

Web-based multimedia cartography applied to the historical evolution of Iqaluit, Nunavut

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ABSTRACT

Technologies advances are changing the way maps are created and displayed. Especially, digital and Web-based multimedia cartography are bringing maps outside the main stream flow by giving a new life to archive data such as old paper maps and photographs. Historical Cartography is a way of building bridges between the past, the present and the future. This is the main purpose of 'The Historical Evolution of Iqaluit' Mapping Project. Its main objective is to develop an electronic interactive map of Iqaluit, the booming capital city of the new territory of Nunavut in Northern Canada. By using graphic interfaces and interactive navigation tools, the user is able to visually reconstruct spatio-temporal changes in the city over the last 50 years (1948-1998). The viewer can intuitively perceive transformation of the city through orthomosaics, pictures, maps and 3D animation. Such a cartographic product may serve many purposes including culture, tourism, education, and also city planning and development. Understanding the development of the town over time is valuable for education of youth and interesting for city visitors and tourists. Finally, understanding the spatial and historical development of the city is also important for decision-support, especially for city planning and development purposes.

Key words: Multimedia cartography, graphic interfaces, visualization, historical evolution; Iqaluit.

1. Introduction

This paper presents the results of a 2-year project (1999-2001) initiated by the Mapping Services Branch (MSB) of Geomatics Canada, Natural Resources Canada, Ottawa. The project was aimed to investigate and test various methods and tools for a more effective knowledge and use of the Internet for cartographic visualization. The convergence of digital mapping and the Internet has paved the way for new mapping and other sophisticated interactive applications. Iqaluit, the capital city of the Canadian newly created territory of Nunavut, was chosen for the case study. This choice was guided by the large amount of data produced during the publication of the Commemorative Map of Nunavut by the MSB. Further, the choice was guided by a growing interest for the Canadian Northern territories among researchers, governments, business people and the general public. The Historical Evolution of Iqaluit interactive map Project also received a partial funding from the Government of Nunavut.

2. Project Overview

Based on the concept of interactive cartographic visualization, its main objective was the development of Web based interactive maps of Iqaluit, the booming capital city of the new territory of Nunavut in Northern Canada. By using a graphic interface and interactive navigation tools, the user is able to visually reconstruct change in space and time of the city over the last 50 years (1948-1998) through aerial photographs and thematic map layers and therefore, intuitively perceive transformations in the form of dynamic or animated maps on computer screen. Such a cartographic product may serve many purposes including culture, tourism, education, and also city planning and development. Understanding the development of the town over time is valuable for education of youth and interesting for city visitors and tourists. Moreover, displaying change in a very dynamic environment of a fast-growing town like Iqaluit is also very important for decision-support. That may help to learn about the history of the city and to understand the spatial growth process of the city area so as to plan its future development in a more suitable way. The main outputs of the project are a CD-ROM and ultimately, a web site.

The project was handled in a multidisciplinary way given the variety of issues pertaining multimedia cartography. The main components that are addressed include mapping; Web development and graphic interfaces; Orthophotos and 3D animation, and finally Geographic interpretation and Potential applications.

2.1 Maps

This section addresses multimedia cartography for the Web: design for the screen, samples of wrong and right colour matching, sound delivery, text and places names placement, and requirements for purpose-driven design and good communicative maps.

2.1.1 Objectives

One of the project objectives was to create multimedia maps by integrating voice, animation and pictures (e.g. Talking Map; Places Name Map). This component addressed several design issues of Internet cartography including Web standards and technological limitations (i.e., 216-colour web-safe palette). The aim of the project was to show good cartographic practice and emphasize quality cartographic products available on the World Wide Web.

2.1.2 Design issues

Some of the design issues taken into consideration when designing maps for on screen viewing were combining aesthetics, concision and precision to create a purpose-driven map. These included appropriate and theme driven colour selection and matching, efficient text placement and a purpose-driven design. The issues addressed were:

- Graphic communication and ease of on-screen reading/viewing
- Presentation of important information and details, while avoiding drawings and photographs, which would clutter the overall design. A philosophy “less is more” was adopted
- Thematic colour selection and matching for the Web-safe colours

2.1.3 Methodology

The sources for the map data were the Canadian National Topographic System maps (NTS), aerial photographs, commercial tourists maps, and field data. The original design for static maps was done with the use of Macromedia FreeHand, Adobe Illustrator and Photoshop, while map animations were developed with Macromedia Director. Maps employing mouse-over (or roll-over) techniques were produced using Macromedia Fireworks.

