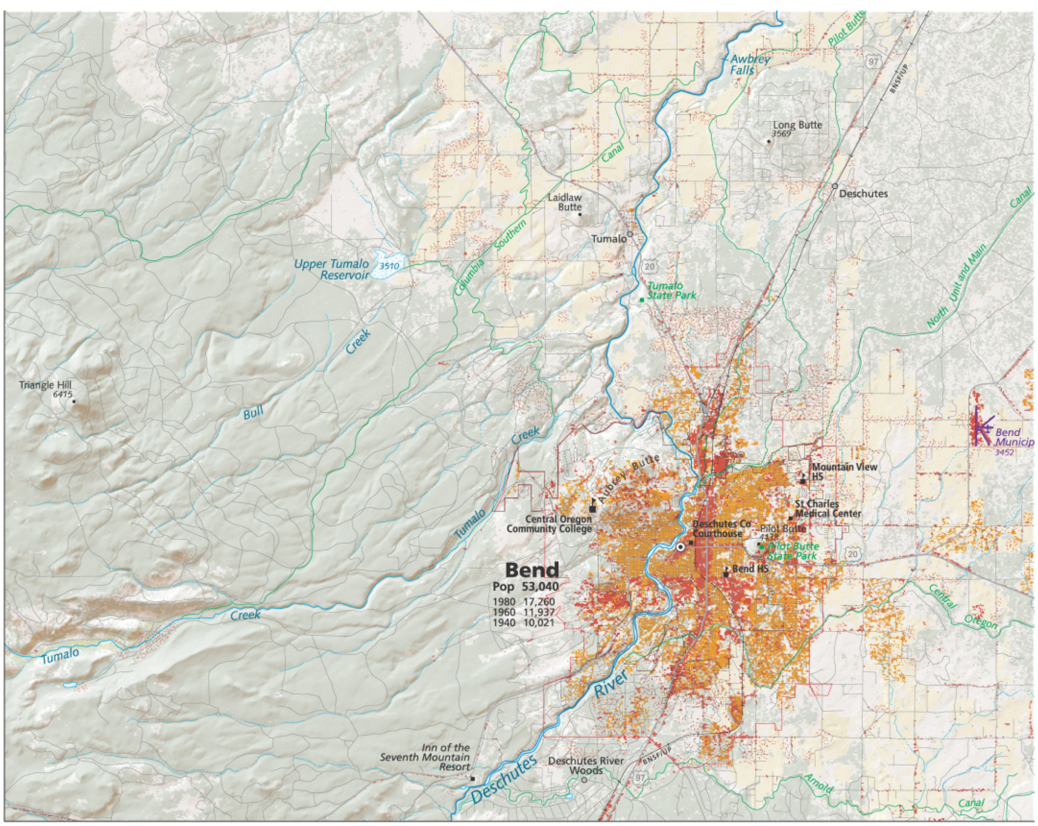


Figure 4. Urban Center map series example (scale 1:150,000).

