Toward a Web-based Multimedia Atlas of British Columbia

by

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ABSTRACT

With rapid development and growth of the Internet and the World Wide Web (WWW), atlases are experiencing a paradigm-shift from traditional paper publications to contemporary Web adaptations. The Internet, by its very nature, presents the user with access to various forms of multimedia (photos, videos, animation, and sound). For atlas design, integration of new technologies introduces innovative possibilities for accessing, visualizing, interacting with, and using spatial information. More than a collection of maps, the key function of the multimedia atlas is to engage the user by providing a variety of multimedia components in a setting that encourages exploration and learning. Macromedia Flash has been selected as the technological solution for a new Atlas of British Columbia. A vector-based program, Flash offers interactive and animated capabilities with small file sizes. This thesis describes the development of a Web-based atlas shell and the integration of three themes to demonstrate the effectiveness of the design strategy and various multimedia features.

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LIST OF ACRONYMS

ASCII	American Standard Code for Information Interchange
ADSL	Asymmetric Digital Subscriber Line
AIS	Atlas Information System
ArcIMS	Arc Internet Map Server (ESRI)
BMGS	Base Mapping and Geomatic Services
CAD	Computer Aided Drawing
CD	Compact Disk
CD-ROM	Compact Disc Read-Once-Memory
CGI	Common Gateway Interface
CRD	Capital Regional District
CSS	Cascading Style Sheets
DHTML	Dynamic HyperText Mark-up Language
DLI	Data Liberation Initiative
DSL	Digital Subscriber Line
DXF	Drawing Exchange File
DWG	Drawing File
E00	ArcInfo Interchange File Format
ESRI	Environmental Systems Research Institute
FLA	Macromedia Flash source file
GIF	Graphics Interchange Format
GIS	Geographic Information System
GML	Geography Mark-up Language

GUI	Graphical User Interface
HTML	HyperText Mark-up Language
HTTP	HyperText Transfer Protocol
JPEG	Joint Photographic Experts Group
LHA	Local Health Area
NAISMap	National Atlas Information Service (Software)
MPEG	Moving Picture Experts Group
OGC	OpenGIS Consortium
PDA	Personal Digital Assistant
PDF	Portable Document File
SHP	ArcView Shapefile (ESRI)
SMR	Standardized Morality Ratio
SSHRC	Social Sciences and Humanities Research Council of Canada
SVG	Scalable Vector Graphics
SWF	Shockwave Flash
URL	Universal Resource Locator
UTM	Universal Transverse Mercator
VRML	Virtual Reality Modeling Language
WWW	World Wide Web
WYSIWYG	What You See Is What You Get
W3C	World Wide Web Consortium
XHTML	eXtensional HyperText Markup Language
XML	eXtensional Mark-up Language

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DEDICATION

To my grandmother, Marie O'Mara.

CHAPTER 1: INTRODUCTION

1.1 General Introduction

This thesis concerns design and production of an atlas initiative for the province of British Columbia. It focuses on recent advances in Web cartography, in particular, development and integration of various media (text, graphs, images and sound) into an atlas, hereafter referred to as "multimedia" atlas. The following pages present the theoretical issues and design parameters of this project, along with a contemporary technological solution.

In the recent past, technological advances in computer hardware and software have revolutionized map production dramatically. With rapid development and growth of the Internet and the World Wide Web (WWW), a new trend has emerged within the field of cartography – Web-based mapping. "More than any other technological development in the past century, the Web forces us to examine the purpose of cartography and our means of map production" (Peterson, 1999: 571). This new medium brings innovative design features that allow the user access to a more interactive and dynamic environment. For atlas design, integration of new technologies introduces new possibilities for accessing, visualizing, interacting with, and using spatial information.

The paradigm shift from traditional paper atlases to mobile electronic versions (CD-ROMs) and toward Web-based adaptations has provided the user with the potential for greater control over what information is displayed (data selection) and how it is presented (changing colours, scale, orientation, etc.). In addition, an individual now can access a host of multimedia products, such as sounds, images, videos, and animations.

"Multimedia mapping products can be dynamic, interactive, associatively accessed, modifiable and functional products that use a synthesis of audio and visual media for cartographic representation" (Miller, 1999: 52). More than a collection of maps, the key function of the multimedia atlas is to engage the user by providing a variety of multimedia components in a setting that encourages exploration and learning.

Most countries have published national atlases, but only a few have made the transition to the Web; of these, early innovators are Canada, the United States, and Switzerland (Kraak, 2001). Within Canada, several provincial atlases are available on CD-ROM, such as the *Atlas of Saskatchewan* and the *Atlas of Québec*; but to date, no significant movement has been made towards Web adaptations, except at the federal level (*National Atlas of Canada 6th edition*). The *Atlas of Québec* has initiated an online version, but it is in the early stages of development – the atlas shell has been designed, but most of the themes (such as population and history) have little or no data.

In British Columbia, the last provincial atlas produced was the 1979 *Atlas of British Columbia: People, Environment and Resource Use*. Since this publication is twenty-five years old, "a new atlas for BC, telling a comprehensive story of the province's geography and its people through maps, words and multimedia is long overdue" (Keller, 2001: 25).

1.2 Research Objectives

The ultimate aim of this research is to design a Web-based shell that would facilitate the development of a multimedia atlas for British Columbia. Atlas compilation, design, and production have been (and will continue to be) a labour-intensive task involving years of work by numerous researchers and cartographers. As such, administrative issues, including editorial organization, funds acquisition, and atlas distribution, will not be addresses in this thesis. This research is not intended to produce a comprehensive atlas of British Columbia, but to provide a design blueprint and an initial starting point that can be built upon and continued by others. The atlas, as discussed by Monmonier (1981:209), is "the epitome of geographic knowledge, and all active geographers should view themselves as potential atlas authors or contributors". Hence, the Geography Departments in British Columbia and especially at the University of Victoria's Geography community are invited to continue the work initiated here to create a more comprehensive 'story' of British Columbia.

Secondary to this objective is the integration of three themes into this generic atlas shell to demonstrate the effectiveness of the design strategy and various multimedia features. Theses themes, chosen for their diversity, are:

- Historical – 18^{th} century European exploration of the Pacific Northwest;
- Earth Science – retreat of the last ice sheet in British Columbia; and
- Socio-economic – pneumonia/influenza mortality rates from 1989 to 2002.

1.3 Thesis Organization

Following this introductory chapter, the remainder of this thesis is divided into six chapters. Chapter Two provides a conceptual background by reviewing the literature on atlas design. It explores the progression of atlases from traditional paper publications to contemporary Web adaptations; discusses advantages and limitations of working within the WWW medium; and introduces the concept of a multimedia atlas information system. Chapter Three examines alternative contemporary technological solutions for multimedia atlases. In addition to a review of commercial Web mapping products and mark-up programming languages, this chapter will evaluate and discuss existing atlases on the Web. Chapter Four establishes design options and specifications for the atlas of British Columbia; presenting and justifying the chosen methodology. Chapter Five reports on the development of the atlas shell. Chapter Six details the integration of the three themes into the atlas shell and discusses the various multimedia applications used. Chapter Seven summarizes the thesis and outlines future research and/or further development.

CHAPTER 2: CONCEPTUAL BACKGROUND

2.1 INTRODUCTION

Atlases occupy a unique niche in society. Used professionally as a tool for research, education, and decision-making, and used recreationally for armchair exploration, "the atlas forms the basis for how people conceive the world in which they live" (Cartwright and Peterson, 1999:2). Defined by Kraak and Ormeling (1996: 183) as "intentional combinations of maps, structured in such a way that given objectives are reached", atlases are one of the most widely known cartographic products. Borchert (1999) speculates that nearly every household in the developed world owns a world, school, or road atlas. Atlases are used to locate geographic phenomenon or to discern geospatial patterns related to the physical or socio-economic environment of a specific region (Kraak, 2001). To assist users in understanding geographic themes, atlases can be supplemented with additional visualization tools, such as graphs, diagrams, tables, sketches, air photos, satellite images, and photographs (Mersey, 1996).

This chapter explores the progression of atlases from conventional paper publications to contemporary Web adaptations; discusses advantages and limitations of working within the WWW medium; and introduces the concept of a multimedia atlas information system.

2.2 The Traditional Atlas

2.2.1 Introduction

With the publication of the first atlas, in 1570, Abraham Ortelius revolutionized the way people viewed the world. In a single volume, Ortelius had compiled the known world into a series of conveniently sized, uniform maps. Heralded as a "complete success, commercially and otherwise", by 1598, twenty-eight editions of the atlas had been published in a variety of languages (Brown, 1954:163). From this auspicious beginning, atlas production advanced and flourished, becoming an object of public interest and curiosity, and in future years, an important specialty within cartography.

The early atlases were concerned primarily with the spatial patterns of the known world by showing the distribution of selected physical and political features, such as countries, cities, ports, oceans, rivers, lakes, and mountains. Today, one can distinguish among many different atlases: for example, reference, school, topographic, national, and thematic atlases (Kraak, 2001).

2.2.2 National and Regional Atlases

National and regional atlases have common origins, but as Nicholson (1970:128) points out, "true regional atlases are not usually national atlases in miniature". A national atlas serves two important functions: It provides a coherent summary of a country's physical and human geography and, more importantly, it represents a symbol of national unity or national pride (Monmonier, 1994). Regional atlases, by their nature, cover smaller political units, but often have the same broad goals as their national counterparts – albeit, they emphasize pedagogical use rather than research (Nicholson, 1970).

The question beckons whether a province, such as British Columbia, is more akin to a nation or a region. The difficulty with the term region is that it can be defined in a multitude of ways, across a continuum of scale; from small, discrete areas with distinct (physical or cultural) characteristics, such as the Okanagan Valley, to vast territories that cross national/international borders, such as the Appalachian Mountains. If, as Monmonier (1994) suggests, a nation is characterized by its history, culture, and intense nationalism, then each of the provincial 'regions' can be considered nations. In this respect, the unique physical and human geography of British Columbia dramatically define it as a nation: from the rugged and diverse physiography – culminated with the Pacific coastline, which shapes the western edge, and the Rocky Mountains, which forms the eastern boundary – to the populace's general sense of being separate and distinct from the rest of the country (Wood, 2001).

The first recognized 'modern' national atlas, the *Atlas of Finland*, was published in 1899. A departure from previously produced atlases, it "presented in a very concise, economical and clear manner a tremendous variety of information on the physical environment, population and economy of the entire country" (Fremlin and Sebert, 1972:5). Fifty-seven years later, Professor K.A. Salichtchev (an Honorary Fellow of the International Cartographic Association) set up an International Commission on National Atlases to examine national atlases in existence and make production (non-technical) and improvement recommendations, and establish a standardization of design and content to aid in comparability (Ormeling Sr., 1979). Salichtchev's recommendations (Fremlin and Sebert, 1972:31) included:

- *Separation of content into five structured divisions, physical geography, population, economy, cultural, and political and administrative structure, usually with an introductory section preceding the content specifications.*
- *Methods of representing phenomena with different types of distribution: at points, along lines, in discrete areas, sparse and continuous across area.*
- *Use of a simple, rounded [standardized] scale of 1:1,000,000, by which all other scales can be related (doubling or halving). An ideal format should be 40-50 cm by 60-70 cm when opened.*
- *A single projection for all maps should be used, with a fundamental aim to restrict distortions; for the world's largest countries, recommendations are made on the appropriate projection to be used. For example, the equidistant right conic projection is suggested for Canada.*
- *Graticules should appear (but not emphasized) on all maps, except in "map-diagrams", choropleths, "maps-with-graphs", inset maps or "social topic" maps.*

Canada has a long tradition of national and provincial atlas production. Published in 1906, the *National Atlas of Canada* is considered the country's first 'national' atlas and made Canada only the second country to publish a national atlas (Nicholson and Sebert, 1981). Since that time, six editions of the *Atlas of Canada* have been produced, with the latest version moving away from traditional publication methods in favour of a virtual medium, the WWW. Provincial atlases were produced sporadically throughout the 20th century, but real development did not come until after World War II, when production of a third edition of the national atlas, coupled with the establishment of a

Commission on National and Regional Atlases, motivated provincial governments' interest (Nicholson and Sebert, 1981).

British Columbia was the first province to produce a modern reference atlas, the *British Columbia Atlas of Resources* (1956), with an updated edition released in 1979, simply called the *Atlas of British Columbia* (Nicholson and Sebert, 1981). In recent years, several single topic thematic atlases have been produced for the province, such as *The Geography of Death: Mortality Atlas of British Columbia, 1985-1989* (1992) and *The British Columbia Health Atlas* (2002). But since 1974, no successful movement has been made toward a contemporary atlas for the entire province.

2.2.3 Limitations

Atlas production has been, and continues to be, a challenging process that requires a great deal of time, financial resources, and labour. Monmonier (1981) identifies five attributes of atlases that can impact their production:

1. scope of subject matter;
2. comprehensiveness;
3. geographic scope;
4. level of supplementary material; and
5. authorship structure.

It can take years (often decades), a considerable budget, and a large team of experts to research, compile, edit, proof, and print a conventional atlas. For example, the *Historical Atlas of Canada* project had contributions from hundreds of authors and assistants from universities, governmental departments, and private organizations across Canada. The three volumes took approximately fourteen years to complete and were funded through the Social Sciences and Humanities Research Council of Canada (SSHRC), the Ontario government, and private and corporate donations (Historical Atlas of Canada Online Learning Project, n.d.).

The lengthy process associated with conventional atlas production is not only time-consuming but also very expensive. In most circumstances, the funding required to initiate and complete an atlas project can be obtained only through government agencies and/or educational institutions. Morrison (1995) suggests that any successful effort to produce a comprehensive (national) atlas must be made by a consortium of organizations, encompassing both commercial and governmental agencies.

The main purpose of the traditional atlas has been to provide information for visual analysis – it supports no interactive capabilities and only limited analytical ones (Keller, 1995). This static quality fails to provide the user with current data or access to additional information; in essence, the user is seeing a snapshot of a particular region at a particular moment in time. As Robinson (1993) notes, portraying time series data or trends (such as the changing distribution of fish species) are not easily achieved with conventional atlases.

The physical format of printed atlases presents problems for both cartographer and user. The rigid structure and format of a bound atlas restricts the use of innovative designs or varying scales. Often, to maximize the areal coverage and increase the level of detail displayed, cartographers resort to producing over-sized volumes. These large, cumbersome books may be well suited to spacious libraries and educational institutions, but are not appropriate for casual perusing. Alternatively, some atlases are collections of separate sheets compiled in a box or folder, which allow for easier access, transport, and update. However, this format introduces other problems, such as ease of loss.

One component that can exert powerful constraints on any atlas initiative is the ideological/political influence. This force can be very obvious, such as the stated preferences of a government or private funding agency, or subtle, such as societal/cultural ideologies. Together, or separately, both can apply strong demands on the type and variety of maps displayed in an atlas. As discussed by Monmonier (1996), culture accounts for many routine, seemingly automatic decisions about features and their portrayal, as well as policy on collecting and disseminating cartographic information. If not carefully managed, the strong colonial influence within British Columbia could overwhelm the role of the First Nations in the telling of British Columbia's story.

2.3 CONTEMPORARY ATLAS FORMATS

2.3.1 Introduction

Throughout history, scientific and technological advances have been precursors to developments within the mapping sciences. Recently, rapid growth and evolution of computer technology has altered cartographic production significantly. No longer limited to the paper medium, current atlas products are distributed via CD-ROMs and the Internet (WWW). These 'electronic' or 'digital' atlases represent a new dimension in the use of atlas information, containing data and software to produce and interact with maps not possible in book form (Rystedt, 1995).

2.3.2 Electronic Atlases

The Netherlands Cartographic Society define an electronic atlas as,

> an information system set up for the interactive consultation of digital geographic databases concerning certain area or theme and containing data which are comparable in terms of the level of generalization and the resolution at which the data were collected (Bos *et al.*, 1991).

Kraak and Ormeling (1996) describe three different types of electronic atlases:

1. View-only, an electronic version of a paper atlas (usually scanned images of the maps) with no extra functionality.
2. Interactive, an atlas that allows users to manipulate data sets by providing choices on the viewing scale and often the map contents; often multimedia elements are linked to the map via hyperlinks.
3. Analytical, an interactive atlas with some geographic information system (GIS) functionality.

From these definitions, it is clear that the level of interaction determines the complexity of the electronic atlas and, ultimately, the amount of data users can access. Cammack (1999:156) provides a working definition of an interactive map as that which "reciprocates spatial information between the map and map-reader" and wherein "communication of information should elicit responses that change the cognitive map of the map reader and the appearance of the interactive map." Similarly, the author of the *Atlas of the Federal Republic of Germany* emphasizes that the interactivity of the atlas stems from the user determining the style and appearance of the map and not constructing a map from scratch (Lambrecht, 1999).

2.3.3 CD-ROM

Introduced in the early eighties, CD-ROM (Compact Disc, Read-Only-Memory) technology dramatically revolutionized both the music industry and, to a lesser degree, the publishing world (Cartwright, 1999). Currently, the medium of choice for the music industry is the Compact Disc (CD), whereas in the publishing world, CDs act as supplements to many books. The popularity of the medium was (and still is) based on its ability to accommodate large files (minimum storage of 540 megabytes), its compact, durable design, its fairly low cost, its ease of distribution, and its standardization (Cartwright, 1999).

Electronic atlas development began in the late 1980s, with many of the first electronic atlases published on CD-ROM (Kraak, 2001). Early digital atlases, such as the *Atlas of Arkansas* (published on floppy diskettes), had the appearance and feel of their traditional counterparts in that users 'flipped' through a collection of static images (Keller, 1995). Later electronic atlas products incorporated burgeoning technologies that offered greater interaction and dynamic capabilities. Currently, the *Atlas of Switzerland* represents the pinnacle of electronic atlas (CD-ROM) development, by presenting an interactive, dynamic, and analytical environment that rivals any GIS. Users are presented with a host of options, from changing the viewing angle of 3D terrains to altering the colours and number of classes of choropleth maps.

2.3.4 WWW Environment

"The WWW is an information discovery system for browsing and searching the Internet's worldwide 'Web' of digital information" (Cartwright, 1999: 23). As a means of disseminating cartographic and geographic information, the advantages of the WWW as a medium can be summarized by its accessibility and actuality (van Elzakker, 2001). Unhindered by political or geographical boundaries, the tremendous amount of 'free' information on the Web is available twenty-four hours a day for those with the appropriate computer hardware, software, and Internet connection. Moreover, the virtual, temporary nature of the WWW means that information displayed on a website can easily be updated and modified. Unlike their paper counterparts, which can contain outdated data due to time-consuming processes of compilation, production, and printing, Web atlases can provide users with more current information. Frappier and Williams (1999) propose that the evolution of a country's human and economic characteristics will increase the need for information and knowledge of that nation. With the continuous growth of the WWW, it is likely that individuals will use the Web as a tool to access the most current information on a specific geographic topic or particular region.

The Web is unrivalled in its capacity to allow for a more interactive and dynamic environment, for its ability to reach many users at minimal costs, and for its virtually platform independence (Kraak, 2001). The ability to access information on the WWW, regardless of the operating system, through user-friendly Web browsers has the potential to provide instant access to map products as well as a host of other multimedia information, such as video, sounds, animations, and virtual reality. Muehrcke (1990:13) believes that the interactive capability of the Web offers the greatest opportunity for cartographic design innovations, stating that "we must be willing to challenge all design assumptions associated with printed maps if we are to optimize the design of the new interactive map form". Peterson (1997) notes that exposure to interactive maps on the

Internet encourages the map user to explore alternative methods of representation that may lead to better map use skills and improve and increase the use of maps on paper.

One of the significant advantages of the Web to Internet atlases is the ability to hyperlink to other sites. For cartographers, there is a fine line between effectively and efficiently displaying data and overwhelming the user with too much information. In a Web setting, the difficulty encountered by trying to graphically depict, or include all pertinent information, can be alleviated with links to other data sources, i.e., websites.

However, while the potential of online mapping seems boundless, there are limitations that create problems for both the map user and the producer. One of the most prominent of these issues is time. The virtual world created by the Internet and the WWW is measured in bandwidth and download time – the greater the bandwidth, the faster the connection. Although Canadian household Internet connection speeds are increasing (through the use of cable modems and telephone (DSL) connections), Statistics Canada (2004) found that of the households with Internet capability, 35% still connect to the Internet using telephone dial-up access.

In spite of high-speed connections, users do not want to spend time waiting for large files to download. Research into Web design and usability guidelines by the (US) National Cancer Institute (2004) has shown that Web users rated download times of five seconds or less as good, six to ten seconds as average, and over ten seconds as poor. Therefore, to gain the attention of users, the file size of Web maps cannot be too large.

Another issue is that creators of Web maps have little control over the final appearance of their product due to the technical nature of the medium. Output can change with users' browser and operating system, graphic card and display quality (resolution), as well as users' preferences for display – colour balance, contrast, and brightness (van Elzakker, 2001). In addition, maps on the Web are constrained by the size and quality of computer display screen (Harrower *et al.*, 1997). The challenge for cartographers is to accommodate the technical constraints of the medium and to minimize the difficulties encountered by the physical nature of the technology.

2.3.5 Multimedia Atlas Information System (AIS)

An AIS shares some similarities with a Geographic Information System (GIS) in that both are computer-based information systems that handle geospatial data. However, the two systems differ in a number of important areas (Table 1). The most outstanding differences are in the visualization and accessibility of the information. Similar to traditional paper atlases, a multimedia AIS is concerned primarily with the presentation of data on a certain area or topic in conjunction with a given purpose (Ormeling, 1995). Accessible to both novices and experts, the emphasis is on the visualization of geographic information to assist users in developing visual analysis (Delazari and Cintra, 2002).

	GIS	**Multimedia AIS**
Use of interface	complex	easy
Users	experts	non-experts
Computing time	long	short
Control by	users	authors
Main focus	handling of data	visualization of topics
Data	unprepared	edited

Table 1. Comparison between GIS and multimedia AIS (Schneider, 1999).

Interaction and multimedia components should be managed carefully – both should have purpose and not be driven by technological capability. With rapidly evolving technologies, there is a risk in digital atlas design that atlas researchers will let computing innovations set the digital atlas research agenda and lose sight of why they are developing digital atlas products and for whom (Keller, 1995). The degree of interaction will vary between atlases and will depend on the purpose of the atlas and the target audience. For example, design of a multimedia atlas for school children will require a different level of interactivity and complexity than one designed for GIS professionals.

2.4 USER SURVEYS

In any cartographic design process, one of the most important preliminary stages is establishing the intended audience. With recent technological advances, the atlas design process, and the user's role in it, is more important than ever. As Carrière (1999:121) discusses, "atlas authors must be aware that they are serving a large population of users, from the anonymous surfer to the specialist researcher". Atlases are an inclusive form of cartography that invite all users the opportunity to explore the world through maps (Cartwright and Peterson, 1999).

Unfortunately, the literature is deficient in its assessment of users' needs and preferences. In several atlas projects, the goal has been to provide users with the opportunity to adapt and manipulate maps to their requirements, and to generate customized cartographic images (Ormeling, 1999), without any indication if the target audience desires these options. Many authors defend their design options by stating that they user *should* be able to, *should* have access to and *should* be interested in the various features presented.

User studies conducted by the University of Victoria's Spatial Sciences Laboratory (Hocking, 1991; Hocking and Keller, 1992a; Keller *et al.*, 1995, Keller, 1995) found that traditional themes and topics are preferred by users, that users do not crave highly specific topics, and that maps showing information based on complex calculations and excessive expert interpretations do not interest the user. In addition, a recent survey of Internet tourism maps, revealed the following list of interactive capabilities that Web travel maps should possess (Richmond and Keller, 2002):

- zooming in/out: 89%;
- features in map hyperlinked to text, pictures, other webpages, etc.: 81%
- features in map hyperlinked to other maps: 62%
- panning: 61%
- turning layers on/off: 41%
- animation: 8%

2.5 CONCLUSION

The literature appears to struggle with the various terms used to define the new atlas products, with no definite consensus. 'Electronic' and 'digital', have been used interchangeably to describe both Internet and CD-ROM atlases, whereas multimedia atlas information systems appear to concentrate on atlases with multimedia and/or GIS functionality. For the purposes of this thesis, therefore, the term multimedia atlas will be used to describe an Internet/Web-based atlas with multimedia components.

The progression from traditional paper atlases to recent Web-based adaptations has provided the author with an array of technological approaches to atlas design and production. Chapter Three explores the contemporary Web mapping software and mark-up programming languages suitable to design, produce, and access a multimedia atlas.

CHAPTER 3: CONTEMPORARY TECHNOLOGICAL SOLUTIONS

3.1 INTRODUCTION

Designing a Web-based atlas involves developing and implementing a strategy that will meet the needs of users. For such a system, defining the audience and their expectations will dictate the type and amount of data, the navigation, access, query, and analysis capabilities available, as well as the appearance of the interface. In the recent past, many Web-based mapping products have become available from leading GIS software vendors like ESRI, MapInfo, and Intergraph. Although these products provide comparable services, the complexity of the tools and the analytical capabilities can be unique. The option also exists to program a solution from scratch using one or a combination of programming languages. Selecting a solution that is appropriate for the strategy can be difficult. This chapter will discuss alternative contemporary technological approaches and review existing Internet atlases.

3.2 DATA FORMATS

The platform independence, or ability to access information on the WWW regardless of the operating system (such as Windows, Linux, AppleOS, etc.), is one of the important features of the Web as a medium for disseminating geospatial data. Retrieving and displaying the information is accomplished through user-friendly Web browsers. However, there are a limited number of standardized data formats that can be used to store the information and let browsers interpret and show content correctly (Köbben, 2001).

The organization responsible for monitoring and defining data formats is the World Wide Web Consortium (W3C). Without a standardization of data formats, the Web would deteriorate into a jumble of conflicting proprietary 'languages' and inaccessible webpages. Unfortunately, browser developers are not bound by the decisions of the W3C and frequently make their own changes to the standard by introducing new file formats (graphic, sound, video, or animation). Often, these changes result in the addition of software components called "plugins", which must be downloaded and installed into the browser so that new formats can be accessed. For example, Adobe Acrobat Reader is a free plugin that allows browsers access to PDFs (Portable Document Files).

3.2.1 Hypertext Mark-up Language (HTML)

Initially, the WWW was created to provide a straightforward technology for the delivery of single hypertext documents across the Internet. Its architecture consisting of three key components (Ciancarini *et al.*, 1999):

1. An elementary communication protocol – the Hypertext Transfer Protocol (HTTP).
2. A simple hypertext document description language, – the Hypertext Markup Language (HTML).
3. An addressing schema for document resources globally valid across the Internet – Universal Resource Locator (URL).

The second of these components, HTML is the basic language all browsers understand (Duffy, 2002). Even a webpage programmed with an embedded language, such as Java, will be 'wrapped' in HTML. The basic element of HTML is the tag, < (opening) and > (closing) symbols that indicate how the file should look when displayed (Feringa, 2001).

The advantages of HTML are based on its unsophisticated characteristics. It is available on virtually all computer operating systems, uses a very simple text-based approach for all its coding, and incorporates widely used graphics files, like JPEG and GIF (Allsopp, 1996). The widespread application of HTML can be seen in the variety of software products that have incorporated it into their structure – from user-friendly word processing programs, such as Microsoft Word, to sophisticated 'What You See Is What You Get' (WYSIWYG) programs, like Macromedia Dreamweaver.

For interactive map design, Cammack (1999) identifies two issues with HTML: 1) hypertext is a limited view of interaction, in that hypermedia allows users to click on graphics and pictures, but adds little in the way of interaction; and 2) format compatibility with the browser is complicated by the fact that older browsers do not recognize new HTML tags and parameters.

3.2.2 Dynamic HyperText Markup Language (DHTML)

A new development in Web data format from Microsoft, DHTML is a combination of HTML 4.0, cascading style sheets (CSS), and programming (Feringa, 2001). Stored in external files to the HTML documents, CSS is a breakthrough in Web design because it allows developers to control the style and layout of multiple webpages by editing a single CSS document (Refsnes Data, 1999). In addition to greater control over the layout of page elements, DHTML provides users the ability to interact with and change webpages without having to communicate with the server (Webnox Corp, 2003).

For cartographers, DHTML can increase user interaction by allowing the map-reader to change display characteristics at the client computer (Cammack, 1999).

A significant development in Web data format that has been incorporated into the latest versions of the two major Web browsers (Netscape Navigator and Microsoft Internet Explorer), DHTML has compatibility issues with older versions of these browsers. This presents a major problem for both Web cartographers and users – not being able to retrieve some or all of the information means that the map will fail to communicate its message simply because the user cannot access the data (or in some cases cannot see it on the screen). Since it is unrealistic to expect all users will have the newest version of either Web browser, it may be necessary to warn users of the potential conflict and provide a link directing them to an upgraded version of the browser.

3.2.3 eXtensional Markup Language (XML)

XML is a simple, very flexible text format originally designed to meet the challenges of large-scale electronic publishing, but taking an increasingly important role in the exchange of a wide variety of Web data (Connolly, 2001). XML is a markup language, much like HTML, but differs in that it was designed to describe data, not simply display it. Moreover, XML offers the author freedom to define the tags and the document structure (Refsnes Data, 2002). In XML, every markup has meaning because it gives information about the data described between the tags. Conventions can be used to organize the data and common structures can be implemented so that the data can be shared (Feringa, 2001). It is important to note that XML was not devised as a replacement for HTML, but to complement it; in future Web developments, it is possible

XML will be used to describe the data, while HTML will be used to format and display the same data (Refsnes Data, 2002).

3.2.4 eXtensional HyperText Markup Language (XHTML)

Slated as the next standard in Web development, XHTML is a reformulation of HTML 4.0 in XML that became a W3C recommendation in January 2000 (W3C, 2001). With the increasing range of browser platforms, particularly in wireless communication devices (i.e., cell phones and palm-sized Personal Digital Assistants – PDAs), it is important that people be able to access the same information on the Web. XHTML is intended to be used in conjunction with tag sets from other XML vocabularies, so that in principle, XHTML tags can be combined with SVG graphics tags or XML tags from any other XML vocabulary (W3C, 2001).

3.2.5 Geography Mark-up Language (GML)

Introduced in 1999, GML is an XML encoding standard developed by the OpenGIS Consortium (OGC) for the transport and storage of geographic information, including both the spatial and non-spatial properties of geographic features (OpenGIS Consortium, 2001). "GML represents a new way to represent and manipulate geographic information; just as XML is now helping the Web to clearly separate content from presentation, GML will do the same in the world of geography" (Lake, 2001).

Galdos Systems, Inc. (2001) summarizes the advantages of GML as including:

- better quality maps due to ability to display geographic features at varying resolutions;

- not restricted to one particular Web browser;
- custom map styling provided through choice of stylesheets;
- more sophisticated linking capabilities with embedded features;
- improved query capability;
- user control over content (ability to display/hide information via a clickable legend);
- animated features; and
- display of GML on XML-enabled devices, such as PDAs and cell phones.

