DESIGN RESOURCES

DR-22 Tactile Maps as Navigational Aids

Center for Inclusive Design and Environmental Access

Tactile Maps as Navigational Aids

Heamchand Subryan, M.Arch/M.F.A.
IDeA Center, SUNY Buffalo

Issue and Its Importance to Universal Design

There are three primary activities in wayfinding: spatial orientation, navigation and destination identification. Conventional technologies used for orientation include maps like “you are here maps” and campus models. Navigation methods include traditional maps, direct experience, and route instructions. Identification technologies include conventional room signs, symbols and landmarks like artwork. Accessibility standards and the Orientation and Mobility profession have developed many tactile and audible tools for all three aspects of wayfinding. These include tactile maps and models, tactile signs, talking signs and talking GPS systems. Technology is developing rapidly so we can expect these assistive technologies to start influencing mainstream products. In fact, talking GPS systems and tactile signs are now commonplace. The former are preferred by many sighted users and the latter are mandated by accessibility codes for the blind and visually impaired. This Design Resource focuses on tactile maps and models. Others will follow on navigational aids and destination identification.

For those experiencing vision loss the successful navigation of buildings or landscapes is often dependent upon the quality, availability and accessibility of navigational aids. Traditionally, sight impaired individuals have relied upon walking canes, guide dogs and sighted guides to help negotiate the environment. More recently high tech aids such as GPS navigation systems and small-scale interactive models have been introduced. While all of these methods are designed to help reduce barriers in the environment, cost and opportunity may prohibit their use by some. A more portable, economical and inclusive form of information to aid wayfinding for the sight impaired is the use of a tactile map. Tactile maps are available in a number of different forms, from the personal scale to the building scale, and they democratize access to information for all users regardless of economic means.

Figure 1: Walking Cane, Guide Dogs, GPS navigation

Sight impaired users sometimes find it more challenging than do sighted users to comprehend tactile information, but studies show that the benefits realized by using this type of aid are substantial. Fundamentally tactile maps have the capability to provide a more comprehensive understanding of the site and to give the user access to additional layers of information from which they are able to generate more precise mental representations of their occupied environments (Harder and Michel, 2002). Whether walking to a desired location, finding the way around an office building or visiting an amusement park, tactile maps and small-scale models can help blind and visually impaired people perform tasks with the same independence as sighted individuals.

Existing Research and Evidence

Tactile maps are an essential part of wayfinding for those experiencing vision loss. Research shows that tactile maps and small-scale models promote better comprehension of and enhanced knowledge of relatively unfamiliar outdoor environments for the blind (Ungar, Blades, Spencer, 1999). Findings in a comparative study on the differences between blind participants using an interactive audio tactile map and those using verbal directions to find a specific location determined that a blind or visually impaired individual had a better chance of navigating by using tactile interactive methods than by relying on verbal directions from a bystander (Arditi, 1999). In addition, a 1998 study by Espinosa et al. on the effectiveness of various wayfinding methods such as direct experience, verbal description, and cartographic representation established that the participant's spatial knowledge was better with the use of tactile maps (Espinosa and Ochaita, 1998). And in Ungar and Blades's study of children's abilities and how they orient themselves with and without the use of tactile maps, findings showed that through direct and indirect examination the use of tactile maps worked in aiding the children's performance (Ungar and Blades, 1994).

Tactile maps also help to improve the cognitive abilities of blind and visually impaired individuals (Picard and Pry, 2009). In their 2009 study Picard and Pry evaluated the use of a small urban terrain model by sight impaired participants and found that even limited exposure to small scale models enhanced their spatial knowledge of the environment (Picard and Pry, 2009).

Types and Usage of Tactile Maps

Tactile maps may be categorized into two types: 'orientation' maps that provide large amounts of information and 'portable' maps that are often smaller for personal use (Harder and Michel, 2002). Orientation tactile maps are intended for long-term installations and so are made out of strong, durable materials. This type of map may be constructed using a wide range of methods including plastics molded through vacuum forming, etchings in magnesium or bronze, or embossing techniques on card stock or metal foil (Horsfall, 1997) (Figure 2). The recent availability of rapid prototyping machines such as CNC routers and 3D printers provide another production method for tactile maps (Figure 2). The durable nature of the materials used to create orientation tactile maps make them suitable for installation as emergency evacuation aids in large buildings and facilities, and as wayfinding maps and floor plans in public facilities and spaces. They can also function as interpretation devices in museums, parks, tourist destinations and schools.

Portable tactile maps, on the other hand, are constructed for temporary use. They are usually made out of disposable material such as paper with embedded plastic fibers (swell paper) that expands when heat is applied to locations onto which images have been drawn or photocopied (Horsfall, 1997). Portable tactile maps are often distributed to end users at schools, universities, and museums.