2.1.4 Results

The maps produced for the project can be classified as static and dynamic, and further subdivided into view only and interactive (Kraak and Brown, 2001). Figure 1 presents a locator map of the Nunavut using the Web colour palette to great advantage. Greens and blue are the foundation of this map, with textures playing against the smooth colours to command the attention of the viewer. B

ience, English and Inuktitut speaking.



Figure 1: Locational map (http://maps.nrcan.gc.ca/visualization/nunavut_map.html).

Figure 2 shows a “picture map”. Moving a computer mouse over boxed place names results in display of a picture. This serves as an overview of the regions where pictures are carefully chosen to best reflect major towns of Nunavut.



Figure 2: Picture map (http://maps.nrcan.gc.ca/visualization/introduction/picture_map.html).

Figure 3 is an example of an application of voice annotations in a map interface to let users hear the pronunciation of place names in Inuktitut.

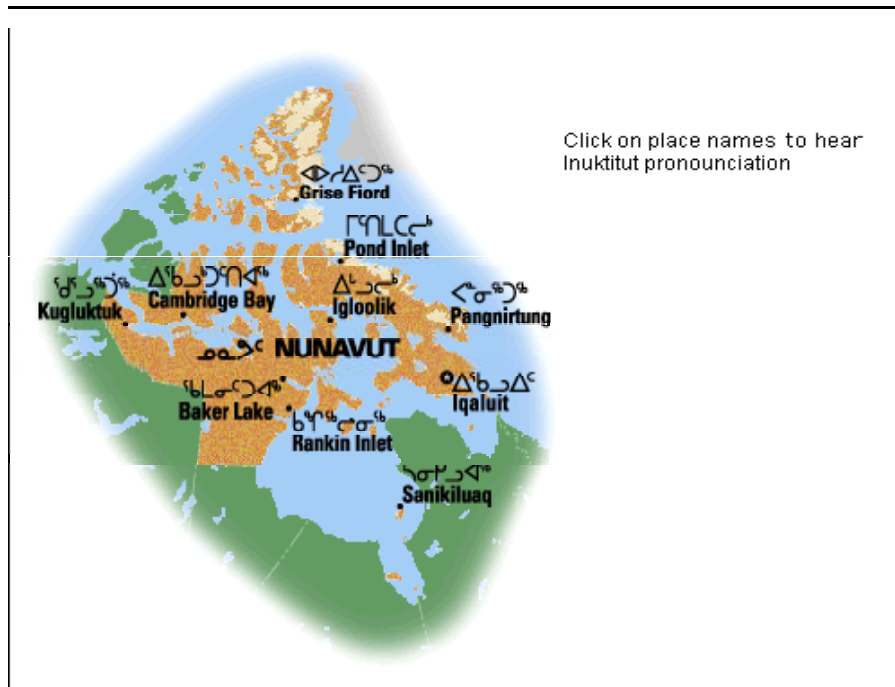


Figure 3: Talking map (http://maps.nrcan.gc.ca/visualization/introduction/talking_map.html).

2.1.5 Future considerations

In the future, it is planned to explore how audio could be used to represent terrain and land cover. The unification of animation and maps has not yet received the attention, which would meet its full potential. Looking into these two areas would, serve to make the web site more engaging.

Further investigation should be focused on cartographic communication: the map as interface, map animation, map as narrative and maps to support data display. Standards in name pronunciation and typonomy could become important issues in areas like the Nunavut with more than one local language.