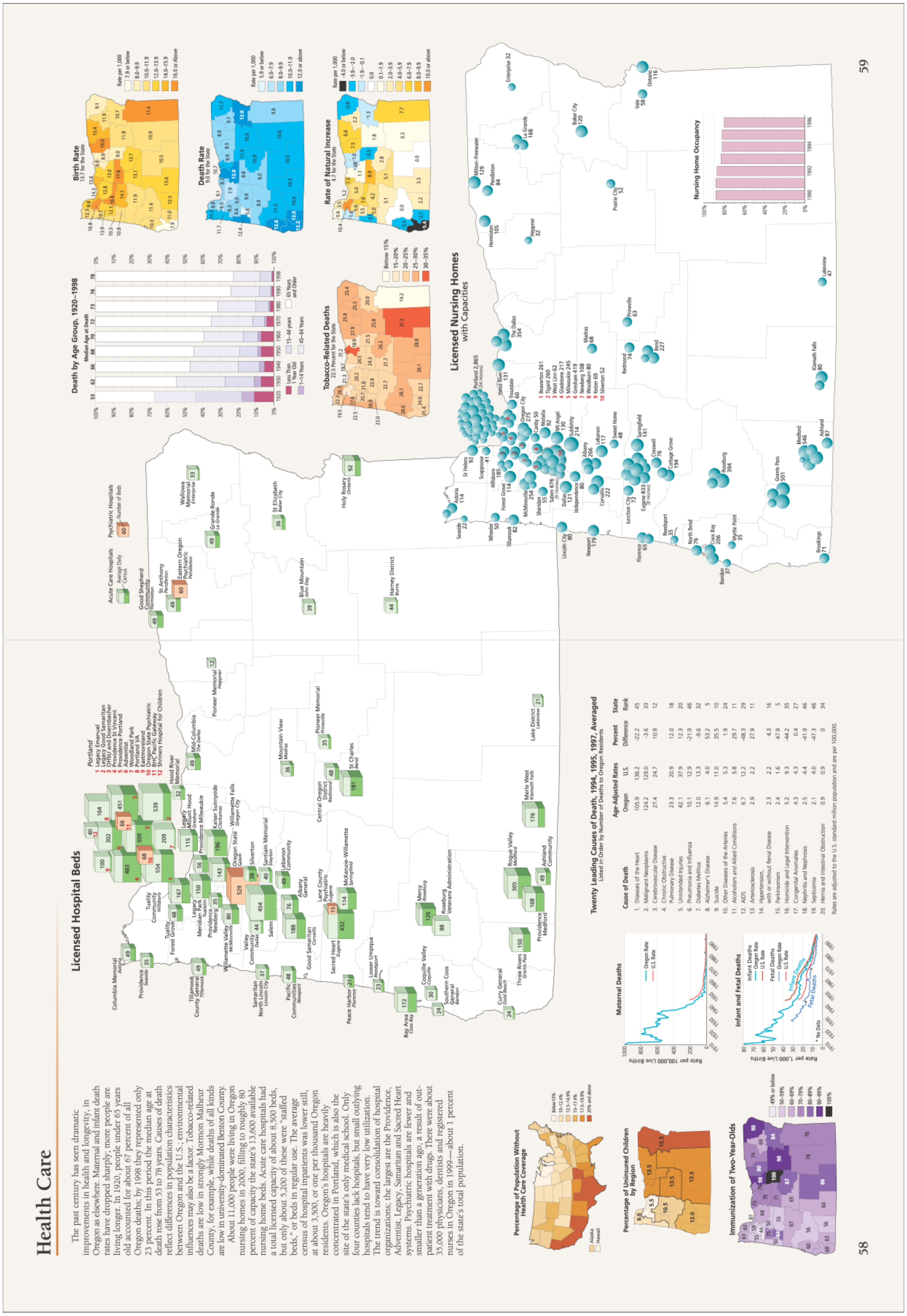
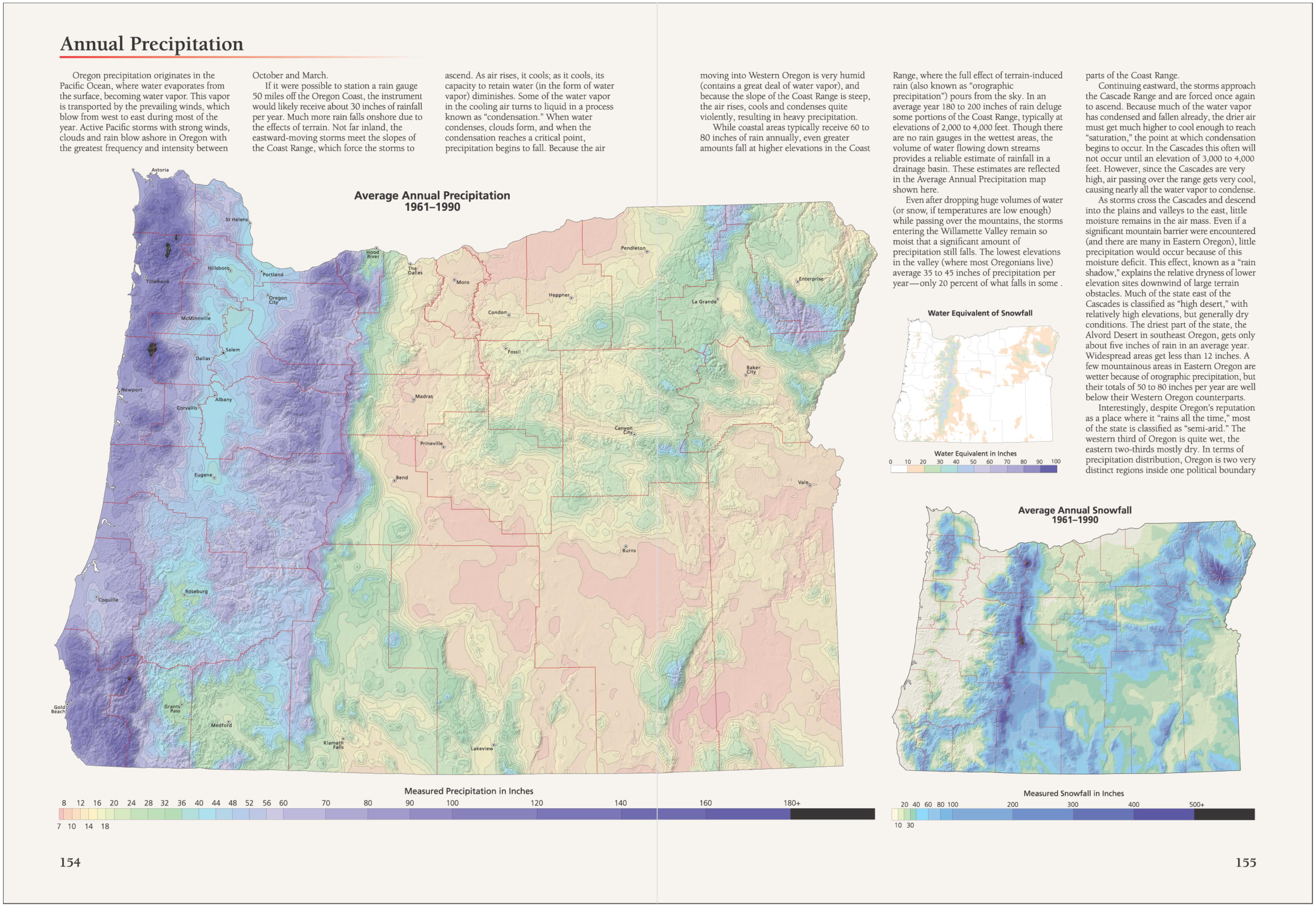


