

TRANSPORTATION RESEARCH SYNTHESIS

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INVOLVING INDIVIDUALS WITH VISUAL IMPAIRMENT IN PROJECT DECISION-MAKING: A SURVEY OF PRACTICE

Prepared by CTC & Associates LLC

The Americans with Disabilities Act (ADA) of 1990 required national and state agencies to make facilities and services accessible to individuals with disabilities, including people with visual impairment. MnDOT and other state departments of transportation are working to meet ADA requirements. One major focus of this compliance effort is MnDOT's review of how it can involve individuals with visual impairment in the process of planning and designing transportation facilities.

MnDOT is exploring best practices for involving persons with visual impairment in transportation facility planning and design. This Transportation Research Synthesis presents the results of a limited literature search and surveys of state transportation agencies and advocacy and service organizations to determine effective approaches to communicate with individuals with visual impairment and to engage them in transportation project decision-making.



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The purpose of this TRS is to serve as a synthesis of pertinent completed research to be used for further study and evaluation by MnDOT. This TRS does not represent the conclusions of either the authors or MnDOT.

Involving Individuals with Visual Impairment in Project Decision-Making: A Survey of Practice

Introduction

The MnDOT Office of Transportation System Management is exploring best practices for assessing the transportation-related needs of the community of persons with visual impairment and for involving members of this community in decisions related to fulfilling those needs in MnDOT projects. Of particular interest are lessons learned by other state departments of transportation (DOTs), metropolitan planning organizations and regional development commissions that have conducted substantial work in this area to understand how they assess the transportation priorities of people with visual impairment related to pedestrian travel, transit and light rail, and how they involve individuals with visual impairment in decision-making about transportation facility features and plans.

To gather information about best practices, researchers performed a literature search and contacted advocacy groups and organizations experienced in identifying the needs of individuals with visual impairment and communicating with this community. Using the findings from this effort, investigators conducted two surveys: one issued to transportation agencies and the other to advocacy groups and service organizations that serve people with visual impairment. The surveys sought to identify effective methods for learning the transportation needs and priorities of individuals with visual impairment, tools and technologies used to communicate new facility plans to this community, and agencies that have successfully communicated these plans. Follow-up interviews with selected survey respondents produced additional information about successful practices.

This Transportation Research Synthesis presents the findings from the surveys along with the results from the literature search and follow-up interviews.

Summary of Findings

This Transportation Research Synthesis is divided into three areas:

- Survey of practice.
- Insights from state transportation leaders.
- Related research.

Survey of Practice

Two online surveys were distributed in this project: one survey to state transportation agency members of the American Association of State Highway and Transportation Officials Council on Active Transportation and the Transportation Research Board Standing Committee on Pedestrians, and a second survey to state service organizations and advocacy groups that work with people with visual impairment. Eight state transportation agencies and 19 advocacy and service organizations responded to the surveys. Follow-up interviews gathered additional information from selected state transportation agencies responding to the survey.

Survey results from both groups have been combined in this report and are presented in the following categories:

- Learning about the needs of persons with visual impairment.
- Communicating facility plans to persons with visual impairment.
- Identifying effective transportation agencies.
- Participating in multistate research.

Learning About the Needs of Persons With Visual Impairment

Tools and approaches used by transportation agencies and recommended by advocacy and service groups for persons with visual impairment included surveys, face-to-face meetings and behavioral research. Other tools and approaches recommended by respondents included outreach to advocacy groups, focus groups, screen reading services and tools for simulating blindness in demonstrations.

Communicating Facility Plans to Persons With Visual Impairment

Approaches and tools used at face-to-face meetings to share information with persons with visual impairment included tactile maps, scale models and braille documents. Many respondents suggested combinations of all of these tools along with on-site demonstrations, large-print documents and samples of materials that may be used at the transportation facility. Five transportation agencies indicated they did not have tools or established practices for communicating plans to people with visual impairment outside of face-to-face meetings.

Identifying Effective Transportation Agencies

Few respondents were able to recommend transportation agencies that are recognized as effective in working with persons with visual impairment. National and metropolitan agencies that were identified are provided in the report.

Participating in Multistate Research

In the state transportation agency survey, respondents were asked about their interest in participating in a national or multistate research effort into effective ways of involving people with visual impairment in making decisions about transportation facilities planning. Six of the eight respondent agencies indicated interest in participating in this research.

Insights from State Transportation Leaders

Follow-up interviews with survey respondents from Alaska Department of Transportation and Public Facilities and Rhode Island and Washington State DOTs provided additional information about successful practices. Respondents suggested networking with state service agencies and local service organizations for persons with visual impairment. They also encouraged meeting with individuals with visual impairment. One respondent pointed to the value of staffing a transportation agency with employees with visual impairment, which would benefit workplace culture more than offer potential insight into transportation needs.