2.2 Web Site Development and Graphic Interfaces

This section addresses web site development and interfaces of two types, map based and Graphical User Interfaces (GUI)

2.2.1 Objectives

The main objectives of the web implementations were to investigate the best way to promote on screen visualization and the use of cartographic data without the degradation of cartographic communication standards. Also to investigate limitations and possibilities of the Internet (colour, font, size, map interfaces, etc.). Another objective was to design and implement an efficient and user-friendly Web site containing heterogeneous or even complex cartographic features and geospatial information and finally to promote good cartographic practice and representation in visual communication

2.2.2 Methods

The graphic interfaces have been produced using Macromedia Fireworks and overall web implementation was done using Macromedia Dreamweaver and Allaire HomeSite. Some key processes in web implementations were:

- Establishing project information: selecting data/information or materials relevant to the content and suitable for Web distribution, out of the 3 components of the project such as papers and documents downloadable in Portable Document Format (PDF) and Rich text Format (RTF).
- Developing the information architecture for the web site: designing a Web site structure for easy navigation and efficient use by the viewer. The web site was divided into four sections: Project Information, Case Study, Iqaluit Map and Introduction to Nunavut. The Case study is the main section and it includes the information, materials and results of the three project components (such as graphic interfaces, multimedia maps, orthomosaic and animation). This section of the web site is presented in English and French, with an introduction to Nunavut also in Inuktitut.
- Creating a web site layout: this includes the design of a “Common Look and Feel” templates compliant with the guidelines developed by the Treasury Board Secretariat.
- Editing content information: preparing data for integration into the web site, including redesigning some of the graphics and maps, editing text, and creating hyperlinked structure for the web site.
- Uploading the web site to the Intranet: transferring the content to the dedicated Web server for testing purpose.
- Creating French equivalent of the web site to comply with the Government Web publishing requirements.
- Uploading a complete web site to the Internet: this final posting of the web site on the Internet follows a successful testing, based on heuristic evaluation of the web site usability and feedback from users.

2.2.3 Results

“Common Look and Feel” interface

The web site of the Internet Based Cartographic Visualization (Figure 4) designed to comply with Treasury Board of Canada Secretariat for Government Websites requirements regarding the “Common Look and Feel” layout for all government web sites. These regulations apply to content formats, graphical layout as well as other Web site elements such as standardized metadata information.

