TACTILE MAPPING PROJECT AT CANADIAN FEDERAL MAPPING AGENCY - MAPPING SERVICES BRANCH

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Abstract

Until recently, very few blind and visually impaired people have had the opportunity to use maps and geospatial information. Thanks to advances in technology, such as the development of special inks, papers and global positioning systems, tactile and low vision map making can provide a range of products, which can improve the well being of the visually impaired community. The applications of tactile maps include learning spatial concepts, learning geography, assisting with mobility, and building confidence by providing the tools to acquire knowledge and improve everyday life situations.

In 1998, Mapping and Services Branch of Natural Resources Canada initiated a tactile mapping program to serve the community with special needs. This paper will share some research results of the project, discuss user needs, provide information on currently available technology, and introduce upcoming technologies and trends in development. It will discuss the various types of tactile and audio-tactile maps of Canada developed by the Mapping Services Branch in cooperation with the geomatics industry and tactile map users, and describe the current activities carried out within the project.

1. Introduction

Blindness is one the most feared of all disabilities: it limits ability to learn about space and makes everyday tasks extremely challenging. People who are blind from birth have difficulty imagining the space, distance or size of anything that can't be touched. They, and others, who have lost their sight due to illness or accident, must rely on the help of other people or guide dogs to find their way in a non-familiar environment.

With new technological advances in tactile mapping, everyday life for the blind and visually impaired can become less cumbersome, allowing them and their caregivers more independence. Developing maps for the blind has a three-fold purpose: to enable education, encourage participation and perhaps most importantly, to counter the exclusion frequently faced by people with disabilities.

Since the United Nation's International Year of the Disabled in 1981, governments throughout the world have become more aware of the impact of a variety of disabilities on their citizens and have attempted to become more responsive to their needs [http://www.un.org/esa/socdev/enable/disiydp.htm]. The Government of Canada recently wrote, "It is timely, for consumers, government officials, and content and service providers to work together to harness the potential of new technologies, so that print disabled Canadians may benefit from government programs that facilitate access to information for study, work, leisure and life-long learning" [Fulfilling the Promise, 2000]. The Government has also developed a public policy framework and a plan to ensure that print disabled Canadians can get timely, affordable and usable information to facilitate their full participation in the emerging knowledge-based economy. It also has plans to deliver its information and services online by 2004 [http://publiservice.cio-dpi.gc.ca/gol-ged/].

In this spirit, in 1998, Mapping and Services Branch (MSB) of Natural Resources Canada initiated a tactile mapping project to serve the community with special needs. The initiation of this program was part of an international project by PAIGH (Pan American Institute of Geography and History) and Carleton University, entitled 'Cyber Cartography for the Americas' [http://www.ipgh.org.mx]. One of the components of the PAIGH project was the production of TELALA (Tactile Electronic Atlas of Latin America). This atlas was based on multimedia technology created by Tactile Audio -Visual Graphics (TAG), developed at the University of Newcastle, Australia [http://www.newcastle.edu.au/index.html]. When MSB's Tactile Mapping Project investigated the situation in Canada, we found that there were very few maps available for the blind, and began further research in this area [Tactile Mapping Project Report, 2001, 21pp.].

This paper will share some research results of the project, discuss user needs, provide information on currently available technology, and introduce upcoming technologies and trends in development. It will discuss the various types of tactile and audio-tactile maps of Canada developed by the Mapping Services Branch in cooperation with the geomatics industry and tactile map users, and describe the current research and development activities carried out within the project.

2. User Profiles

The number of blind and visually impaired people in Canada is increasing. In 1991 more than 2% of the Canadian population identified themselves as having lost a significant amount of vision that cannot be corrected by standard eyeglasses. Between 1990 and 2000 the number of clients serviced by the Canadian National Institute of the Blind (CNIB) increased from 60 000 to over 100 000. Of these, about 5 000 are blind children of school age, and approximately two-thirds are people over the age of 60. The proportion of blind persons is higher in Canada's aboriginal communities, as it is in other poor or disadvantaged communities around the world [CNIB Client Statistics, 2001].

