Atlas of Saskatchewan – A Product of Technological Innovation

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Introduction

The Centennial Edition (First edition) of the Atlas of Saskatchewan was published in 1969 and the Millennium Edition (Second edition) in 1999. Both volumes shared several major similarities. Like other modern atlases, they contain many multi-coloured maps, accompanying by explanatory and elaborative texts, statistical graphs, diagrams, and photographs, as well as a detailed gazetteer of both physical features and cultural features in the province. For their contents, the two atlases adopt a thematic approach, offering documentation to promote geographical understanding of Saskatchewan. They portray the province's heritage and history, physical environment, wildlife, natural resources, population, economy and major cities, in individual themes and in their interrelations and interactions over space and time. For portability, the Millennium edition retains the same dimensions as its predecessor. Both atlases have been produced in hardcover, sewn-bound volumes, and printed on quality paper to ensure their physical durability.

There are significant differences between the two editions, as there has been a time gap of three decades between their publications. Many new themes and much details in both maps and texts have been incorporated in the 1999 edition, as vast amounts of data and research findings have accumulated, and changes and developments taken place during those interim years. The new edition features 83 new themes and 75 texts with over 130,000 words, and it contains 104 pages more than the previous edition. The advent of earth-observing satellite technology since the early 1970s has made it possible to include in the Millennium Atlas imagery obtained by space remote sensing platforms: NOAA, GOES, Landsat and Radarsat, providing atlas readers several glimpses of the province as seen from space.

Traditional Film-based Technology in Atlas Production

When the first edition of the Atlas was prepared during the second half of the 1960s, scribing and photomechanical techniques—cutting edge film-based technology for map production at that time—were used. The technological innovation successfully replaced the traditional pen-and-ink drafting method. It made possible the production of high-quality multi-coloured maps. However, as both scribing and peel coat techniques used in the colour separation process were essentially manual processes, map production, in general, was still labour intensive and time consuming. Because of the great diversity of themes in atlases, coupled with varying degrees of map details, it is necessary to include in those publications maps of a wide range of scales. A series of base maps, as well as all line symbols must be manually produced on scribe coats. The scribed base maps, combined with appropriate boundary lines are then transferred photomechanically onto peel coats and photographically onto films to provide guides for generation of colour area symbols and patterns, respectively. High-quality lettering for names, legends and titles was produced. Manually-operated typesetting machines were often used to produce high-quality lettering for place names and feature names, legends and titles on maps. These types must be tediously placed on film transparencies, in accordance with established name or type placement principles. Every stage in the production process must be proof read, using blue prints of map images produced by the diazo process. The complex design of many of the multi-coloured maps in 1969 edition, in terms of the number of colours and the variety of symbols used, involved many individual steps in their preparation of colour separation flaps from base maps compilation to production of press negatives. All the coloured photographs in the volume must be colour separated manually, using the process camera. On the whole, although very high-quality maps could be generated, the production process remained a tedious and time-consuming task.

Introduction of Computer Technology in Thematic Mapping – A Transition

Computer technology used in thematic map making first came into being when the SYMAP mapping program was introduced by the Harvard Laboratory for Computer Graphics and Spatial Analysis in the mid-1960s. Maps were produced by computer on-line printers which used alphanumeric characters to generate line and area symbols. Time requirement for thematic map production was reduced, but the finished products were generally not considered to be satisfactory by most cartographers. Use of point symbols, as well as lettering for place names on those maps remained a great challenge to map designers. Pen plotters driven by appropriate mapping software were able to generate achromatic or coloured line symbols of selected thickness. In general, the outputs from these devices represented a great improvement over those of the line printers, nevertheless, in terms of graphic quality, they were still considered by professional cartographic designers to be inferior to maps produced by the scribing and photomechanical techniques. Like on-line printers, line plotters still had problems in providing well-designed lettering for place and feature names on maps. Cartographers also experienced great difficulty to position names, or to spread individual letters of a name in their proper spacing along curved line symbols on maps when using computerized device of this type.

Digital Revolution in Mapping and GIS Technology for Atlas Production

The era of digital mapping technology and Geographic Information System (GIS) technology used for map production arrived in the 1980s. Since then, both of them have been evolving at a very quick pace. These technologies have brought much improved graphic design capability, as well as great flexibility and high efficiency in data processing, data management, data transfer, and map production. A high degree of automation has much reduced the tediousness, and made map production much less labour intensive, and thus more cost effective. Further, they have made possible the production of atlases in both printed and electronic forms, including multi-media CD-ROM atlases and web-based atlases.

Planning of the Millennium Edition of the Atlas of Saskatchewan began in mid-March 1995. The plan for the new Atlas envisaged and subsequently adopted a cost-effective approach to produce an updated provincial atlas in print form, using state-of-the-art digital mapping and GIS technology. The book version would make information immediately accessible to the public at relatively low cost. At the completion of the book Atlas, the digital data files for the Atlas contents created by the project would be used for the production of electronic products of the Atlas family. These digital products would include an interactive, multi-media CD-ROM edition, and finally an internet version which would allow users to work directly with the digital database to query, analyze, and customize displays and outputs of Atlas information.