3.2.6 Scalable Vector Graphics (SVG)

Another W3C recommendation, SVG is a language for describing two-dimensional graphics and graphic applications in XML (W3C, 2003). Heralded as "one of the most exciting developing technologies" (Traversa, 2001), this relatively new standard is generating fervor thanks to its vector graphics capability, as well as its XML based (open source) format, readable by humans (Neumann and Winter, 2002). The ability to read the code has been one of the more publicized features of SVG, but as discussed by Artymiak (2002), "graphics or animation are very different from text encased in HTML, and being able to view the raw code of an image does not make it any easier to understand, no matter what file format is used."

A powerful tool for creating vector graphics on the Web, SVG's features include (Quint, 2003):

- comprehensive basic vector graphics primitives typically found in drawing systems, such as lines, polygons, circles, ellipses, etc;

- capacity to group graphical objects and organize them hierarchically offering great flexibility for transformations and styling;
- advanced graphics capabilities, including stroking, solid fills, gradient fills, alpha transparency, clipping, masking, and filters;
- support for raster images and text; and
- provision of extensive dynamic capabilities: animation and scripting.

For cartographers, SVG promises to be an important technology for distributing vector-based graphics with interaction and animation. However, because it is a recently developed standard, SVG has yet to be adopted widely.

3.2.7 Java

One of the more well-known computer languages, Java is an object-oriented language similar to C++ that has been simplified to eliminate language features which cause common programming errors (INT Media Group Inc., 2001). The advantage of Java is its platform independence; it can run on any computer with the 'Java Virtual machine' interpreter – a plugin that is part of the Netscape and Internet Explorer Web browsers (Plewe, 1997). The Java Virtual machine interprets Java data, called 'applets', and runs them on the client computer (INT Media Group Inc., 2001).

Before executing an applet, Java's security manager checks its code for prohibited operations; if the security manager identifies a prohibited operation, it initiates a security exception that prevents the applet from running (Wang and Jusoh, 1999). For users, access to the requested information may be denied because the applet's certificate is invalid, meaning that it may not be recognized by the Web browser. Thus, a Web designer must explain the security issue to ensure that the pertinent object can be executed on the client's computer, and the user must download a security certificate (Wang and Jusoh, 1999).

The object-oriented programming of Java allows cartographers to create any type of interaction they need, but it requires a great deal of programming knowledge and applets process slowly on client computers (Cammack, 1999). When deciding to use Java, cartographers must consider the level of interactivity required, the commitment to programming, and the speed at which the application will run in the users' browsers.

3.2.8 JavaScript

Similarly named and constituted, Java and JavaScript are fundamentally different (see Table 2). JavaScript is a scripting language that was developed independently by Netscape to enable Web authors to design interactive sites (INT Media Group Inc., 2001). JavaScript authoring is not as complex as Java programming and does not have Java's static typing and strong type checking (Köbben, 2001). Unlike a Java applet, which is complied before it is put on the server, in JavaScript, the Java Virtual machine compiles the code one line at a time on the client computer (Cammack, 1999). Thus, JavaScript allows response to Web-based forms and direct processing of data, and can be used to create pop-up windows (Figure 1), change page elements on the fly, create and store data on the user's computer, change dates on a webpage, and more. (Feringa, 2001).

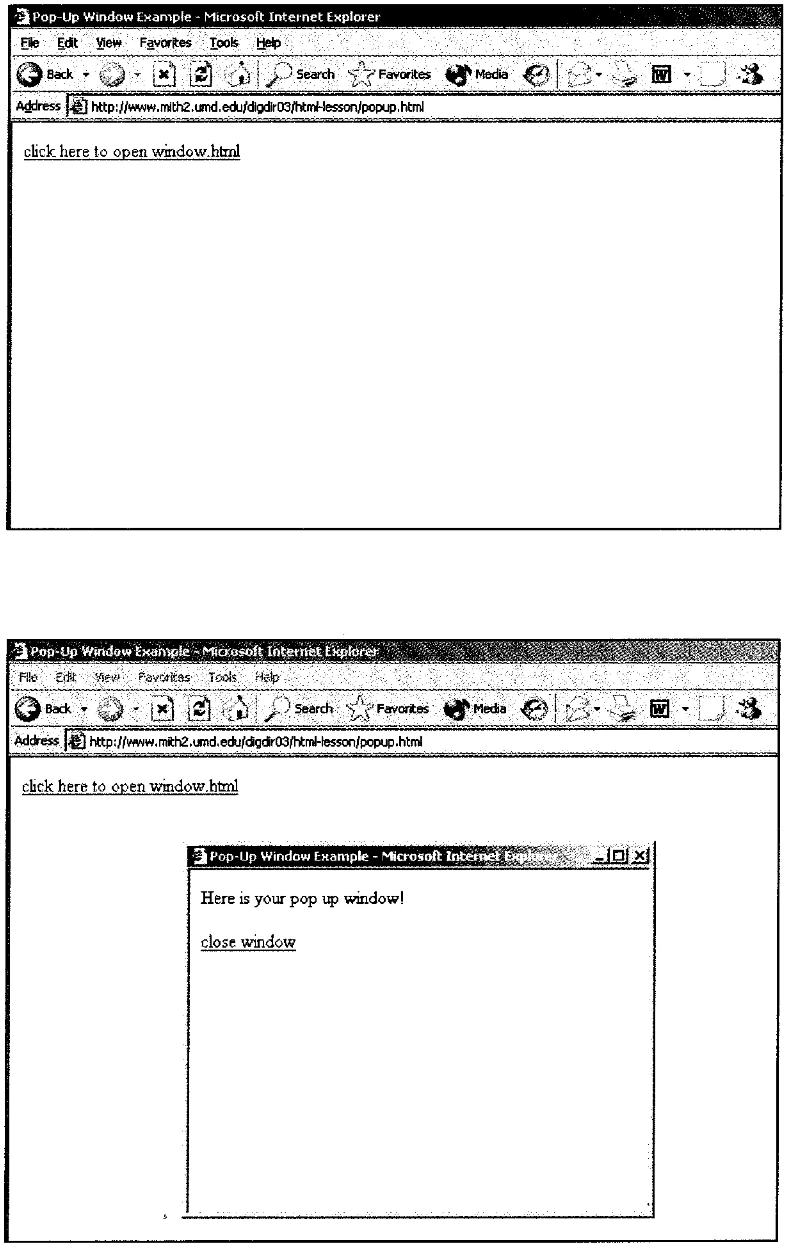


Figure 1. Pop-up window example (Maryland Institute for Technology in the Humanities, 2001). Clicking on the link (click here to open window) opens the pop-up window.

JavaScript	Java
Interpreted (not compiled) by client.	Compiled bytecodes downloaded from server.
Object-based. No distinction between types of objects. Inheritance is through the prototype mechanism and properties and methods can be added to any object dynamically.	Object-oriented. Objects are divided into classes and instances with all inheritance through class hierarchy. Classes and instances cannot have properties or methods added dynamically.
Code integrated with, and embedded in, HTML.	Applets distinct from HTML (accessed from HTML pages
Variable data types not declared (loose typing).	Variable data types must be declared (strong typing).
Dynamic binding. Object references checked at runtime.	Static binding. Object references must exist at compile-time.
Cannot write directly to hard disk.	Can write to hard disk.

Table 2. JavaScript compared to Java (Köbben, 2001: 81).

3.2.9 Virtual Reality Modeling Language (VRML)

Unlike the data formats discussed previously that produce two-dimensional images, VRML is a language to describe three-dimensional scenes and a standard for building three-dimensional objects in the WWW (Fuhrmann and Kuhn, 1998). These objects can be created either as ASCII text files, which require considerable programming knowledge, or converted into VRML from commonly used three-dimensional file formats via an automatic translation program (Feringa, 2001). The complexity of the three-dimensional structures can be specified in detail by defining shapes, sizes, colours, lighting effects, and transformations (Hume, 1996).

As the name implies, VRML produces a virtual environment in which the user can experience movement by 'flying' over or 'walking' through an artificial landscape.

"Besides the freedom of movement inherent to a VRML 'world', the ability to incorporate imagery, animation, sound, and motion physics promises to make map reading an enriching participatory experience" (Swanson, 1991: 181). For cartographers, a three-dimensional representation offers visualization advantages unavailable in traditional two-dimensional mapping. This includes the potential to make spatial data more understandable to users, especially to those with limited map reading skills (Patterson, 1999).

3.3 WEBSITE CONFIGURATION

Most of the design concepts for Web maps are based on a general client/server structure, which splits an application into tasks between the client and the server (Gartner, 1999). The important choice for designers of interactive maps is the location of map interaction – depending on how tasks are designated, either the client or server will receive the information, process it, and respond to the user (Cammack, 1999).

3.3.1 Client-side Functionality

In any client-side based product, the data and software are transferred (downloaded) to the client's computer so that the user's system executes the processing (Huang *et al.*, 2001). Once loaded onto the client's computer, Internet access is halted. According to Plewe (1997), client-side functionality falls into one of two categories – thin or thick clients. Thin client functionality means that the server handles most of the processing, so the browser need only process the display. Thick client setup means the user's computer handles the majority of the processing. Typically, client-side solutions are implemented by augmenting the Web browser with plugins or Java (Mishra, 2000).

The primary advantages of client-side solutions are the abilities to enhance the user interface and to improve performance (Huang *et al.*, 2001: 445). By using the client computer to perform the interactive processing, the rate of user interaction is based only on the speed of the client computer. Furthermore, moving the interactive processing to the user will increase the number of clients the server can simultaneously support (Cammack, 1999).

The major difficulties associated with client-side functionality are that downloading the data may be time-consuming and complex data processing functions limited and not as efficient as those in a powerful server (Huang *et al.*, 2001). If the download time is excessively long, the computer may stall, effectively ending the session and requiring the user to close the browser and re-establish the connection, or restart the computer. Another drawback is server access priority on the client computer: if the client hard drive is restricted, interactive changes and history from an interactive map session may not be stored (Cammack, 1999). If the interactive map is small and can be regenerated quickly, this is not a concern; the problem occurs when the map requires the computer to 'store' the information on the hard drive to reconstruct it.

3.3.2 Server-side Functionality

In a server-side site, the interactive effects are performed on the server – the user's request is transmitted to the server, which processes the appropriate response (Cammack, 1999). Server-side applications are characterized by the existence of the main software and databases on the server side, which are linked with the Web server through a Common Gateway Interface (CGI) script (Huang *et al.*, 2001). The CGI protocol defines communication between the server software and the application, and the way the browser can transfer information to the CGI application through the Web server by adding commands and parameters to the URL (Köbben, 2001).

Centralizing applications on a server simplifies development, deployment and maintenance (Mishra, 2000). Likewise, concentrating the processing workload on a primary server reduces the volume of data sent across the Internet to the user, transferring only necessary data, not the entire database (Cammack, 1999). Moreover, the platform independence of server-side systems means it can be used by any Web browser on any operating system, without the need to install plugins (Köbben, 2001). The main problem with this type of Web-based mapping is server load, or in this case, server *over*load (Huang *et al.*, 2001; Köbben, 2001; Cammack, 1999; Plewe, 1997). Simultaneous processing of diverse requests from many clients can quickly overwhelm the server, resulting in slow processing time or inability to process at all. Even the most menial of tasks (like zooming) increase the network traffic and response time because each request to the server must be processed, generated into a new map, and returned to the user interface (Plewe, 1997).

Although discussion separates client-side from server-side solutions, in practice often a combination of the two is used – "when the mapping environment needs to be more versatile, supplying interactivity or dynamic maps, functionality can be added to the client or server side" (Köbben, 2001: 85). An amalgam of the two approaches can incorporate the specific advantages of each and can overcome some of the difficulties encountered in the application of only one solution. Recognizing this, many software vendors have developed Internet mapping applications that combine client- and server-side features. The following section will examine some of theses products.

	Server-side solution	Client-side solution
Advantages	Can adhere to all Internet/Web standards. Can utilize existing mapping (GIS) functions. Centralizes administration of data and mapping (GIS) application software. User support minimal. Comparatively mature and simple.	Modern GUI (Graphical User Interface) and flexible interaction. Vector data can be used. Good performance for operations that occur locally. Less Internet traffic. Not restricted to Internet document/graphic standards. Can be installed on demand, no permanent disk space is used.
Disadvantages	Limited interface. Lack of interactivity. Creates many requests.	Time consuming for downloading data and software. Difficult for complex data processing.

Table 3. A comparison of client- and server-side applications (Huang *et al.*, 2001: 444).

3.4 Internet Mapping Software

In an era of "dot-com" companies dominating virtually all aspects of the economy, GIS developers have been clambering to create an Internet strategy for their own products. To this end, companies such as ESRI, MapInfo, Intergraph, and AutoDesk have integrated Web-enabled functionality into their systems. A perfunctory assessment of these products shows some similarity, but further examination reveals these systems are based on fundamentally different views of geographic data and technologies (Limp, 1997). The following section will examine the strengths and limitations of these products, and provide a critical review of their practical applications.

3.4.1 AutoDesk MapGuide

MapGuide is a client/server suite consisting of three components: 1) client, a Java application or browser plugin; 2) author, a WYSIWYG tool for building application configurations; and 3) server, that runs within the Web server as a CGI and is used to manage such things as data connections and load balancing (Lime, 1999). MapGuide's website describes some of the new features of the latest version (AutoDesk, 2003):

- it supports a XML-based map file format which increases the flexibility of the application;
- it enables access to interactive maps and designs via desktop and mobile devices;
- it provides data interoperability or support for integrating and accessing all major GIS and CAD [Computer Aided Drawing] data formats;
- it uses vector (CAD-based) maps or raster images;
- it coordinates system support of more than 800 worldwide coordinate systems;

- it provides two flexible online viewing options: LiteView (which requires no download or special plug-ins, so visitors have immediate interactive access to GIS data) and Viewer (which offers robust display, query, and analytical features); and
- it includes better looking maps by way of improved rendering of map data within the MapGuide Viewers increasing application usability and acceptance.

It may be telling that the authors of MapGuide have targeted their product to a certain clientele, particularly local governments, utilities, and communications firms (CAD/CAM Solutions of Canada, 2001). The sample applications offered to potential customers show little user interactivity, with basic GIS functions – zooming, identifying features (pop-up windows with additional information), and layer/legend selection.

3.4.2 Intergraph GeoMedia WebMap

GeoMedia WebMap, a Web-based visualization tool, is an open GIS solution that uses no proprietary languages or data formats, and provides direct access to all major GIS/CAD data. This enables users to access data in its native format (without translation or conversion) and perform queries on live data to get the answers they need (Intergraph, 2003). Like many of the other software packages, GeoMedia WebMap offers functionalities such as displaying vector or raster data, zooming, panning, queries, and measuring distances.

The product demonstration provided on the GeoMedia WebMap website highlights some of the GIS capabilities of the software. These features are similar to those of Autodesk's MapGuide, with panning, zooming, feature identification, layer selection (off/on), but GeoMedia WebMap goes one step further. It offers the user more interactive controls such as changing the colour, style, and width of the symbols (point), linear, and areal features. In this way, it appears that Intergraph has created a product that caters to government agencies or those sectors interested in land inventory/management, transportation and route planning.

3.4.3 MapInfo MapXtreme

MapXtreme is a highly customizable general purpose mapping and analysis package that allows for the dynamic creation of maps and queries (Lime, 1999). MapXtreme is available in two editions, Windows NT and Java. The major difference between the two products is in terms of vector/raster supportability –Java handles both while Windows NT is restricted to raster. From the perspective of Internet functionality, the Java version of this software has an advantage in its inherent qualities as a language designed for the Web. However, the GIS capabilities of the Windows NT version are superior to that of its counterpart. In addition to the panning, zooming, re-centering, and thematic features of the Java version, MapXtreme for Windows offers: 1) object processing – the ability to create applications that combine, buffer, intersect or erase objects like points, lines, and polygons and return resulting data; and 2) object editing – create, modify, and delete objects, such as points, lines, and boundaries on a map (MapInfo, 2002). Ultimately, choosing between the two will depend on the appropriateness of the format for the cartographer's design strategy.

3.4.4 ESRI ArcIMS

Founded in 1969, Environmental Systems Research Institute (ESRI) Inc. has provided GIS solutions longer than any other firm (Spitzer, 1997). As one of the initial GIS companies and one of the most aggressive in promoting all of its products, it is not surprising that ESRI provides the broadest range of Internet mapping solutions (Lime, 1999). ArcIMS (Internet Map Server) is a fully functioning GIS system that uses ArcXML, a GIS extension to standard XML, to communicate between clients and servers (ERSI, 2001). Some of the key GIS capabilities available with ArcIMS include image rendering, feature streaming, data extraction, geocoding, and the ability to perform both spatial and attribute queries on underlying data (ESRI, 2002). In addition, ArcIMS offers a wide range of products, from lightweight browser-based applications to full-featured GIS desktop solutions (ESRI, 2002).

An examination of websites powered by ArcIMS illustrates the wide variety of purposes to which the software has been used. Like other packages, it has powered websites directed towards business (real estate) and governmental organizations (land parcel records, particularly querying tax information). However, it also has supported other websites with thematic content, such as the Lewis and Clark site, which provides historical, geographic, satellite, and other information about Lewis and Clark's Expedition (ESRI, 2000). The GIS functionality of this site is limited (as one zooms into the map, the level of detail does not increase) and takes a long time to regenerate map images and access or retrieve information.

One site offering greater detail with an increasing scale is the Tele Atlas Route Server (Tele Atlas North America, Inc., 2003). This website prompts users to select two locations in the United States using either an address or zip code, and provides a map detailing either the quickest or shortest route between those two locations. As one zooms into the map, the level of detail increases, to the point that it is possible to identify major street names. Unfortunately, the GIS capabilities of this site are limited to zooming in and out.

3.4.5 Customized Solutions

In addition to the software developed by several GIS companies, many websites have integrated a variety of programming components (i.e., 'plugins') into existing software to create a customized solution. The Capital Regional District (CRD) for Vancouver Island, British Columbia, has initiated a Web-based *Natural Areas Atlas* to provide "a comprehensive information tool about natural areas for use by anyone interested or involved in land use planning and stewardship in the Capital Regional District" (CRD Natural Areas Atlas, 2002). This site incorporates a wide range of information from differing government agencies and community groups in an interactive and (relatively) user-friendly setting (Figure 2).

The *Atlas of Switzerland* represents another customized approach to mapping (http://www.atlasderschweiz.ch/index_en.html). This atlas represents a truly interactive environment, in which the user has complete control over the look of the final map product – even to the point of adjusting for the number of class breaks that occur within the range-graded symbols or choropleth map. In the course of atlas development, the authors found that "implementation of a fully-featured interactive atlas can be done best by using commercial software in conjunction with specially tailored mapping modules" (Hurni, Bär & Sieber, 1999:111).

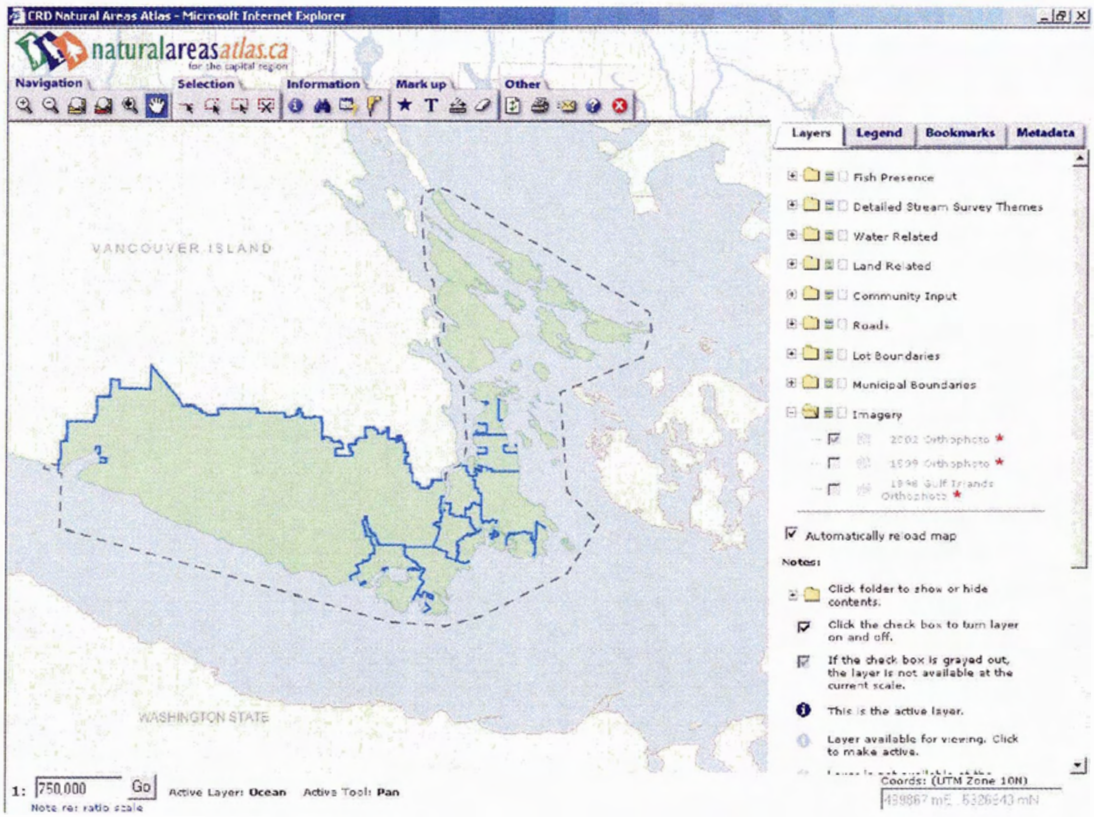


Figure 2. CRD Natural Areas Atlas user interface (http://www.crd.bc.ca/es/natatlas/atlas.htm)

3.5 Web Atlases

Although the technology to produce and/or display maps on the Web has existed for a number of years, Internet atlas production has been sparse. There are a number of reasons for this disparity, but it would appear that many of the same limitations that plagued traditional paper atlases – financial resources, time commitment, research, data compilation, and manipulation – continue to trouble their contemporary counterparts.

Initially, the focus of this review was restricted to provincial atlas initiatives within Canada. However, after a perfunctory assessment of provincial Web-based atlases, with disappointing results, the review was expanded to include Canadian and American Web atlases of varying geographic scales. Two CD-ROM editions were included (*Atlas of Switzerland* and the *Atlas of Saskatchewan*) because they represent diverse and unique approaches to atlas design and presentation.

3.5.1 Atlas du Québec et de ses regions

The *Atlas of Québec* (http://www.atlasduquebec.qc.ca/atlas/accueil.htm) and its areas is organized into three distinct divisions: First, the 'National' atlas gives an overall portrait of the entire province; next, the Interregional atlas uses a common framework for Québec's seventeen municipalities to enable regional comparisons; finally, the Regional atlases, designed by local teams, present regional development that meets the needs of the respective environments (Atlas du Québec et de ses regions, 2003). While the 'National' and Interregional atlases present static (thematic) maps, the Regional atlases vary in approach. For example, the *Atlas de l'Outaouais* (http://www.outaouais.org/atlas.html) presents thematic maps of that particular region as static GIF images (Figure 3), whereas *l'Atlas du Bas-Saint-Laurent* (http://atlasbsl.uqar.qc.ca/) offers a Macromedia Flash site, with various interactive tools, such as panning, zooming, turning layers on/off, and hiding/revealing legends (Figure 4).

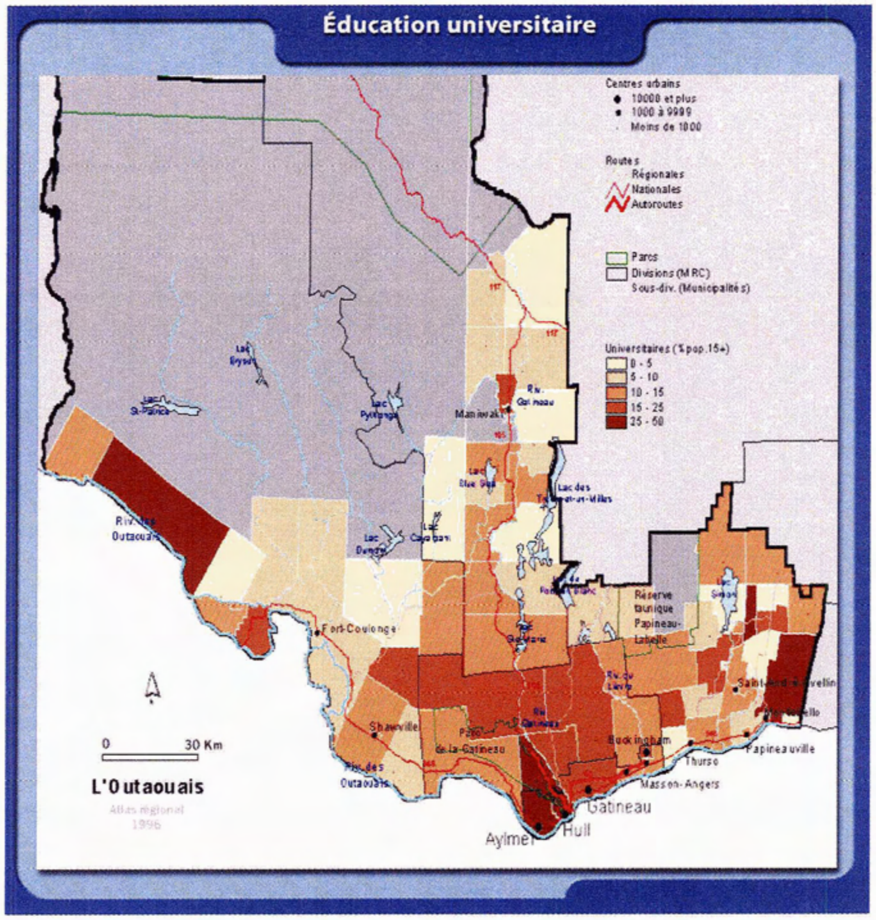


Figure 3. Static map (GIF) from the *Atlas de l'Outaouais* showing university enrollment. (http://www.outaouais.org/atlas.html)

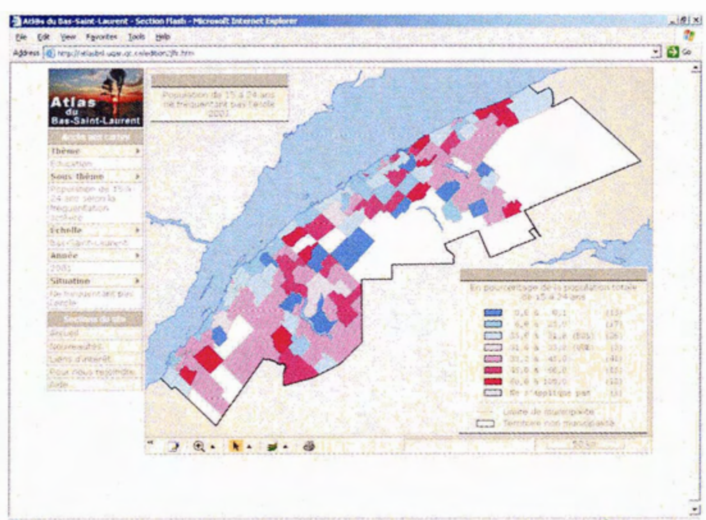


Figure 4. Flash (choropleth) map from the *l'Atlas du Bas-Saint-Laurent* illustrating 15 to 24 year olds not attending school. (http://atlasbsl.uqar.qc.ca/edition2/fr.htm)

The *Atlas of Québec* is a well organized site that offers a drop-down menu or a table of contents to guide users through the various themes and sub-themes. The interface utilizes a small amount of the (Web) page yet maximizes the map display element. Limited in its interactive and multimedia capabilities, the thematic (predominantly choropleth) maps display census data, such as employment, population and education (Figure 5).

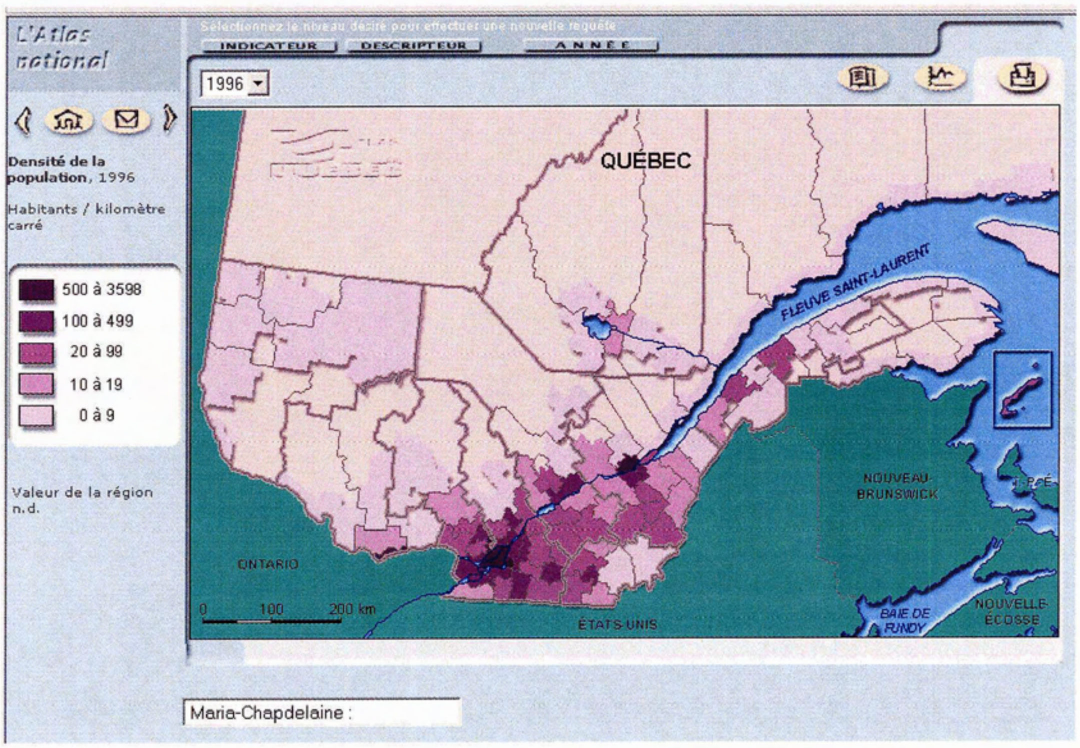
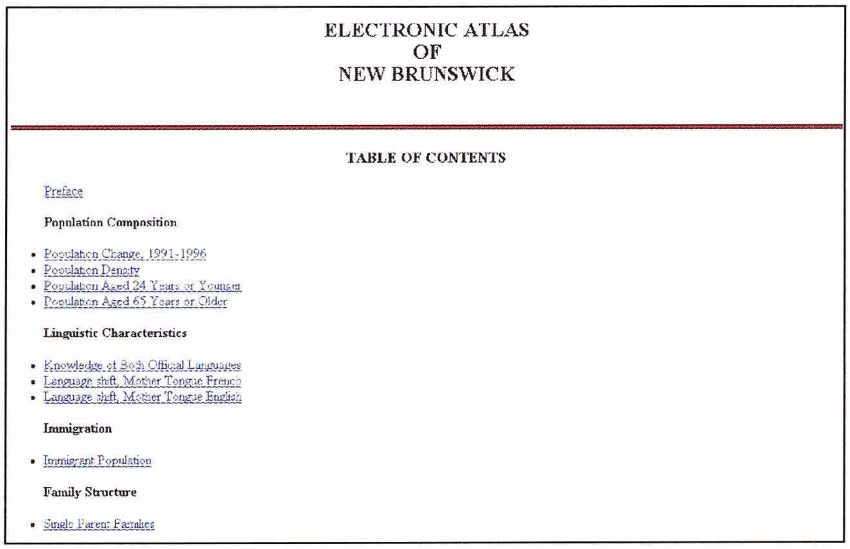


Figure 5. User interface for the *Atlas of Québec*. Accessing various themes/sub-themes is accomplished through the drop-down menus (indicateur, descripteur, and annee).