Related Research

A limited literature search and interviews with advocacy organizations conducted before the survey produced little information about research and efforts to communicate with persons with visual impairment about transportation needs and solutions. Advocacy groups identified the high-priority concerns that people with visual impairment have with transportation services and offered to work closely with MnDOT in opening

communication channels with this community, such as organizing presentations at advocacy group chapter meetings and participating in public meetings. Interviewees stressed the need for direct interaction with individuals with visual impairment and recommended transportation agencies work with local service and advocacy organizations.

Resources from the literature search and advocacy group interviews are presented in the following categories:

- National resources.
- Communication and needs identification.
- Signs, crossings and roundabouts.
- Assistive technology.
- Designing for persons with visual impairment.
- Research in progress.

Next Steps

Interviewees consulted during this research recognized MnDOT and Minnesota State Services for the Blind as leaders in working with individuals with visual impairment. Going forward, MnDOT may wish to consider:

- Following up with organizations recommended by survey respondents to identify successful strategies and tools used in communicating with persons with visual impairment and getting their feedback about transportation facility design and function.
- Developing channels of communication with advocacy groups for people with visual impairment, such as the Minnesota chapter of the National Federation of the Blind.
- Developing a pooled fund or other research proposal for a multistate or national study of best practices in communicating with and involving persons with visual impairment in transportation facility planning and design.

Detailed Findings

Introduction

MnDOT's Office of Transportation System Management is exploring best practices for assessing the transportation-related needs of individuals with visual impairment. The agency would like to involve this community in decision-making processes related to transportation facility design plans. Of particular interest to MnDOT are lessons learned by other state departments of transportation (DOTs), metropolitan planning organizations and regional development commissions that have worked substantially in assessing the transportation priorities of persons with visual impairment related to pedestrian travel, transit and light rail.

Survey of Practice

Survey Approach

Following a literature search and consultation with select advocacy groups for individuals with visual impairment, two online surveys were distributed. One survey was sent as a web link by email to state transportation agency officials identified on member lists for the American Association of State Highway and Transportation Officials (AASHTO) Council on Active Transportation, and the Transportation Research Board (TRB) Standing Committee on Pedestrians, as well as to two city transportation agencies recommended by sources consulted during the literature search, for a total of 49 agencies.

A second survey was sent, also as a web link in an email, to 57 state service organizations and advocacy groups that work with people with visual impairment. At least two survey respondents then forwarded the survey link to an unknown number of recipients in their own mailing lists, expanding the potential survey responses further. Following review of the preliminary final report with the MnDOT Technical Advisory Panel for this research, investigators reached out to six more organizations and extended survey invitations to five, driving the overall number of persons and organizations surveyed (not including the unknown number of persons the survey was sent to by some of the survey respondents) to 62 organizations and advocacy groups. In every iteration, then, investigators surveyed 111 sources.

The goal of both surveys was to identify effective methods for learning the transportation needs and priorities of persons with visual impairment, tools and technologies used to communicate new facility plans to this community, and agencies that have successfully communicated these plans.

Eight state transportation agencies responded to the survey:

- Alaska.
- Kentucky.
- New Hampshire.
- Oklahoma.
- Rhode Island.
- South Dakota.
- Washington.
- Wyoming.

Twenty respondents from 19 advocacy and service organizations responded to the survey:

- Accessible Design for the Blind.
- American Foundation for the Blind.
- Arizona Rehabilitation Services Administration.
- Carroll Center for the Blind.
- Colusa County (California) Office of Education.
- Illinois Bureau of Blind Services.
- Iowa Department for the Blind.
- Kentucky Office of Vocational Rehabilitation.
- Massachusetts Commission for the Blind.
- Minnesota State Academy for the Blind.

- Minnesota State Services for the Blind (two responses).
- National Federation of the Blind.
- National Federation of the Blind of Minnesota.
- New York State Commission for the Blind.
- Oakland (Michigan) Schools Intermediate School District.
- Oklahoma Department of Rehabilitation.
- Pittsburgh (Pennsylvania) Public Schools.
- Practical and Creative.
- Sound Transit (Central Puget Sound Regional Transit Authority, Washington).

The questions for both surveys are provided in [Appendix A](#). The full text of survey responses is provided in a supplement to this report. [Appendix B](#) provides the contact information for survey respondents. [Appendix C](#) provides information on other organizations that may be useful for MnDOT follow-up, but that were not respondents to these surveys.

Summary of Survey Results

Respondents' feedback from both surveys is presented below in the following topic areas:

- Learning about the needs of persons with visual impairment.
- Communicating facility plans to persons with visual impairment.
- Identifying effective transportation agencies.
- Participating in multistate research (in transportation agency survey only).

Learning About the Needs of Persons With Visual Impairment

Respondents from both groups were asked to indicate the most effective methods and tools used to communicate with people with visual impairment to learn about their transportation needs and facility requirements or preferences. More than half of respondents indicated that face-to-face meetings with individuals with visual impairment and surveys of this community are useful. Twenty-three of 28 respondents use face-to-face meetings, and 16 of 28 respondents use surveys. Only two respondents (both from advocacy organizations) suggested using behavioral research, and 15 respondents described other practices. The respondent from the Kentucky Transportation Cabinet indicated that the agency had no experience working with persons with visual impairment on facility plans. Survey responses are summarized in Table 1 and Table 2.