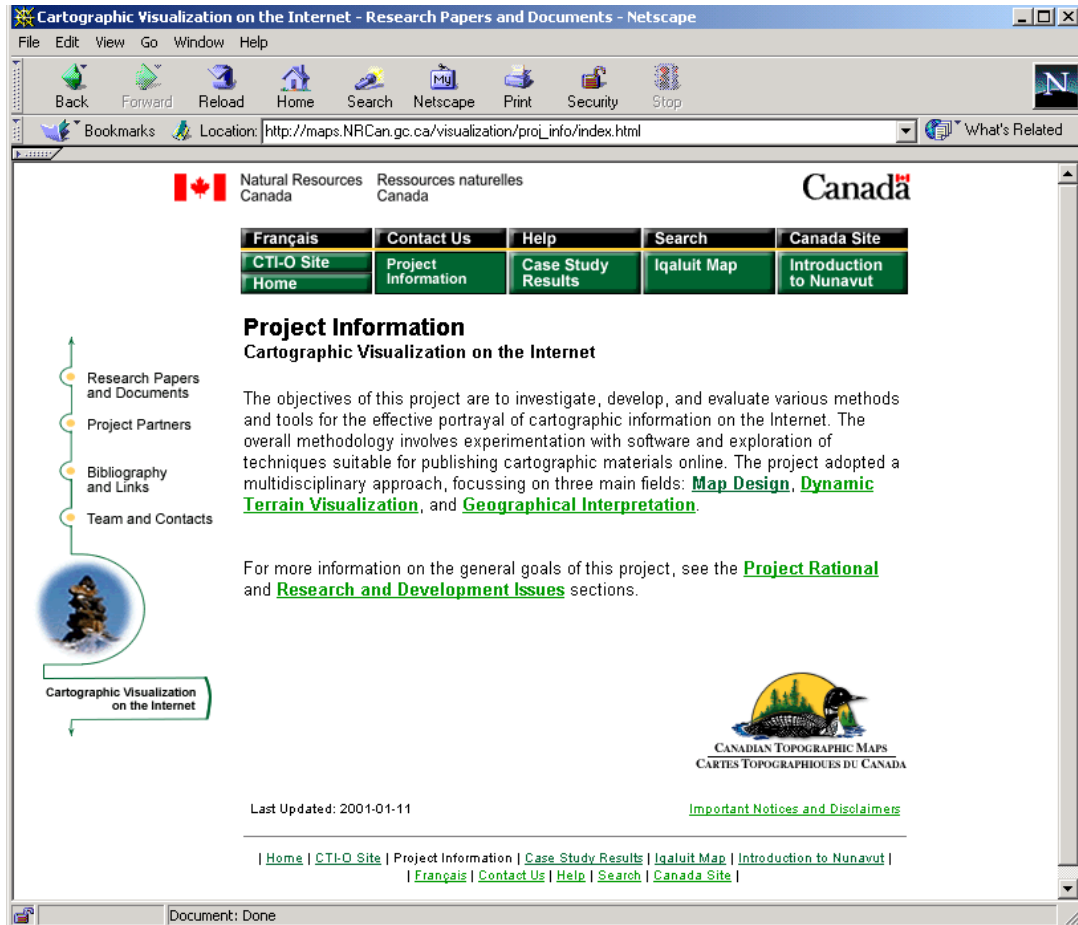


Figure 4: Introductory page for the Internet based Cartographic Visualization web site (http://maps.NRCan.gc.ca/visualization/proj_info/index.html).

Visual search interface

Interactive visualization interface (Figure 5) was developed to display of Iqaluit buildings and services. This identification map is an excellent tool for visual search of information. This interface uses frames to display information for the specific buildings/areas however it can be also implemented using single page with “named anchors” or behaviours for opening new browser windows (for additional infromations).

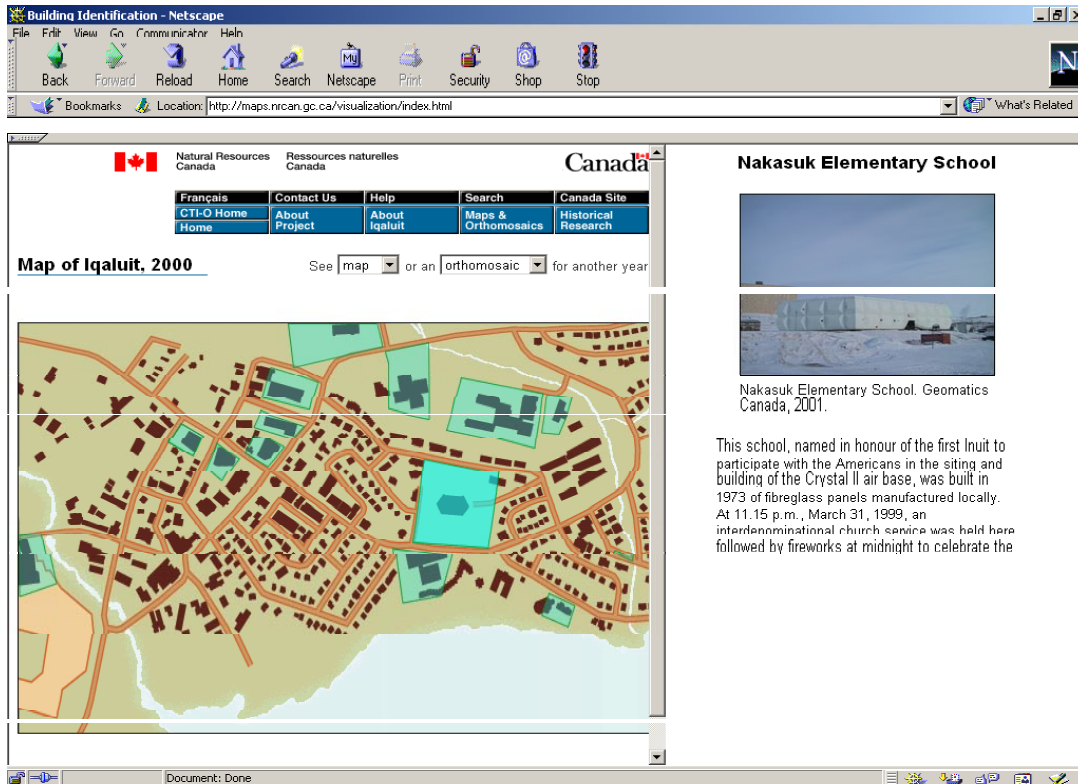


Figure 5: Interface for the Iqaluit City Services Map (<http://maps.NRCan.gc.ca/visualization/interfaces/map/index.html>).