3.5.2 Electronic Atlas of New Brunswick

A "work in progress", the Electronic Atlas of New Brunswick (http://www.lib.unb.ca/gddm/maps/nbatlas/NBatlas.html) presents simple thematic maps from the 1996 Census (UNB Libraries, 1998). Its apparent purpose was to demonstrate the types of maps (and data) that could be produced from Statistics Canada's Data Liberation Initiative (DLI). As a result, the authors supply a very limited number of maps, using static JPG images (Figure 6).



ELECTRONIC ATLAS
OF
NEW BRUNSWICK

TABLE OF CONTENTS

Preface

Population Composition

- Population Change, 1991-1996
- Population Density
- Population Aged 24 Years or Younger
- Population Aged 65 Years or Older

Linguistic Characteristics

- Knowledge of Both Official Languages
- Language shift, Mother Tongue French
- Language shift, Mother Tongue English

Immigration

- Immigrant Population

Family Structure

- Single Parent Families

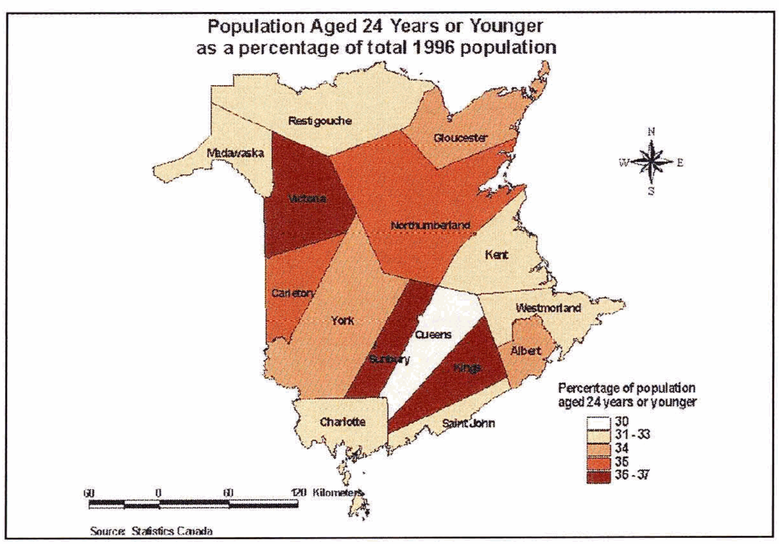


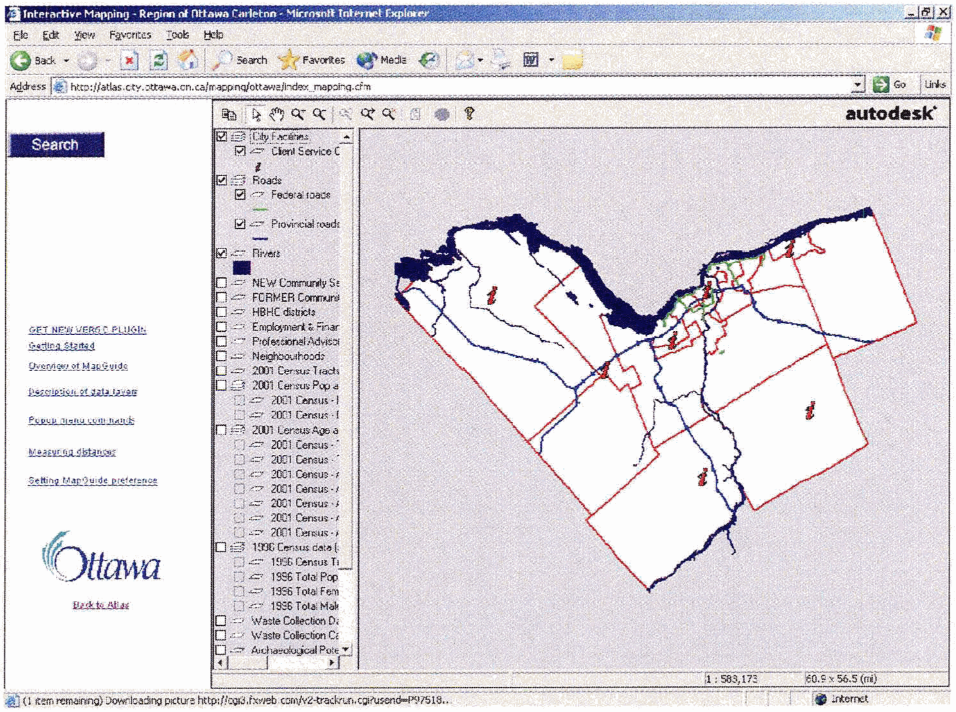
Figure 6. Table of contents for the *Atlas of New Brunswick* (top image) and a sample map from the atlas (bottom image). (http://www.lib.unb.ca/gddm/maps/nbatlas/NBatlas.html)

3.5.3 Atlas of Ottawa

The *Atlas of Ottawa* (http://ottawa.ca/city_services/maps/atlas/index_en.html) provides a variety of geographic and mapping products using a combination of interactive and static maps. Comprised primarily of census and locational data, the maps are shown in several different formats (City of Ottawa, 2002):

- The 2001 census demographic maps are available in JPG or PDF, as well as tables of raw data.
- A "picture" atlas of maps (JPG or PDF) highlights various locational features in Ottawa, such as libraries, parks, city facilities, and road networks. However, despite the name, the number of pictures in this section is very limited.
- A 1999 air photo mosaic of the Ottawa area permits five zoom levels, such that clicking on the map will increase the level of detail up to 1:15,000 (Figure 7).
- A general use and school CD-ROM can be downloaded, featuring a free GIS viewer (ArcExplorer) and a sample of the city's databases, so users can produce their own maps.
- An interactive map with various GIS capabilities, such as zooming, layer control, and buffer creation (Figure 7).

The Atlas of Ottawa does not have a definite table of contents. Instead, the first page includes links to other webpages within the site as well a host of maps to download. Concentrating on static maps of census and locational data, the atlas does not offer any multimedia features but it does provide an interactive mapping component. However, as noted, because it is essentially a GIS mapping tool powered by AutoDesk's MapGuide, the interactive capabilities are limited to pan, zoom, measure, and buffer.



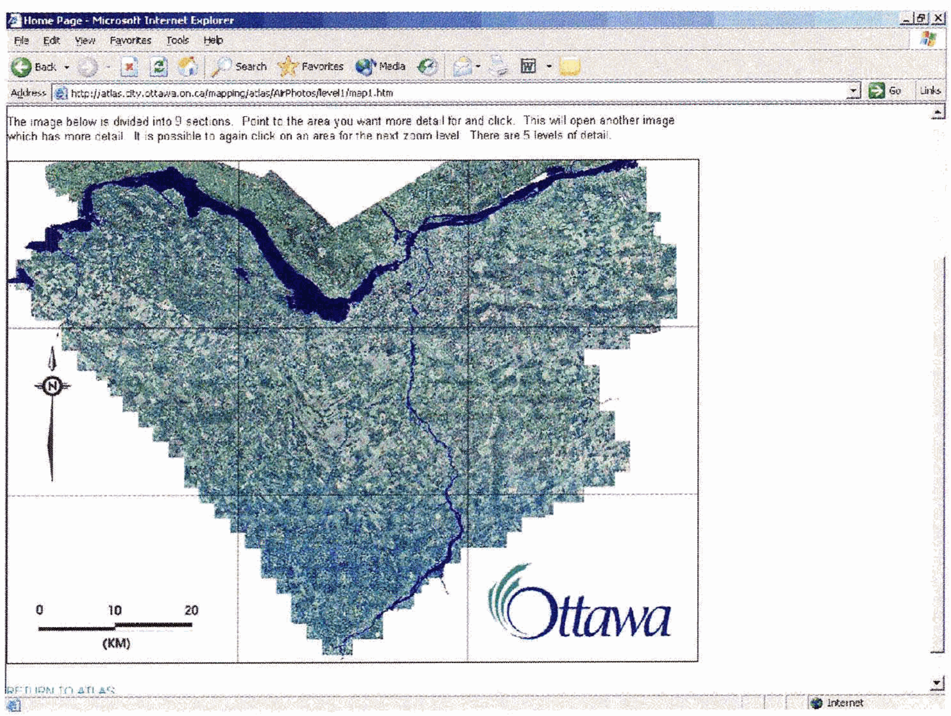


Figure 7. Two unique features of the *Atlas of Ottawa*: the interactive mapping component (top) and the city of Ottawa 1:15,000 air photos (bottom). (http://ottawa.ca/city_services/maps/atlas/index_en.html)

3.5.4 Historical Atlas of Canada Online Learning Project

The *Historical Atlas of Canada Online Learning Project* (http://mercator.geog.utoronto.ca/hacddp/toc-pop.htm) uses maps and data generated for the three-volume atlas and redesigns them for the Internet, creating an interactive environment where users can zoom in and out, turn map layers on or off, and access tables of data behind the maps (Historical Atlas of Canada Online Learning Project, n.d.). One of the unique features in this atlas is a section entitled "Learning Activities" which provides tutorials on particular subjects to facilitate the effective use of the atlas resources. The project is in early stages of development, with fifteen percent of the content completed (Figure 8).

Powered by ESRI's ArcIMs, the *Historical Atlas of Canada Online Learning Project* uses both static and interactive maps to display thematic data. Themes and units are well-organized into main maps, related maps, notes, illustrations, graphs, and resources such as learning activities and related websites (Figure 9). Unfortunately, numerous attempts to interact with several of the maps ended with the server stuck on data retrieval.

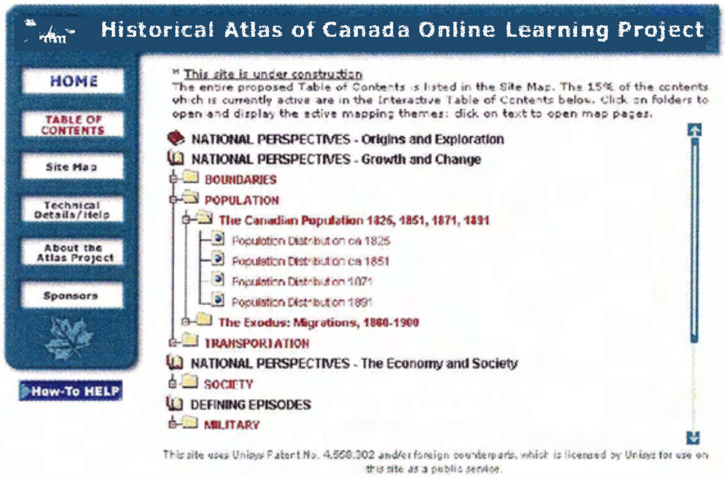


Figure 8. Table of contents for the *Historical Atlas of Canada Online Learning Project*; the + symbol expands a theme into various headings and sub-headings. (http://mercator.geog.utoronto.ca/hacddp/toc-pop.htm)

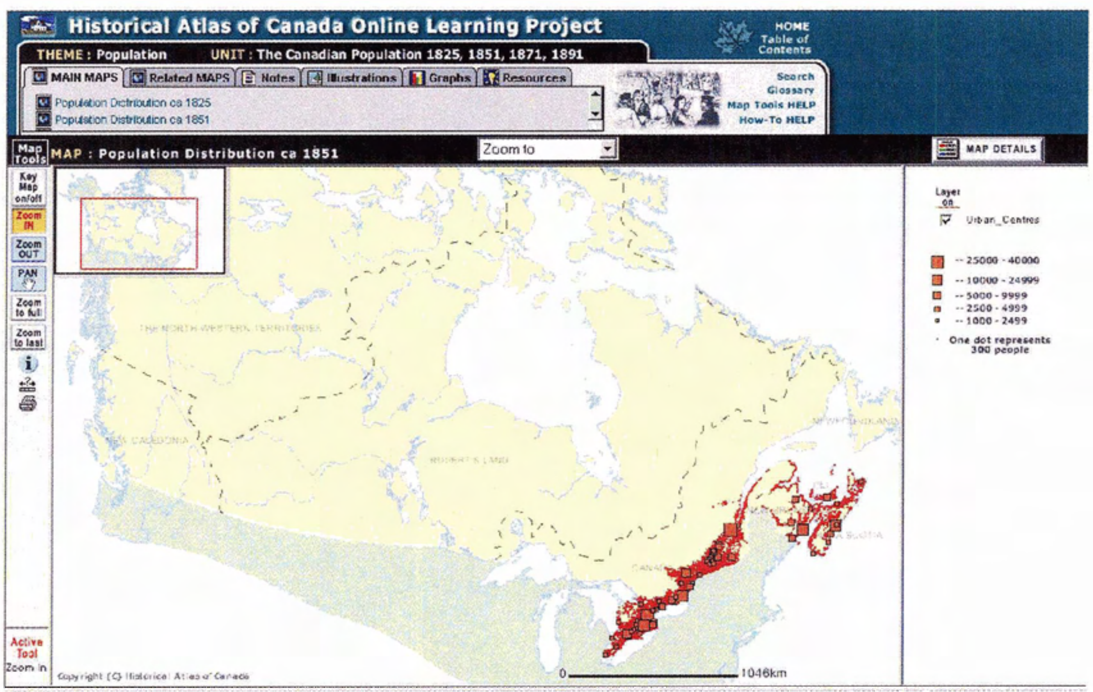


Figure 9. User interface for the *Historical Atlas of Canada* Online Learning Project. (http://mercator.geog.utoronto.ca/hacddp/toc-pop.htm)

3.5.5 Atlas of California

The only reviewed atlas to utilize Macromedia Flash, the *Atlas of California* (http://www.nacis.org/2003Contest/katz/index.html) integrates select physical, cultural, and historical data in an interactive 'GIS-type' setting. Flash has the capability to incorporate various multimedia components, such as video, animation, and sound, but the majority of the interactivity in the atlas is restricted to turning layers on/off and zooming (Figure 10). The limited thematic content and level of interaction can be attributed to the atlas' pedagogic origins – initiated through an advanced cartography course at Humboldt State University. Still, the atlas does present information in a clear and interesting manner. Most importantly, for atlas designers, this project demonstrates that Internet atlas development can be accomplished in a relatively short amount of time.

Figure 10. Earthquake map from the *Atlas of California*. The images illustrate the layer structure (clicking one of the legend boxes displays that layer) and the zoom capabilities (zooming in or out is accomplished via the slider bar and the red 'zoom window' in the index map allows the user to 'pan and scan'). (http://www.nacis.org/2003Contest/katz/index.html)

3.5.6 Atlas of Saskatchewan

The *Atlas of Saskatchewan* was chosen for this review because it is one of the few atlases that has incorporated all the multimedia components listed in Table 4. The CD-ROM edition presents a wide variety of themes, such as Archaeology, History, Climate, Population, and Tourism. Unlike many of the other atlases reviewed, users are not required to 'construct' maps, but are enabled to interact with the maps and the associated multimedia components. Martz and Fung (2000) identify some of the key features of the atlas:

- sound and animation to help communicate geographical information;
- interactive panning to explore the richness and depth of the larger and more detailed maps (Figure 11); and
- dynamic links between graphical and textual material to help the user navigate the tremendously complex body of information compiled for the atlas.

The simplicity and elegance of this atlas can be misleading because it was designed for a broad range of users. While less complex than its 'GIS-type' contemporaries, its intrinsic educational value surpasses any technical shortcomings.

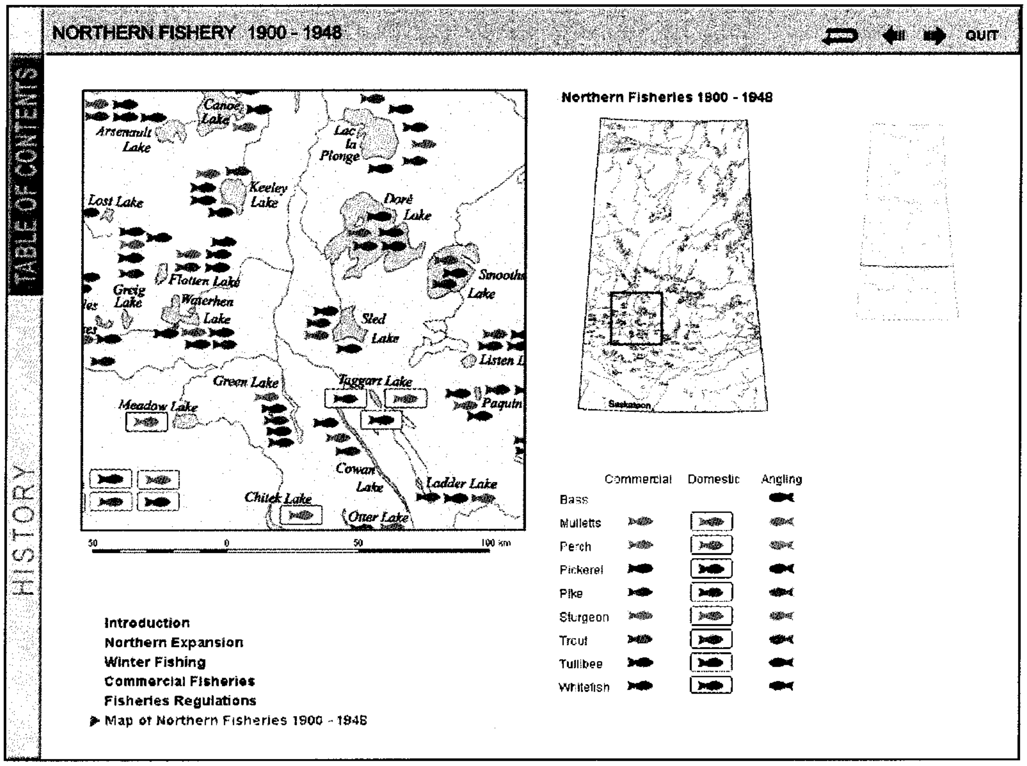


Figure 11. Interactive panning from the *Atlas of Saskatchewan*: the window in the top left is linked to the red window on the right – as the red window is moved around the map, the window on the left displays a larger view.

3.5.7 Atlas of Switzerland

This atlas was selected for review because it represents the pinnacle of user interaction within an atlas information system (Figure 12). Not only can users interact with various features on the maps, they can change the colours and classes of the choropleth maps through specially designed analytical tools. The atlas includes 3D topography (Figure 13) which can be viewed as map relief (above the terrain), block diagram (perspective), or panoramas (in or above the terrain). All can be customized to suit the needs of the user, such as changing the light source position, point of observation, and altitude (Swiss Federal Office of Topography, 2000).

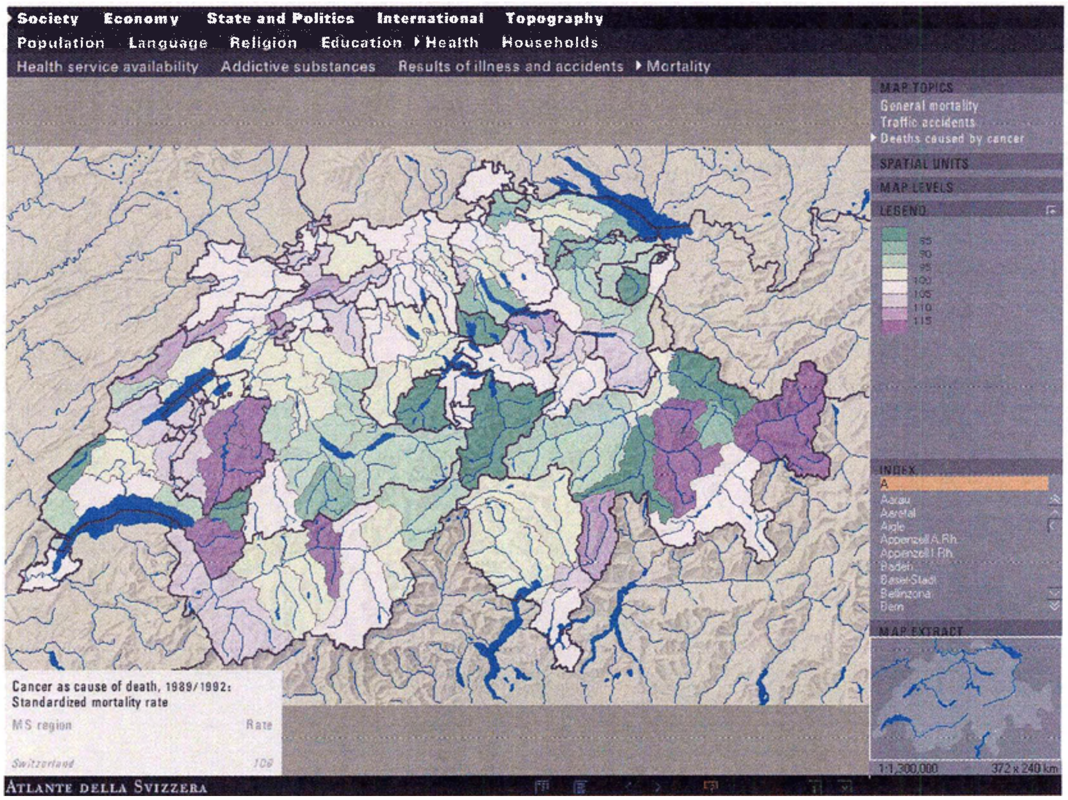


Figure 12. User interface for the *Atlas of Switzerland*. Incredibly detailed, the user has a host of options and tools to choose from.

Figure 13. 3D terrain model from the *Atlas of Switzerland*. The tools on the right allow the user to change various features, such as altitude and point of observation.

The *Atlas of Switzerland* has been designed primarily for public use, but the complexity and analytical capabilities suggest a more knowledgeable user. While there is no question that the authors have created an exciting and captivating educational product, some of the analytical features, such as changing the class boundaries, infer detailed understanding of cartographic and statistical principles.

Because the atlas' creators made an early attempt to place their product on the Web, a prototype is accessible, with limited functions. However, due to "several reasons" not explained on the website, work on the project has permanently ceased.

3.5.8 Atlas of Canada

The Atlas of Canada (http://atlas.gc.ca) website contains a comprehensive collection of maps and related materials. The current edition of the atlas (6th edition) provides users with the opportunity to interact with maps (via an ArcIMS server) by offering the usual 'GIS-type' options: zoom, pan, and a 'get statistics button. Maps from previous atlas editions are available in the 'Map Archives' to view and download.

The Atlas of Canada is an innovative product that provides a large amount of data to Web users, but it is unstable. The interactive environment has a very small map viewing area that provides very little meaningful interaction. In addition, the website has been redesigned and modified several times which makes it difficult for users (including the author) to navigate and find data. Overall, the Atlas of Canada does not provide users with a very interesting or informative experience.

3.5.9 Discussion

Table 4 provides a summary of the technical features of the previously discussed atlases: scale (pan/zoom), layer control (turning layers on/off), measure tool; multimedia components within each atlas: animation, sound, photographs, graphs/illustrations, text (supplementary); and the software or programming language.

	Scale (Pan/ Zoom)	Layer Control	Measure Tool	Animation	Sound	Photographs	Graphs/ Illustrations	Text	Software/ Programming Language
Atlas du Québec et de ses regions	X	X				X	X	X	HTML, Javascript, Macromedia Flash
Electronic Atlas of New Brunswick									HTML
Atlas of Ottawa	X	X	X						HTML, Autodesk MapGuide
Historical Atlas of Canada	X	X	X				X	X	ESRI ArcIMS
Atlas of California	X	X					X	X	Macromedia Flash
Atlas of Saskatchewan	X			X	X	X	X	X	Macromedia
Atlas of Switzerland	X	X	X				X		Macromedia Director
Atlas of Canada	X						X	X	ESRI ArcIMS

Table 4. Atlas comparison highlighting technical features (scale, layer control, and measure tool) and multimedia components (animation, sound, photographs, graphs/illustrations, and text).

The preceding review of Web-based atlases indicates that Internet atlas production has a long way to go, in both quantity and quality. This disparity can be attributed to 'traditional' limitations or the slow acceptance of new technology, but the fact remains that Web-based atlas are not well represented, either regionally or nationally.

The review has revealed a number of interesting trends. Firstly, the majority of atlases use commercial software more than programming languages. Many of the atlases use a GIS based approach which, in turn, affects the variety and type of functionality – layer control and measuring distances are common features in these systems. Secondly, most of the atlases used choropleth maps to display census data, with many of these maps exported from a GIS as static images (JPEG or GIF) – the 'telltale' north arrow and scale bar associated with ArcView, ESRI's *very* popular GIS package, was present in many maps (see Figure 5). Thirdly, and more importantly, multimedia components are employed rarely, if at all. Animation and sound were not present in any of the Web atlases, only in the CD-ROM *Atlas of Saskatchewan*, and photographs were used sparingly. It appears that existing (Web) atlases are not taking advantage of the various multimedia features offered by the Internet.

3.6 Conclusion

The creation of a Web-based atlas is a complex task involving decisions about the intended audience, type and amount of data, cartographic design issues, and technological considerations. Ultimately, the choice and implementation of the technological solution will impact the look of the atlas and the capabilities and functionality of the system. The following chapter will examine the design options and specifications for a future Web-based Atlas of British Columbia.

CHAPTER 4: DESIGN OPTIONS AND SPECIFICATIONS

4.1 INTRODUCTION

As stated by DeLucia (1974: 83), design is "the most fundamental, challenging, and creative aspect of the cartographic process". In a multimedia setting, this process is made more complex by a greater number of design constraints, a greater and more varied quantity of media, and the incorporation of tools to enable users to interact directly with maps and map-based information (Miller, 1999). Contributing to the overall process are the wide variety of programming languages and software available, and the rapid evolution of Web innovations and standards. Selecting one technological approach to meet all design criteria can be a difficult and complicated task; what is considered revolutionary and exciting today may be replaced by a new development tomorrow. This chapter explores the design challenges of multimedia atlas design and presents a conceptual design blueprint for the Atlas of British Columbia.

4.2 ATLAS DESIGN GUIDELINES

4.2.1 Introduction

Cartography has very few definitive rules that govern map design and production. Progressive cartographers can challenge the conventional thinking – Does water have to be blue *all* the time? – but in reality, map users have been exposed to maps that adhere to a traditional set of guidelines (such as blue for water). Atlas design and production is no different – in fact, it could be argued that the nature of traditional atlases (intentional combinations of maps with a well-defined structure) lends itself to a more rigid set of guidelines. In the following sections, traditional and contemporary guidelines for atlas design will be examined and discussed for their intrinsic value, concluding with a list of applicable guidelines for the Atlas of British Columbia.

4.2.2 Traditional Atlas Guidelines

Traditional printed atlases have been in existence for hundreds of years. Consequently, the lessons learned throughout their development are significant issues that should be considered and, where possible, adapted for contemporary digital atlases. One of the first attempts to establish a standardization of design and content occurred in 1957 with the International Commission on National Atlases. The selected recommendations (see page 8 for the other recommendations) made by this commission (Fremlin and Sebert, 1972:31) included:

- *Separation of content into five structured divisions, physical geography, population, economy, cultural, and political and administrative structure, usually with an introductory section preceding the content specifications.*

Establishing and organizing the thematic content is one of the most important issues for any new atlas initiative. As stated by Keller *et al.* (1995:413), "if the information displayed and discussed is of no relevance or interest to the user, no amount of expensive graphics or gadgetry will sell it". While a tradition of well-established atlas themes and topics has been identified, Keller (1995) points out that there has been a gradual shift away from the physical and strict depictions of spatial distributions and relationships, towards the human dimension of landscape and environment, and the telling of a story.

A perfunctory examination of current atlases (digital and traditional) by the author reveals that most atlases follow a variation of the defined structure initially set by the International Commission on National Atlases. Consequently, this project will use the traditional thematic layout as a base to work from and incorporate the research findings by UVic's Spatial Sciences Laboratory (Hocking, 1991; Hocking and Keller, 1992a; Keller *et al.*, 1995, Keller, 1995) to organize the thematic content.

- *Methods of representing phenomena with different types of distribution: at points, along lines, in discrete areas, sparse and continuous across area.*

Simply stated, geographic features should be represented with the appropriate symbol. Geographic phenomena and data can be represented cartographically as point, line, and area symbols according to their level of measurement (nominal, ordinal, interval, and ratio); Figure 14 illustrates the classification of map symbols according to their level of measurement. Regardless of the medium (paper or Web), the symbols must depict, clearly and accurately, the mapped data.

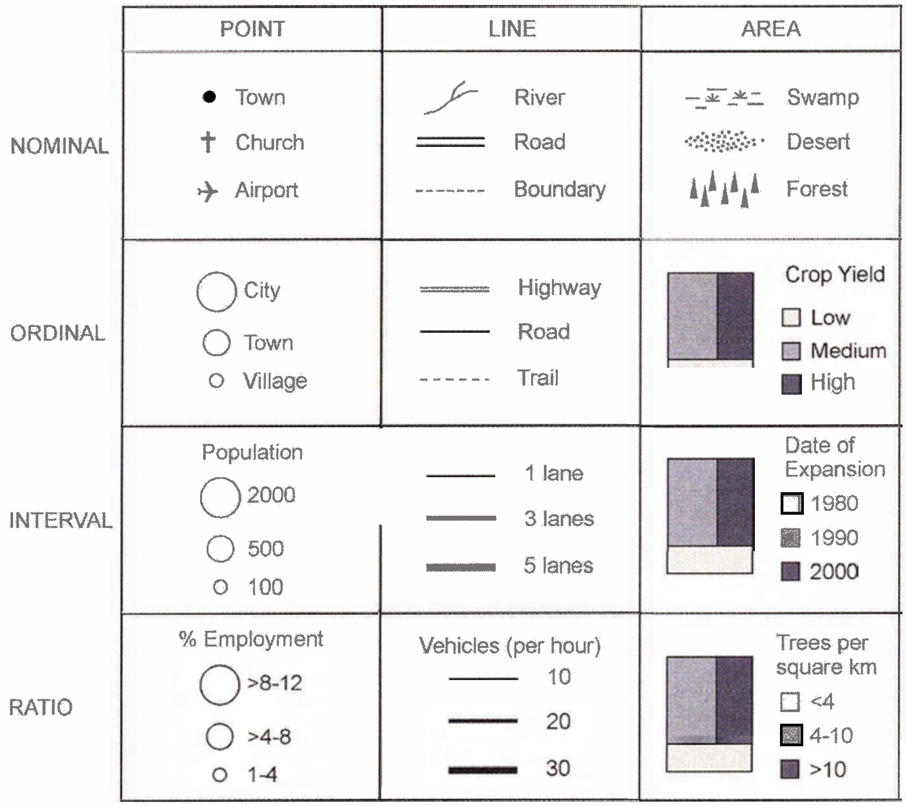


Figure 14. Classification of point, line, and area data according to varying levels of measurement (modified from Dent, 1999).