Table 1. Effective Information-Gathering Methods: Transportation Agencies

State	Surveys	Face-to-Face Meetings	Behavioral Research	Other
Alaska		X		
Kentucky				X
New Hampshire		X		
Oklahoma		X		X
Rhode Island	X	X		X

State	Surveys	Face-to-Face Meetings	Behavioral Research	Other
South Dakota		X		X
Washington		X		
Wyoming				X

Table 2. Effective Information-Gathering Methods: Advocacy Organizations

Agency/Organization	Surveys	Face-to-Face Meetings	Behavioral Research	Other
Accessible Design for the Blind		X		X
American Foundation for the Blind	X	X		X
Arizona Rehabilitation Services Administration	X			
Carroll Center for the Blind	X	X		X
Colusa County Office of Education		X		
Illinois Bureau of Blind Services				X
Iowa Department for the Blind	X	X		
Kentucky Office of Vocational Rehabilitation	X	X		
Massachusetts Commission for the Blind	X	X		X
Minnesota State Academy for the Blind	X	X		
Minnesota State Services for the Blind 1	X	X		X
Minnesota State Services for the Blind 2	X	X		X
National Federation of the Blind	X	X	X	
National Federation of the Blind of Minnesota	X	X		
New York State Commission for the Blind		X		
Oakland Schools Intermediate School District	X		X	
Oklahoma Department of Rehabilitation		X		
Pittsburgh Public Schools	X	X		X
Practical and Creative	X	X		X
Sound Transit	X	X		X

Other Outreach Practices

Several respondents identified other methods that were effective in learning about the transportation needs and priorities of persons with visual impairment. Outreach to specialist agencies and groups, meetings and focus groups were among the practices recommended. Feedback from respondents about these methods is summarized below:

Outreach to Agencies, Specialists and Consumer Groups

- *Accessible Design for the Blind*: Orientation and mobility specialists, rehabilitation agency counselors and transition counselors (those who work with high school age individuals to prepare them for employment), and rehabilitation centers.
- *Carroll Center for the Blind*: Certified orientation and mobility specialists (COMS).
- *Illinois Bureau of Blind Services*: National Federation of the Blind (Baltimore, Maryland).
- *Pittsburgh Public Schools*: Service providers to persons with visual impairment.

Email Communication With Persons With Visual Impairment

- *Massachusetts Commission for the Blind*.
- *Practical and Creative*.
- *South Dakota DOT*.

Employment

- *Sound Transit*: Employ people with vision disabilities in transportation agency program.

Focus Groups and Work Groups

- *American Foundation for the Blind*: Meet in person or by telephone.
- *Rhode Island DOT*: Formerly worked with and participated in the Rhode Island Department of Health's statewide Disability Community Planning Group, which included several agencies representing the community of persons with visual impairment. Also worked directly with the state veterans hospital's blind support group and with the Governor's Commission on Disabilities.

Meeting Attendance

- *American Foundation for the Blind and Pittsburgh Public Schools*: Attend meetings of local chapters of organizations such as the National Federation of the Blind and the American Council of the Blind (listservs and email lists may be available).
- *Minnesota State Services for the Blind*: Attends a monthly meeting of the State Rehabilitation Council–Blind. These meetings provide an opportunity to present to consumer groups and individuals who are blind.

Online Research

- *Wyoming DOT*: Research online to identify and consult with other organizations.

Screen Reader Compatibility

- *Oklahoma DOT*: Agency website works with screen readers, allowing people with visual impairment to review posted Oklahoma DOT news and documents.

Simulation Tools for Agency Staff

- *Colusa County Office of Education:* Give simulators (such as goggles altered to represent various eye diseases) to staff and agency representatives so they can experience crossing the street, accessing intersection controls, using maps and other activities from the perspective of a person with visual impairment.

Communicating Facility Plans to Persons With Visual Impairment

Both groups were asked what methods and tools were used or recommended to communicate transportation facility plans in public meetings to ensure persons with visual impairment could provide input. Tactile maps were most frequently recommended (18 respondents) along with scale models and braille documents (11 respondents). Several respondents recommended a combination of tactile maps (prepared by someone familiar with presenting information in this format) and detailed written or verbal descriptions. Almost all respondents recommended other practices.

Respondents from five of the eight transportation agencies—Kentucky Transportation Cabinet and New Hampshire, Oklahoma, Rhode Island and South Dakota DOTs—indicated they don’t use tools or technologies for sharing new facility design features, have limited experience with these tools and technologies, or haven’t scheduled these types of meetings. The South Dakota DOT respondent reported that meetings have primarily dealt with specific construction projects or with the Americans with Disabilities Act (ADA) transition plan regarding compliance in the public rights of way, and those meetings relied on open discussion.