2.1 User Groups and Needs

The blind population is very diverse and can be divided into three main groups:

- *People who are blind from birth* do not easily understand geo-spatial concepts such as distance, size and scale; in effect, they see space with their hands. Tactile maps can significantly help children to learn geography and earth sciences.

- *People who have lost their sight due to illness or accident*, or who have extremely limited sight that allows them to be designated "legally blind", primarily experience problems of mobility. The use of geo-spatial technology could help these groups be more independent.

- *The visually impaired group*, which consists mainly of the elderly; will continue to grow in Canada due to the aging of the post World War II "baby boom" generation. (Canada's population has the largest proportion of "baby boomers" in the world - approximately 25%). This group needs such cartographic products as maps with larger print and less detailed information.

In addition, a fourth and largest group, who are not actually blind, is referred to as *print disabled people.* This group consists of people who suffer from dyslexia and all who can't type, have reduced hand mobility (due to arthritis, carpal tunnel syndrome, etc.) and would prefer alternative interfaces. This group has been estimated at 10% of the Canadian population [Fulfilling the Promise, 2000].

While it has often been pointed out that new geo-spatial technological developments can be of benefit to the entire population and not only to a specific group, their impact on the blind community will be significantly greater, as they often provide the only means by which the blind can receive and use geo-spatial information. Thus, it is necessary to encourage governments to make these developments available and financially accessible to this group.

3. Current Tactile Maps

Although geo-spatial data and new technologies can considerably help improve the quality of life of the blind, as well as facilitate learning, our investigations showed that the current use of maps for the blind in Canadian schools is very limited. The blind population is relatively small: in Ottawa, a city with a population of 1 000 000, there are currently 87 blind primary and secondary school children enrolled. Whether in regular community schools where ‘special needs’ children are integrated into the public school population (as in Ottawa), or in the very small number of specialized residential schools for blind children, we found very little use of maps for teaching geography, and no geo-spatial technologies in use at all.

In one school for the blind in Quebec, we saw a beautiful, but extremely labor intensive, wall map that used raised nails to indicate boundaries and other features. Another school in Ontario used an out of date globe, produced in Germany, which consisted of wooden blocks representing various countries. Other maps in use are most often hand made, one at a time, by teachers, using string, glue guns, sandpaper, cardboard or any other material that will give a “feel” to the finger tips. Reproduction techniques, when available, also tend to be crude. Producing handmade maps with embossed aluminum foil is a more efficient technique that allows several maps to be reproduced from a model. Vacuum forming reproduction makes use of a product called *Thermaform*. It produces tactile images when exposed to heat and creates thin, flimsy plastic tactile maps. These latter systems, however, were available only at larger residential schools and not in community schools.

3.1 Issues in Cartographic Design

A number of cartographic issues affect the design and production of tactile maps. The blind “read” with their finger tips and can differentiate symbols by touch only. The visually impaired user needs a much higher degree of feature generalization with levels of omission, exaggeration, and distortion never imagined by the designer/producer of conventional cartographic products. The extreme variability in visual abilities within the blind and visually impaired community also makes design decisions very difficult. The level of detail that can be incorporated thus depends on the capability of each reader. Other design issues include the size of lines, the types of symbols used, and standardized representation. A particular technical issue is the need for technical design to match printing capabilities, as reproducibility has been a problem with some tactile maps in the past.

Beyond design and production, training must be provided to potential map users. Basic geographical concepts, such as proportion, scale, point of view, location and orientation must be well understood before working with maps. The tactual graphic language must be introduced to the user prior to map reading through exercises with the visual and tactual graphic variables. Design and production of effective maps also requires blind user advice, feedback and testing. New products on video monitors will have to be evaluated as a means of communicating spatial information, which is very difficult. Cognitive and perceptual research will be needed in order to improve map design in all hardware and software forms.

Standardization also poses a major challenge, since no map design conventions now exist in the international community, though some individual countries, including the U.K., Japan and Australia, have implemented standards. While some researchers have suggested that standardization is not possible, since users have such varying abilities, most agree that there is a need for consistency and clarity to facilitate the reading of maps.
(This section is largely drawn from Regina Vasconcellos’ article, “Tactile Mapping Design and the Visually Impaired User” [Vasconcellos, 1996]; used by permission.)