Use of a simple, rounded [standardized] scale of 1:1,000,000, by which all other scales can be related (doubling or halving).

The use of a simple, rounded scale allows the user to calculate and compare distances quickly. Hocking and Keller (1992a) found that users insist on having a stated scale, preferably including a bar scale for measuring distances. However, using a representative fraction (such as 1:1,000,000) presents two problems: The user may not be familiar with representative fractions and the scale of the map can change with the user's display (screen size and resolution), rendering the representative fraction useless. In a digital environment, a graphic (bar) scale is more appropriate and accurate because the map (and associated scale) would change with the user's screen and window dimensions.

A scale provides the user with additional information but it may not be necessary on all maps, particularly thematic maps. For example, a choropleth map highlighting mortality rates does not require a scale – its presence does not help the user understand the visual and spatial differences displayed. As such, the decision to add a scale will depend on the purpose of the map.

- *A single projection for all maps should be used, with a fundamental aim to restrict distortions; for the world's largest countries, recommendations are made on the appropriate projection to be used. For example, the equidistant right conic projection is suggested for Canada.*

Every projection will distort at least one of the following properties: shape, area, distance, or direction. Selecting an appropriate projection is determined by the purpose of the map and the region to be represented. Generally, conic projections are used to represent mid-latitude regions; for British Columbia, the Alber's Equal Area Conic or Lambert's Conformal Conic would be appropriate.

In their user perspective on atlas design and content, Hocking and Keller (1992a) did not receive many comments or a consensus on map projections – some liked the use of one conventional projection, while others preferred a variety. One of the advantages of a single projection is that the user is presented with a consistent view of a region, which strengthens spatial understanding. Still, varying projections and scales should be incorporated in the introductory section to place the region in an international (global) and national context.

- *Graticules should appear (but not be emphasized) on all maps, except in "map-diagrams", choropleths, "maps-with-graphs", inset maps or "social topic" maps.*

A graticule showing lines of latitude and longitude is not a crucial map component, especially for thematic maps. Instead, the graticule should be incorporated in the introductory section as part of the (global) contextual setting.

User surveys by the Spatial Sciences Laboratory (Hocking, 1991; Hocking and Keller, 1992a; Keller *et al.*, 1995) endeavored to define (traditional) atlas design parameters by surveying the atlas community, particularly students and teachers. In addition to the comments stated previously, their research found:

- *A need for up-to-date material, with dates clearly stated and sources clearly referenced.*

One of the biggest issues with traditional atlases is that maps and supplementary materials become outdated quickly, with no easy way to integrate new information. In a Web setting, maps can be updated frequently and easily (assuming the necessary editorial and logistical support are in place). For this reason, it is crucial that the map's 'last update' date be identified clearly and that sources be available to the user.

- *Text must be relevant, tied directly to the maps, and succinct.*

The maps and multimedia components are the main focus of the atlas. The textual information is important, but it should be concise and relevant.

- *An index is very important, including a thematic index separate from a gazetteer.*

Unlike paper atlases, the table of contents in a multimedia atlas can be available on every webpage, so users can access any map at any time. Therefore, the need for an index, listing all maps, may not be necessary. A (interactive) gazetteer is an important feature that should be incorporated.

- *The importance of clarity: Atlas maps and diagrams showing information that is easy to read and understand, i.e., not too cluttered or too complicated.*

There is a fine balance between portraying too much, or too little, information. Above all, the information that appears on the map or as supplementary material should be relevant to the map's overall message. Because an atlas encompasses such a variety of topics, assembling knowledgeable individuals and establishing an editorial team is an important step towards creating a coherent product.

- *Colour is an important factor; it should be bold, clearly separated, and consistent throughout the atlas.*

In addition to its aesthetic qualities, colour is an important organizational element for establishing visual hierarchy – separating, grouping, and presenting information

(Boyle, 1997). The consistent use of colour throughout the atlas can help draw together the various thematic components and create a familiar and comfortable space for the user.

4.2.3 Contemporary Atlas Guidelines

Although the literature has been relatively circumspect with respect to contemporary atlas guidelines, there have been a number of recent articles which addressed this issue.

In their discussion of the *Atlas of Switzerland* as an Interactive Multimedia Atlas Information System, Hurni *et al.* (1999: 102) provide a summary of the main guidelines they consider to be important to atlas development:

- *All maps should be scalable within a reasonable range. The maps should be drawn appropriately for the level of detail and symbolization.*

This guideline implies that the scale of the map should be scalable (increased or decreased) within a specified range, and that the level of detail change accordingly (more detail with larger scale). While it may be beneficial to zoom into regions to see greater detail, the complexity associated with this feature can be detrimental to the website's functionality. A common tool on GIS mapping websites, zooming uses a considerable amount of bandwidth that can create viewing problems for the user. In many cases, the zooming option is slow and inconsistent, even with a broadband (high-speed) connection. For many websites, it is a 'play' option that does not provide more information or understanding.

- *All map objects of interest should be query-enabled or searchable.*

A well-established component of GIS, the query 'tool' provides additional information (such as area, perimeter, length, x/y coordinates, classification, etc.) for specific map objects. One of the problems with making '*all map objects of interest*' available, is that the designer has to specific which objects will be of interest (query-enabled) to the user, or conversely, all objects have to be available. Either method requires a substantial undertaking with database organization, storage, and retrieval. In a Web setting, this translates into considerable use of bandwidth and time, and the increased potential for computer problems ('crashing' or stalling during data retrieval). It is not obvious why query of area or distance is relevant on all maps displayed in a Web-based atlas – query functionality should be appropriate to the theme displayed.

- *Maps should be built up from layers, which can be individually turned on and off – as far as it makes sense.*

Building a map from a selection of layers is another common feature of GIS. With this option, the user controls what is displayed on the map by choosing (turning layers on and off) various data layers. The implication here is that the user is responsible, to a degree, for the final map output. In a multimedia atlas setting, users should be encouraged to *explore* the map through its multimedia components without having to first 'build' it.

- *Anti-aliasing should be used to improve the quality of the map graphics.*

Anti-aliasing is a software technique that corrects the coarse appearance of graphics on low-resolution monitors by partially filling the edge pixels and thereby gives a smooth curve to the graphic (Hurni *et al.*, 1999) (Figure 15). Anti-aliasing is not a concern for this project because most of the current Web-based mapping products incorporate anti-aliasing techniques.

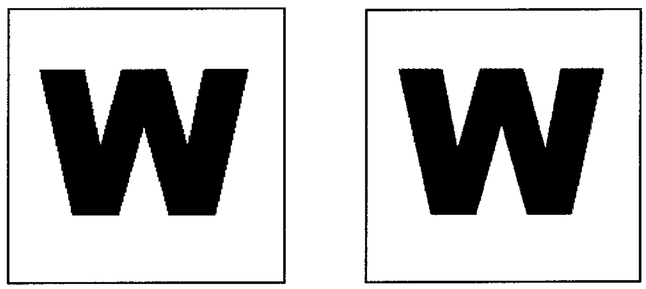


Figure 15. Anti-aliasing has been applied to the image on the right, which smoothes the jagged edges seen in image on the left (Clark, 1997).

- *Dithering should be applied for limited colour display devices.*

When images created at a high resolution, 24-bit (16.7 million colours), encounter computer systems set at low resolution, 8-bit (256 colours), the system tries to approximate the colour that cannot be represented by combining colours it does support (Figure 16), with the result that the colour become "dithered" (Hurni *et al.*, 1999). Dithering could be a concern in that it reduces the overall sharpness of an image and often introduces a noticeable grainy pattern into the image (Figure 17), especially apparent when full-color photos are dithered down to the 216-colour browser-safe palette (Lynch and Horton, 2002). However, Weinman (2003) believes that, because so few computer users view the Web in 256 colors anymore the browser-safe colour palette is unimportant. Lynch and Horton (2002) support this view, stating that most Web users have computers and monitors set to 'thousands' or 'millions' of colours, so there is no longer any need to restrict color choices to the 216 Web-safe colors.

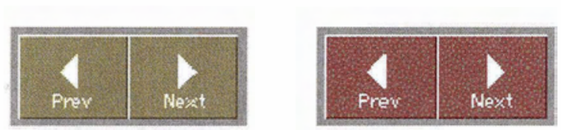


Figure 16. The graphic on the left uses the browser-safe colors, whereas the graphic on the right did not and the colour has dithered (Lynch and Horton, 2002).

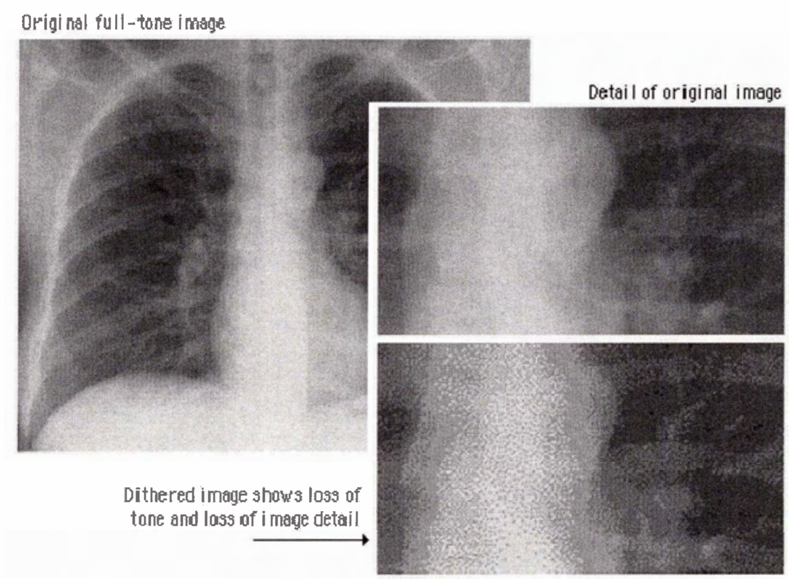


Figure 17. Illustrates the loss of detail in dithered graphics (Lynch and Horton, 2002).

- *The overall atlas graphic design should hide most of the system interface appearance.*

The maps and associated multimedia components are the primary focus of the atlas and should be maximized to their full extent within the confines of the webpage. Consequently, the interface should be straightforward to navigate, yet remain 'hidden' as much as possible. Pop-up windows and drop-down menus are just some of the options available to help minimize the interface.

- *The interface should require a minimum of help.*

The interface is the 'control-panel' for the atlas – it allows the user to navigate through the website and interact with the various tools and multimedia components. As such, the navigation aids (graphics) and 'controls' should be instantly recognizable, easy to use, and consistent in both appearance and placement.

To investigate design and functionality issues with the *Atlas of Canada* (website), the atlas staff initiated a comprehensive user survey. Based on their research, the authors (Williams *et al.*, 2003) suggest the following recommendations:

- *Define the audience and the mission. Never assume anything about your users, let them tell you and test, test, test. Do as many iterations as time and money allow.*

The first and most important step in the cartographic design process is the identification and definition of the 'problem' to be addressed (Delucia, 1974). The map purpose should be clear and succinct so that the end product successfully communicates its intended message to the audience. In defining the purpose, it is necessary for the cartographer to ascertain as much information as possible about the map users. Identifying the target audience will help establish the design criteria and functionality of the atlas. For example, design of an interactive atlas for school children will require a different level of interactivity than one designed for GIS professionals.

Establishing a target audience can be difficult for contemporary atlases because the Web is 'open' to anyone with a computer and Internet connection. Even within traditional atlas design, it has been recognized that atlas users are an elusive and varied group, not readily identifiable (Hocking and Keller, 1992a). Ideally, a user survey would be initiated prior to atlas development; unfortunately, this is beyond the scope of this project. It is strongly recommended that any future work incorporate a user assessment of the prototype.

- *Clean, clear uncluttered aesthetics are essential. Remove everything that is not needed – function and page layout are more important than aesthetics.*

An aesthetically pleasing product is a significant part of the design process, but it can be difficult to accommodate all likes and dislikes. It is more important to have a well-organized and functional product.

- *Fast direct access to primary content is paramount. Have a clear hierarchy of content.*

Users want access to information in the fewest possible steps, so it is important to design the site hierarchy so that real content is only a click or two away from the main menu pages (Lynch and Horton, 2002). An efficient hierarchy provides quick and easy access to materials with no 'dead-ends' (Figure 18). To avoid dead-ends, each page should have a hyperlink back to the table of contents or home page.

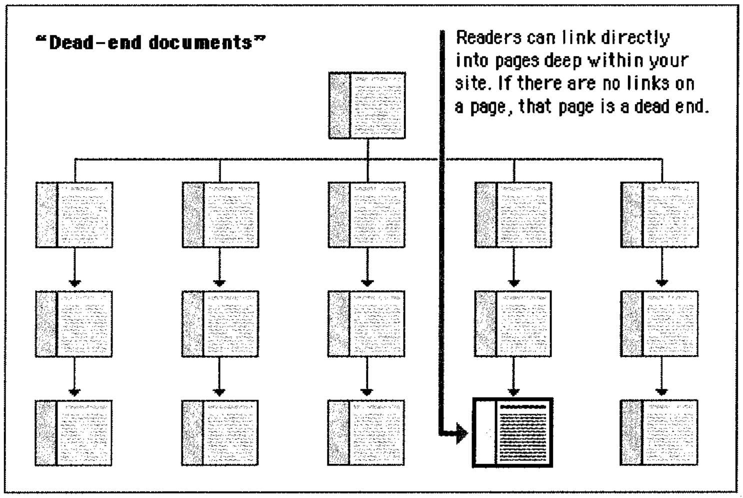


Figure 18. Dead-end documents (Lynch and Horton, 2002).

- *Spend time, but not too much on labels: you cannot please everyone. Avoid jargon, select words users would understand.*

As discussed previously, *all* text should be straightforward, concise, and relevant. Gratuitous complexity will confuse the user and discourage future visits to the site.

In addition to the previous, two additional guidelines merit attention:

- *The image and file size of the maps and related multimedia should be as small as possible (without compromising any of the graphic quality and/or data presentation) to facilitate a faster downloading time* (Kraak, 2001).

In a Web environment, time is a key issue. If an image, file, or webpage takes too long to download, the user will lose interest. Research has shown that users will tolerate less than ten seconds for most computing tasks (Lynch and Horton, 2002). For that reason, the designer must balance content (including aesthetics) and functionality with file size.

- *The technical nature of the medium means that the output can change with the users' browser and operating system, graphic card, and display quality (resolution), as well as the users' personal preferences for display – colour balance, contrast, and brightness (van Elzakker, 2001). Therefore, it may be necessary to design the site with a minimum (or 'average') configuration, or to allow users to select from a list of [display] configurations.*

It is difficult, if not impossible, to create a Web-based product that will look identical on every computer screen. With computer and Internet technology advancing daily, standards change rapidly. For this project, designing a site with a minimum configuration would be unreasonable given that it incorporates some 'high-end' features, such as video and animation.

4.2.4 Design Guidelines Summary

Regardless of the medium, there are a number of common guidelines inherent to atlas design. These recommendations will define the conceptual framework for the Atlas of British Columbia:

- define the target audience and the purpose of the atlas;
- structure the thematic sections on traditional divisions (integrating contemporary topics) using labels the user will understand;

- interface must be user-friendly and conveniently concealed;
- well-organized and structured hierarchy of content;
- functionality is more important than aesthetics;
- clear, uncluttered, easy to understand maps and graphics;
- a bar scale is more appropriate and easier to use than a representative fraction;
- a single projection for the thematic base map;
- text must be relevant and succinct; and
- dates clearly stated and sources referenced.

From the previous discussion on traditional and contemporary atlas design guidelines, simplicity is a crucial element in the design process. Repeatedly, authors and Web designers stressed the importance of presenting clear, uncomplicated information in a consistent and predictable manner. To meet the needs and expectations of the users, identifying the target audience and purpose of the atlas is strategic in structuring the site design.

4.3 Technical Specifications

4.3.1 Introduction

In terms of atlas design, the Web presents a unique challenge. Traditional atlases are well organized combinations of maps and supplementary information structured by specific map scales and map sequences (Kraak, 2001b). This structured organization is challenged by the capabilities of the Internet because the structure of the Web and webpages differ significantly from printed atlases or CD-ROM applications (Richard, 1999). Most computer users know how to turn pages and read a book; but how can users access information when the product is no longer necessarily in linear form? (Hurst, 1997). On many websites, users have the ability to 'jump' from topic to topic without following any particular order. Most websites are not designed to be read sequentially like a book, but the user is encouraged to move around the site easily, which requires that subject groups and their relations be organized in a logical structure (Feringa, 2001).

The following sections will examine the technical and multimedia components for the Atlas of British Columbia, beginning with a discussion on the target audience, followed by: the GUI (Graphical User Interface); organizational structure; legends; scale (zooming and panning); sound; photographs; animation; and supplementary information (text, graphs, illustrations, metadata, hyperlinks).

4.3.2 Primary Uses and Audience

The Atlas of British Columbia is intended to serve three primary purposes:

1. an educational tool (a tool to gain insight into British Columbia's physical and human landscape, history, and economic activities);
2. an item of curiosity (armchair travel); and
3. a means for comparison, the so-called 'Jones Syndrome'.

First and foremost, the atlas serves as a tool for educational purposes. As discussed by Dymon (1995), visually powerful cartographic presentations promise an exciting new direction for geographic education – providing an interactive relationship between students and the atlas. Secondly, as an item of recreational curiosity, the atlas is an excellent way to 'explore' the physical and social landscape of British Columbia.

Finally, as a tool for comparison, the atlas satisfies the inherent need in human nature to draw comparisons and to evaluate how we are performing relative to somebody or something else (Keller, 1995).

The underlying principle of this project is visualization of topics. Users are encouraged to *explore* the map through its multimedia components, without having to first 'build' the map, or decipher complex instructions. While the pedagogic goals of the atlas clearly indicate a predisposition towards educators and students, the atlas is meant to serve a wide range of individuals: the general public. With such a wide range of abilities and knowledge, it is necessary to strike a balance between the extremes and accommodate the 'average' user.

4.3.3 Graphical User Interface

The organizational structure of the website is important, but the success of a multimedia product is determined primarily by its Graphical User Interface (GUI), which enables product functionality, navigation, and visual display of content (Miller, 1999). The GUI of multimedia atlases have been designed after certain metaphors to simulate real world tools or phenomena: Some follow the well-known Windows/Mac interface of pull-down menus and windows, whereas others simulate an office, an interactive globe, a cockpit, a data store, a time machine, or a tour guide (Borchert, 1999).

Regardless of appearance, the GUI is typically comprised of two components (Miller, 1999):

1. the map object, a responsive display that is the primary means of product control and which provides direct spatial access to product content; and

2. the marginal objects that exist outside the bounds of the map object that incorporate display, access, navigation, and interaction tools.

For example, the *Atlas of Switzerland* and the *National Atlas of Canada* websites are designed with map object windows and marginal tools or "control panels". Within the map object or "hypermap" (Figure 19) – georeferenced multimedia – there exists a number of possible linkages to multimedia documents (Kraak and Ormeling, 1996).

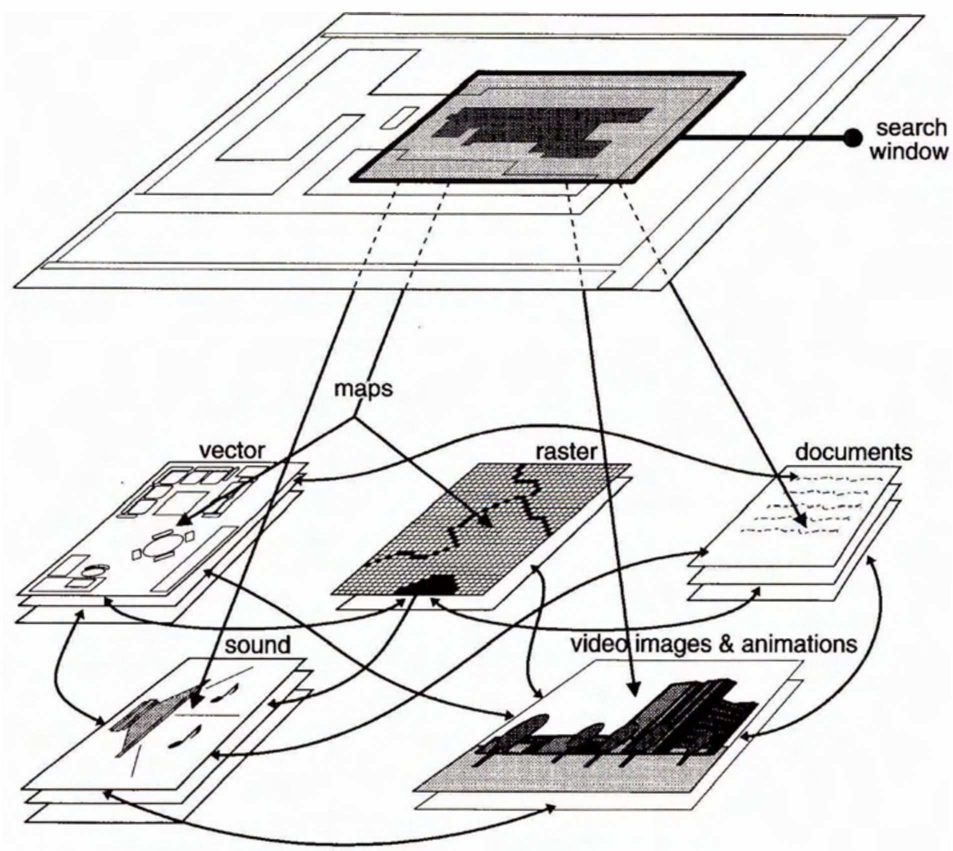


Figure 19. Hypermap principles: finding multimedia documents and their links based on a spatial search (Kraak & Ormeling, 1996: 191).

To enable user access to the various media presented without technology getting in the way, the interface must be intuitive (using familiar features, such as magnifying glass for zooming), built on real-world knowledge, and provide enjoyment (Ingram, 1996). Najjar (1997) suggests that successful multimedia designers build their products with primary emphasis on the user by:

- keeping the user interface simple;
- being consistent;
- letting the user control the interaction;
- giving immediate feedback for every user action;
- using familiar metaphors; and
- letting the user explore the product safely.

In a virtual environment, a Web-based atlas is open to a variety of users with differing abilities and should be designed for the average user so that expert knowledge of the GUI is not required (Richard, 1999).

4.3.4 Organizational Structure

The opening sections of the website will provide a brief introduction to the atlas, data available, any downloads or plugins required, and any potential conflicts that could be encountered by the user's computer, such as optimal screen resolution or browser requirements. The intention is to inform the user of any and all potential issues before they enter the site and, where appropriate, to provide links that would improve the overall experience.

Due to the breadth and scope of the themes within this atlas, a hierarchical structure should be implemented to facilitate individual pages. Organizing the atlas using a conventional thematic approach, such as a table of contents, is recognized and understood by most users (Frappier, 2000), and will be employed. Navigation through the atlas will be accomplished through an expandable/collapsible table of contents, which will remain accessible to the user at all times. The advantage of such multi-page websites is their breakdown of the content into 'chunks' which focus the map-reader's attention on specific information (Cammack, 1999). Scrolling through the themes, the user will have the choice of selecting either a broad topic, such as Earth Science, or a specific subdivision within that theme, such as Earthquakes.

Keeping the user oriented within the site will serve not only to tell the user where they may go, but also where they are and where they have been (McGregor, 2002). One of the most common navigational aids within a website is 'bread crumbs' (Figure 20). Bread crumbs show users where they are in the hierarchy and how the information is structured (van Welie, 2003). As the site develops, an alphabetical index should be incorporated as part of the organizational structure, so that users have another option for navigation.

Figure 20. Bread crumbs show the path from top level to the current page (Sun Microsystems, 2004).

4.3.5 Legends

In a Web setting, legends can be designated as either non-interactive (like those found on paper maps) or interactive. One of the advantages of non-interactive legends, if displayed as a separate window, is the ability to move and minimize it. In this way, the legend does not interfere with the map contents and can be viewed at the user's discretion. With interactive legends, van den Worm (2001) differentiates between pop-up legends (Figure 21), which are activated when the user selects a map object, and control-panel legends (Figure 22), which are used to control the information that appears on the map.

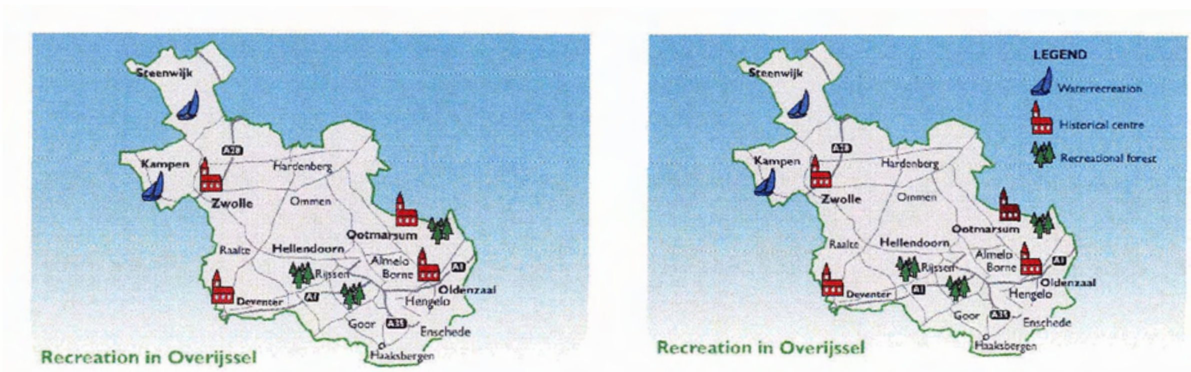


Figure 21. Pop-up legend: Clicking on any of the map symbols causes the legend to 'pop-up' in the top right corner (van den Worm, 2002).

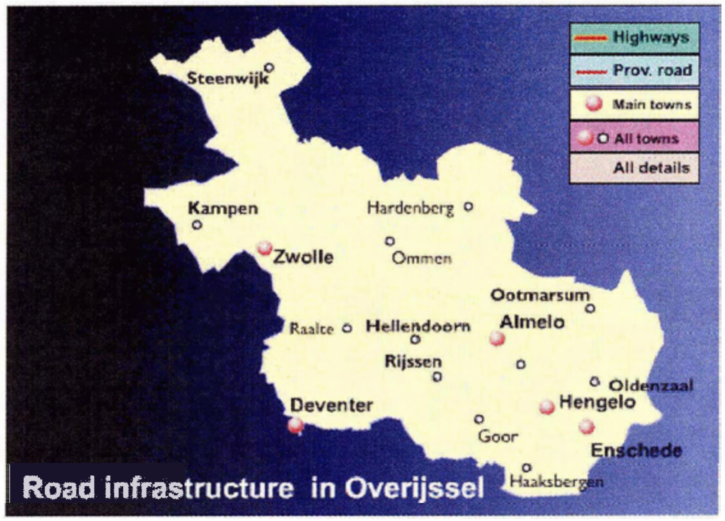


Figure 22. Control-panel legend: Clicking on one of the legend options (such as All towns) makes that feature visible (van den Worm, 2002).

4.3.6 Scale (Zooming and Panning)

British Columbia is the third largest province in Canada: From north to south it stretches 1,200 kilometres, and from east to west as much as 1,050 kilometres; also, it has a land and freshwater area of 95 million hectares, and boasts an impressive 7,000 kilometre coastline (BC Stats, 2001). The unique challenge of fitting British Columbia's size and slightly irregular shape to a standard monitor screen is not easily done. Additionally, with such a large landmass, any data must undergo a significant reduction in the level of specific detail that could be displayed – a cartographic process called generalization. For example, a city depicted on a small-scale map (1:1,000,000) could be symbolized by a circle; then, zooming in to a larger scale (1:50,000), the level of detail increases to show the areal extent of the city.

To increase the level of detail with increasing scale, two options are available – static stepped or dynamic zooming (Figure 23). Static stepped zooming is characterized by a series of maps created at various scales or scale ranges, so that, as the user zooms in, the software selects the appropriate map for the scale selected (van den Worm, 2001). In this situation, the user has the illusion of controlling or selecting the scale, since the software will default to the map with the closer scale range as specified by the cartographer. With dynamic zooming, there is a direct link between the image and a database that facilitates a change in symbolization; so the larger the scale, the more detail is shown (van den Worm, 2001). Dynamic zooming, typically restricted to GIS mapping software and complex programming languages, has the potential to give the user complete control over the scale, although the size and nature of the database will ultimately dictate the amount of information accessible.

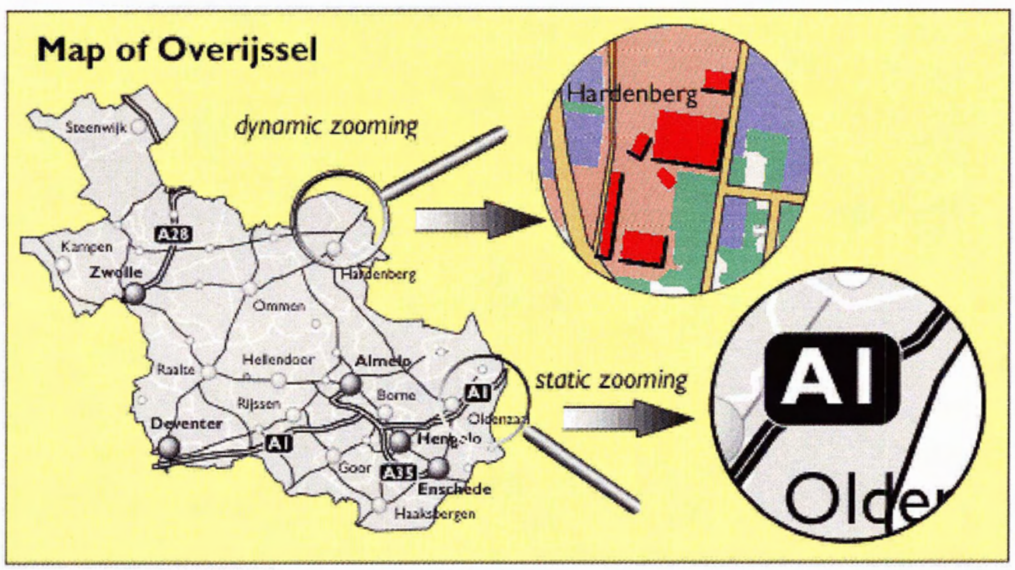


Figure 23. Map illustrating static and dynamic zooming of a vector-based image (van den Worm, 2001:92).