Survey responses from all participants are summarized in Table 3 and Table 4.

Table 3. Effective Information-Sharing Tools: Transportation Agencies

State	Braille	Tactile Maps	Scale Models	Other
Alaska	X			X
Kentucky				X
New Hampshire				X
Oklahoma				X
Rhode Island				X
South Dakota				X
Washington		X	X	X
Wyoming				X

Table 4. Effective Information-Sharing Tools: Advocacy Organizations

Agency/Organization	Braille	Tactile Maps	Scale Models	Other
Accessible Design for the Blind		X		X
American Foundation for the Blind		X		X
Arizona Rehabilitation Services Administration				
Carroll Center for the Blind	X	X	X	X
Colusa County Office of Education		X		X
Illinois Bureau of Blind Services	X	X	X	
Iowa Department for the Blind	X	X		X
Kentucky Office of Vocational Rehabilitation	X	X	X	X
Massachusetts Commission for the Blind	X	X		X
Minnesota State Academy for the Blind	X	X	X	X
Minnesota State Services for the Blind 1		X		X
Minnesota State Services for the Blind 2			X	X
National Federation of the Blind	X			X
National Federation of the Blind of Minnesota	X	X	X	
New York State Commission for the Blind		X		X
Oakland Schools Intermediate School District		X	X	X
Oklahoma Department of Rehabilitation		X		X
Pittsburgh Public Schools	X	X	X	X
Practical and Creative		X	X	X
Sound Transit	X	X	X	X

Other Communication Practices

Below are other effective methods provided by respondents for communicating transportation facility plans to persons with visual impairment:

Face-to-Face or Individual Interactions

- *Oklahoma DOT.*
- *Rhode Island DOT:* The agency has interacted with individual members of this community to change bus stop locations, adjust curb heights in commercial locations and modify the Registry of Motor Vehicles drivers manual to include information about persons with visual impairment.

Presentations and Meetings

- *Accessible Design for the Blind*: The respondent noted that when using a slide show, presenters should avoid using the phrase “as you can see here.”
- *Colusa County Office of Education*: Maps and on-site demonstrations of new designs.
- *Wyoming DOT*: One-on-one or small group interactions during public meetings.

Training, Presentation Materials and Other Tools

- *Alaska Department of Transportation and Public Facilities (DOT&PF)*: Braille and any other tool the individual is comfortable using or has been using.
- *Carroll Center for the Blind*: Orientation and mobility training from a COMS.
- *Kentucky Office of Vocational Rehabilitation, Massachusetts Commission for the Blind, Minnesota State Academy for the Blind, National Federation of the Blind, New York State Commission for the Blind and Pittsburgh Public Schools*: Copies of presentation materials available in an accessible format: large print, braille, audio or electronic (accessible with screen reader software).
- *National Federation of the Blind*: Training for transportation agency staff.
- *Sound Transit*: Simple tactile designs (minimal detail needed to convey the design) and 3-D models.
- *Washington State DOT*: Tactile maps, building plan layouts, sample materials and building models.

Identifying Effective Transportation Agencies

Survey participants from both groups were asked to identify any local, metropolitan, state or national transportation agency they have worked with that communicates plans effectively with persons with visual impairment. Below are the transportation agencies recommended by survey participants along with contact information (when available).

National Agencies

Airport Disability Compliance Program, Federal Aviation Administration, Des Plaines, Illinois.

https://www.faa.gov/about/office_org/headquarters_offices/acr/com_civ_support/disability_compliance/

This program ensures that travelers with disabilities are aware of and have access to airport activities, programs and services, and that airport operators and sponsors meet regulatory requirements.

Americans with Disabilities Act Program, Federal Highway Administration, Washington, D.C.

<https://www.fhwa.dot.gov/civilrights/programs/ada/>.

Federal Highway Administration’s ADA programming ensures that pedestrians with disabilities have an equal opportunity to use the public rights of way in the transportation system and that roadway owners and managers comply with accessibility standards for facilities, programs and activities.

Contact: Sharon Field, ADA Program Team Leader, 202-366-4634, sharon.field@dot.gov.

Americans with Disabilities Act Program, Federal Transit Administration, Washington, D.C.

<https://www.transit.dot.gov/regulations-and-guidance/civil-rights-ada/americans-disabilities-act>

The Federal Transit Administration’s ADA programming ensures equal opportunity and access for persons with disabilities.

Regional and Metropolitan Agencies

EMBARK, Oklahoma City, Oklahoma.

<https://embarkok.com/>

EMBARK transit system offers “bus, ferry transit, bike share and downtown parking solutions in the Oklahoma City metro area.”

Louisville Metro Public Works, Louisville, Kentucky.

<https://louisvilleky.gov/government/public-works>

Louisville Metro Public Works maintains and improves Louisville’s roadway, bicycle and pedestrian system.