3.2 Other Challenges

A lack of financial resources also contributes to the lack of map production and availability for use by the blind. The blind user community is relatively small and little or no funding is available for this type of technical innovation. The CNIB is not well funded for aids such as maps and even computers.

The fact that mapping for the blind is not a profit-making venture has made it hard to attract interest and financial support from the geomatics industry. As well, because tactile mapping is such a specialized field, it can be challenging to develop partnerships with other government departments and divisions, as well as to obtain more general funding.

4. New Technological Developments

With a range of new geo-spatial and other technological developments, a new field of cartography is emerging called *tactile mapping*. *Tyflological products* (from the Greek word for ‘blind’), which involve all types of graphics for the blind and visually impaired, are also being developed. Australia, the United Kingdom, the United States, Poland and Japan are very active in these fields.

4.1 New Types of Materials

Recent advances that allow the creation of new, simpler and more cost-effective tactile maps include the development of new types of papers and inks.

- *Coated Papers*
  New papers, both heat-sensitive and water-sensitive, are now on the market. The Tactile Mapping Project used *Flexipaper*, a product of the United States, to produce city area maps for mobility training. The drawn or printed map is put through a heat source resulting in a raised image. A great advantage of these maps is that designs can be sent electronically, or made available through a web site, and maps printed on site with the necessary equipment. Water-sensitive-paper, in which drawn or printed lines are raised by the application of moisture, is also available.

- *Raised inks*
  Another recently developed technology is raised ink. Tactile Vision Inc., a Canadian company, developed an "ink" that rises and hardens when heated to produce very detailed line-work, [http://www.tactilevision.com/]. The advantages of this technique are that maps can be printed on ordinary paper and have a sharp and durable image that is easy to read. This technology is being used now by American Printing House, in the United States, and more recently in Poland.

- *Various plastics*
  Thermo-formed plastics, (e.g. *Thermaform*) can incorporate a variety of textures and elevations and are favored by some designers for presenting a wide range of information and data.

4.2 Multimedia Communications Systems

Multimedia systems, which integrate image and voice, can further enhance communication of geospatial data. Mapping Services Branch (MSB) tested TAG, the Tactile Audio-Graphic system developed in Australia. This system was purchased by MSB as a mapping system to allow blind and visually impaired persons to draw and use tactile maps. The system has voice-assisted interaction, making it possible for a blind person to use the system and produce simple maps and graphics and to annotate them with a voice commentary. Such systems can also assist in mobility training by allowing the sighted to produce on-demand tactile maps of unknown areas of the city and annotating by voice to explain features portrayed on the map. MSB produced several types of tactile maps based on this technology. One example is a talking map of downtown Ottawa, and an audio-tactile map of Canada. These maps need the TAG system for the audio component but can be used independently of the system as well. At the present time research is being conducted to develop audio-tactile maps on the Internet [Information and Services for Persons with Disabilities Cluster, 2001].

4.3 Electronic Maps with Global Positioning Systems (GPS) for Position Finding

Tactile, audio-tactile or geo-spatial data can be combined with GPS for maps that are used to enhance mobility. Such systems are used in the United States but not in Canada due to the small user community and high cost of geo-spatial data here. A Canadian company, VisuAide, merged, in 1993, with Arkenstone, now a part of Freedom Scientific of the USA, to develop tools to increase the orientation and mobility of the blind and visually impaired. Its talking map, *Atlas Speaks*, can access a collection of digital data on CD's covering most of USA. Users enter a starting point or address, then the destination, into a portable computer. A synthesized voice then tells them how to get there – which streets to take, where to cross and when to turn left or right. The information can be recorded or printed out in Braille to be taken along on the journey.

The Strider/Sextant system provides yet another new method of orientation and mobility that uses geo-spatial databases and Global Positioning Systems (GPS) which can help blind people locate their position and guide them using voice synthesizing systems to reach their destination. These systems can open new opportunities for mobility of the blind. Systems like this are available for the blind in all major American cities. Such technologies could be more economically viable when produced for the tourist market, such as the CityGo system produced by VisuAide, Canada, and then modified for the blind and visually impaired users [http://www.visuaide.com/].