Figure 2: Tactile maps and images produced though methods such as swell paper printing, thermoforming, metal etching, and 3D printing

Portable tactile maps are also available through computing technology and the Internet. Companies such as TouchGraphics, a wayfinding system developer that specializes in learning tools and gaming apparatuses for the impaired user, have furthered the independence of blind and visually impaired individuals through the development of portable tactile maps using a website interface. Known of as TMAPs, this interface, or TMAP, allows users to simply enter their desired address or addresses on the website and in response the company will send a printed version of that location with the surrounding area. As TMAP technology improves, users with Braille printers will be able to print portable tactile maps in their own homes (Miele, Landau, Gilden, 2006). The development of this technology will give blind and visually impaired individuals similar wayfinding capabilities to those with sight. This same service can provide organizations with tactile maps for their clients or customers.

GPS navigation aids are another form of portable tactile mapping that uses computing technology to increase independence for users. The GPS system developed by the Sendero Group to enable blind and visually impaired pedestrians to access local street and building information while in that environment is a good example of this new approach to mapping. Similarly the Zoom map, developed at Huseby Resource Centre in Oslo, Norway, helps users to "zoom in" to a specific location and learn more about that site through touch rather than through sight. The Zoom map software is designed to provide site information to individual users by printing hardcopies of tactile maps from a macro to a micro scale. Maps are printed in sequential formats and each new map is more detailed than the previous (Yayla, 2009). Permanent tactile maps can easily be made three-dimensional by using rapid prototyping technologies.

Information on tactile maps may be either simple or complex but should always be legible and intuitive. Simple maps may include just a set of raised lines depicting street routes; while a complex map may be composed not only of streets, but also of buildings, landscape features and symbols. Permanent maps should be designed so that the end user is able to easily recall information even after stepping away. For this reason it is important that tactile maps not be cluttered. A substantial body of research exists that examines the layout of information on tactile maps. Bentzen (1980) points out that when designing this type of map consideration should be focused on "information content, scale, size, choice of symbols, information density, labeling, and indexing." Designers should exclude any unnecessary information but at the same time should avoid adding too little. Users of tactile maps are often able to comprehend individual symbols, but too many symbols may cause difficulty in performing simple route mapping tasks (Bentzen, 1980). Additional empirical research has focused on the 'shape recognition accuracy and speed and accuracy of locating shapes' (Berla and Butterfield, 1977), 'legibility and meaningfulness of symbols and features' (Lambert & Lederman, 1989), 'roughness of textures' (Lederman, 1983), 'smooth and rough substrates' (Jehoel et al., 2005), and 'fingertip sensitivity to elevation levels' (Johansson and LaMotte, 1983)

Just as the representation of information has evolved, so too has the production of tactile maps. Recently, advances in CAD-CAM production have made the production of tactile scale models that have more relief and detail than conventional tactile maps feasible. This is also particularly evident with the increased availability of new methods such as 3D printing. Both of these approaches to producing tactile models can benefit from the knowledge available on research with tactile maps. What is even more exciting is the combination of 3D printing capabilities and touch based sensing technologies. Together, these advances provide a way to create a more immersive wayfinding experience for blind and visually impaired individuals. As 3D printing technology becomes more readily available and less expensive, the potential for this type of interaction increases tremendously. The combination of touch based sensing and 3D printing has the potential to produce dynamic interaction which will benefit a larger demographic through universally designed interfaces that are accessible by an even wider range of users.

Conclusion

Multi-sensory wayfinding aids such as tactile maps help to remove barriers to access for those with sight impairments. Unfortunately maps of this type are available on an ad-hoc basis only and users cannot count on this information to be provided in every environment. More research is needed to improve the tactile wayfinding experience so that information is easy to locate, consistent and reliable for all users regardless of ability. Emerging computing technologies that allow for the integration of smart technology and dynamic interfaces give all users access to the same information at the same time and may provide a straightforward solution in addressing the navigational needs of the sight impaired population. To date limited research has been conducted to determine how these types of technologies might be best used. Continued efforts to improve our understanding of the most effective methods of integrating these features into tactile wayfinding systems and products for the blind and visually impaired will allow for a more inclusive and universally designed world.

Acknowledgements

This paper was developed in part with funding from the National Institute on Disability and Rehabilitation Research (NIDRR), U.S. Department of Education, through the Rehabilitation Engineering Research Center on Universal Design and the Built Environment (RERC-UD), a partnership between the Center for Inclusive Design and Environmental Access (IDeA) and the Ontario Rehabilitation Technology Consortium (ORTC).