2.2.4 Future considerations

Web based educational and training tools

One of the future considerations of the project is to explore techniques suitable for training and education through the Internet. Such a material requires development of adequate content, information architecture and navigation, textual and graphical representation, as well as investigation of interactivity techniques and multimedia.

Technical challenges pertaining to the web

One of the research prospects pertaining to the publishing on the Internet is continuing investigation of new Web techniques and technologies. Some of the areas to be investigated are web design issues, such as use of colour, and cartographic symbolization; technological issues such as reduction of file sizes (static images, animation and multimedia files), and others.

Implementation of the third language – Inuktitut

Based on cooperation with Department of Culture, Language, Elders and Youth (CLEY) and feedback from Iqaluit, one of the project future objectives is to translate the content of the web site to Inuktitut, which is the main language of Inuit living in Nunavut. Implementation of the web site in three languages (two official and one native) will be a model for other government departments, which work in association with the North. The triple language web site will require additional web structure and exploration enabling technologies for the use of type symbols (used in Inuktitut), which are suitable for Web publishing.

2.3 Orthomosaics and 3D animation

2.3.1 Orthophotos

An orthomosaic is made up of geometrically corrected and then georeferenced images or aerial photographs called orthoimages. Then an orthomosaic is created by merging a set of adjoining orthophotos in a single larger image in a process called mosaicking. Part of the orthomosaics was produced on the Helava digital photogrammetry station (Socet Set) by

using georeferenced raster stereo-models. The remaining orthophotos were generated on the PCI (EASI PACE) and ERDAS image processing software packages.

Roll Number	3 Date	4 Flight Height	Scale	Ground resolution
A28444	03/08/00	5,300 ft	1:10,000	1.0 m
A28353	03/08/95	7,800 m	1:15,000	1.6 m
A21180	13/08/69	6,350 ft	1:12,330	0.5 m
A16165	24/07/58	30,000 ft	1: 57,900	0.4 m
A11535	23/07/48	10,000 ft	1: 19,600	0.4 m

Table 1: Description of the aerial photographs used for the orthomosaics.

For this case study a total of five orthomosaics reflecting key periods I, the development of Iqaluit (1948, 1958, 1969, 1995 and 2000) were created. The National Air Photo Library (NAPL) provided aerial photographs except for the 2000 coverage provided by the Municipality of Iqaluit (Iqaluit 1:2000 Mapping Project, Jack M. Byrne Consulting). However, handling photos of different scale, quality and resolution has been the main challenge of image processing (table 1). In addition, display constraints imposed by the Web (screen size and resolution) have forced the team to display only a portion of the orthomosaic (and the maps as well) at high resolution. The area of interest chosen for that purpose is the core city around the 'Ring Road'.

The five orthomosaics were used to create a Building identification interface. The techniques used in the design of this interface are rollovers for clickable buildings and frames. The orthomosaics were also used as input to generate vector and raster maps for different visualization options: single display and overlay based on year selection. In addition, 3D flyby animation was also produced using the orthomosaics. Description of the processes is given below.

2.3.2 Generation of 3D animation

Three-dimensional Terrain rendering have become an increasingly popular tool for landscape visualization. 3D landscapes or on-screen animations are created by draping orthoimages on digital elevation models (DEMs) and then generated frames out of them. A 3D static animation is made up of separate frames than can be displayed sequentially, whereas an interactive animation gives the user complete control over all navigation or flight parameters using appropriate tools from the browser.

Three-dimensional Terrain Analysis capability now available in most GIS software packages are use to create rendered virtual landscapes out of real data. Resulting flybys provide the viewer very realistic representation of the land. This is why such a visualization tool was chosen to allow the viewer to virtually recreate an aerial perspective view of Iqaluit city area for each of the five periods.