An alternative to the zooming strategies outlined above is interactive panning. In this technique, the user pans over a small-scale index map with a floating window that acts as a magnifying glass. As the window passes over the index map, a corresponding

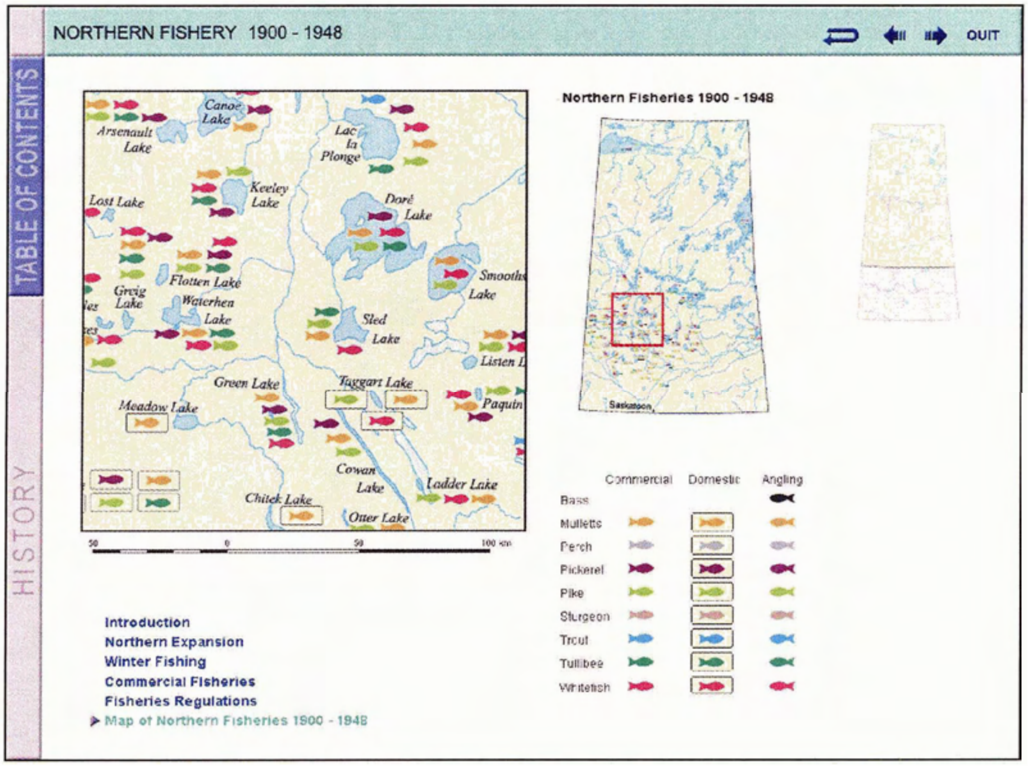


Figure 11. Interactive panning from the *Atlas of Saskatchewan*: the window in the top left is linked to the red window on the right – as the red window is moved around the map, the window on the left displays a larger view.

3.5.7 Atlas of Switzerland

This atlas was selected for review because it represents the pinnacle of user interaction within an atlas information system (Figure 12). Not only can users interact with various features on the maps, they can change the colours and classes of the choropleth maps through specially designed analytical tools. The atlas includes 3D topography (Figure 13) which can be viewed as map relief (above the terrain), block diagram (perspective), or panoramas (in or above the terrain). All can be customized to greatest application can be seen in the 'Bird Song' section. Included in this exceptional theme are thirty species and one hundred different bird songs, as well as a map that highlights the breeding, wintering, summering, and migration patterns of each bird.

For the Atlas of British Columbia, sound may be difficult to integrate in a meaningful manner because of the limited number of themes and the availability of suitable audio data. For example, it is not appropriate (or beneficial) to use sound in a map showing mortality rates for pneumonia/influenza.

4.3.8 Photographs

Maps are selected representations of the real world. For this reason, many map-readers find it difficult to visualize information displayed on a map, such as contour lines on a topographic map. Peterson (1997b:8) estimates that "more than half of the educated population do not have a basic understanding of maps". In a multimedia environment, a map can come to life by linking pictures of entities in the real world with features found on the map (Morrison, 1995). However, Hocking and Keller (1992a:115) received mixed comments regarding photographs in their atlas user survey:

> Whereas there is positive comment regarding photographs from a number of pupils, their presence is viewed with suspicion by a number of adults as a cheap filler, useful only to break up the maps. If at all, photographs should be used only if "appropriate" to "display significant features", or to "provide context for discussion".

While in traditional atlases, photographs can take-up valuable space, in a virtual setting they can be 'hidden' and revealed when required, using rollovers, hyperlinks, or pop-up windows. This does not mean that the comments cited above are not without validity: Photographs, like all atlas components, must be managed carefully.

Richard (1999) recommends the following guidelines for Web graphics:

- make image file size as small as possible;
- use the appropriate file format for the type of image (flat colour images should be saved as GIF, whereas continuous tone images should be saved as JPEG); and
- perform tests to get the smallest file size without losing photo integrity (quality or detail)

If the quality of the photograph or the size of the file cannot be reduced without compromising the quality of the picture, an alternative is to present a 'thumbnail' of the image. With this method, the user is given a preview of the image and can decide whether or not to download (view) the file.

4.3.9 Animation

The widely recognized limitation of static maps to depict the temporal dimension has contributed to the special status of animation in cartography (Peterson, 1998). Animations are an expressive way to explain complex processes, such as the growth and development of a city or the evolution of a river delta (Kraak, 1996). Although cartographic animation has existed for many years, only recently has the ability to produce professional-quality animated maps been within the financial means of most cartographers (Harrower, 2004). In addition, the Web has provided a practical and inexpensive way for millions of users to access animated maps on demand (Harrower, 2004).

Users must feel that they are active participants with the animation, not merely bystanders. It is important to have tools available that allow for interaction; viewing just the animation will leave users with many questions about what they have seen (Kraak, 2001a). A control panel with pause, play/resume, step forward, and step backward buttons can give users access to the full range of motions. For example, a step-wise action (forward and backward) provides the user with time to examine individual frames without having to replay scenes repeatedly (Figure 24). Alternative scenarios include a moving slide bar or a list of time periods from which the user can select a particular episode.

Animation provides users with a dynamic, educational, and visually exciting glimpse into the temporal nature of spatial data. But caution must be exercised with its use. With the availability and (relative) simplicity of current technology, it is easy to fall into the trap of using animation for the sake of animation and entertainment. However, this would not contribute to the pedagogic goals of the atlas. For the Atlas of British Columbia, animation can be used to illustrate, for example, the retreat of the ice sheet during the last glaciation or the navigation (ship) routes taken by 18th century explorers.

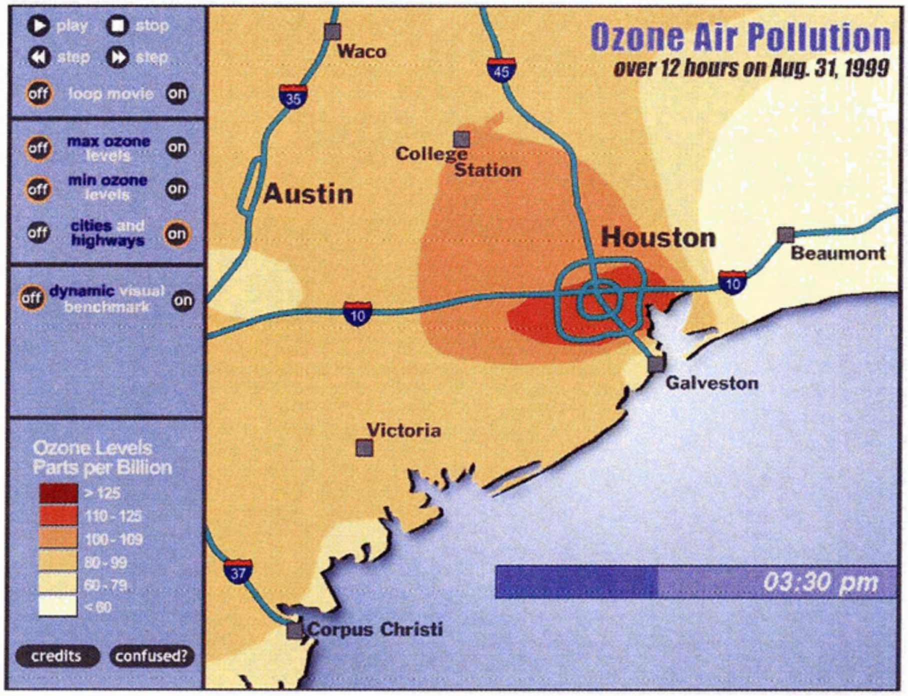


Figure 24. An animated map showing the distribution of ozone over a twelve hour period (Harrower, 2002). The controls are located in the top left corner (play, stop, step forward and step back)

4.3.10 Supplementary Content

In addition to the aforementioned media components incorporated into the atlas, text, graphs, and illustrations should be used to augment content where appropriate. As discussed, user surveys discovered that, where applied, text must be relevant, tied directly to the maps, and succinct (Hocking and Keller, 1992a). In a Web setting, text, graphs, and illustrations need not require large amounts of space, but can be made accessible through either a scrolling (text) window or pop-up window, which this project will use. Also, metadata need not be embedded on each map, as per most paper maps, but should be made available to the user through menus and legends, at their discretion (such as via expanding/contracting menus and pop-up windows).

Hyperlinks to sites offering more detailed sources of information and data should be established for each theme. As discussed in previous chapters, cartographers must judge carefully the amount of information displayed on a map – too little and the user won't grasp the topic, too much and the user may become overwhelmed. Even so, atlases cannot be the 'last word' on all subjects and cannot show every phenomenon or illustrate every part of the geographic environment (Fremlin and Sebert, 1972). Hyperlinks can alleviate these issues by providing relevant sources of supplementary material.

4.3.11 Summary

The discussion to this point has emphasized what *will* be used in the atlas and what *should* be included. Chapters Five and Six will demonstrate these guidelines and suggestions through the atlas shell production and thematic development, respectively. To summarize:

- primary uses: educational, curiosity (armchair travel), and comparison;
- target audience: general public and educators;
- an interface that focuses on the 'map object' and minimizes the space occupied by the marginal controls, such as navigation;
- use of a hierarchical structure;
- interactive legends, preferably pop-up, that can be moved at the user's discretion;
- scaling (zooming and panning) will be depend on the technological solution;
- animation and sound that is appropriate to the theme, with user controls;

- high quality photographs (including graphics and illustrations) that complement a theme but are not cumbersome to the user (i.e., file size too large); and
- hyperlinks to additional information.

As a whole, the design and technical guidelines form the conceptual design framework for the Atlas of British Columbia. The next step is to establish a technological solution that will meet these requirements.

4.4 TECHNOLOGICAL SOLUTION

4.4.1 Introduction

Selecting a technological solution that satisfies all the design criteria is a difficult task. As discussed in Chapter 3, a myriad of technological approaches are available, from packaged software to programming languages. Much of the mapping software in use today (such as ESRI's ArcIMS) offer an impressive array of GIS capabilities, but focus more on data handling than visualization. Moreover, the high cost associated with these programs is beyond the budgetary limits of most projects.

4.2.2 Technological Requirements

The previous sections have outlined the conceptual framework for the Atlas of British Columbia. To meet those needs, the selected technology must be:

- able to incorporate multimedia components, such as sound, animation, and video;
- vector-based;
- inexpensive;

- user-friendly, or in this case, 'author-friendly' – relatively easy to learn with a strong network of support (instructional websites, user-forums, books); and
- accessible to a wide range of users, i.e., across multiple platforms.

4.4.3 The Technology

During the development of Canada's NAISMap (National Atlas Information Service) Software, one of the first interactive atlases on the Internet, a number of important lessons were discovered (Frappier, 2000):

1. commercial approaches are more useful than in-house solutions, particularly in terms of development cost reduction and capacity of organizations to provide technical support;
2. no software system satisfies all the selection criteria, including ease of use, tool adaptation, protection of the database, and system security; and
3. developing personalized software is awkward, and the industry's capacity to respond to specific needs is very limited.

Deciding which of the many potential features to include within an electronic atlas will ultimately come down to a question of resources and available expertise (White, 1998).

As outlined in Chapter 3, the majority of existing Web atlases used commercial software more than programming languages. In many ways, the commercial approach is faster and easier to use than a programming language because software packages are equipped with ready-to-use templates and components. Unfortunately, most of the atlases reviewed in Chapter 3 incorporated GIS based software packages, which do not use the multimedia components outlined for this project. In addition, most are beyond the project's budgetary constraints. Still, two technologies present themselves as prospective solutions: Macromedia Flash MX, a commercial software package, and SVG, a programming language.

Introduced in 1997, Flash is a vector-based graphics format (SWF) that has become the most widely distributed vector format with interaction (Neumann and Winter, 2002). A popular tool for creating animation and interaction on the Web, Flash is capable of creating a wide range of applications, from simple animations to sophisticated data interfaces and interactive learning environments (Boston University WebCentral, 2002). Its popularity among Web designers has grown because it is a complete solution: a well-designed authoring application, a robust file format, and a widely distributed player (Artymiak, 2002). Furthermore, the innovative features associated with the latest version of Flash provide designers with easier integration of multimedia components.

Macromedia (2002) estimates that of the world's 485 million Web users, 97.8% can view Flash content. According to Adobe (2000), the SWF file format is ideal for presenting vector-based interactive and animated graphics with sound for the Web because it is vector-based, has a smaller file size, and its graphics are scalable and play back smoothly on any screen size and across multiple platforms. As well, Flash movies are self-contained ensuring that the content will be delivered consistently regardless of what browser, operating system, or other installed software visitors may have (Boston University WebCentral, 2002).

Of the programming languages available, one presents itself as a potential solution: SVG. As a relatively new standard, SVG has created a great deal of excitement within the cartographic community, particularly within Switzerland's Institute of

Cartography. At the first SVG conference, Neumann and Winter (2002) enthused that the new language was, "to the benefit of cartographs [*sic*], who, for the first time in Web history, will be in a position as to comply to maximum graphical demands." SVG has been recognized as a Web standard by the W3C, and its popularity is growing.

The capabilities of SVG and Flash are very similar – "more or less everything that SVG promises to do is possible with the SWF (Flash) format of Macromedia" (Feringa, 2001:184). The biggest difference between the two technologies is their distribution and availability. As discussed, more people on the Web can be reached with Flash than with SVG. This discrepancy is due in part to the size of the SVG player, which requires a 2 MB download – not a realistic way to reach the Web masses (Goad, 2002). Table 5 highlights some of the similarities and differences associated with SWF and SVG.

	SVG	SWF
Official W3C Open Standard	yes	No
File sizes	relatively compact	a little more compact than SVG, due to binary format
Streamable	no	Yes
Plug-in size	large, about 2MB	small, about 200k
Plug-in availability	fair (Adobe estimates about 10 percent)	very good, more than 90% percent availability
Zooming and Panning	yes	Yes
Stop Animations	yes	Yes
Anti-aliasing	yes	Yes
Text (text blocks, text wrapping, alignment, paragraphs, styles)	no	Yes
Sound	principally yes, (but sound is not part of SVG specification)	yes, embedded; supports streaming and mp3 compression
Video	video are not part of SVG specification; must be handled by other players	yes, embedded
Animation	yes, frame-based/time-based/interpolation-based; script based	yes, frame-based/time based; script-based
Buttons	no, but can be implemented with JavaScript and events	Yes
Scripting language, Programming	JavaScript, ECMA *(European Computer Manufacturers Association)* JavaScript, Java Bindings, ActiveX controls	proprietary, Macromedia ActionScript (close to ECMA JavaScript), may be mixed with ECMA
Import to graphics-software	yes, it is also designed as a graphics exchange format	yes, some software provides import-filters
Export from graphics-software	yes (CorelDraw, Adobe Illustrator, Sketch, etc.)	yes (Macromedia Freehand, CorelDraw, Adobe Illustrator, etc.)
Conversion scripts from other graphics- or GIS-formats	yes	Yes

Table 5. Comparing .SWF (Shockwave Flash) and .SVG (Scalable Vector Graphics) file format specifications (Neumann, 2004).

Therefore, to meet the design requirements and functions discussed previously, Macromedia Flash MX has been chosen as the technological solution for this project. Flash's proficiency with animation, audio, video, and user interaction, makes it an ideal solution for a multimedia Atlas of British Columbia. With financial and time constraints, this product offers ease of use, a well-developed network of support (website tutorials, chat rooms, and books), and financial affordability.

4.5 CONCLUSION

Macromedia Flash MX is a multimedia product that creates webpages with highly sophisticated interactive interfaces, animation, and information graphics (Feringa, 2001). From the point of view of cartography, this is the most up-to-date standard for the representation of vectors (Neumann and Winter, 2002). Multimedia development is dynamic and cannot be achieved on the basis of principles alone, but will include a continuous need to invent, represent, experiment, and refine (Boyle, 1997). The design and production process of this atlas will involve thorough testing and evaluation, as well as a number of compromises, in order to display the information effectively and efficiently. Chapter Five will detail the development of the atlas shell.

CHAPTER 5: ATLAS SHELL DEVELOPMENT

5.1 INTRODUCTION

The following chapter describes the development of the atlas shell. The opening section provides information on the template's technical specifications: Screen resolution, site organization, and internal file structure. Following the technical details, the structural components of the atlas are examined sequentially, starting with the opening page of the website (splash screen), followed by the template for the page layout, the table of contents, and the base map.

5.2 TECHNICAL SPECIFICATIONS

5.2.1 Screen Resolution

From a Web designer's viewpoint, creating a site that maintains its appearance on different monitors with varying screen resolutions can be a difficult task. Screen resolution (the amount of information a computer monitor can display) is not dependent on the size of the screen and can be set to varying levels: 640x480, 800x600, 1024x768, and 1280x1024 (Figure 25). Screens set at high resolutions, such as 1024x768, display more information because the content is compressed (Figure 26); this compression occurs without loss of details because high resolution is capable of displaying more pixels on the screen (EchoEcho, 2002).

On many websites and chat rooms, there is debate over the most advantageous screen resolution to use when designing a site. Discussion centers on access versus performance: Whether it is better to use minimum configurations to ensure *all* users have access, or to create a website with higher resolution and maximum content, but lose some visitors. Recent Web statistics (Table 7) illustrate that users with screen resolutions of 1024x768 and higher have increased in the last year. As technology develops and larger computer monitors become cheaper, resolution standards will continue to reflect this trend (Zorn, 2001).

For the Atlas of British Columbia, screen resolution for design is set at 1024x768 to reflect the increasing commonality of higher screen resolutions and the enhanced ability to display greater content.

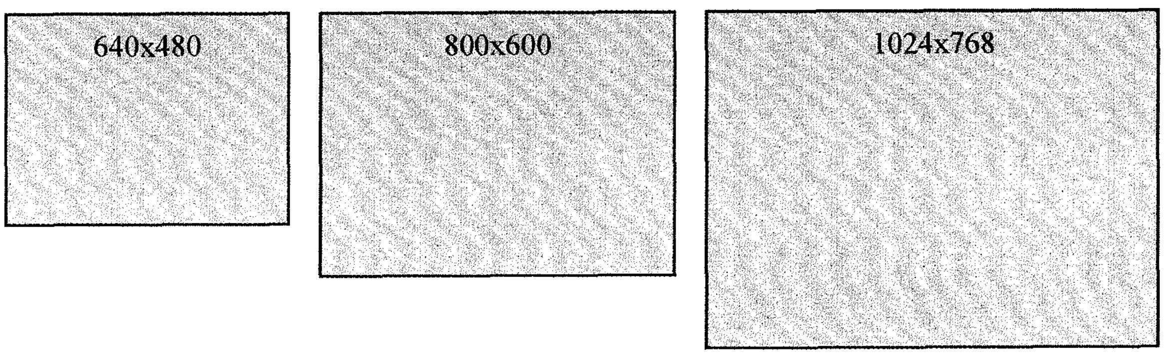


Figure 25. Common screen resolutions showing how much content will fit on the screen, not how the screen actually looks (EchoEcho, 2002).

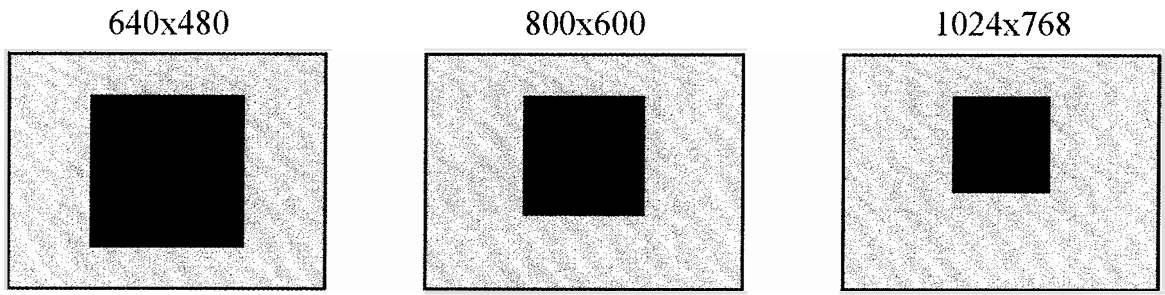


Figure 26. The same image viewed on three different screen resolutions. The example shows that screens set at high resolutions compress the content more than screens set at low resolutions (EchoEcho, 2002).

Screen Resolution	**Jul 02**	**Oct 02**	**Jan 03**	**Apr 03**	**Jul 03**
1024x768 or more	44%	45%	46%	47%	49%
800x600	50%	49%	47%	46%	44%
640x480	3%	2%	2%	2%	2%
Other or Unknown	3%	4%	5%	5%	5%

Table 6. Display Statistics (Refsnes Data, 2003).

5.2.2 Website Organization

As discussed in Chapter 4, this website follows a hierarchical structure (Figure 27). A hierarchical structure provides direct links from the home page to each of the main topics and allows users to move quickly to topics of interest. Dividing the atlas into various themes organizes and presents information in a more efficient manner, and facilitates navigation through the site. Each theme contains a list of sub-topics, beginning with an introduction to the theme. Currently, the user has the option of selectively picking a sub-topic from any of the themes. As the atlas is populated with more content, the user can select a sub-topic at random, or progress through a theme sequentially.

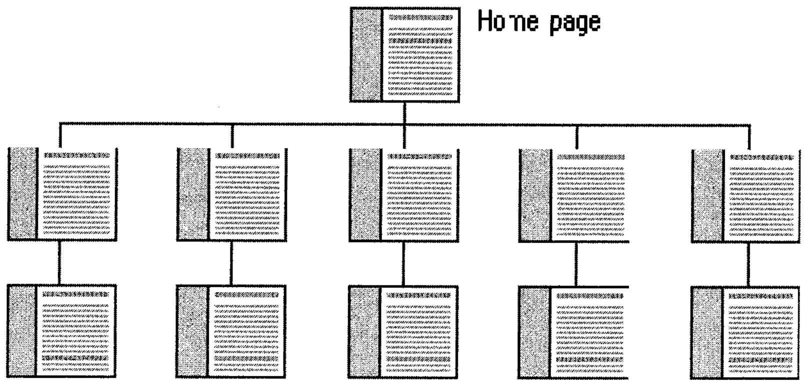


Figure 27. Hierarchical structure (Lynch and Horton, 2002).

5.2.3 Internal File Structure

Flash MX uses a number of different file formats to save and display information. Initially, files are saved within the Flash environment in FLA format – editable files that can be used only within the authoring software. The FLA file is 'published' (exported) as a more compact, non-editable SWF file as well as a HTML document for use on the Web. Although Flash exports the two files as separate entities, the HTML file will not function properly in a Web browser unless *both* files are stored in the same directory. The HTML instructs the browser how to display the SWF file; if the SWF file is not in the same folder, the HTML code won't be able to find or display it.

To guarantee that the SWF and HTML files for each topic are stored correctly, the internal file structure reflects the site organization – subtopics are organized into folders based on their thematic content. The added benefit of this structure is that the URL will list the name of the folder as well as the name of the HTML file. For example, HTML and SWF files for a glacial retreat map would be stored in a natural environment folder and would appear in the address bar of the browser window as: *http://www.BCAtlas.ca/NaturalEnvironment/GlacialRetreat.html.* As the site develops, additional folders can be added to accommodate new topics or themes.

5.3 ATLAS TEMPLATE

5.3.1 Splash Screen

The 'front-piece' of a website, the splash screen is the first contact the user has with the Atlas of British Columbia before entering the content sections of the website (Figure 28). It provides the user with specific requirements for using the site, including browser prerequisites, minimum monitor resolution, as well as a link to download and install for free the latest Flash player from Macromedia. To direct the user into the website, the 'enter' button is strategically placed in the center of the page and changes colour when a user's mouse passes over it.

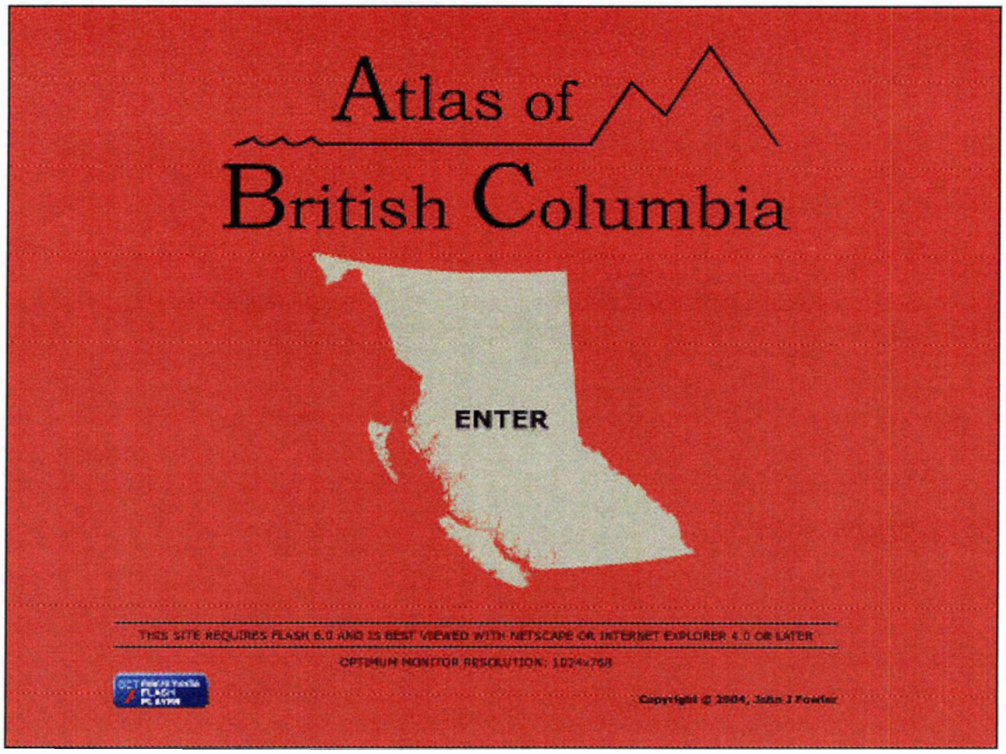


Figure 28. Splash page for the Atlas of British Columbia.

5.3.2 Page Layout

The basic structure of the main page is designed to be simple and consistent, creating a space that is predictable and familiar for the user (Figure 29). As recommended by Lynch and Horton (2002), the user interface follows general navigation and layout conventions of major websites because users are familiar with those conventions. In addition, Lynch and Horton (2002) suggest that every Web page contain the following information to ensure a well-structured interface:

1. an informative title;
2. the creator's identity (author or institution);
3. a creation or revision date;

4. at least one link to a local home page or menu page; and
5. the 'homepage' URL on the major menu pages in your site.

The header contains the table of contents and the atlas logo, which is situated at the top of every page, providing a consistent point of reference throughout the website. The footer balances the webpage aesthetically, but, more importantly, provides essential data about the date of the page and the copyright. The main page is designed to utilize much of the available space for the map and multimedia components (Figure 30).

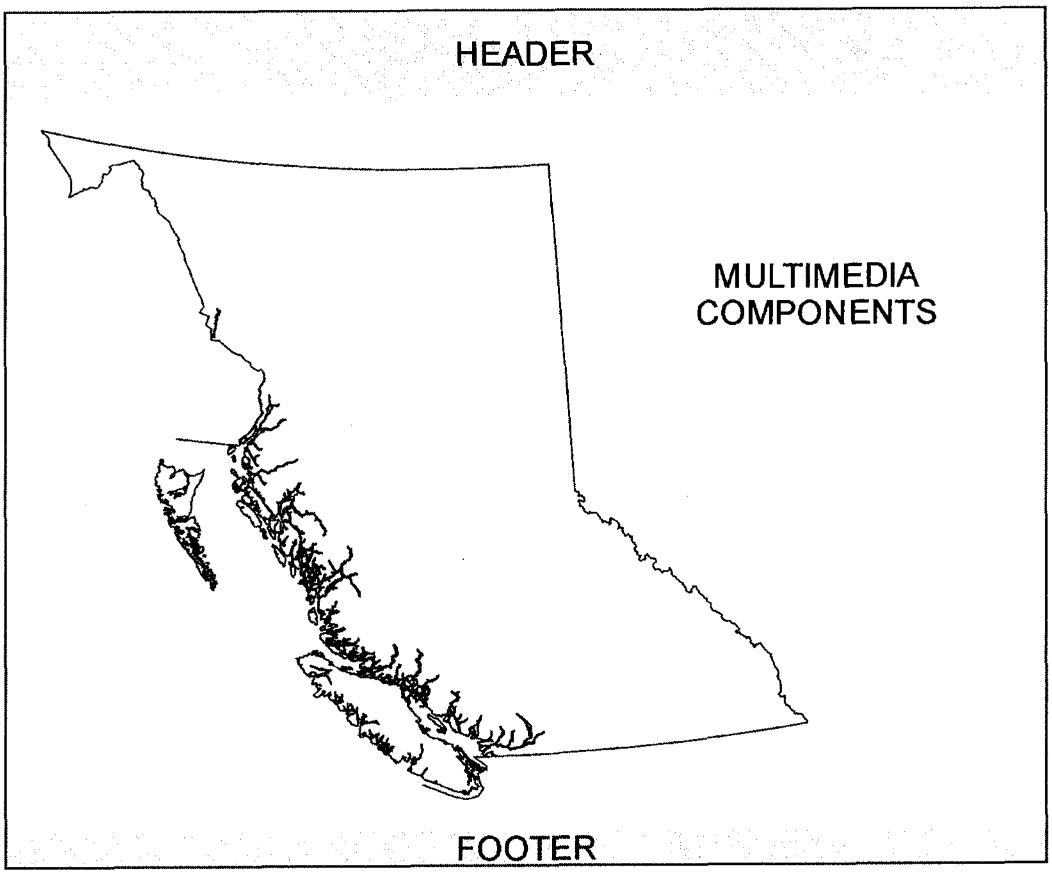


Figure 29. Basic layout of the atlas shell.