Figure 5. Health Care page pair.



Annual Precipitation

Oregon precipitation originates in the Pacific Ocean, where water evaporates from the surface, becoming water vapor. This vapor is transported by the prevailing winds, which blow from west to east during most of the year. Active Pacific storms with strong winds, clouds and rain blow ashore in Oregon with the greatest frequency and intensity between October and March.

If it were possible to station a rain gauge 50 miles off the Oregon Coast, the instrument would likely receive about 30 inches of rainfall per year. Much more rain falls onshore due to the effects of terrain. Not far inland, the eastward-moving storms meet the slopes of the Coast Range, which force the storms to ascend. As air rises, it cools; as it cools, its capacity to retain water (in the form of water vapor) diminishes. Some of the water vapor in the cooling air turns to liquid in a process known as "condensation." When water condenses, clouds form, and when the condensation reaches a critical point, precipitation begins to fall. Because the air moving into Western Oregon is very humid (contains a great deal of water vapor), and because the slope of the Coast Range is steep, the air rises, cools and condenses quite violently, resulting in heavy precipitation.

While coastal areas typically receive 60 to 80 inches of rain annually, even greater amounts fall at higher elevations in the Coast Range, where the full effect of terrain-induced rain (also known as "orographic precipitation") pours from the sky. In an average year 180 to 200 inches of rain deluge some portions of the Coast Range, typically at elevations of 2,000 to 4,000 feet. Though there are no rain gauges in the wettest areas, the volume of water flowing down streams provides a reliable estimate of rainfall in a drainage basin. These estimates are reflected in the Average Annual Precipitation map shown here.

Even after dropping huge volumes of water (or snow, if temperatures are low enough) while passing over the mountains, the storms entering the Willamette Valley remain so moist that a significant amount of precipitation still falls. The lowest elevations in the valley (where most Oregonians live) average 35 to 45 inches of precipitation per year—only 20 percent of what falls in some parts of the Coast Range.

