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

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

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

INTRODUCTION

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

project; namely, the production of an interactive, multimedia *Atlas of Saskatchewan (CD-ROM Edition)* that was released in November 2000 (Martz and Fung 2000).

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

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

CARTOGRAPHIC COMMUNICATION

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

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These principles are equally important to cartographic design in a multimedia (usually digitally-based) framework. The implementation of multimedia features provides access to a much greater range of communication tools and, perhaps most importantly, allow the user to play a more active role in exploring geographic data. Citing Marshall McLuhan's well-known observation that "the medium is the message", Peterson (1995) emphasizes the effect of the choice of medium on the ability of a map to

transmit geographic information. McLuhan (1967) suggested that technology such as electronic media affect the message being communicated and that dependence on traditional print media has impaired our visual communication skills. Peterson (1995) suggests that like McLuhan's view of the printed word, printed maps may have closed our minds to imaginative expression and communication of spatial information.

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

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

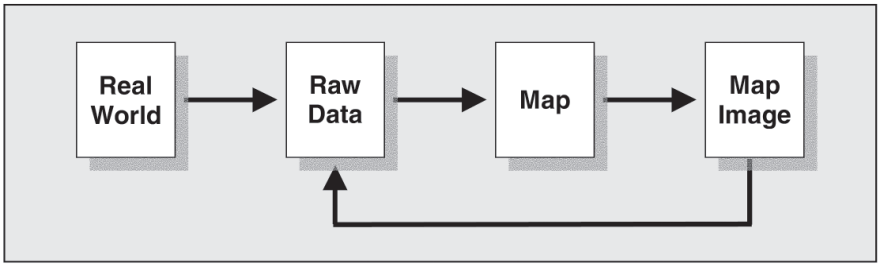

Figure 1. Muehrcke model of cartographic communication (Moellering, 1980) in which map contents are abstracted from real world information through the manipulation of raw data to a mapped image.

MULTIMEDIA AND MAPPING

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

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

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

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

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

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

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THE ATLAS OF SASKATCHEWAN ON A MULTIMEDIA PLATFORM

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

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

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

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Navigational links were also incorporated into the content. These links were used when elements from a page had to be broken up and placed on different screen pages, and also provided the CD-ROM version with the ability to link related information form other sections within the chapters. This was necessary because of the need to transform atlas pages designed

for a print medium, at 9.5 inches wide by 13.5 inches tall, to fit the format of a monitor that is landscape oriented and typically varies in size from 15 inches to 19 inches on the diagonal. In support of these linking capabilities, a history button was incorporated to allow the user to return to previously viewed screens. It was felt that while it was essential to provide comprehensive "random access" to the entire *Atlas* content from any page, it was also important to allow the user to backtrack through their personal chronology of views. Basically, an effort was made to both preserve the familiarity of sequential book access while taking advantage of the enhanced navigation functionality made available through new technology.

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

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

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

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

TECHNICAL CONSIDERATIONS

The need to incorporate particular functionality and interactivity determined the choice of software for production. An important secondary consideration was the decision that the *CD-ROM Atlas* be available for both PC and Macintosh platforms. It was also recognized that the software chosen could impose minimum hardware requirements on the end user. The production team agreed that the CD-ROM would be more than simply an electronic version of a page turning application. The aim was to

find a software program that would be able to incorporate a diverse range of elements in a multimedia environment. The software also had to be resilient enough to handle the large amounts of data that were designated for this project. Consideration was given to producing the *Atlas* as a set of HTML documents or PDF documents. Each of these was felt to have significant limitations with regard to the design objectives. Authoring software proved to be the best solution for integrating the many features and functionalities required for this project. Through consultation and experimentation, Macromedia Director[1] was chosen as the core production software.

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

THE IMPLEMENTATION PROCESS

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

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

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Conceptualization

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

Dissemination of Duties

The next stage in the development of the CD-ROM was the dissemination or distribution of duties. This was critical to the success of such a large

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

Storyboarding

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

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

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

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

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

Data Extraction and Transformation

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

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

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

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

Authoring

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

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Quality Control

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

Publishing

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

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

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

CONCLUSION

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

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

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

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

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