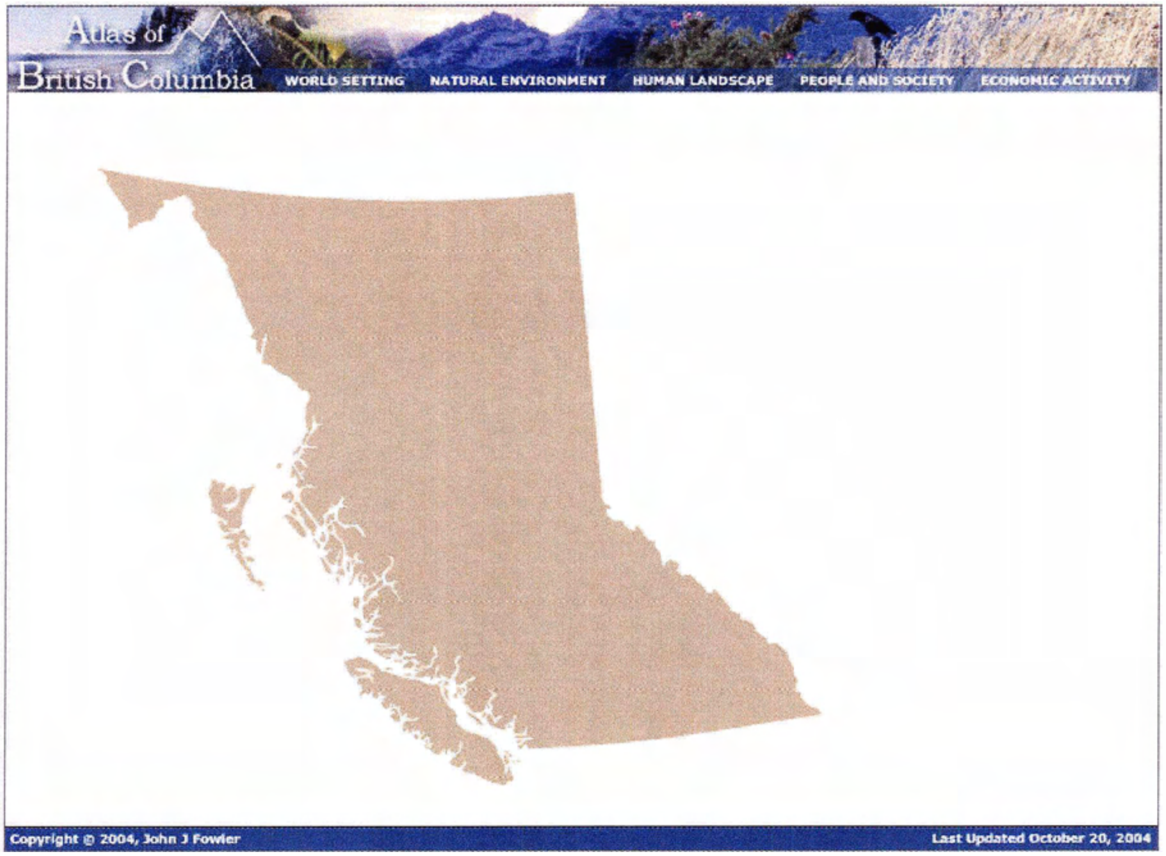


Figure 30. Atlas of British Columbia template.

5.3.3 Table of Contents

The traditional format of regional atlases follows a clear, well-defined procession of topics as outlined by Salichtchev (Frelim and Sebert, 1972): It commences with a general and physical introduction, followed by thematic coverage of population, economy, and culture, and concludes with the political and administrative structure. Research conducted by Keller (1995) and the University of Victoria Spatial Sciences Laboratory (Hocking, 1991; Hocking and Keller, 1992a; Keller *et al*., 1995) has found that, over time, there has been a gradual shift in emphasis away from the physical, towards the human dimension of landscape and environment, as well as a trend away from strict depictions of spatial distributions towards the "telling of a story". Building on this research, as well as work conducted by the Tri-University Atlas Project (an atlas initiative commenced by the University of Victoria, Simon Fraser University and the University of British Columbia), the table of contents for this project consists of the following themes (headings):

- World Setting
- Natural Environment
- Human Landscape
- People and Society
- Economic Activity

To maximize the space available for the map and multimedia components, the table of contents is positioned at the top of the [Web] page and operates via a pulldown menu. As the user rolls over each of the themes, the text changes colour and an arrow (pointing downwards) appears; clicking on the theme opens the list of topics (Figure 31). To close a theme menu, the user can click on the theme name or move the mouse outside the extended menu.

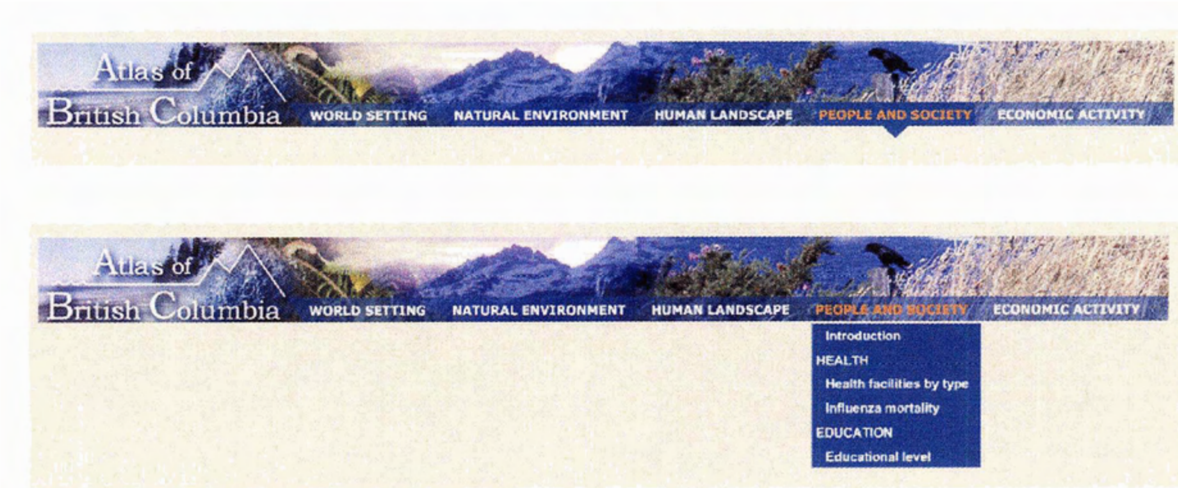


Figure 31. Table of contents illustrating the pull-down menu.

5.3.4 Base Map

The base map for this project was downloaded from GeoGratis, a Natural Resources Canada website that distributes free geospatial data of Canada. The base map for British Columbia is part of the Atlas of Canada base map series, the official bases used for the production of all their maps. At a scale of 1:2,000,000, the datasets cover (Natural Resources Canada, 2003):

- drainage – coastlines, rivers, lakes;

  boundaries – federal, provincial, district, dividing lines;
- transportation – primary and secondary highways, selected ferry routes, rail networks;
- populated places; and
- national parks.

To depict the geographical extent of British Columbia, Alber's Equal Area Conic or Lambert's Conformal Conic are the most appropriate choices. The major difference between the two projections is that Alber's preserves area, whereas Lambert's preserves shape; visually, there are very little differences between the two projections (Figure 32). Lambert's projection would be more appropriate for this project because the shape of the province is maintained, but Alber's has been officially adopted by the provincial government of as one of its standard projections for spatial data storage and use. With the availability of data using Alber's projection and the small visual difference between it and Lambert's projection, Alber's Equal Area Conic (with standard lines 50°N and 58.5°N) has been chosen as the base map projection.

As outlined by the provincial government (Province of British Columbia, 2001), the Albers Equal Area Conic projection is suitable for British Columbia because:

1. It is appropriate for representing the whole province on one projection plane.
2. Latitude lines are represented by simple curves and longitude lines by straight lines.
3. It distorts area very little. Because Albers distorts much more outside the standard parallels than between, setting standard lines of 50° N and 58.5° N minimizes the total distortion of area across the province as a whole, from Victoria to the Yukon border.
4. Its area representation is very close to Universal Transverse Mercator (UTM); average difference of 0.05 % (maximum difference of 0.08 %) within the province.

5. Its distance representation is also very close to UTM; average difference in latitude of 0.15 % (maximum difference of 0.30 %) and the average difference in longitude of 0.17 % (maximum difference of 0.32 %) within the province.

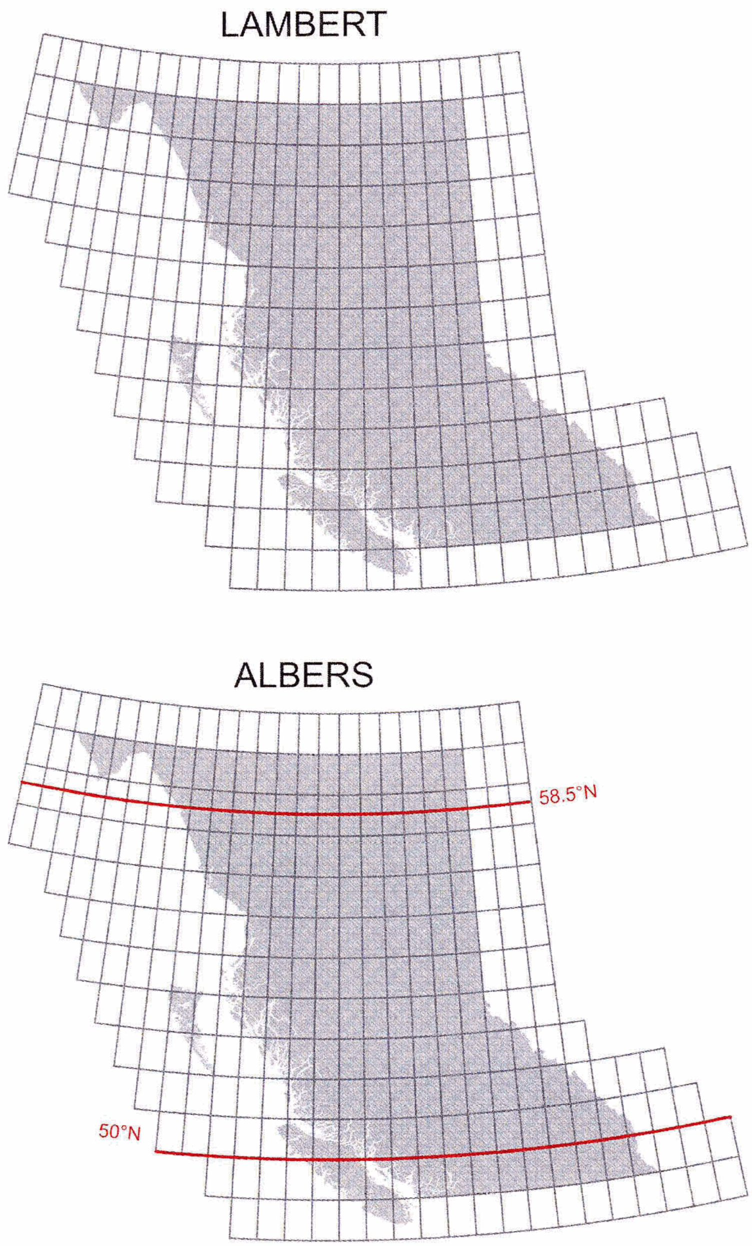


Figure 32. Lambert Conformal (top) and Albers Equal Area (bottom) Conic Projections of British Columbia. Standard lines are denoted in red.

To ensure compatibility with varying data formats, the provincial base map exists in several different files formats:

- ESRI Arc shapefiles (*.shp)
- Macromedia Freehand 10 (*.fh10)

The shapefile format was chosen because it is georeferenced (reference grid coordinates) and much of the data available from various government agencies exists in this format, or a format that can be integrated readily into ArcGIS. Freehand was selected because of the strong partnership between Freehand and Flash, both of which are Macromedia products.

Initially, the base map was downloaded as an E00 file format, an ESRI ArcInfo interchange file format, and converted to a shapefile using a conversion tool in ArcMap. The shapefiles created from this conversion were exported as Adobe Illustrator files (*.ai), which were then imported into Freehand. Inserting the base map into Flash is accomplished using the import command in Flash or simply 'cutting and pasting' the file from Freehand.

5.3.5 Atlas Shell Development

From the previous discussion, development of the atlas shell appears to be a straightforward process. However, its simplistic design and functionality belies the amount of time and effort spent. In addition to learning the intricacies of Flash MX, many hours were spent experimenting with different designs, templates, and Flash components, to arrive at the current atlas template.

5.5 Conclusion

The atlas shell is not meant to be a static product. As the project continues to develop, the shell will modify and adapt to new design features, data, and developing technology. The flexibility and relative effortlessness of Flash ensures the project's development and progression. Chapter Six describes integration of the three themes into the atlas shell and discusses the various multimedia applications used.

CHAPTER 6: THEMATIC COMPONENTS

6.1 INTRODUCTION

To this point, the primary focus of this thesis has been development and construction of an atlas shell. Because the shell is the backbone of this project, considerable time, research, and attention has been devoted to its development to ensure its functionality and ease of use. Secondary to this objective has been the integration of three themes into this generic atlas shell to demonstrate the effectiveness of the design strategy and various multimedia features. Although relegated to a subsidiary role, integration of the thematic content is fundamental to the success of the atlas: Populating the shell with content (including multimedia) that is informative and interesting will determine the success of the atlas as a whole. The following chapter details the development of the three themes and the multimedia components.

6.2 DATA

6.2.1 Introduction

Data research, acquisition, and manipulation are time-consuming and often tedious steps in the map compilation process. In the not-too-distant past, compiling information for a map often meant long hours at a digitizing tablet or scanner, converting the desired information into a useable digital format. In today's 'electronic age', digital data are collected still through scanners and digitizing tablets. But now, more commonly, data can be downloaded in digital format.

6.2.2 Digital Data

The Internet is unparalleled in its ability to disseminate and store information. At no other point in history has information been so 'freely' distributed and accessible, with many websites serving as repositories of digital data. One such site, the *Digital Chart of the World* (http://www.maproom.psu.edu/dcw/), provides 1:1,000,000 scale geographic data in vector format (E00) (Penn State University Libraries, 2003). In Canada, the federal government provides selected digital geospatial data free of charge from such websites as *GeoGratis* (http://www.geogratis.com) and the *Atlas of Canada* (http://atlas.gc.ca). Because each province is responsible for regulating and distributing its own digital information, the availability and price of the data vary accordingly. Recently, British Columbia's provincial government began charging for digital products, as explained by the Base Mapping and Geomatic Services (BMGS) Branch:

> Each year, BMGS moves further away from dependence on product sales of off-the-shelf Provincial Base Atlas products to delivery of specific products and services of a corporate nature and seeks support from clients who underwrite the cost of development, delivery and maintenance of them (Government of British Columbia, 2003).

This move towards a fee-based system stifles public access to data and makes it more difficult to find and use information for educational and research purposes.

6.2.3 Copyright

In general, copyright is concerned with the legal right to produce or reproduce a work or a substantial part of it in any form; it is restricted to the expression of an idea in a fixed manner (text, recording, drawing) and does not extend to the idea itself (Industry Canada, 2003). Under the Canada's *Copyright Act*, any original work written down, recorded, or entered as a computer file is automatically and immediately protected (Media Awareness Network, 2003). However, introduction of the 'information highway', has made copyright on the Internet difficult to define and enforce, as demonstrated by the music industry's legal struggles to control distribution of its product. Benyekhlef (2003) maintains that this complexity is due to a number of factors inherent in the Internet's nature: the delocalization of the information; its great fluidity and elusiveness; its multimedia character (data, voice, sound, image); its intangibility; its often interactive nature; the multiplicity of players involved in telematics; and, above all, the irremediably international character of the communication networks.

Regardless of the complexities created by the Internet, information obtained from Web sources must be referenced. In this project, all materials have been referenced and every attempt made to protect the copyright of the website itself, by providing a copyright link in the footer. In addition, the configuration of the Flash file format (SWF) is such that it is difficult to copy or use any of the information displayed.

6.2.4 Data Manipulation

As mentioned previously, data research, acquisition, and manipulation are challenging tasks in the map production process. Before commencing a detailed discussion on the three themes, it is necessary to discuss the general procedures involved with data management for this project.

As outlined in Figure 33, the compilation process began with a data search. This involved a two prong approach: a conventional search through traditional avenues, such as libraries and archives, as well as an examination of available digital products through the WWW and various government agencies. Data available only in paper format was scanned as a graphic image file (either JPEG or GIF), imported into a drawing package (Freehand or CorelDraw), digitized on-screen, edited, and then exported to Flash. Data acquired digitally was imported into one of several software packages, depending on the format of the data.

Generally, the atlas' digital data existed in three formats: ArcInfo interchange files (E00) which have been converted to shapefiles (shp); DWG/DXF files; and graphic image files (GIF, JPEG). Although Flash can import various file formats directly (see Figure 33: dotted line), the capabilities offered by other drawing packages, such as Freehand and CorelDraw, allow for easier handling and editing of vector files.

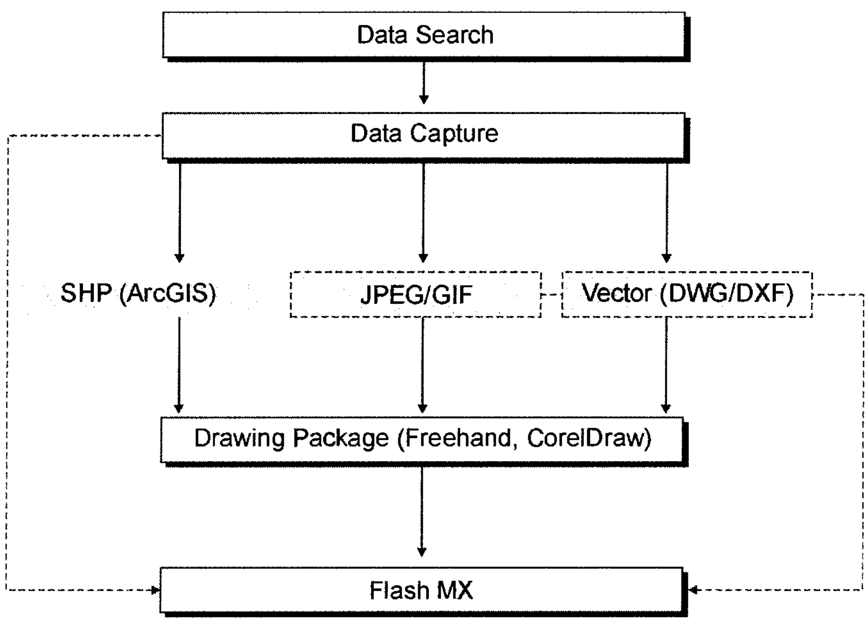


Figure 33. Map compilation process.

6.3 THEMATIC CONTENT

6.3.1 Introduction

As noted earlier, integration of thematic components into the atlas shell is meant to illustrate the capabilities of a Web based atlas product. To this end, every attempt has been made to incorporate and demonstrate various multimedia features, such as sound, video, animation, photographs. However, there are limits: Obviously, it is difficult to incorporate sound and video into a health component that focuses on mortality data. Therefore, while some of the features may seem gratuitous, given the previous discussions on multimedia and appropriate usage, they were created in good faith to highlight the atlas's potential and Flash's capabilities as a tool within it.

6.3.1 Earth Science

The earth science module focuses on the retreat of the ice sheet during the last ice age. Routinely, maps showing the distribution and subsequent retreat of ice sheets in British Columbia use either a series of maps, representing each different stage, or one map delineating various stages using different linetypes (dotted, dashed) and/or different coloured regions. While both of these mapping methods provide a good representation of British Columbia's glaciation, they do not encourage visual progression or movement of the ice sheet. But animation can do so; and thus, retreat of the ice coverage has been incorporated into this project using animation.

The keystone of Macromedia Flash MX is its ability to produce animations easily and quickly. Flash creates animation through two techniques: frame-by-frame animation or a process called 'tweening' (Figure 34). Frame-by-frame animation is akin to traditional animation, where the designer is responsible for small changes between successive 'cells' (or frames) to create movement. Unlike frame-by-frame animation, which can be labour intensive, create large files, and appear jerky, tweening is quicker to produce and has a much smoother transition between frames. To 'tween' a graphic, the designer specifies a start and end keyframe, then utilizes Flash to create a series of incremental changes between these two keyframes producing animation. To animate the retreat of the ice sheet, shape tweening, or transforming the shape of a graphic, was used exclusively.

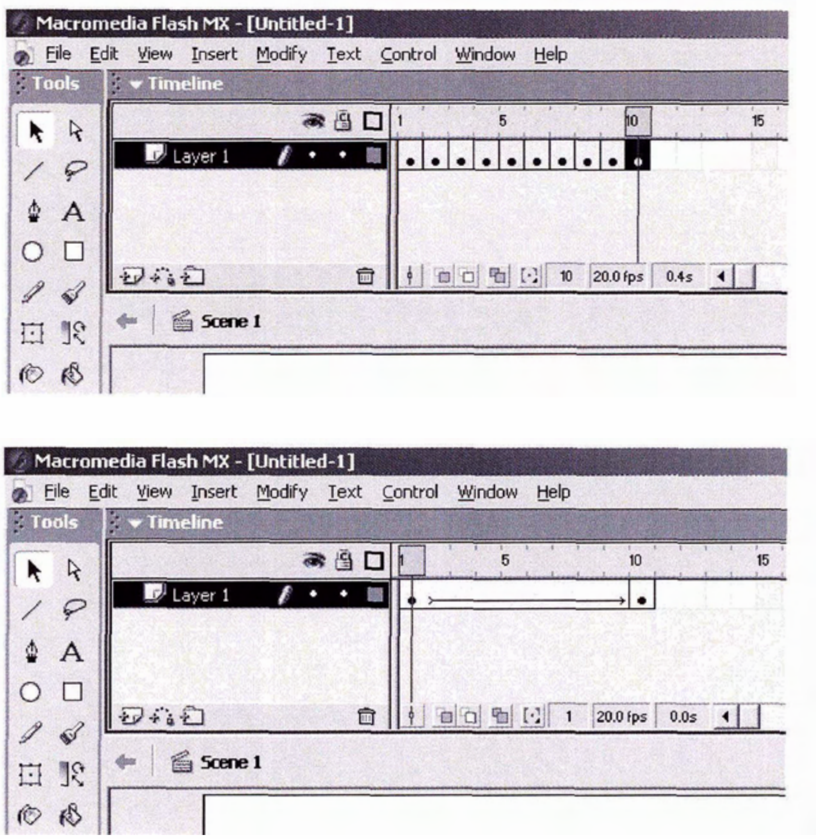


Figure 34. Animation in Flash: frame-by-frame (top) and tweening (bottom). Note the greater number of keyframes used in frame-by-frame animation compared to tweening.

As straightforward as this may seem, production of the retreating ice mass required a considerable amount of planning and organization. Once the digital data were compiled and entered (imported) into Flash, the glacial episodes were broken into different layers and folders according to time periods. To create a shrinking ice sheet, each time period required its own shape tween – a task accomplished easily *if* the ice sheet remained as one contiguous entity. Unfortunately, Flash will not create a shape tween correctly if the graphic begins as one complete graphic and breaks into several smaller pieces, as the ice sheet invariably did. To counter this problem, the 'ice pieces' were distributed to individual layers (approximately 105) to keep the shape and motion consistent with the retreating ice sheet. In addition, tweens for each time period were staggered so that there would be no overlap between consecutive episodes (Figure 35).

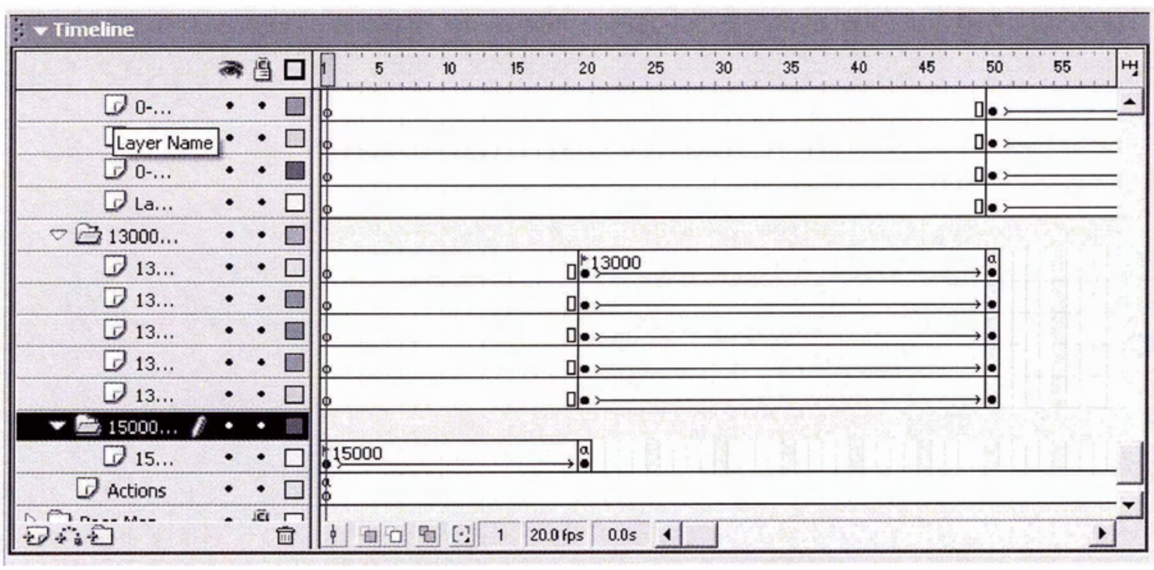


Figure 35. Folder and layer structure of the shape tweens. Note that as one time period ends (15000), the consecutive one (13000) begins; labels for each time period (set of tweens) appear in the uppermost tween.

To accurately portray the amount of time between glacial periods and, ultimately, the speed with which the ice retreated, each frame was assigned a numeric value representing number of years. After several trials, one hundred years appeared to be the most practical value in terms of file size and time spent watching the simulation. In this way, the speed of the animated ice sheet was defined by the number of years between episodes, so that 15,000 to 13,000 years had twenty frames and 7000 to 0 (present), seventy frames.

With the animation sequences organized, the final step involved creation of an interactive legend. The legend provides the user with the opportunity to select a time period and, to a degree, control the animation. A graduated timeline with a red arrow marker (Figure 36) was used to reinforce the theme of a retreating (shrinking) ice sheet. Each time period button was assigned a button which changes colour as the user rolls-over it. Pressing any button once displays the extent of the ice sheet for that particular time period (Figure 37). Hitting the same button again, or any of the buttons twice, causes the shrinking ice sheet animation to begin; the arrow's movements are synchronized to follow the ice sheet animation for each time period. The animation stops at the next time period, continuing only at the request of the user.

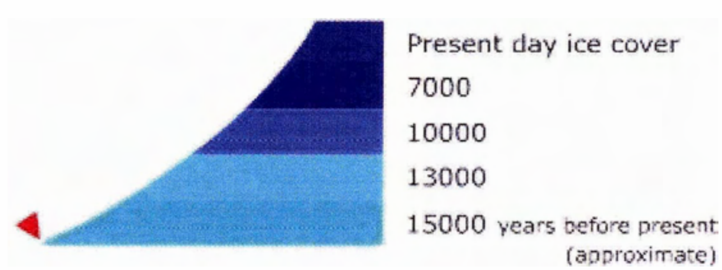


Figure 36. Interactive legend for glacial retreat.

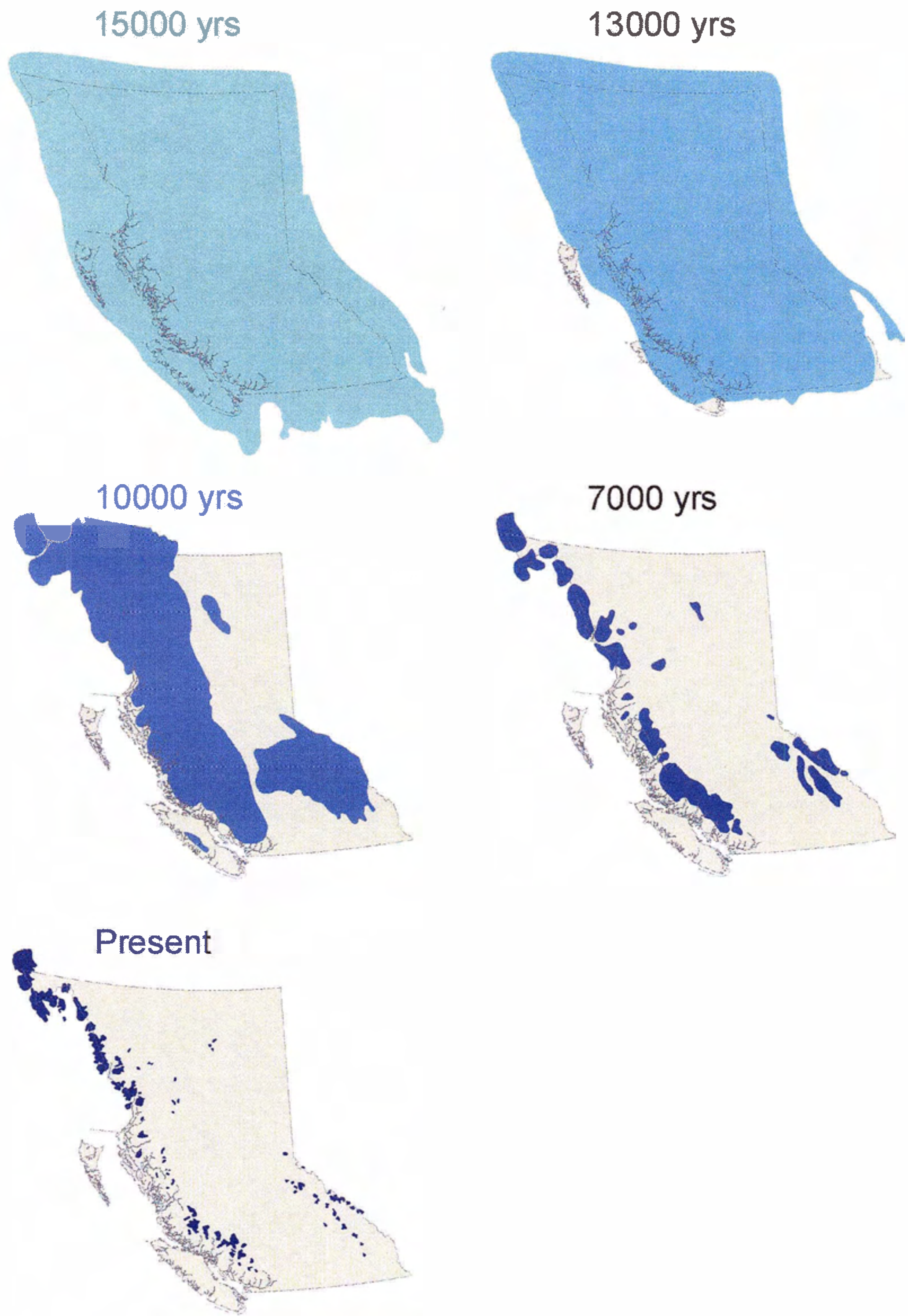


Figure 37. Extent of the ice sheet at each time period; starting from the top left at 15,000 years before present, progressing through 13,000, 10,000, 7000, and present day (0).

In addition to animation, two other features have been added to the theme – a scrolling text box and a video clip. The text provides background information on the last Ice Age and subsequent retreat of the ice sheet. A brief introduction, it is not meant to be a detailed but a supplement to the animation. The video clip, obtained from the BC Archives' *Moving Images Collection*, is a sample from a collection of digital (MPEG) files. The selected clip is part of the press release footage from Expo '86, highlighting a mountainous region in British Columbia. Incorporating the video clip into the webpage is accomplished easily, by importing the file into the Library (a panel that organizes and stores symbols, graphics, video and sound clips), dragging and dropping it onto the Stage, and then assigning buttons to control the playback.