Continuing eastward, the storms approach the Cascade Range and are forced once again to ascend. Because much of the water vapor has condensed and fallen already, the drier air must get much higher to cool enough to reach "saturation," the point at which condensation begins to occur. In the Cascades this often will not occur until an elevation of 3,000 to 4,000 feet. However, since the Cascades are very high, air passing over the range gets very cool, causing nearly all the water vapor to condense.

As storms cross the Cascades and descend into the plains and valleys to the east, little moisture remains in the air mass. Even if a significant mountain barrier were encountered (and there are many in Eastern Oregon), little precipitation would occur because of this moisture deficit. This effect, known as a "rain shadow," explains the relative dryness of lower elevation sites downwind of large terrain obstacles. Much of the state east of the Cascades is classified as "high desert," with relatively high elevations, but generally dry conditions. The driest part of the state, the Alvord Desert in southeast Oregon, gets only about five inches of rain in an average year. Widespread areas get less than 12 inches. A few mountainous areas in Eastern Oregon are wetter because of orographic precipitation, but their totals of 50 to 80 inches per year are well below their Western Oregon counterparts.

Interestingly, despite Oregon's reputation as a place where it "rains all the time," most of the state is classified as "semi-arid." The western third of Oregon is quite wet, the eastern two-thirds mostly dry. In terms of precipitation distribution, Oregon is two very distinct regions inside one political boundary

Figure 6. Annual Precipitation page pair.

Tips for Designing Effective Animated Maps

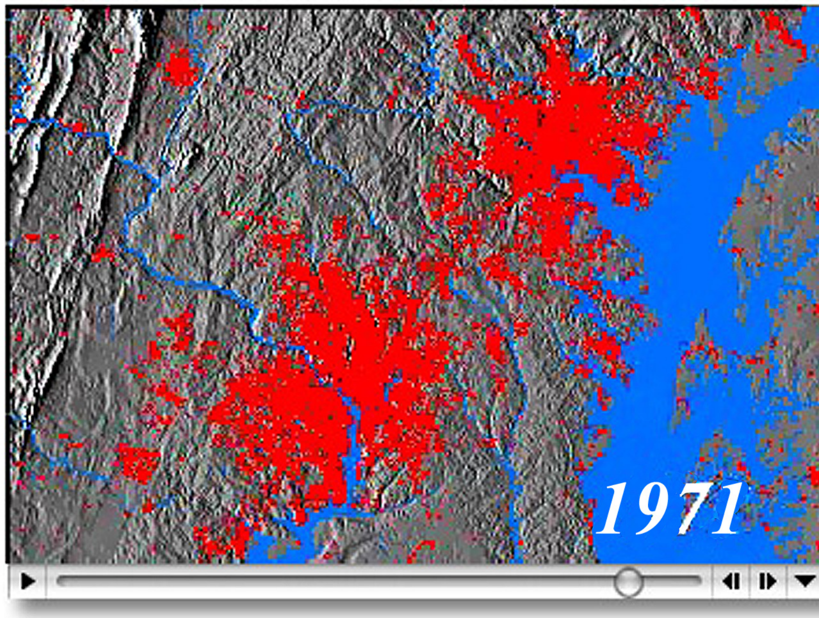


Figure 1.