4.4 Haptic Interfaces

Haptic (pertaining to the sense of touch*)* devices are being developed in the field of computer science. These include a vibrating haptic mouse that can give feedback when scanned over a map, for example, in search of a specific location. This new technology is currently being tested in Mapping Services Branch.

New technologies can offer many new ways of teaching and enhancing the mobility of the visually impaired community in a very cost-effective way. The schools of today have access to a great deal of technology and information [http://www.schoolnet.ca], and this should extend to the blind and visually impaired community. Today's new technologies can offer a sense of independence and opportunity once enjoyed only by sighted people.

5.0 Prototype Maps Developed at MSB

Having identified a low use of maps in the educational institutions and in mobility training centers in Canada, we purchased the TAG tactile mapping system and used it in combination with a map drawing package, Corel Draw, to develop several types of tactile maps.

- *An audio-tactile map of a downtown city area* was produced using TAG (Tactile Audio-Graphic) and Tactile Vision's Inc. raised ink technology [see Fig.1]. The map was drawn at a 1:500 metre scale allowing no space for any labeling in Braille. The audio interaction capability permits to annotate the features portrayed on the maps. The map was tested by blind people using the audio component of TAG capable of finding objects or areas on a map. Another feature of this system is function to calculate travel distances. These capabilities are extremely important to a blind person as it permits independent self-learning and assists greatly in mobility training.

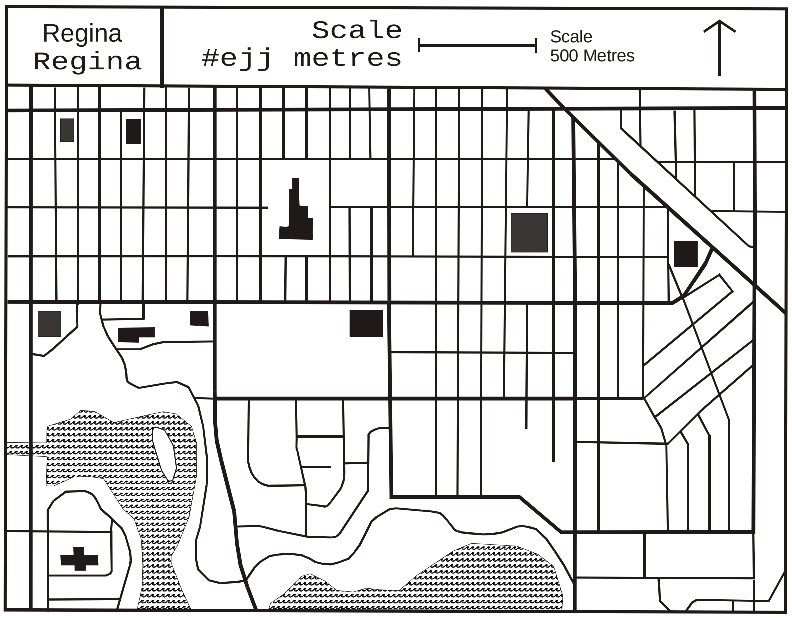

Fig. 1 Audio-tactile Map of City of Regina (reduction 1:4)

- *Topographic city area maps* were produced to demonstrate the use of topographic maps to enhance the mobility of a blind person by offering general knowledge of the surroundings where s/he lives or works. The development of these mobility maps motivated mobility instructors working for the CNIB in Ottawa to draw maps, using this new technology, for their blind clients. A cost-effective production flow was developed permitting production of mobility maps at CNIB Ottawa and creating a base for the implementation of an on-demand service for other centres in Canada.

- *The Tactile Atlas of Canada* was developed in cooperation with Tactile Vision Inc., which has developed an atlas of the United States for the Library of Congress. The atlas includes tactile maps of each province and territory as well as a map of Canada. Primarily made for the educational community, the atlas could also be used by adult blind and low-vision, users. The main features shown are political boundaries, lakes and rivers, and cities – all derived from the standard map of Canada produced by the National Atlas of Canada. Symbology was determined based on consultation with Tactile Vision and through user interviews at schools.