6.3.2 Socio-economic (Health)

The socio-economic section of the atlas incorporates mortality data provided by British Columbia's Vital Statistics Agency. The data contains statistics on various mortalities within the province during three time frames: 1989-1993, 1994-1998, and 1999-2002. This information has been further divided into three additional categories: males, females, and both genders. With a number of mortality causes to choose from, the choice to focus on influenza/pneumonia was a result of the recent media spotlight on influenza. In the Fall of 2003, the spread of influenza, its potential as a 'killer', and the North American public's apparently frantic need for flu shots, dominated news reports. With all the attention on influenza, questions invariably arose that seemed pertinent to this project: Have morality rates for a particular region increased or decreased? What regions are consistently high or low? Are the mortality rates worse for men or women?

Mapping influenza/pneumonia mortality rates could provide some answers to these questions, as well as motivate further examination and research possibilities.

Influenza/pneumonia data provided by Vital Statistics uses Standardized Mortality Ratio (SMR) to show geographic variations within the province. An internationally recognized health status indicator, SMR is a ratio of the number of observed deaths to the number of expected deaths occurring among residents of a geographic region (Province of British Columbia, 2002). For analytical purposes, the province has been subdivided into eighty-nine Local Health Areas (LHA) corresponding to geographic subdivisions used by the Ministry of Health.

To present the data in a meaningful way, each time period uses choropleth (shaded) maps for the 'both genders' category to display influenza/pneumonia spatial variations (Figure 38). SMR for male and female populations within a specific region are accessible through a mouse-over technique. As the user's mouse rolls over each LHA, the LHA's colour changes to orange and a data window appears (Figure 39), providing the name of the LHA, the male/female SMR for that time period (highlighted in orange), as well as the male/female SMRs for the other time periods. Providing the user with data for all the time periods at a glance allows for a quick comparison over time.

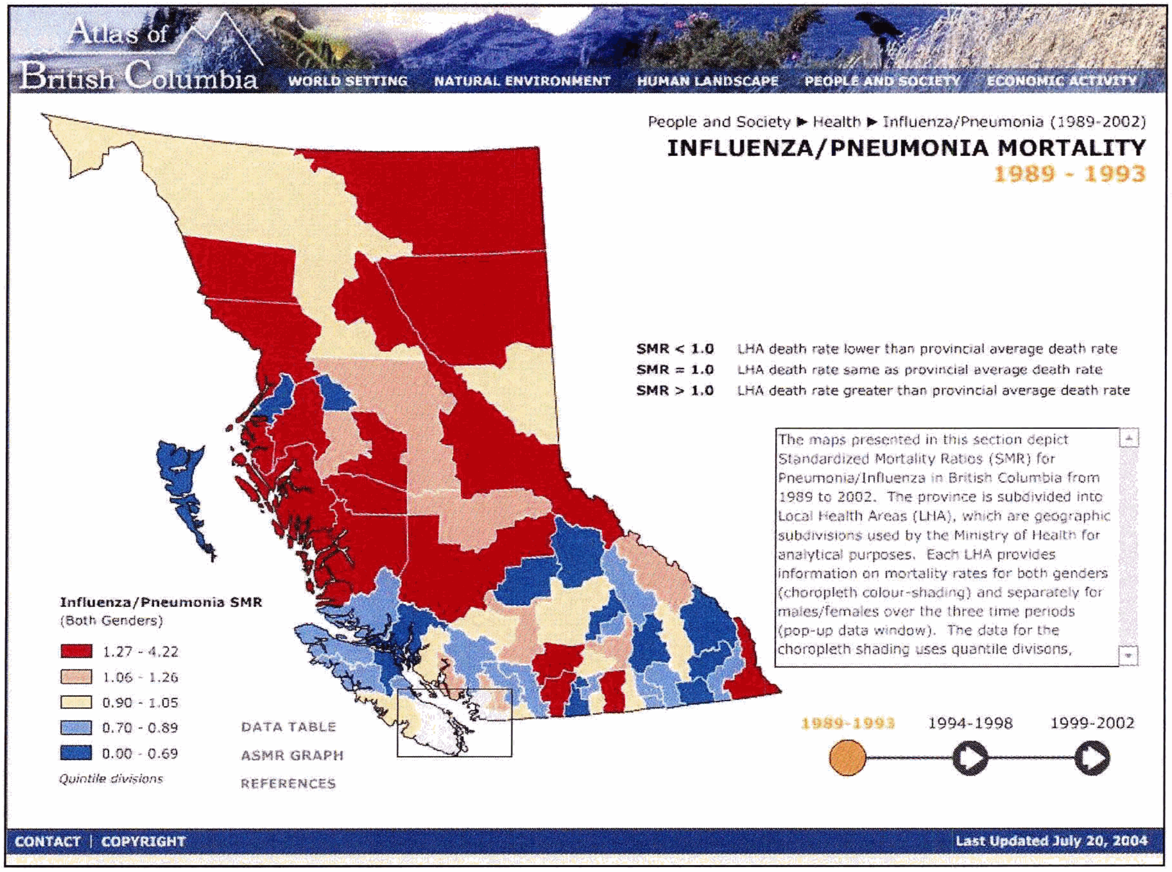


Figure 38. Influenza/Pneumonia choropleth map for the time period 1989-1993.

PEACE RIVER NORTH (LHA 060)

	1989-1993	1994-1998	1999-2002
Male	1.62	1.45	1.17
Female	1.52	0.89	0.69
Both	1.58	1.19	0.94

Figure 39. Data pop-up window.

Users can access maps and data for any time period using forward and backward buttons (arrows) located at the bottom of each section; in Figure 38, the forward buttons are visible in the bottom right corner. From any time period, the user can progress sequentially forward or backward, or jump between any of the three time periods. This option gives the user some control over the map sequence and encourages them to compare maps at their discretion.

One of the challenges inherent in this particular theme is the inability to view relevant portions of the map because certain LHAs (primarily, the Lower mainland) cover small geographic areas. To access these smaller LHAs, and increase their visibility, a larger scale inset was created; in Figure 38 the inset box is visible in the bottom (south-west) portion of the map. When the user rolls-over the inset, the box is filled with a transparent orange colour and text appears '**Click for Inset Map**'; clicking on the box opens the inset map (Figure 40). The inset uses the same mouse-over feature to display LHA information and includes most of the same options as the smaller scale map of the province. To return to the main map, a back-button symbol is placed in the bottom left corner.

In addition to the choropleth map and pop-up data window, a number of supplementary features have been placed on each of the three pages. Two links, *Data Table* and *ASMR Graph* (see Figure 38), provide more in-depth information on influenza/pneumonia mortality in the form of pop-up windows (Figure 41). These pop-up windows remain hidden until activated by the user (clicking on each of the links); once opened, they can be moved around the screen at the user's discretion. A scrolling text box provides a brief synopsis on LHA divisions, choropleth shading and the classification system used to divide the data into classes (quintiles), SMR, and the classification codes (ICD-10) for influenza/pneumonia.

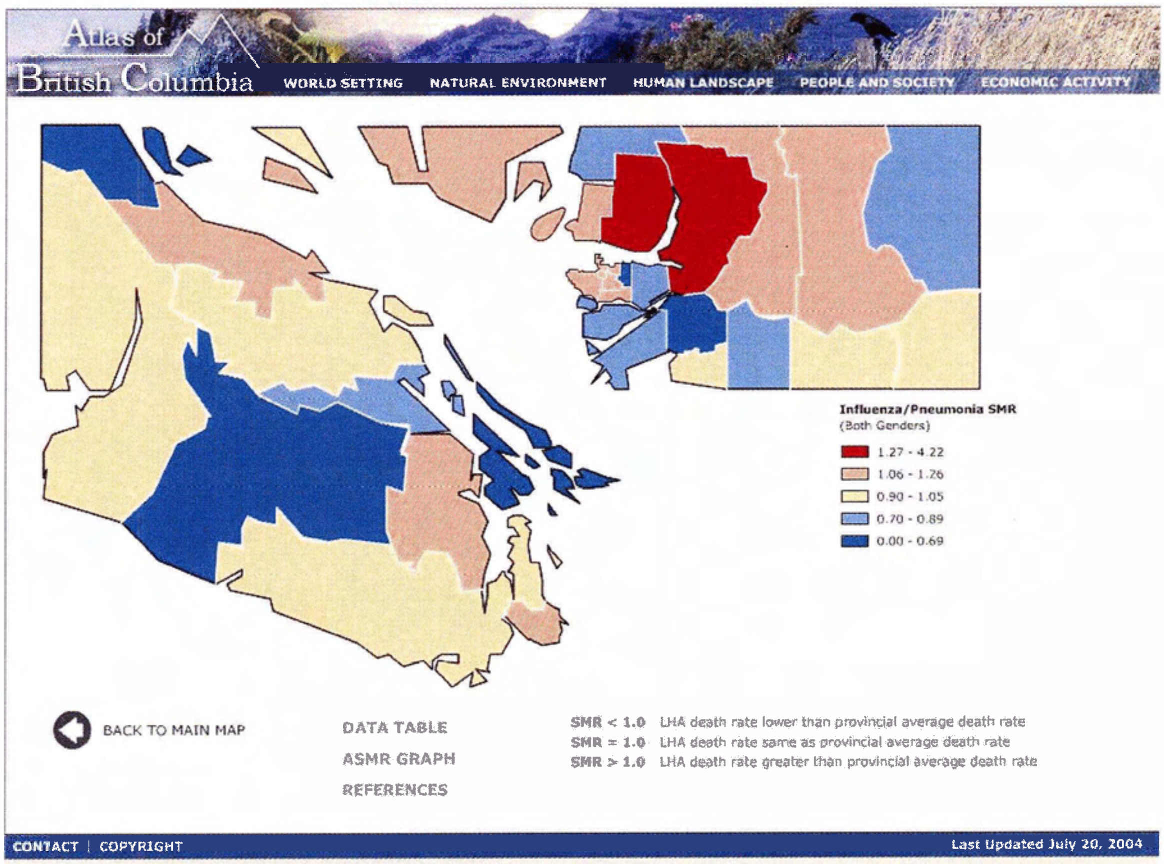
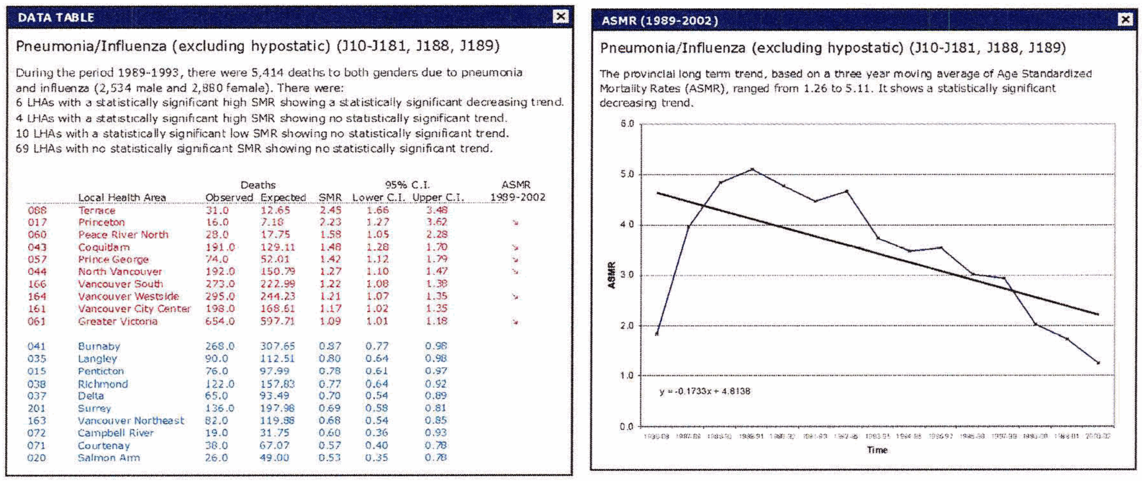


Figure 40. Larger scale inset map showing the smaller LHAs.


DATA TABLE

Pneumonia/Influenza (excluding hypostatic) (J10-J181, J188, J189)

During the period 1989-1993, there were 5,414 deaths to both genders due to pneumonia and influenza (2,534 male and 2,880 female). There were:
6 LHAs with a statistically significant high SMR showing a statistically significant decreasing trend.
4 LHAs with a statistically significant high SMR showing no statistically significant trend.
10 LHAs with a statistically significant low SMR showing no statistically significant trend.
69 LHAs with no statistically significant SMR showing no statistically significant trend.

		Deaths			95% C.I.		ASMR
	Local Health Area	Observed	Expected	SMR	Lower C.I.	Upper C.I.	1989-2002
088	Terrace	31.0	12.65	2.45	1.66	3.48	
017	Princeton	16.0	7.18	2.23	1.27	3.62	↘
060	Peace River North	28.0	17.75	1.58	1.05	2.28	
043	Coquitlam	191.0	129.11	1.48	1.28	1.70	↘
057	Prince George	74.0	52.01	1.42	1.12	1.79	↘
044	North Vancouver	192.0	150.79	1.27	1.10	1.47	↘
166	Vancouver South	273.0	222.99	1.22	1.08	1.38	
164	Vancouver Westside	295.0	244.23	1.21	1.07	1.35	↘
161	Vancouver City Center	198.0	168.61	1.17	1.02	1.35	
061	Greater Victoria	654.0	597.71	1.09	1.01	1.18	↘
041	Burnaby	268.0	307.65	0.87	0.77	0.98	
035	Langley	90.0	112.51	0.80	0.64	0.98	
015	Penticton	76.0	97.99	0.78	0.61	0.97	
038	Richmond	122.0	157.83	0.77	0.64	0.92	
037	Delta	65.0	93.49	0.70	0.54	0.89	
201	Surrey	136.0	197.98	0.69	0.58	0.81	
163	Vancouver Northeast	82.0	119.88	0.68	0.54	0.85	
072	Campbell River	19.0	31.75	0.60	0.36	0.93	
071	Courtenay	38.0	67.07	0.57	0.40	0.78	
020	Salmon Arm	26.0	49.00	0.53	0.35	0.78	

Figure 41. Data Table and ASMR pop-up windows.

6.3.3 Historical

The historical component of the atlas illustrates the European exploration of British Columbia's coastline in the 18th Century. The decision to focus on this aspect of British Columbia's history was based on three factors:

1. the impact of these explorations on British Columbia's development – in a relatively short amount of time (approximately 50 years), much of British Columbia's coastline was mapped;
2. the cartographic progression of British Columbia reflected in the explorers' discoveries; and
3. the availability of data.

The section is meant to introduce the user to the explorers, the areas they explored, and the maps produced from their expeditions.

The introductory page of the historical section provides the user with two navigation options: A listing of links to all the explorers by country of origin, or a chronological progression, starting with the earliest explorer (Figure 42). Regardless of the choice, each page has a forward and back 'explorer' button, as well as a link back to the table of contents (Figure 43). These navigation links are positioned consistently at the bottom of each page.

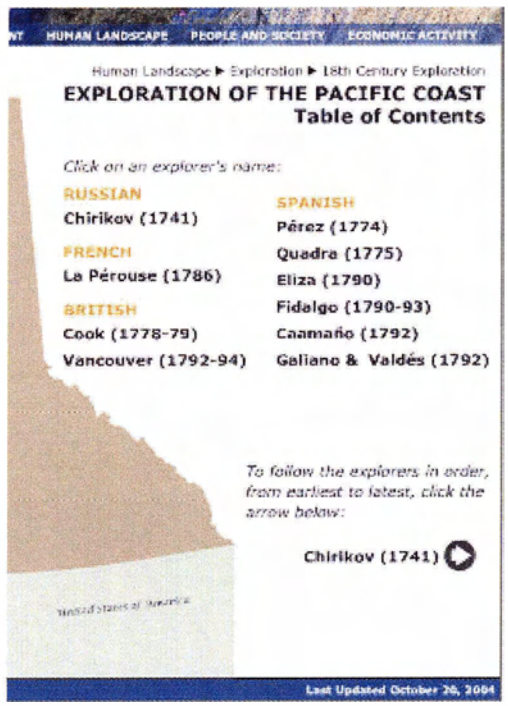


Figure 42. The navigational options for the exploration theme: the list of explorers by country of origin and the chronological sequence, starting with the first explorer.

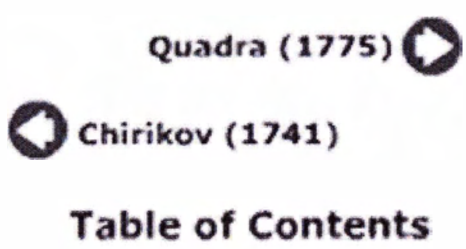


Figure 43. A sample of the navigation buttons.

Each of the ten explorers has their own webpage that contains an animation showing the exploration route, a brief summary of the expedition, and thumbnail maps of their discoveries (Figure 44). The animation begins as soon as the user opens the page and loops continuously. The decision not to provide the user with controls for the animation was based on the fact that giving control did not contribute to the user's experience. Because the exploration route is visible at all times, the animated ship simply provides an entertaining way to visualize the ship's passage. Although it was not stated, savvy Web users can control the animation by right-clicking on the map and selecting from the list of options.

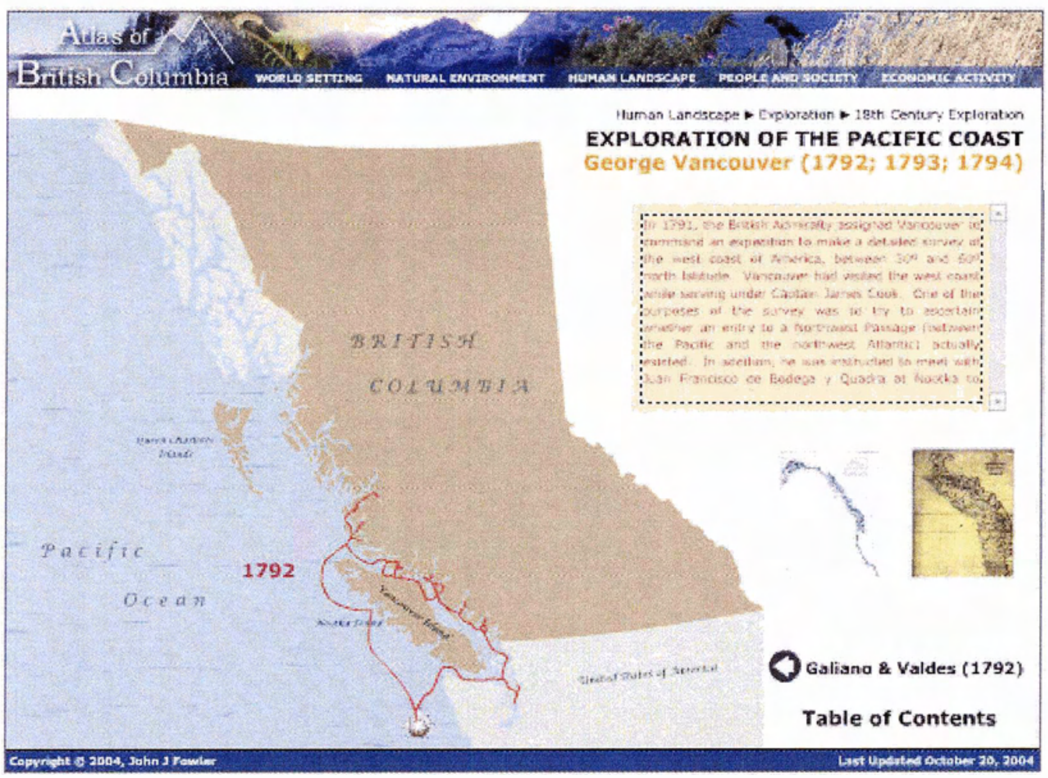


Figure 44. An example of one of the explorer's webpages. The organization and structure of the page layout is identical for all the explorers.

Thumbnail maps are available to the user as an additional resource, to be viewed at their discretion. As the user scrolls over the thumbnail, the border changes orange and text appears '*Click on image to view map'*. Clicking on a thumbnail opens a new window with a larger image and information about the map (Figure 45).

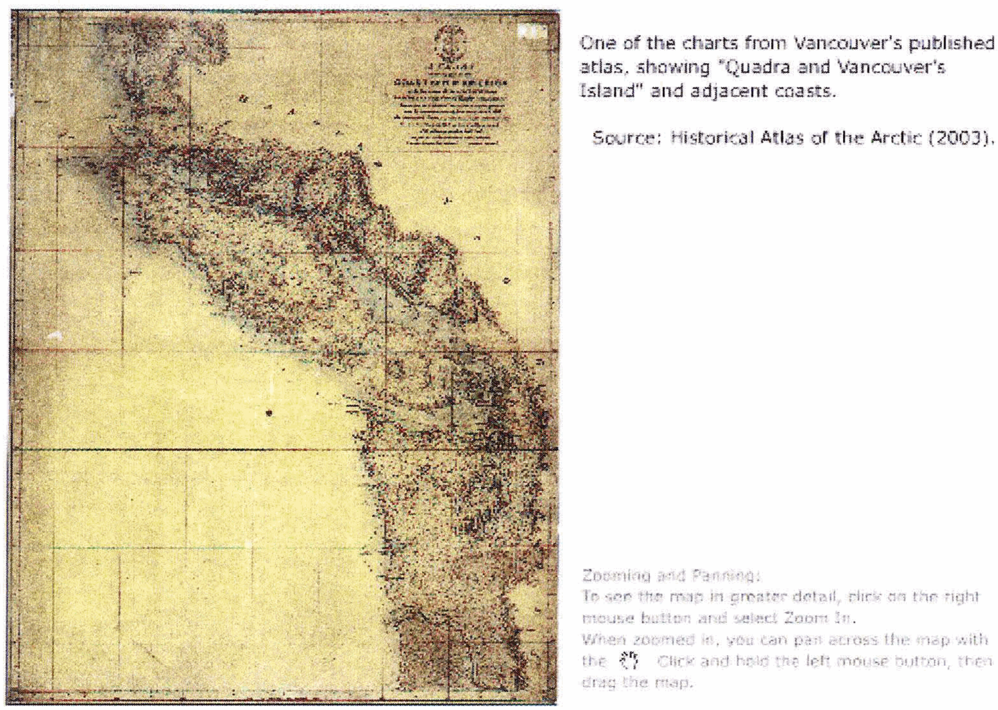


Figure 45. A sample map from Vancouver's explorations. Instructions for zooming and panning are available in the bottom corner.

A deliberate effort was made to incorporate a historical 'feel' to this section of the atlas. The background for the Pacific Ocean is meant to mimic a watercolour painting. The colours used for the text, scrolling text box, landmasses, and passageway were obtained directly from historical maps. In addition, the text on the animated map is a calligraphy-style font.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

This thesis set out to design and produce a Web-based multimedia atlas for the province of British Columbia. The preceding chapters presented the theoretical background for a new atlas initiative (Chapter 2); examined contemporary technological solutions (Chapter 3); established design options and specifications, presented a chosen methodology (Chapter 4); reported on the atlas shell development (Chapter 5); and detailed the integration of the three themes and their multimedia components into the atlas shell (Chapter 6). This final chapter highlights some of the key aspects of the project and outlines future developments for the Atlas of British Columbia.

7.2 CONCLUSIONS AND RECOMMENDATIONS

7.2.1 Introduction

Atlases occupy a unique role within society: Used professionally for research and education, and recreationally for 'armchair travel', they tell the story of a region and act as repositories of historical, cultural, economic, political, and physical data. Recent advances in computer technologies, coupled with rapid development and growth of the World Wide Web, has revolutionized map production dramatically; and today, Web maps take many different forms, from static images to interactive/analytical information systems. However, atlases have yet to make their presence felt strongly on the Internet, so it is hoped and anticipated that the auspicious conception of this project will both contribute to the literature and demonstrate the possible opportunities for Internet atlas production.

7.2.2 Project Summary

Construction of the atlas shell and development of the thematic components proved to be a challenge. Organizing and structuring the thematic data in a meaningful manner was paramount to producing a meaningful and exciting product. More than any other part of this project, the shell underwent numerous modifications and adaptations. The atlas shell is not a discrete product – developments in the themes invariably lead to changes in the atlas shell. It would be easy to say that the project is finished, but the Atlas of British Columbia is dynamic; as it expands and develops there will be a continuous need to invent, experiment, and refine.

This need to improve and develop the atlas can not proceed without thorough testing and evaluation. One of the biggest flaws with this project is the lack of user testing. Time constraints and resources were the two biggest contributors for this omission. The next logical step in the evolution of the atlas would be to test the existing product on a variety of users, particularly K-12 students, and incorporate their responses into the atlas.

One technical problem that did not get satisfactorily resolved was the issue of how to zoom within the atlas. Web searches, postings on chat rooms, research through Flash produced literature and manuals, and e-mails to various organizations and individuals failed to yield assistance. Flash does offer zooming (and panning) within the browser – right-clicking in the browser window opens a menu – but a more structured zoom feature should be incorporated.

It bears noting that, while beyond the scope and affordability of this project, a number of commercial products are available to enhance Flash's capabilities. Programs such as TruSpectra® Image Server and Zoomify™ offer zooming tools for Flash MX (and Flash MX 2004), although these appear to be designed for high resolution images. Another product which promises exciting possibilities is Swift 3D®, a vector-based tool capable of producing three-dimensional designs and animations, and which emphasizes high-quality renderings with small file sizes.

7.2.3 Macromedia Flash MX

Overall, Macromedia Flash MX has proven to be a reliable and powerful tool for creating a user interface that incorporates multimedia components. One of the biggest challenges presented by the program was the time spent becoming familiar with the basic components. Flash shares similar features with other graphics packages, such as CorelDRAW and Freehand; nevertheless, many weeks were dedicated to learning the intricacies of the program. Like many new software packages, the early stages of its learning curve can be very steep.

While Macromedia Flash MX is quite good at integrating various multimedia components quickly and easily, the atlas still required a lot of manual programming and manipulation. The problem arises from the fact that data, such as spreadsheets, can not be imported directly into a template or a specified field. For example, the pneumonia/influenza mortality data for each of the local health areas had to be added manually for males, females, and both (genders) for each of the three time periods. This process is very time-consuming and fraught with potential errors.

Recently, Macromedia released a new version of Flash, Flash MX 2004, which presents interesting upgrades to the existing program, such as third party extensions, cascading style sheets (CSS), new professional video capabilities, and improved programming language (Actionscript 2.0). At a Flash MX 2004 launch party organized by Macromedia, software designers of the new program guaranteed easier and quicker integration of multimedia and animation, along with a greater number of pre-designed symbols (such as buttons) and 'UI Components'(complex movie clips for user interface).

7.3 FUTURE DEVELOPMENTS

An atlas cannot be produced without co-operation and considerable financial (and intellectual) support. Therefore, the next logical step for the Atlas of British Columbia is to secure funding and set-up a team to work on the thematic content. A small, well-organized group would keep financial costs down and help to maintain control over the product. With a project manager to oversee the operation, research assistants could research and analyze data, consult experts, and edit content, freeing the cartographers/graphic designers to integrate such information into Flash. This process will not happen overnight, but merits the effort, since an atlas "telling a comprehensive story of the province's geography and people" is long overdue.

LITERATURE CITED

ADOBE SYSTEMS INC. (2000). Understanding the SWF (Flash) File Format. Retrieved December 15, 2002. http://www.adobe.com/support/techguides/webpublishing/flash/main.html

ALLSOPP, G. (1996). Designing for the World Wide Web. Bulletin of the Society of Cartographers, 30(1).

ARTYMIAK, J. (2002). SWF Is Not Flash (and Other Vectored Thoughts). O'Reilly & Associates, Inc. Retrieved August 2, 2003. http://www.oreillynet.com/pub/a/javascript/2002/05/24/swf_not_flash.html

ATLAS DU QUÉBEC ET DE SES REGIONS (2003). Frequently Asked Questions: Structure and Function of the Atlas. Retrieved May 16, 2003. http://www.atlasduquebec.qc.ca/atlas/Infos-Atlas/Info-FAQ.htm

AUTODESK (2003). Autodesk MapGuide 6.3 Features & Benefits. Retrieved July 4, 2003. http://www3.autodesk.com/adsk/files/2995602_MapGuide6.3_FB.pdf

BENYEKHLEF, K. (2003). International Standards for Protection of Personal Data and the Information Highway. Department of Justice, Government of Canada. Retrieved November 10, 2003. http://canada.justice.gc.ca/en/cons/jeh/karim.html

BC STATS (2001). Quick Facts About British Columbia. Ministry of Management Services, Government of British Columbia. Retrieved December 10, 2002. http://www.bcstats.gov.bc.ca/data/qf.pdf

BORCHERT, A. (1999). Multimedia Atlas Concepts. In W. Cartwright, M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 75-86. Berlin: Springer.

BOSTON UNIVERSITY WEBCENTRAL (2002). Flash MX: Introduction. Retrieved June 18, 2003. http://www.bu.edu/webcentral/learning/flash1/index.html

BOYLE, T. (1997). Design for Multimedia Learning. Prentice Hall: London.

BROWN, L.A. (1979). The Story of Maps. Dover Publications, Inc.: New York.

BOS, E. S., GEUDEKE, P. W., ORMELING, F. J., SIJMONS, A. H., AND WILLEMS, G. F. (1991). Kartografisch woordenboek 1.1 (Dutch cartographic dictionary). Retrieved September 2, 2002. http://geography.uoregon.edu/infographics/advcart/411w1999/AtlasAnalysis.htm

CAD/CAM SOLUTIONS OF CANADA INC. (2001). GIS eNews. Retrieved January 10, 2002. http://www.ccsc-online.com/gis/news/2002/gisenews0111.htm

CAMMACK, R. G. (1999). New Map Design Challenges: Interactive Map Products for the World Wide Web. In W. Cartwright, M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 155-172. Berlin: Springer.

CARRIÈRE, J. (1999). Atlas du Quebéc et de ses régions. In W. Cartwright, M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 119-124. Berlin: Springer.

CARTWRIGHT, W. (1999). Development of Multimedia. In W. Cartwright, M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 11-30. Berlin: Springer.

CARTWRIGHT, W. (1997). New Media and their Application to the Production of Map Products. In A.M. MacEachren and M.-J. Kraak (Eds), Geoscience and Computers, 23(4), pp. 447-456.

CARTWRIGHT, W AND PETERSON, M.P. (1999). Multimedia Cartography. In W. Cartwright,M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 2-10. Berlin: Springer.

CIANCARINI, P., TOLKSDORF, R. AND VITALI, F. (1999). Towards an interactive Web. Retrieved January 7, 2002. http://flp.cs.tu-berlin.de/pagespc/ieeeip/ciancarini.html

CITY OF OTTAWA (2002). Atlas of Ottawa. Retrieved May 24, 2003. http://atlas.city.ottawa.on.ca/mapping/atlas/atlas.htm

CLARK, T.M. (1997). General Tutorials - Anti-aliasing. Retrieved February 17, 2004. http://www.grafx-design.com/02gen.html

CONNOLLY, D. (2001). W3C Architecture domain, Activity Statement. Retrieved January 5, 2002. http://www.w3.org/XML/Activity

CRD Natural Areas Atlas (2002). Description of the Natural Areas Atlas Initiative. Retrieved October 10, 2003. http://www.crd.bc.ca/es/natatlas/overview.htm

DELAZARI, L.S. AND CINTRA, J. P. (2002). Is an Electronic Atlas a Geographic Information System? Retrieved August 10, 2002. http://www.asovig.org/Documentos/Stamato%20L_Cintra%20J_Atlas.pdf

DELUCIA, A. A. (1974). Design: The Fundamental Cartographic Process, Proceedings of the Association of American Geographers, Vol. 6, pp. 83-86.