Contact: Jason Yeager, Traffic Engineer, Louisville Metro Public Works, 601 W. Jefferson St., Room 2, Louisville, Kentucky 40202, 502-574-1195, jason.yeager@louisvilleky.gov.

Metro Mobility, Metro Transit, Minneapolis–St. Paul, Minnesota.

<https://www.metrotransit.org/metro-mobility>

Metro Mobility is “a shared public transportation service for certified riders who are unable to use regular fixed-route buses due to a disability or health condition.”

RTS (Regional Transit Service), Rochester, New York.

<https://www.myrts.com/>

RTS provides public transportation services in Monroe, Genesee, Livingston, Ontario, Orleans, Seneca, Wayne and Wyoming counties.

Participating in Multistate Research

Respondents from state transportation agencies only were asked about their interest in participating in a national or multistate research effort into effective ways of involving people with visual impairment in making decisions about transportation facilities planning. Six transportation agency respondents indicated interest in participating in this effort: New Hampshire, Oklahoma, Rhode Island, South Dakota, Washington State and Wyoming DOTs.

Insights from State Transportation Leaders

Researchers contacted survey respondents from three state transportation agencies—Alaska, Rhode Island and Washington State DOTs—based on their survey responses, which indicated significant experience communicating with persons with visual impairment. Key points from those interviews are summarized below.

Alaska

Rashaud Joseph, Alaska DOT&PF's statewide ADA coordinator, works within the agency on accessibility needs of persons with visual impairment, as well as on all ADA transition plan activities. Alaska DOT&PF uses braille in facility signage and in some presentation materials. Joseph's office is still recovering from the earthquake that struck the Anchorage area on November 30, 2018, and he was unable to offer more extensive detail for the final tasks of this research project.

Audio Tools. Advocacy organizations for persons with visual impairment have worked with Joseph on facility presentation needs. Joseph identified a technology one unnamed organization uses that includes a headset with goggles; the technology provides audio narration of terrain and objects that are identified within the visual field of the goggles. He also noted this organization employs smartphone applications that offer audio of terrain features.

Braille. Most braille used in presentation materials is a letter-for-letter transcription of standard English. Joseph works closely with the agency's Aviation and Airports Division, which uses braille-capable printers. Turnaround time for document requests in braille is a day or less.

Funding. Braille signs and installation are budgetary responsibilities of the specific office managing the facility and must be budgeted into project plans. Aviation and Airports is the repository of the agency's braille printers for documents because it has the greatest need, with 237 airports under its purview. Many of these publicly available document braille needs are funded by ADA transition plan grants for supplies and equipment.

Contact: Rashaud Joseph, Statewide ADA Coordinator, Alaska Department of Transportation and Public Facilities, rashaudjoseph@yahoo.com, 907-351-0884.

Rhode Island

Marc Malkasian, former ADA transition plan manager at Rhode Island DOT, currently works in the agency's Administrative Services Division.

Malkasian emphasized working with other agencies within state government and making personal contact with individuals with visual impairment. The Disability Community Planning Group, sponsored by the Rhode Island Department of Health, was an early partner in Rhode Island DOT's ADA activities. As the ADA transition plan manager, Malkasian also worked closely with the Rhode Island Governor's Commission on Disabilities during inspections, public meetings and interagency meetings. Lacking funding for tools like braille printing, the agency's ADA unit relied on face-to-face meetings with individuals with visual impairment and groups.

Malkasian cited the success of the ADA unit's Accessible Pedestrian Signal (APS) program (see <http://www.dot.ri.gov/community/safety/safetydot.php>), which has received recognition from both state and federal agencies and has marked Rhode Island DOT as an agency that is concerned about and responsive to persons with visual impairment. Citizens use a public request form published by Rhode Island DOT to request the installation of an APS signal at an intersection. After reviewing the request (which sometimes requires

consultation with the state traffic commission), Rhode Island DOT installs the APS.

Barry Simpson, chief of program development in the agency's Office of Civil Rights, indicated potential for acquiring a braille-capable printer for presentation handouts.

Contacts:

Barry Simpson, Chief of Program Development, Office of Civil Rights, Rhode Island Department of Transportation, barry.simpson@dot.ri.gov, 401-563-4000.

Marc Malkasian, Administrative Services Division, Rhode Island Department of Transportation, marc.malkasian@dot.ri.gov, 401-222-3260, ext. 4515.

Washington

Larry Watkinson, deputy director in the Office of Equal Opportunity, Washington State DOT, is responsible for civil rights and ADA compliance within the agency and on its ferries, rights of way, sidewalks and agency buildings.

Audio Tools. Watkinson in his own work as a person with visual impairment relies on audio services in standard copiers, Job Access with Speech (JAWS) for Microsoft Windows, NonVisual Desktop Access (NDVA) software, Adobe Professional's accessibility features and various iPhone platform applications. His office uses Kurzweil 1000 software to convert PDFs to audio. He also relies upon an audio feed from PowerPoint Notes to prompt him during PowerPoint presentations and enjoins sighted colleagues to help explain detail at public meetings.