Here are the main steps for generation of a 3D flyby:

- Conversion of the DEM from GRD to TIN (Microstation)
- Triangulation (Microstation)
- Rendering (MicroStation): Output a non-georeferenced 8-bit RGB image in TIF format.
- Production of a georeferenced raster image on PCI Easi Pace (.PIX format).
- Generation of a Terrain File (.TER format) on IQ Media Terrain Viewer software.
- Productions of a 3-D landscape scene on IQ Media Terrain Viewer software.
- Definition of a flight path vector in ASCII format on Terrain Viewer
- Generation of Video (AVI files) from terrain files (IQ Media Terrain Viewer software).

Some methodological issues pertaining the production of a 3D flyby and interactivity:

Definition of a flight path: The flight path file is a path travelling over a 3-D that includes position and orientation information. A flight path (in ASCII format) is made of a solid line joining a series of nodes that hold the geometric values of the current flight position (tilt angle, speed, direction, view direction, and elevation). A similar flight path has been set for the five so as to simulate a fly over the city area from the same aerial perspective. The viewer can therefore, visually detect the main changes such as new areas of development.

Animation: Terrain database images in TER format and flight path files in ASCII format are use as input to generate a video movie in AVI format. The video movies (AVI files) can be produced using any GIS Terrain modelling capability such as ESRI 3D Analyst or ERDAS Virtual GIS. Once a flight path has been created, it can be turned into a digital video movie. The movies can be created at different resolutions. Resulting animated frames (AVI files) can be run with common plug-ins such as Real Player, QuickTime or Windows Media Player. However this option does not allow any interaction with the user. Interactivity can be achieved only with specific plug-ins such as IQ Media Terrain Viewer, or Skyline TerraExplorer.

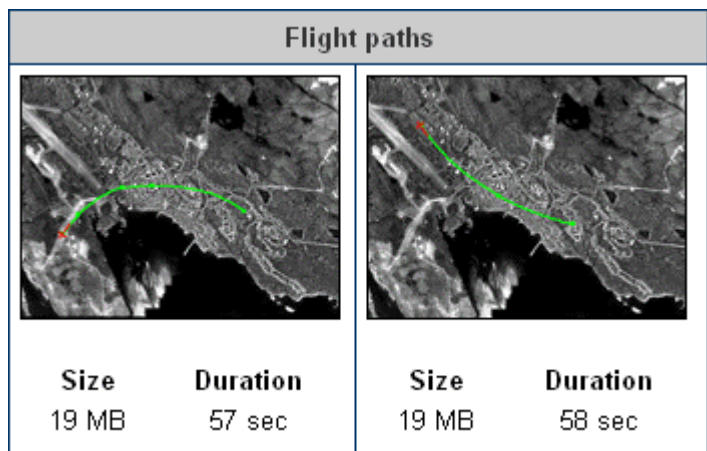


Figure 1: Samples of the orthomosaics showing flightpath definition.

2.4 Geographic interpretation and potential applications

This project demonstrates that realistic computer-generated visual display of geographic information can be achieved by linking text, sounds and images to graphic features to represent dynamic city growth process. The large number of partners that were involved in the project is an indication the final output may serve to several purposes in northern communities. Therefore potential applications can be anticipated from cartographic, GIS, cultural, planning and educational perspectives, just to name a few.

The Internet allows producing maps with dynamic and interactive capability for the viewers. Such new cartographic products may enhance the power of visual cartographic evidence and facilitate problem solving. Policy makers can now use geospatial data sources along with on-line mapping and analytical tools as an aid to achieve balanced decisions on natural resource management, environmental protection, emergency preparedness and sustainable practices. Internet-based new cartographic products are addressing an increasing number of potential applications both in conventional and new fields including culture, tourism and education:

From both GIS and cartographic perspectives the map interfaces demonstrate some tools for interactive Web mapping. Some of the issues addressed include vector-raster data integration for visual analysis, navigation and on screen data selection, map feature identification and location. For instance, animated maps bring focus to the movement of physical structures across the landscape. This technique was used to simulate the displacement of some buildings, which changed location within the area over time.