References

Arditi, Aries. Holmes, Emily. Reedijk, Peter and Whitehouse, Roger. (1999). Interactive tactile maps, visual disability, and accessibility of building interiors. Visual Impairment Research, Vol. 1(2): 11-21.

Amick, N., Corcoran, J. (et al.) (1997). Guidelines for design of tactile graphics. http://www.aph.org/edresearch/guides.htm

Bentzen, B.L. (1983). “Orientation Aids.” Foundations of Orientation and Mobility, American Foundation for the Blind, 291-354.

Berla, Edward. Butterfield, Lawrence.(1977). Tactual Distinctive Features Analysis: Training Blind Students in Shape Recognition and in Locating Shapes on a Map. Journal of Special Education, Vol. 11(3).

Blades, M., Ungar, S. and Spencer, C. (1999), Map Use by Adults with Visual Impairments. The Professional Geographer, Vol. 51: 539–553.

Espinosa, M. Angeles Ochaita, Esperanza. (1998). Using Tactile Maps to Improve the Practical Spatial Knowledge of Adults who are Blind. Journal of Visual Impairment & Blindness, Vol. 92(5): 338-345.

Harder, Arne. Michel, Rainer.(2002). The Target-Route Map: Evaluating its Usability for Visually Impaired Persons, Journal of Visual Impairment & Blindness, Vol. 96(10): 711-723.

Horsfall, Bob. (1997). Tactile Maps: New Materials and Improved Designs. Journal of Visual Impairment & Blindness, Vol. 91(1): 61-65.

Jehoel S. Ungar S. McCallum D. Rowell J.(2005) An evaluation of substrates for tactile maps and diagrams: Scanning speed and user preferences, Journal of Visual Impairment & Blindness Vol. 99(2): 85-95.

Lambert, L. & Lenderman, S. (1989). An evaluation of the legibility and meaningfulness of potential map symbols, Journal of Visual Impairment & and Blindness Vol. 83(8): 397-403.

Lenderman, S. (1983). Tactual Roughness Perception: Spatial Temporal Determinants, Canadian Journal of Psychology, Vol. 37(4): 498-511.

Miele, J. A., Landau, S., & Gilden, D. (2006). Talking TMAP: Automated generation of audio-tactile maps using Smith-Kettlewell's TMAP software. British Journal of Visual Impairment, Vol. 24(2): 93-100.

Picard, Delphine. Pry, Rene. (2009). Does Knowledge of Spatial Configuration in Adults with Visual Impairments Improve with Tactile Exposure to a Small-scale Model of Their Urban Environment?. Journal of Visual Impairment & Blindness, Vol. 103: 199-2009.

Ungar, S., and Blades, M. (1994). Journal of Visual Impairment & Blindness, Can the visually impaired children use tactile maps to estimate directions? May/Jun94, Vol. 88(3).

Yayla Lisa. (2009). Huseby Zoom Maps: A Design Methodology for Tactile Graphics, Journal of Visual Impairment & Blindness, Vol. 103(5): 270-276.

Photo Credits

Figure 1:

Photo 1:
Dear Bus Driver. "72150711JR004_White_Cane_Ac". 13 October 2006. Online image. Flickr. 27 January 2011. http://www.flickr.com/photos/22756012@N04/2719552141/

Photo 2:
Wisconsin Evangelical Lutheran Synod(WELSnet). "Seeing eye dog". 27 January 2011. Online image. Flickr. 27 January 2011.
http://www.flickr.com/photos/welsnet/3401302629/sizes/o/in/photostream/

Photo 3:
Sean Donnelly/Tribune-Review.
http://www.myvisiontest.com/newsarchive.php?action=tag&id=94

Figure 2:

Photo 1:
http://www.gopbc.org/gopbc_technology.htm

Photo 2:
Tactile Graphics: A beginner's guide to graphics for visually impaired children
L. Sheppard & F. K. Aldrich. Primary Science Review, 65, 29 - 30, 2000.
http://www.lifesci.sussex.ac.uk/reginald-phillips/beginnersPaper.htm

Photo 3:
http://www.ap.buffalo.edu/idea/udny/section4-1c.htm

Photo 4:
http://img535.imageshack.us/img535/4375/20hires01s.jpg

Cover Image:
Bonanni,Leonardo. "DSC_6861". 12 April 2008. Online image. Flickr
http://www.flickr.com/photos/amerigo/2408401869/sizes/l/in/photostream/

DESIGN RESOURCES

DR-22 Tactile Maps as Navigational Aids

University at Buffalo
School of Architecture and Planning

378 Hayes Hall
3435 Main Street
Buffalo, NY 14214-3087

Phone: (716) 829.5902 | TTY: (716) 829.3758

Email: ap-idea@buffalo.edu

Fax: +1 (716) 829.3861