Braille. Watkinson observed that younger generations of persons with visual impairment may rely on smartphone applications more than on braille, which is still heavily advocated by organizations like the National Federation of the Blind and the American Council of the Blind. The Washington State School for the Blind's Ogden Resource Center (ORC), which produces documents for Washington State DOT, requires a lead time of three to four weeks for braille, thermal maps and other products. The ORC uses the latest U.S. standard, Unified English Braille code, for text, though it also produces braille in other styles upon request. For mathematical work, it employs the Nemeth Braille Code. The ORC uses Irie brand embossers (<https://irie-at.com/braille/>) and Braille 2000 (www.braille2000.com) software for braille printing.

Thermal Forms. Watkinson relies on thermal forms—plastic sheets with heat-raised lines—for handouts with simple architectural renderings of key design elements of new facilities, particularly for the Washington State DOT ferry system, and for images of new ferry boats during presentations. Braille does not transfer well to these small format handouts, which usually are distributed in 8-1/2- by 11-inch sizes, and occasionally in sheets up to 24 inches high. The ORC uses American Thermoform (www.americanthermoform.com) products for thermal form and tactile map production.

Tactile Maps. These large display placards are usually placed on a tabletop and offer more extensive tactile representations of architectural detail than thermal forms. Tactile maps include braille text. Tactile maps are sometimes used in major presentations to the public. For map legends, Washington State DOT relies on standard signage legends for bathrooms and more, but raised.

Funding. Whichever agency or office is behind the facility presentation must budget for presentation materials for individuals with visual impairment. Funding is driven by ADA requirements.

Watkinson also recommended soliciting help from skilled practitioner agencies and said he has relied professionally on insight and advice from MnDOT's ADA transition plan group, which he describes as a "gold standard." Watkinson, who is visually impaired, encouraged agencies to hire people with visual impairment to enhance workplace culture, potentially making persons with visual impairment more approachable.

Contact: Larry Watkinson, Deputy Director, Office of Equal Opportunity, Washington State Department of Transportation, watkinsl@wsdot.wa.gov, 360-705-7097.

Related Research

This section presents national and international research related to the transportation needs, designs and communication with persons with visual impairment. Resources are presented in the following categories:

- National resources.
- Communication and needs identification.
- Signs, crossings and roundabouts.
- Assistive technology.
- Designing for persons with visual impairment.
- Research in progress.

National Resources

Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians With Vision Disabilities, J. Elliott, K. Lohse, J. Toole, I. Lockwood, J. Barlow, B. Bentzen and C. Porter, Federal Highway Administration, October 2017.

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/accessible_shared_streets/fhwahep17096.pdf

From the abstract: This document reviews notable practices and considerations for accommodating pedestrians with vision disabilities on shared streets. It focuses on streets where pedestrians, bicyclists, and motor vehicles are intended to mix in the same space. The guide includes a description of shared streets, an overview of vision disabilities and the strategies people with vision disabilities use to navigate in the public right-of-way. It discusses the specific challenges pedestrians with vision disabilities face when navigating shared streets. It provides an overview of relevant U.S. guidance, a toolbox of strategies for designing shared streets that improve accessibility for pedestrians with vision disabilities, and ideas on how accessibility for pedestrians with vision disabilities can be addressed in the planning and design process. It provides information from case studies of completed shared streets in the United States that highlight accessibility features and lessons learned, as well as a bibliography that includes sources specifically referenced in the body of the guide and other sources that inspired the guide content and may be useful for shared street designers.

Intelligent Situation Awareness Navigation Aid, Federal Highway Administration, October 2017.

https://www.fhwa.dot.gov/multimedia/research/advancedresearch/intelligent_situation.cfm

Video at https://youtu.be/QdeF_o3RDs0

From the abstract: [T]he Federal Highway Administration's Exploratory Advanced Research (EAR) Program funded research projects to examine new technology solutions to provide guidance assistance to visually impaired pedestrians navigating in large, unstructured environments. Researchers demonstrated one of three different wayfinding technologies at the U.S. Department of Transportation Headquarters in Washington, D.C. The Intelligent Situation Awareness Navigation Aid (ISANA) provides a wearable technology that interprets the visual environment in real time and uses GPS-like voice guidance to assist the user.

Assistive Technologies for Visually Impaired Persons: Developing Situational Awareness and Guidance Solutions for People With Vision Impairment and Other Disabilities, Federal Highway Administration, 2015.
<https://www.fhwa.dot.gov/publications/research/ear/15040/15040.pdf>

FHWA's Exploratory Advanced Research (EAR) Program funded three research projects "to examine new technology solutions for wayfinding and navigation guidance for people with vision impairment and other disabilities." These projects—Intelligent Situation Awareness and Navigation Aid for Visually Impaired Persons, Navigation Guidance for People with Vision Impairment, and Extended Event Horizon Navigation and Wayfinding for Blind and Visually Impaired Pedestrians in Unstructured Environments—are summarized in this fact sheet.