  Standardization of symbols could be possible in the future with greater exposure of the atlas and feedback from users while working more closely with others who produce similar products. Some standardization had been done but the lack of maps being produced has made it difficult to prove which symbols give better results. The W. Ross Macdonald School, the largest residential school in Canada, gave the atlas a positive review and purchased copies for every classroom in their school.

  The Atlas drew media attention at the 19^{th} ICA International Cartographic Conference 1999, in Ottawa, Canada, and was recently selected by the Canadian National Cartographic Committee for display at the International Cartographic Exhibition at the ICA International Cartographic Conference, ICC 2001, in Beijing, China.

6. Plans for the Future

Canada is fortunate in having a rich, efficient, infrastructure. Data for maps is part of our existing geo-spatial data infrastructure, and can be used for production of maps for blind and visually impaired people. The Tactile Mapping Project's vision has several components: education, mobility, the Government on Line program and research into tactile mapping on the Internet.

6.1 Maps for Education

The education component of the project includes plans to ensure that the Tactile Atlas of Canada, with voice annotations and internet-enabled, is used in the educational system and available to every blind and visually impaired child. Canadian children should have improved access to maps for learning geography, history or any subject that has a spatial component. Mapping Services Branch also hopes to produce thematic issue-oriented tactile atlases (which might include such themes as population density, the environment, land use, etc.). Such maps should be linked to school curricula and become an integral part of the SchoolNet program [http://www.schoolnet.ca].

While there is no systematic program to produce maps for blind children in Canada as yet, the Geological Survey of Canada has expressed interest in developing tactile geological maps of the country. GeoAccess, a division of Natural Resources Canada, is interested to co-operate in developing the Tactile Thematic Atlas of Canada, linked to its national electronic atlas program.

The Tactile Mapping Project is also promoting the development and availability of local topographic city maps so users will have a true sense of where they live. Canadian Mapping Services Branch is planning to start an Internet based on-demand mapping services financed by the GOL (Government on Line) initiative.

6.2 Maps for Mobility

Tactile Mapping Project staff is currently training the mobility instructors from the Canadian National Institute for the Blind (CNIB) in Ottawa. CNIB instructors from the Ottawa office believe maps greatly assist in mobility training and recommend similar programs for other CNIB offices across Canada.

Technology based on geospatial data, GPS and voice-guiding systems is available for most major cities in the United States; we would like to encourage Canadian industry to develop similar systems for Canada. However, the cost of digital data is a major drawback. At the present time, the policy on distributing digital data is under review.

Mapping Services Branch further promotes the creation of mobility maps for schools and university campuses. At least one Canadian University, York University in Toronto, has special funds available for such products.

6.3 Internet Based Tactile Mapping - Government On-Line

"Government On-Line" is the Government of Canada's plan to deliver programs, services and information over the Internet and a key component in this plan to improve service delivery to Canadians [http://publiservice.cio-dpi.gc.ca/gol-ged/]. A commitment has been made: *"By 2004, our goal is to be known around the world as the government most connected to its citizens, with Canadians able to access all government information and services on-line at the time and place of their choosing*." *"… Among its investments, the Government will increase support for the development" of new technologies to assist Canadians with disabilities*…" [http://www.sft-ddt.gc.ca/sftddt_e.htm].

Mapping Services Branch joined Human Resources Canada and Transport Canada to form a cluster called "Information and Services for Persons with Disabilities". Our commitment to the cluster involves:

- Allowing visually impaired users to access maps and geospatial databases through a touch and voice-based interface.
- Creating a screen reader–compliant web site that will allow visually impaired clients and their service providers and caregivers to download maps and geospatial data for production of tactile and audio-tactile maps and graphics. This will enable visually impaired clients to read and use maps for mobility and educational purposes.
- Undertaking research to support the development of a touch and voice-enabled Internet interface.

An audio-tactile tablet would facilitate independent map reading by blind people in a network environment. At the present time, maps are studied with the help of teachers or mobility training instructors. By adding voice annotation to the map, the need for teacher assistance will be significantly reduced. The voice can help the user to find features on the map or graphic, and to learn more about the features portrayed on a map. Such capability is presently available in a stand-alone mode at Mapping Services Branch, based on a commercial Tactile Audio-Graphic System (TAG). This system does not operate in a network environment; one of the proposed goals of this project is to develop a similar capability, which can function in the Internet environment.