Urban Planning and management: Detection and monitoring of change in a very dynamic environment and fast-growing city like Iqaluit is very important for decision-support. That may help understanding trends in spatial growth of the city area so as to plan its future development in a more desirable way. As a decision-support tool multimedia cartographic products may be used for city delimitation, housing development projects (real estate), and site study and landscape analysis. For instance, the Building identification interface could apply to legal surveys and the management of real estate in the city area.

Developers can make multimedia presentations to planning boards using realistic 3D fly-through models of their proposals to display predicted spatial evolution of the city area based on both past and present situation. A 3D visualization of the town area can be used to show the spatial distribution of predicted city development areas.

Cultural and education: Such cartographic products would be useful for cultural education in schools (Web site, museums) and for tourism (virtual touring). The product designed so far remains open for further development by inclusion of new materials. Local schools and Inuit elders can contribute to the improvement of the product by collecting additional information from their community on the model of the existing Natural Resources Canada's Atlas of Communities. Furthermore, many tourist and cultural products could be designed around the same concept, including interactive demo maps for the Museum and also for the upcoming Inuit Heritage Centre.

As future prospects, the Iqaluit Research Centre in Iqaluit was thinking of a project of a 7000-km long winter trek across the Canadian Arctic that would link 19 communities, from Tuktoyuktuk to Iqaluit, with recorded information about trails, landmarks or travel corridors between communities. Audio and video data collected in the communities would be inserted into a GIS, and eventually posted on the Internet.

Nova Borealis Consulting, a Iqaluit-based private company, was planning to conduct for Tourism Nunavut a Web-based multimedia project to develop and market hiking trails around Iqaluit. That work would involve the use of digital topographic maps and oblique photographs, DEMs, orthophotos, and flybys. The company was also planning to develop a Web site for the City of Iqaluit based on orthophotos to provide a town map with building identifier tools including a "walk-through" with panning capability from various locations.

3 Future Considerations

Based on the assets of the current Cartographic Visualization project, such initiative would take into account the current Natural resources of Canada priorities such as sustainable development of Northern Canada, addressing climate change and security of Canadians. Such a project would address the following perspectives or issues:

- Cartography of the Arctic: specific approach to mapping extreme environments
- Decision support: use of GIS and geospatial data for planning, the management and conservation of natural resources and analysis of climate change in the Arctic (case study in Nunavut)
- Culture: using multimedia cartography to promote Inuit culture and safeguard traditional knowledge and tourism within the Arctic region.

4 Conclusions

As potential applications, 3D animations can help a wide range of users in diverse industries understand their spatial information better by accurately displaying data in a highly realistic, interactive digital environment. The sharing of information is made easier by saving rendered landscapes as 3D images or movie files that can be viewed on any desktop. Additionally, dynamic 3D visualization captures the imagination of an audience and creates high impact, compelling presentations. As potential applications for decision-support, engineers, urban developers and landscape ecologists can simulate 3D worlds for a better perception of terrain and make high impact presentations to planning boards of their proposals using 3D fly-through models.

With the advances in multimedia Web technologies, there is an opportunity to enhance map communication and conduct more research in the area of multimedia cartography. New way of cartographic communication and new techniques of portraying information can be of great benefit to Web community and especially to people in the North. New approaches to map design should be developed to adopt to the mapping of the North and mapping of issues related to indigenous knowledge.

Furthermore, there is an opportunity to undertake study in Web based education, as there is an opportunity and a need for effective training tools, especially in remote areas of the North. At the time when very minimum cartographic training is offered by schools and when cartography courses are being removed from university curriculum, Internet has a great potential for introducing online courses to promote good cartographic design and effective communication.

Additional Notes

The paper was written based on the Internet Based Cartographic Visualization, a Research and Development project of the Centre for Topographic Information – Geomatics Canada, Ottawa, Canada (1999-2001). The project led by Dr. Eva Siekierska included the following members: Dr. Dieudonné Mouafo (research scientist), Ken Francis (M.A., cartographer), Anita Muller (M.A., cartographer and Web page designer), Jean-Louis Moisan (B.Sc., geomatics engineer).

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Project Web site:

<http://maps.nrcan.gc.ca/Visualization/>