Technological Innovations in Transportation for People With Disabilities, 2011 Workshop Executive Summary, Federal Highway Administration, 2011.

<http://www.fhwa.dot.gov/advancedresearch/pubs/11042/11042.pdf>

This four-page summary provides an overview of the workshop, a brief description of six presentations and a summary of the workshop findings. Tools and technologies addressed during these sessions included tactile print maps; GPS; geographic information systems; and remote infrared audible signs, which can merge with mobile technologies.

National Technical Assistance Center on Blindness and Visual Impairment, National Research and Training Center on Blindness and Low Vision, Mississippi State University, undated.

<https://www.ntac.blind.msstate.edu/>

Transportation website: <https://www.ntac.blind.msstate.edu/consumers/transportation/>

The website of the National Technical Assistance Center on Blindness and Visual Impairment offers a number of resources on transportation and the needs of individuals with visual impairment. On its transportation web page, the center describes a national survey of 492 individuals with visual impairment and blind adults about the stress associated with transportation (see **Communication and Needs Identification**). Results from the survey indicate that persons with visual impairment have tremendous interest in public transportation, that they are concerned about convenience and safety in their public transportation options, and that people with visual impairment require orientation and mobility training to use public transportation.

Related Resource:

A Transportation Guide for Persons Who Are Blind or Have Low Vision, Adele Crudden, National Research and Training Center on Blindness and Low Vision, April 2014.

https://www.blind.msstate.edu/docs/Blind_Transport.pdf

From the abstract: A number of transportation options to get to and from work may be available in your community. Although there may be service providers or others who will assist you in finding and accessing transportation, you will be making the decisions about the best way to get to and from work. Expending the time and effort to learn the possible options is the first step to finding the ride that best suits your needs. Every option may not be available in your community. Suggestions for locating or developing transportation options are provided.

Communication and Needs Identification

“Designing the Appropriate Data Collection Method for Public Transport Passenger Satisfaction Analysis,”

Blawal Hussain, Mohammad Maghrour Zefreh and Adam Torok, *International Journal for Traffic and Transport Engineering*, Vol. 8, Issue 2, pages 177-183, 2018.

[http://ijtte.com/uploads/2018-04-25/b2ddba6e-53f7-2912ijtte.2018.8\(2\)03.pdf](http://ijtte.com/uploads/2018-04-25/b2ddba6e-53f7-2912ijtte.2018.8(2)03.pdf)

From the abstract: In the current paper, at first, the relevant data collection methods have been reviewed and then a passenger satisfaction questionnaire has been designed which rates the extent of Budapest PTP [public transport passengers] satisfaction and dissatisfaction on a Likert chart. It should be underlined that [a] different set of individual characteristics (age, gender, level of education, overall passenger health condition, etc.), as well as different service attributes (price, frequency, ease of boarding and alighting, etc.), are considered in the aforementioned questionnaire for further cluster analysis of the collected data.

“Planning Shared Streets,” Section 6, Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities, J. Elliott, K. Lohse, J. Toole, I. Lockwood, J. Barlow, B. Bentzen and C. Porter, Federal Highway Administration, October 2017.

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/accessible_shared_streets/fhwahep17096.pdf

Section 6 of the report addresses four methods to ensure that shared streets work for pedestrians with vision impairment: involving key stakeholders, ensuring accessibility at project meetings and providing accessible project websites, educating people regarding shared street goals and features, and monitoring the performance of a shared street post-construction.

“Stress Associated with Transportation: A Survey of Persons With Visual Impairments,” Adele Crudden, Jennifer L. Cmar, Michele C. McDonnall, *Journal of Visual Impairment and Blindness*, Vol. 111, No. 3, pages 219-230, May-June 2017.

Citation at <https://eric.ed.gov/?id=EJ1142802>

From the abstract: This study evaluated transportation-related stress and factors predicting stress among persons with visual impairments. Participants with visual impairments completed electronic surveys rating their stress levels experienced when completing various walking and public transportation tasks. They also indicated activities they avoided due to transportation stress. Higher stress was reported for navigating unfamiliar bus routes, walking in urban areas without sidewalks, and walking in unfamiliar places. Significant predictors of walking stress were age, years since vision loss, dog guide use, physical limitations, and frequency of public transportation use. Significant predictors of public transportation stress were age, orientation and mobility (O&M) training, physical limitations, and frequency of public transportation use. Most-avoided activities due to transportation-related stress were entertainment or leisure activities and visiting family and friends.

“Clustering the Mobility Needs of Persons With Visual Impairment or Legal Blindness,” Susanne Zimmermann-Janschitz, Bettina Mandl and Antonia Dückelmann, *Transportation Research Record 2650*, pages 66-73, 2017.