The three different editions: book, multi-media CD-ROM, and internet, furnish examples of the several modes of presentation for geographic information and reflect the rapid evolution of digital technology applied in the cartographic environment. The book provides a snapshot for posterity of the province at the end of the First Millennium. Atlas electronic versions, on the other hand, offer a very powerful and extremely versatile form of learning and communication. The digital files compiled during the first phase of the project for the production of the book laid the foundation for the second phase—production of the CD-ROM edition. Atlas information is presented in an interactive, multimedia environment. Animation and sound, therefore, may be used to help communicate geographic information, making learning the geography of the province more interesting for young users. The innovative "pan-and-scan" technology has been introduced to help Atlas users to examine and explore the depth and richness in all the 1:2,750,000 scale maps with complex details. Users are able to navigate, using dynamic links between texts and graphic materials, the tremendously complex body of information in the Atlas. The world-wide-web version, the third phase of the project, will further allow constant revision of Atlas themes, as well as updating geographic data on a regular basis. The book Atlas was published in November 1999, at the proximity of the threshold of the end of the first millennium and the beginning of the second millennium. Therefore, it is also known as the Millennium Edition. The completion of the CD-ROM edition in November 2000, with the addition of several new themes, marks the end of the second phase. It will be followed by the initiation of the detailed planning for the on-line version, the third phase of the project, in the summer of 2001.

Most of the data used for producing the new Atlas existed in digital forms, though a very small proportion in analog forms. The latter, such as colour and black and white photographs, old map manuscripts, and monochromatic drawings, were converted into digital files by means of high-resolution electronic scanners. The analog-to-digital data conversion allowed all the production work for the Atlas to be performed in a digital environment. Some data stored in CD-ROM and zip-disks, or available on the internet were imported for map construction. One notable example of data capture from the internet included the import of climatic data collected in Montana and North Dakota for the production of various types of climatic maps. Climatic data of Alberta, the Northwest Territories and Manitoba were accessed from the Environment Canada CD-ROM. The use of climatic data collected outside Saskatchewan and those collected from within would ensure the production of accurate climatic maps in the Atlas, as all weather and climatic patterns transcend political boundaries. Large data files for map compilation, such as the digital base maps for the province, at scales of 1:3,000,000; 1:7,500,000 and

1:15,000,000, specially prepared for the Atlas project by the GIS center at SaskGeomatics, were transmitted electronically via "file transfer protocol" (FTP). Text materials and highly complex map manuscripts from contributors to the editor were transmitted over the internet and electronic mail. The digital files of completed maps and texts were sent back to the contributors for proof reading, and making minor changes and corrections when necessary. After the files were returned, the editor completed the final page layout, and the digital files were then exported as postscript files to a commercial printer in Saskatoon to prepare colour-separation plates (in CYMK colours) for the production of the printed version of the Atlas. (Figure 1) Although some new themes were introduced, the bulk of the database created for the book Atlas was used for the production of the multimedia CD-ROM Atlas and for the creation of the future web-based version.

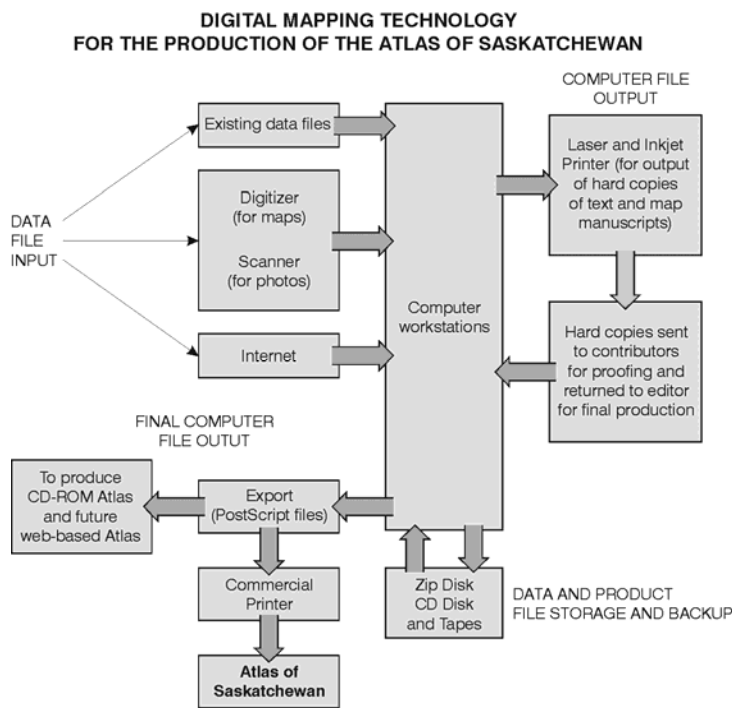

Figure 1

Electronic technology has found wide application in GIS, data processing, mapping and graphic design in atlas production. It reduces drastically the amount of time and effort that are generally required to produce different types of graphic presentation of geographic data, and greatly enhance their accuracy, effectiveness in cartographic communication and aesthetic appeal. Traditionally, block diagrams have been used by geologists to portray the relationship between geological structure, lithology and landforms. This type of perspective illustrations was adopted in the Atlas to depict the nature of continuous statistical surfaces representing six selected types of weather hazard data, including blowing snow, fog, freezing rain, thunderstorms, hail and tornadoes that occurred in Saskatchewan. The employment of digital technology has provided a fresh look to weather mapping.