DENT, B. D. (1999). Cartography: Thematic Map Design, 5th edition. Boston: WCB/McGrawHill.

DUFFY, S. (2002). Introduction to XHTML. Retrieved September 3, 2002. http://www.xguru.com/tutorial/news.asp?id=9

DYMON, U.(1995). The Potential of Electronic Atlases for Geographic Education. Cartographic Perspectives, 20: pp. 29-34.

ECHOECHO (2002). DZine! Online Web Design Magazine: DZine#1 Screen Resolution. Retrieved July 20, 2003. http://www.echoecho.com/dzine001.htm

ESRI (2002). ArcIMS: Mapping and GIS for the Internet. Retrieved August 4, 2003. http://www.esri.com/library/brochures/pdfs/arcims_bro.pdf

ESRI (2001). ArcIMS 3.1 Features and Functions. Retrieved December 21, 2001. http://www.esri.com/library/whitepapers/pdfs/arcims_features.pdf

ESRI (2000). Lewis and Clark Educational Center Creates Interactive Web Site Using Internet GIS Software (Press Release). Retrieved September 23, 2003. http://www.esri.com/news/releases/00_3qtr/lewisclark.html

FERINGA, W. (2001). Appendix B Design, colour, images, fonts, file size. In M.-J. Kraak and A. Brown (Eds), Web Cartography, pp. 195-209. London: Taylor and Francis.

FREMLIN, G. AND SEBERT, L. M. (1972). National Atlases: Their History, Analysis and Ways of Improvement and Standardization. Cartographica Monograph No. 4.

FRAPPIER, J. (2000). The National Atlas of Canada: from paper product to information network. Retrieved September 1, 2002. http://head-smashed-in-a.ccrs.nrcan.gc.ca/nac2/english/about_us/index_pres_e.html#acfas

FRAPPIER, J. AND WILLIAMS, D. (1999). An Overview of the National Atlas of Canada. In C. P. Keller (Ed), 19th International Cartographic Conference Proceedings Vol. 1, pp. 261-266. Ottawa: International Cartographic Association.

FUHRMANN, S. AND KUHN, W. (1998). The Design of Everyday Maps. Retrieved January 2, 2002. http://ifgi.uni-muenster.de/~fuhrman/publ/ica_polen/design1.htm

GALDOS SYSTEMS, INC. (2001). Top Ten Benefits of Using GML. Retrieved February 1, 2002. http://www.galdosinc.com/technology-whygml.html

GARTNER, G. (1999). Multimedia GIS and the Web. In W. Cartwright, M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 305-314. Berlin: Springer.

GOAD, C. (2002). Flash/SWF for GIS. Directions Magazine. Retrieved June 10, 2003. http://www.directionsmag.com/article.php?article_id=208

HARROWER, M. (2004). A Look at the History and Future on Animated Maps. Cartographica, 39: pp. 1-23.

HARROWER, M. (2002). Visual Benchmarks. Retrieved April 10, 2004. http://www.geography.wisc.edu/~harrower/dissertation/index.html

HARROWER, M., KELLER, C. P. AND HOCKING, D. (1997). Cartography on the Internet: Thoughts and A Preliminary User Survey, Cartographic Perspectives, 26: pp. 27-37.

HISTORICAL ATLAS OF CANADA ONLINE LEARNING PROJECT (n.d.). Background on the Historical Atlas of Canada. Retrieved September 27, 2002. http://mercator.geog.utoronto.ca/hacddp/page1.htm

HOCKING, D. (1991). Explorations into Design and Content for a New Provincial Atlas of British Columbia Incorporating Digital Technology and a User Survey. Unpublished masters thesis, Department of Geography, University of Victoria.

HOCKING, D. AND KELLER, C. P. (1992a). A User Perspective on Atlas Content and Design. Cartographic Journal, 29(2), pp. 109-117.

HUANG, B., BIN, J., AND HUI, L. (2001). An integration of GIS, virtual reality and the Internet for visualization, analysis and exploration of spatial data. International Journal of Geographical Information Science, 15(5), pp. 439-456.

HUME, S. (1996). Images, Multimedia and Animation on the Web. Bulletin of the Society of Cartographers, 30(1).

HURNI, L., BÄR, H. AND SIEBER, R. (1999). The Atlas of Switzerland as an Interactive Multimedia Atlas Information System. In W. Cartwright, M. P. Peterson & G. Gartner (Eds), Multimedia Cartography, pp. 99-112. Berlin: Springer.

HURST, P. (1997). Multimedia production - a view from the shop floor. Retrieved July 27, 2002. http://www.dcita.gov.au/Article/0,,0_1-2_2-3_143-4_12050,00.html

INDUSTRY CANADA (2003). Canadian Intellectual Property Office: A Guide to Copyrights. Retrieved November 1, 2003. http://strategis.gc.ca/sc_mrksv/cipo/cp/copy_gd_protect-e.html

INGRAM, F. (1996). Eloquent Interfaces. The Hiser Consulting Group. Retrieved September 20, 2002. http://www.dca.gov.au/nsapi-graphics/?MIval=dca_dispdoc&pathid=%2Fforum%2Fingram.html

INTERGRAPH (2003). Literature Center: GeoMedia WebMap Publisher: Publish without programming. Retrieved July 5, 2003. http://imgs.intergraph.com/freebies/literature.asp?by=part_number&qs=imgs025c0

INT MEDIA GROUP INC. (2001). Webopedia. Retrieved January 3, 2002. http://www.webopedia.com/TERM/J/

KELLER, C. P. (2001). Mapping the Province: Past and Present. In C. J. B. Wood (Ed), British Columbia, The Pacific Province: Geographical Essays, pp. 13-25. Victoria: Western Geographical Press.

KELLER, C. P. (1995). Visualizing Digital Atlas Information Products and the User Perspective. Cartographic Perspectives, 20: pp. 21-28.

KELLER, C.P., HOCKING, D., AND WOOD, C. J. B. (1995). Planning the Next Generation of Regional Atlases: Input from Educators. Journal of Geography, May/June, pp. 412-418.

KÖBBEN, B. (2001). Publishing maps on the Web. In M.-J. Kraak, and A. Brown (Eds), Web Cartography, pp. 73-86. London: Taylor and Francis.

KRAAK, M.-J. (2001a). Cartographic principles. In M.-J. Kraak and A. Brown (Eds), Web Cartography, pp. 53-72. London: Taylor and Francis.

KRAAK, M.-J. (2001b). Web maps and atlases. In M.-J. Kraak and A. Brown (Eds), Web Cartography, pp. 135-140. London: Taylor and Francis.

KRAAK, M.-J. (1996). Integrating Multimedia in Geographical Information Systems. IEEE Multimedia, 3(2), pp. 59-65.

KRAAK, M.-J. AND ORMELING, F. J. (1996). Cartography: Visualization of Spatial Data. Singapore: Prentice Hall.

LAKE, R. (2001). Introduction to Geography Markup Language (GML), Part 1 in GML Series. Retrieved February 2, 2002. http://www.jlocationservices.com/company/galdos/articles/introduction_to_gml.htm

LIME, S. (1999). Using GIS in Building Web Sites. 1999 Minnesota GIS/LIS Conference. Retrieved January 10, 2002. http://www.dnr.state.mn.us/mis/gis/gislis99/handout.pdf

LIMP, F.W. (1997). Weave Maps Across The Web. GIS World, 10(9), pp. 46-55.

LYNCH, P. J. AND HORTON, S. (2002). Web Style Guide (2nd Edition). Retrieved May 10, 2003. http://www.webstyleguide.com

MACROMEDIA (2002). Flash player penetration, September 2002 survey. Retrieved December 18, 2002. http://www.macromedia.com/software/player_census/flashplayer/penetration.html

MAPINFO CORPORATION (2002). MapInfo Products. Retrieved January 25, 2002. http://dynamo.mapinfo.com/miproducts/index.cfm?ProductCategoryID=1

MARTZ, L. AND FUNG, K. (2000). About the Atlas: Preface. Atlas of Saskatchewan (CD-Rom Edition). University of Saskatchewan.

MARYLAND INSTITUTE FOR TECHNOLOGY IN THE HUMANITIES (2001). Introductory Guide to HTML. Retrieved April 20, 2004. http://www.mith2.umd.edu/digdir03/html-lesson/popup.html

MCGREGOR, C. (2002). Developing User-Friendly Macromedia Flash Content (White Paper). Retrieved December 15, 2002. http://www.macromedia.com/software/flash/productinfo/usability/whitepapers/usability_flazoom.pdf

MEDIA AWARENESS NETWORK (2003). Canadian Copyright Act – Overview. Retrieved November 1, 2003. http://www.media-awareness.ca/english/resources/legislation/canadian_law/federal/copyright_act/cdn_copyright_ov.cfm

MERSEY, J. E. (1996). Cartographic Symbolization Requirements for Microcomputer Based Geographic Information Systems. In C. H. Wood and C. P. Keller (Eds), Cartographic Design: Theoretical and Practical Perspectives, pp. 157-176. Chicester: J. Wiley and Sons, Inc.

MILLER, S. (1999). Design of Multimedia Mapping Products. In W. Cartwright, M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 51-64. Berlin: Springer.

MISHRA, A. (2000). Web-based GIS. Retrieved January 13, 2002. http://www.cdacindia.com/html/connect/2q2000/srtil12.html

MONMONIER, M. (1996). How to Lie with Maps. University of Chicago Press: Chicago.

MONMONIER, M. (1994). The Rise of the National Atlas. Cartographica, 31(1): pp. 1-15.

MONMONIER, M. (1981). Trends in Atlas Development. In B.V. Gustell (Ed), Maps in Modern Geography: Geographical Perspectives on the New Cartography, Cartographica Monograph 27, pp.187-213.

MORRISON, J. L. (1995). A Personalized National Atlas of the United States. Cartographic Perspectives, 20(3), pp. 40-44.

MUEHRCKE, P. C. (1990). Cartography and Geographic Information Systems. Cartography and Geographic Information Systems, 17(1), pp. 7-15.

NAJJAR, L. J. (1997). Multimedia User Interface Design Guidelines (IBM TR52.0046). Retrieved July 26, 2002. http://mime1.marc.gatech.edu/mime/papers/multiTR.html

NATIONAL CANCER INSTITUTE (2004). Research-based Web Design and Usability Guidelines: Software/Hardware. http://usability.gov/guidelines/softhard.html

NATURAL RESOURCES CANADA (2003). The Atlas of Canada Base Maps: Abstract. Retrieved March 3, 2003. http://www.geogratis.com

NEUMANN, A. (2004). Comparing .SWF (Shockwave Flash) and .SVG (Scalable Vector Graphics) file format specifications. Retrieved May 3, 2004. http://www.carto.net/papers/svg/comparison_flash_svg/

NEUMANN, A. AND WINTER, A. (2002). Vector-based Web Cartography: Enabler SVG. Retrieved June 30, 2002. http://www.carto.net/papers/svg/index_e.html

NICHOLSON, N. L. AND SEBERT, L. M. (1981). The Maps of Canada: A Guide to Official Canadian Maps, Charts, Atlases and Gazetteers. Great Britain: W. Dawson and Sons Ltd.

NICHOLSON, N. L. (1970). Canada in Six Atlases. The Canadian Cartographer, 7(2), pp. 126-130.

OPENGIS CONSORTIUM (2001). Geography Markup Language 2.0 (OpenGIS Implementation Specification, OGC Document Number: 01-029). Retrieved April 16, 2002. http://opengis.net/gml/01-029/GML2.html

ORMELING SR., F. J. (1979). The Purpose and Use of National Atlases. In B. J. Gutsell (Ed), The Purpose and Use of National and Regional Atlases, Cartographica Monograph 23, pp. 11-24.

ORMELING, F. (1999). Map Concepts in Multimedia Products. In W. Cartwright, M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 65-74. Berlin: Springer.

ORMELING, F. (1995). Atlas Information Systems. In J. Morrison (Ed), 17th International Cartographic Conference Proceedings Vol.2, pp. 2127-2133. Barcelona: International Cartographic Association

PATTERSON, T. (1999). Designing 3D Landscapes. In W. Cartwright, M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 217-230. Berlin: Springer.

PENN STATE UNIVERSITY LIBRARIES (2003). About the Digital Chart of the World Data Server. Retrieved June 16, 2004. http://www.maproom.psu.edu/dcw/dcw_about.shtml

PETERSON, M. P. (1999). Trends in Internet Map Use – A Second Look. In C. P. Keller (Ed), 19th International Cartographic Conference Proceedings Vol.1, pp. 571-580. Ottawa: International Cartographic Association.

PETERSON, M. P. (1998). Active Legends for Interactive Cartographic Animation. ICA Commission on Visualization. Warsaw, Poland. Retrieved October 16, 2002. http://www.geovista.psu.edu/sites/icavis/publications/warsaw98.html

PETERSON, M. P. (1997a). Cartography and the Internet: Implications for Modern Cartography. NACIS XVI Annual Meeting 1996, San Antonio, Texas. Retrieved November 11, 2001. http://maps.unomaha.edu/NACIS/paper.html

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

PLEWE, B. (1997). GIS Online: Information retrieval, mapping and the Internet. Santa Fe, NM: OnWord Press.

PROVINCE OF BRITISH COLUMBIA (2003). Base Mapping and Geomatic Services Branch: Business Plan 2003/04. Retrieved October 26, 2003. http://srmwww.gov.bc.ca/bmgs/BMGS%20Business%20Plan%2003%2004.pdf

PROVINCE OF BRITISH COLUMBIA (2002). Selected Vital Statistics and Health Status Indicators, 131st Annual Report 2002. Ministry of Health Planning, Division of Vital Statistics. Retrieved December 16, 2003. http://www.vs.gov.bc.ca/stats/annual/2002/index.html

PROVINCE OF BRITISH COLUMBIA (2001). British Columbia Albers Standard Projection. Ministry of Sustainable Resource Management. Retrieved August 13, 2003. http://srmwww.gov.bc.ca/gis/bceprojection.html

QUINT, A. (2003). Scalable Vector Graphics. IEEE Multimedia, July-September 2003. Retrieved September 3, 2003. http://www.computer.org/multimedia/mu2003/u3099.pdf?SMSESSION=NO

REFSNES DATA (2003). W3Schools: Browser Statistics (Display Statistics). Retrieved August 2, 2003. http://www.w3schools.com/browsers/browsers_stats.asp

REFSNES DATA (1999). W3Schools: Introduction to XML. Retrieved January 3, 2002. http://www.w3schools.com/xml/xml_whatis.asp

RICHARD, D. (1999). Web Atlases – Internet Atlas of Switzerland In W. Cartwright, M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 113-118. Berlin: Springer.

RICHMOND, E. AND KELLER, C. P. (2002). Users' Comments on Maps and Tourism Destination Marketing on the Internet. CARTO 2002, Waterloo, Ontario.

ROBINSON, G. J. (1993). The NERC Marine Atlas Demonstrator: The development of an electronic atlas. The Cartographic Journal, 30(1), pp. 40-45.

RYSTEDT, B. (1995). Current Trends in Electronic Atlas Production. Cartographic Perspectives, 20(3), pp. 5-11.

SCHNEIDER, B. (1999). Integration of analytical GIS-functions in Multimedia Atlas Information systems. In C. P. Keller (Ed), 19th Inter'l Cartographic Conference Proceedings Vol.1, pp. 243-250. Ottawa: International Cartographic Association.

SPITZER, T. (1997). 1997: Year of the GIS, Part 2. DBMS Online. Retrieved January 18, 2002. http://www.dbmsmag.com/9701d15.html

STATISTICS CANADA (2004). The Daily: Household Internet Use Survey. Retrieved September 10, 2004. http://www.statcan.ca/Daily/English/040708/d040708a.htm

STYNES, K., WOOD, J., DYKES, J., FISHER, P. AND UNWIN, D. (1996). Publishing Cartography on the Web. Retrieved December 27, 2001. http://www.geog.le.ac.uk/argus/ICA/K.Stynes/

SUN MICROSYSTEMS (2004). Retrieved April 8, 2004. http://www.sun.com

SWANSON, J. (1999). The Cartographic Potential of VRML. In W. Cartwright, M. P. Peterson and G. Gartner (Eds), Multimedia Cartography, pp. 181-194. Berlin: Springer.

SWISS FEDERAL OFFICE OF TOPOGRAPHY (2000). Atlas of Switzerland: 3D Topography Panel Functions. CD-ROM Edition.

TELE ATLAS NORTH AMERICA (2003). Tele Atlas Geography Network Demonstration. Retrieved September 26, 2003. http://www.teleatlasgn.com/demo_route_server.html

TRAVERSA, E. (2001). Scalable Vector Graphics: The Art is in the Code. Jupitermedia Corporation. Retrieved September 7, 2002. http://www.webreference.com/authoring/languages/svg/intro/

UNB LIBRARIES (1998). Electronic Atlas of New Brunswick: Preface. Retrieved June 10, 2003. http://www.lib.unb.ca/gddm/maps/nbatlas/

ULRICH, K. (2002). Visual Quickstart Guide: Macromedia Flash MX for Windows & Macintosh. Berkley: Peachpit Press.

VAN DEN WORM, J. (2001). Web map design in practice. In M.-J. Kraak, & A. Brown (Eds), Web Cartography, pp. 87-107. London: Taylor and Francis.

VAN DEN WORM, J. (2002). Web Cartography: Web map design in practice. Retrieved February 19, 2004. http://kartoweb.itc.nl/webcartography/webbook/ch07/ch07.htm

VAN ELZAKKER, C. P. J. M. (2001). Use of maps on the Web. In M.-J. Kraak and A. Brown (Eds), Web Cartography, pp. 21-36. London: Taylor and Francis.

VAN WELIE, M. (2003). WEB Design Patterns: Bread Crumbs. Retrieved March 10, 2004. http://www.welie.com/patterns/showPattern.php?patternID=crumbs

W3C (2001). Document Formats domain, HyperText Markup Language Activity Statement. Retrieved January 5, 2002. <www.w3.org/MarkUp/Activity>

WANG, F. J. AND JUSOH, S. (1999). Integrating Multiple Web-based Geographic Information Systems. IEEE, pp. 49-61.

WEBNOX CORP. (2003). HyperDictionary: Dynamic HTML. Retrieved November 3, 2003. http://www.hyperdictionary.com/dictionary/Dynamic+HTML

WEINMAN, L (2003). The Browser-safe Web Palette. Retrieved May 10, 2003. http://www.lynda.com/hex.html

WHITE, B. (1998). Electronic Atlases: In theory and practice. Bulletin of the Society of Cartographers, 31(2).

WILLIAMS, D., O'BRIEN, D. AND KRAMERS, E. (2003). The Atlas of Canada Web Mapping: The User Counts. Cartographic Perspectives, 44: pp. 8-28.

WOOD, C. J. B. (2001). Introduction. In C. J. B. Wood (Ed), British Columbia, The Pacific Province: Geographical Essays, pp. 1-12. Victoria: Western Geographical Press.

ZORN, R (2001). Changing Your Screen Resolution: Why Would you Want To? Retrieved August 2, 2003. http://editor.actrix.co.nz/byarticle/changeres.htm

APPENDIX A

Step by Step Instructions for Selected Atlas Components

TABLE OF CONTENTS

The table of contents is comprised of five separate pull-down menus (one for each theme); each menu was created as an independent 'movie clip' symbol. Symbols in Flash can be assigned one of three behaviours:

1. Graphic: graphic elements (including animated graphics) that operate in step with the timeline of the movie.
2. Button: buttons sit in a single frame within the movie, but have their own four-frame timeline that displays when the user interacts with it.
3. Movie Clips: movie clips have their own timeline that operates independently of the main movie's timeline.

Although they vary in size (width) and number of sub-headings, the movie clips for the table of contents all follow and use the same framework. The following section will describe the creation of one of the movie clips.

1. **Insert → New Symbol** (select movie clip). Assign a name to the symbol – it can be changed or modified later. In the taskbar menu directly above the stage, the name of the symbol appears (next to the scene number, indicating that we are in the symbol editing mode). **NOTE**: all symbols are stored in the library (to open, **Window → Library** or **CRTL+L** or **F11**). If you click the scene number you exit out of symbol editing; to re-enter symbol editing, open the library and double-click the image that appears before the symbol's name (double-clicking on the name itself allows you to change the name only).

2. Add two more layers. **Insert → Layer**, or click on the 'insert layer' button located under the layers, in the bottom left hand corner (see diagram). Double-click the layer text (i.e. Layer 1) to re-name the layers to Text, Menu, and Actions, respectively.

3. For each layer add more frames, so that each layer has 10 frames (select the first frame in each layer and press **F5** to add a frame). **Insert → Frame** also works, but it is quicker and easier to use the F5 button to add frames.

4. Select frame 5 in the each of the layers and insert a keyframe (**Insert** → **Keyframe**, or right-click on frame 5). What we are trying to do is break the layers into two parts to create a 'Collapsed' and an 'Expanded' section.

5. Select frame 1 in the menu layer and label it Collapsed. Frames can be labeled in the Properties taskbar. Repeat the procedure for frame 5, labeling it Expanded.

6. Select the first frame in the Action layer. Now open the Actions-Frame taskbar and select **Actions** → **Movie Control** → double-click on ***stop*** (a lower case 'a' appears in the frame, indicating ActionScript has been applied). This action will prevent the movie from 'playing' or doing anything without the user's input/interaction. Technically, the *stop* ActionScript could be placed in any layer, but for the sake of convention, and to avoid confusion, it is placed in its own layer.

7. Insert a new symbol, assign it a button behaviour and give it a name (i.e., rectangle1). On the screen draw a rectangle (make sure the colour inside is blue). In the timeline, there are now four keyframes present: Up, Over, Down, and Hit. Theses names indicate a change in the button, as the user interacts with it: as the mouse moves 'over' the button, or when the user presses 'down' on the button. The Hit frame is not visible in a Flash movie, but is very important in defining the interaction area of a button. Insert a keyframe into each of these frames. By default, Flash inserts the same element(s) that are present in keyframe 1 (in this case, Up) into each consecutive keyframe. Now, we have four keyframes with four identical rectangles, but we want the button to change colour when the users rolls over it and presses it. Select the Over text above its keyframe and then select the rectangle. Select a different colour (black). Repeat the procedure for the Down keyframe, making it black. Now when the user rolls over the button, it will change from blue to black and when they press down on it, it will change to black. This new symbol will become the button for the sub-headings.

8. Select the first frame of the Text layer, select the text tool from the toolbox (capital 'A') and enter a title (World Setting). Next, select the first frame of the Menu layer (Collapsed), open the library, select the symbol rectangle1 and drag a copy of it onto the stage. At this point the rectangle can be modified to fit the text.

   NOTE: Changes can be made to any symbol instance (copy) on the stage without affecting the original symbol in the library. If you enter into symbol-editing mode on the stage (double clicking on the symbol), any change made will affect the original and any instances present on the stage.

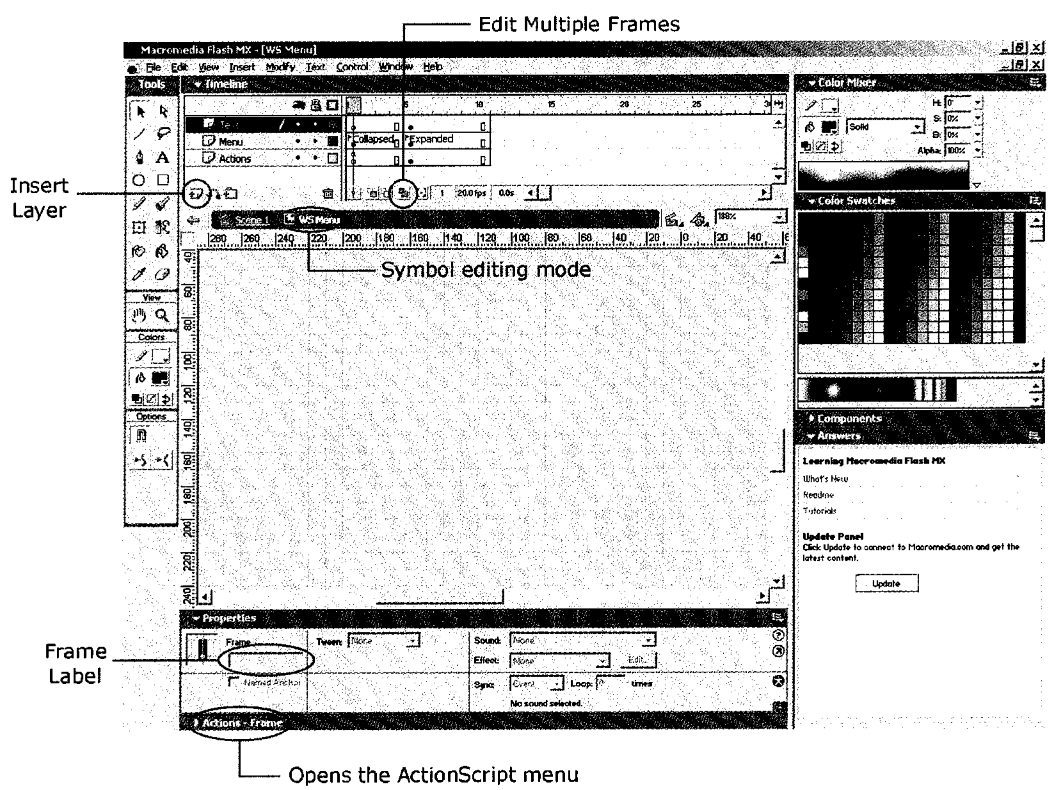
9. Select the rectangle. Open the ActionScript menu, select **Actions → Movie Control** → double-click ***on***, select **Release** in the event options. Then double-click ***goto***, select Go to and Play, under Type select Frame Label, and in the Frame dialog box type in 'Expanded'. When the user hits the rectangle, Flash will move from the collapsed section to the expanded section.

10. Select the first keyframe in the Expanded section of the menu layer (frame number 5). Drag a couple of instances of the rectangle symbol from the library onto the stage – these instances will become the expanded portion of the pulldown menu. The symbols can be aligned to each other using the align commands (**Modify → Align**). Also, we want the expanded rectangles to line-up with the collapsed rectangle. To accomplish this, we can use the **Edit Multiple Frames** button in the timeline; this feature lets you simultaneously see and edit several frames at once (the adjustable marker becomes active above the timeline).

11. In the text layer, select frame 5 ('Expanded section' of the text layer) and add text to accompany the rectangles (sub-headings). At this point the framework for the expandable/collapsible menu is complete, although one problem does exist: When the expanded portion of the menu is open, there is no option to close it and revert back to the collapsed state. To fix this problem we need to add a hidden button.

12. Select the menu layer and frame 5 (Expanded section). Draw a rectangle that will cover the entire menu. Select the rectangle and right-click on it; from the list of options, select **Convert to Symbol**. Assign it a button behaviour and name it Hidden Button. Double click on the newly created button to enter into symbol-editing. Select the **Up** frame and right-click on it, selecting **Cut Frames**. Right-click on the **Hit** frame and select **Paste Frames**. Exit it out of the symbol-editing mode. A faded rectangle appears on the screen, but it will not be visible when the movie is published (exported to HTML). Make sure that the rectangle extends past the collapsible/expandable menu, but not too much.

13. Select the Hidden button symbol on the stage and open the ActionScript menu. Select **Actions** → **Movie Control** → double-click ***on***, select **Release** in the event options. Then double-click ***goto***, select Go to and Play, under Type select Frame Label, and in the Frame dialog box type in 'Collapsed. When the user moves the mouse outside the menu region and hits the hidden button (rectangle), Flash will jump from the expanded section back to the collapsed section.



<u>VIDEO</u>

Importing and using video in Flash is accomplished quickly and effortlessly, using the Sorenson Media's Spark codec, which encodes and decodes (compressing and decompressing) the video data.

1. Select the layer and keyframe in which you want to place the video clip; from the main menu, **File → Import to Library**, and select the video to be imported. A dialog box opens, with a variety of import settings to choose from. Ulrich (2002: 500-501) provides a quick overview of these settings:
    a. **Keyframe Interval.** Refers to crucial frames created as Spark compresses the video clip. Spark encodes the full-frame image only for keyframes, so this setting tells Spark how often to encode a full frame. Higher numbers here translate into a smaller file size because a higher number means a larger interval between keyframes which means fewer keyframes, thus less data to transmit.
    b. **Quality.** Spark applies a JPEG-like compression to the image data, from 0 to 100. In this instance the higher number gives the most faithful rendition of the video, whereas a lower number will produce a highly pixilated version.
    c. **Scale.** The scale setting (0 to 100) allows you to reduce the dimensions of the video clip. Spark always retains the original aspect (ratio of width to height). Once again, smaller numbers translate into a smaller file size.
    d. **Synchronize.** Checking the synchronize box encodes the video in a way that forces Flash to preserve the original duration of an embedded video clip. Unchecking the box, the frames go into lock step, but you get to control how the steps interlock by selecting the ratio of video frames to Flash frames.
    e. **Import Audio.** Flash will only import the video clip's audio if it's sampled at 44.100Hz, 22.050Hz, 11.025Hz, or 5.50125Hz. You can also choose not to import the video clip without the audio component.

2. Once the settings have been made, Flash imports the video clip directly to the library. A warning dialog box will appear if the timeline contains fewer frames than the video clip. Enlarging the span of the timeline may interfere with other features (especially animation), so it is often best to retain the current number of frames by clicking 'No'. Flash truncates the clip to fit the timeline, but the video clip is there in its entirety.

3. Like any other element within Flash, a video clip can be converted or incorporated into a symbol (such as a movie clip). Often, it is easier to keep a video clip and its controls (play, stop, rewind, fast forward) within a movie clip. In this instance we will create a new movie clip symbol and add the following layers: Clip (for the video clip), Controls (for the buttons), and Action. Label the first frame in the clip layer, movie.

4. The next step is to add controls to the video, so that the user can play and stop the video at their discretion. These controls can be designed and produced from scratch, but it is more efficient to use the wide variety of symbols available with Flash. **File → Open as Library**, (find the location of the Macromedia Flash directory) Program Files → Macromedia Flash MX → First Run → Libraries → Buttons.

5. After selecting buttons appropriate for play and stop, we need to add ActionScript to these buttons. First, we need select the first frame of the Action layer, open the Actions-Frame taskbar and select **Actions → Movie Control →** double-click on ***stop***. This will prevent the video clip from playing through and looping continuously. For the play button, select the symbol, open the ActionScript menu, **Actions → Movie Control →** double-click ***on***, select **Release** in the event options. Then double-click ***goto***, select Go to and Play, under Type select Frame Label, and in the Frame dialog box type in movie. For the stop button, select the symbol, open the ActionScript menu, **Actions → Movie Control →** double-click ***on***, select **Release** in the event options. Then double-click ***goto***, select Go to and

Stop, under Type select Frame Label, and in the Frame dialog box type in movie. When the user stops the movie, it will go back to the first frame.

6. Once the movie clip of the video has been completed, it can be ‘dragged’ onto the stage (and embedded into the Flash document). Like all other movie clips, the video can be modified (larger, smaller).