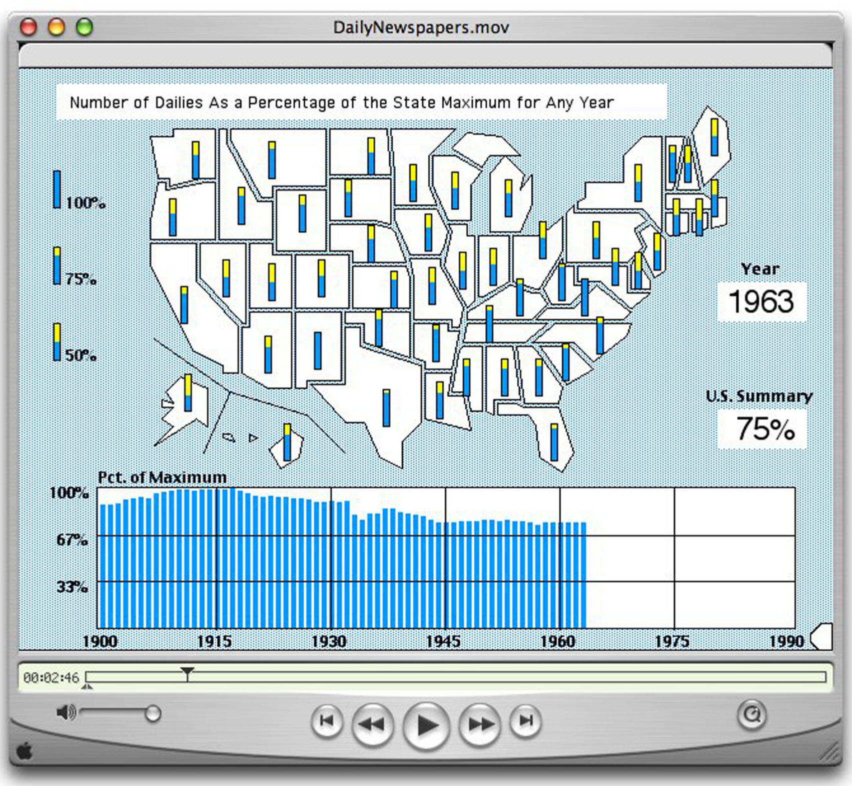
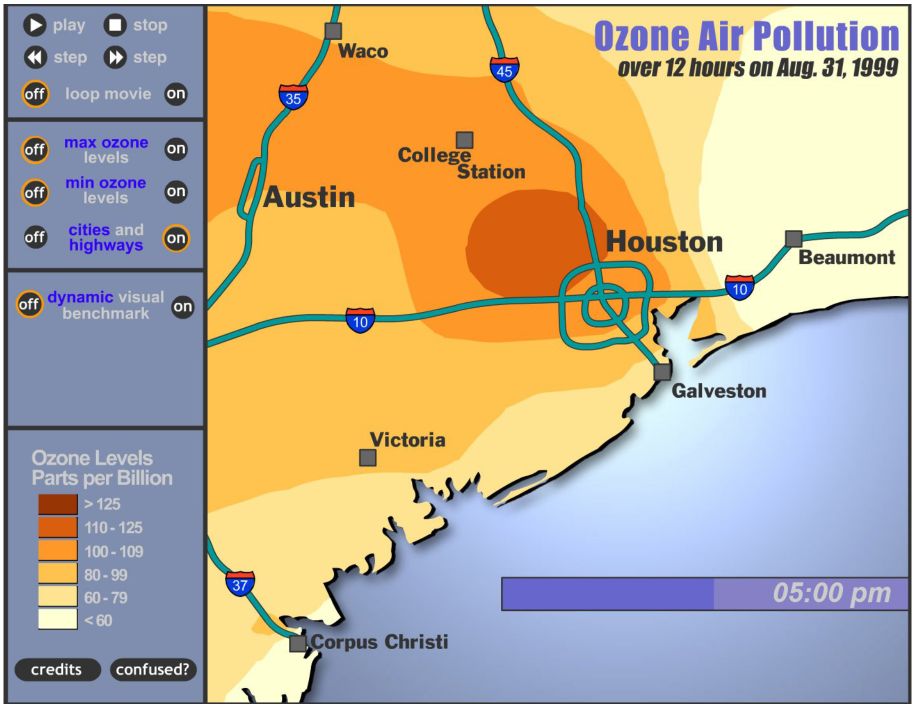


Figure 2.



Ozone Air Pollution
over 12 hours on Aug. 31, 1999
play
stop
step
step
off
loop movie
on
off
max ozone levels
on
off
min ozone levels
on
off
cities and highways
on
off
dynamic visual benchmark
on
Ozone Levels
Parts per Billion
> 125
110 - 125
100 - 109
80 - 99
60 - 79
< 60
credits
confused?
Waco
College Station
Austin
Houston
Beaumont
Galveston
Victoria
Corpus Christi
35
45
10
10
10
37
05:00 pm

Figure 3.