Among the various graphic illustrations that are used to represent the forms and characteristics of terrain on small-scale thematic maps, the most realistic portrayal is perhaps the combination of hypsometric tinting and relief shading. The former method applies colour area symbols to surfaces between highly generalized contours to represent the different elevation levels. The latter is based on the use of light and shadow which create realistic details and patterns of the landform surfaces. Before the advent of digital technology, production of high-quality relief shading maps required map makers with an artistic talent and possessed knowledge of terrain characteristic interpretation of contour maps and air photographs. With the availability of computer software, cartographers are now able to experiment with the direction and intensity of lighting to produce a remarkable graphic effects of terrain portrayal, revealing intrinsic details of the landform surfaces. The task may be achieved in terms of hours rather than months. In the Atlas, the map showing the topography of the province was created by the digital method. An additional eight digital terrain models were produced to represent some significant physical landscape features in the province created by geological structures, glacial erosion and glacial deposition.

The advent of satellite technology has not only vastly affected over our daily lives, but also significantly impacted map production. Specifically, this state-of-the art technology has revolutionized data capture and data transmission for cartographic purposes. Several maps and imagery in the Atlas were generated from data collected by both earth-orbiting and geostationary satellites. Selection of specific types of satellite data for the production of specific maps in the Atlas was based on both the synoptic coverage and the type of data that the sensors of the satellites were able to gather. For example, each individual scene of both NOAA and GOES-8 provided very extensive coverage of the earth's surface. The former, in a mosaic, provided a general view of the vegetation or land cover types in Canada, while the latter revealed specific cloud patterns associated with frontal activities, low pressure centres, and jet streams over the entire southwestern Canada, the United States and Mexico, which added valuable information to the two synoptic climate maps showing typical winter and summer conditions in Saskatchewan. Landsat data was ideal for regional land cover mapping, showing land cover and forest types. The five selected Landsat imagery with their accompanying land cover maps (Poulton Lake, Nipawin, Makwa Lake, Crooked Lake, and Grassland) provided a regional view of the physical environment and land use patterns. The mosaic of Landsat imagery showed in detail the major tree species distribution patterns in the commercial forest zones in the province. Because of the peculiar active microwave and urban feature interactions, many urban land use patterns in Regina and Saskatoon, the two major cities, could be easily distinguished from the two radar imagery obtained by Canada's RADARSAT. Their unique image characteristics were quite different from those of conventional air photos and satellite imagery.

Satellites	*Maps/Imagery in Atlas*
NOAA	Saskatchewan from Space
GOES-8	Synoptic Climatology - Typical Winter and Summer Conditions
LANDSAT	Poulton Lake, Nipawin, Makwa Lake, Crooked Lake, Grassland, Commercial Forest Zone, and Selected Forestry Inventory maps
RADARSAT	Regina and Saskatoon

Radio satellite tracking technology, representing the highlight of the technological innovation used for the production of maps in the Atlas, was applied to bird migration mapping. The traditional method of tracking and recording bird migration involved the banding technique. The chance of recovery was generally very low, as many of the birds caught might not have been reported. By contrast, when using the new state-of-the-art technology migration routes for specific birds can be traced and mapped in detail. The technique involved attaching a small radio transmitter on a female Swainson's hawk captured at her nest found in a farm located several miles outside the town of Kindersley in southwestern Saskatchewan. The radio signals were continuously relayed by an orbiting communication satellite to a ground receiving station. Locations of the bird's initial departure point and her final destination, as well as all her stopping points by longitudes and latitudes and the time of her arrival and departure at those points by hour and minutes were recorded. The data revealed that she left her nest (longitude 109.2 degrees W and 51.5 degrees N) at 7:35 a.m. on August 26, 1996 and arrived in Argentina (longitude 62.2 degrees W and latitude 27.3 degrees S) at 1:34 a.m. on November 24 in the same year, completing a journey of 9,905 kilometres. After spending 88 days in northern Argentina, the hawk left her final stopover spot at 2:57 a.m. on February 19, 1997 and headed north for home. She arrived at her old nest at 6:04 a.m. on April 9. The homeward stretch covered a distance of 10,195 kilometres. The migration route of that bird is shown on page 151 of the Atlas.

No doubt technology for thematic mapping has now reached a significant milestone, and it will continue to evolve with an accelerating speed within the early part of the 21st century. Voice-activated mapping software is already available to map makers. Future digital technology will eventually able to replicate practically all standard film-based techniques, which include automatic feature generalization and geographic name placement. It will offer cartographers more capabilities and flexibility in map design. Production of electronic atlases that allow cartographic visualization and interaction between map makers and map users will become commonplace. One may even further speculate that in the near future cartographers will be able to capture mapping data directly from earth-orbiting satellites that collect spatial data of both physical and cultural features on the earth's surface.