The addition of voice to maps creates another dimension to map reading skills for blind and low vision people. This capability can be compared to having access to thematic attribute databases, which store additional information about features portrayed on the tactile maps. Such annotations are very important as tactile maps are by nature very generalized and include the most basic information. Usually there is insufficient space to allow for inclusion of feature names. These features typically need to be annotated in an abbreviated form due to the large amount of space required to place Braille descriptions on the map. An initial test for implementing this capability could be the annotations to the Tactile Atlas of Canada. The annotated version of the Atlas would be developed in cooperation with schools for blind.

6.4 Research Directions

Mapping Services Branch Tactile Mapping R&D plans include the following components:

- Develop greater familiarity with the use of voice (talking interfaces for text) and how to modify them for use with geospatial data and maps already developed.
- Since current technology to use voice is based on stand alone computers, research is needed into using tactile and audio-tactile maps in internet environments [Information and Services for Persons with Disabilities Cluster, 2001].
- For the development of effective maps knowledge of cognition and user needs are necessary. How much do blind children understand when reading a map? How much is retained? [Rieger, 2000].
- Develop standardized methodology for producing tactile multimedia maps which would address the content (types, quantity), form, materials, and presentation methods to be used.

- Develop a standard symbology for tactile maps, which would include issues of symbol types, number of data classes, contrast and positioning.
- Investigate the characteristics of users including types of users, types of products they need/desire, perception and cognition of tactile maps and spatial learning abilities.
- Investigate the effectiveness of new materials and technologies including papers, special inks that produce raised symbols and tactile tablets.
- Investigate the use of new technologies such as Geographic Information Systems (GIS) data bases, used in conjunction with Global Positioning System (GPS) to provide geographical location and the Tactile Audio Graphic Systems to provide voice annotation to paper/screen maps.
- Development of a Multimedia Interface for reading and interacting with Tactile and Low Vision Maps in the Internet Environment.
- Linking the touch tablet to the Internet for tactile and audio-tactile maps, which would make audio-tactile capability available to all rather than to a single student at a time.

7. Conclusions

There are strong user needs in the blind community for both tactile maps and geo-spatial data based mobility systems. Recent developments such as special inks and papers make the production of tactile maps cost-effective. Technological trends such as the addition of voice and touch to the Internet would make these technologies available to users at even lower cost, though the area still requires extensive research. Moreover, there are potential spin-offs to the general public through the upcoming technologies, especially voice and touch interfaces. These could benefit not only the blind but general users of computers as well.

Tactile and low vision map making is relatively new and therefore very few blind and visually impaired people have had the opportunity to use maps and geospatial information. Geomatics technology provides a range of methods and data sets, which can improve the well being of the visually impaired community. These include learning spatial concepts, learning geography, assisting with mobility, and building confidence by providing the tools to acquire knowledge and improve everyday life situations. These new technologies permit information available from government offices to reach special needs citizens, and make access to this information easier for the general public.

References

CNIB Client Statistics, 2001, Publication NO343-203E-2/01

"Fulfilling the Promise", 2000, A Report of the Task Force on Access to Information for Print Disabled Canadians, 95 pp.

Information and Services for Persons with Disabilities Cluster, 2001, Government On Line, GOL-Tier 2 submission, 15 pp.

Rieger, M., 2000, "Letter of Intent", GEOIDE Network of Centres of Excellence, 4 pp.

Tactile Mapping Project Report, 2001, Mapping Services Branch internal publication, 21 pp.

Vasconcellos, R., 1996, Tactile Mapping Design and the Visually Impaired User. In *Cartographic Design: Theoretical and Practical Perspectives*. Eds. Clifford H. Wood and C. Peter Keller, John Wiley & Sons, pp. 91-102.

http://publiservice.cio-dpi.gc.ca/gol-ged/
http://www.ipgh.org.mx
http://www.newcastle.edu.au/index.html
http://www.schoolnet.ca
http://www.sft-ddt.gc.ca/sftddt_e.htm
http://www.tactilevision.com/
http://www.un.org/esa/socdev/enable/disiydp.htm
http://www.visuaide.com/