<https://trrjournalonline.trb.org/doi/10.3141/2650-08>

From the abstract: The research design of this study exemplifies a new approach [to mobility research] by classifying persons with vision impairment or legal blindness into five target groups, with a hierarchical cluster analysis. The cluster analysis, which uses Ward’s method, was conducted with the results of a nationwide online survey in Austria. The survey encompassed detailed information about mobility barriers, landmarks and

orientation cues, information needs, and technology use. The cluster results provided the basis for designing and developing a geographic information system (GIS)-based online information platform to support persons with vision impairment or blindness. The platform (a) presents accessibility information and points of interest; (b) presents the results of GIS-based analyses, like closest facilities, including navigation guidelines for pretrip planning; and (c) is designed with an accessible user interface.

“Mobility-Enhancing ICT from an Ethical Perspective: Case of a Navigation System for Visually Impaired Persons,” Jana Sochor, *TRB 92nd Annual Meeting Compendium of Papers*, Paper # 13-4637, 2013.

Citation at <https://trid.trb.org/view/1242726>

From the abstract: The aim of this study is to empirically investigate the case of visually impaired persons and the possible effects of a tailored pedestrian navigation system on their mobility. Interview results indicate that with the provision of detailed information about the built environment and public transportation, positive potential effects include an increased ability to travel alone, to travel in unplanned and unfamiliar situations, and to prioritize public transportation use over the use of special transportation services. In the broader sense, the system may also serve an integrity enhancing function by improving the possibility of leading an independent and autonomous life. On the other hand, as with all Information and Communication Technologies (ICT) with positioning and monitoring capabilities, its use also poses ethical challenges and may negatively impact privacy. Privacy perceptions are highly contextual, but the participants’ responses in this context do not indicate high levels of concern for data misuse or being tracked through their data. This does not, however, translate into an absence of concern over technology’s potential negative impacts on personal integrity. As the participants’ comments illustrate, ICT development does not necessarily result in ethically sound, universally accessible technology. While the participants are generally optimistic about the possibilities of using ICT to enhance their mobility, they also emphasize that ICT is not the magic bullet. As such, this study serves to remind us that a coordinated effort on multiple fronts is vital in addressing users’ needs and meeting broader social goals such as social inclusion and the accessibility of transportation, technology, and information.

“Enhancing the Mental Representations of Space Used by Blind Pedestrians, Based on an Image Schemata Model,” Reda Yaagoubi, Geoffrey Edwards, Thierry Badard and Mir Abolfazl Mostafavi, *Cognitive Processing*, Vol. 13, Issue 4, pages 333-347, 2012.

Citation at <https://trid.trb.org/view/1238810>

From the abstract: This article presents an approach designed to assist visually-impaired pedestrians to create mental representations of their immediate environment, with the goal of increasing their ability to navigate in urban areas. The authors propose a computational model for the mental representation of urban areas that uses image schemata to capture the spatial semantics and configural elements of urban space. These image schemata are schematic structures that are continually requested by individuals in their perception, bodily movement and interaction with surrounding objects. The proposed model also incorporates a hierarchical structure to provide different levels of detail tied to appropriate spatial perspectives at each scale. The authors present a typical scenario[,] a blind pedestrian navigating in an urban area[,] to demonstrate the utility of this model.

“Accessibility of Urban Spaces for Visually Impaired Pedestrians,” S.H. Norgate, *Municipal Engineer*, Vol. 165, Issue 4, pages 231-237, 2012.

http://usir.salford.ac.uk/28534/1/Accessibility_of_urban_spaces.pdf

From the abstract: An [aging] demographic together with the predicted increase in visual impairment of older people calls for a renewed consideration of the accessibility and social inclusivity of urban spaces. This paper [synthesizes] the evidence on this topic and highlights areas for future development relating to the accessibility of urban areas for older, blind and partially sighted pedestrians in the light of recommendations and statements by the World Health [Organization’s] ‘Age friendly’ cities initiative, Guide Dogs UK and the [United Kingdom’s] Department of Transport’s shared spaces local transport note.

“Mobility and Access to Transport Issues as Experienced by People With Vision Impairment Living in Urban and Rural Ireland,” Blaithe Gallagher, Patricia Hart, Colm O’Brien, Michael Stevenson and Andrew Jackson, *Disability and Rehabilitation*, Vol. 33, Issue 12, pages 979-988, September 2011.

Citation at <https://www.tandfonline.com/doi/abs/10.3109/09638288.2010.516786>

From the abstract: This article explores mobility and access to transport issues of urban and rural dwelling people with vision impairment in Ireland. Fourteen focus groups took place consisting of 121 people with vision impairment resident in both urban and rural Ireland. Participant selection was representative of the vision impaired community. Data were recorded, transcribed and analysed using thematic analysis. Poor access to public transport and a perceived absence of public awareness about vision impairment are evident from this study. [Customized] disability awareness training is deemed essential for both the public and transport staff. Difficulties with access issues within the physical environment are highlighted. The lack of availability of accessible transport creates an increased dependency on friends and family, and restricts access to medical, social and rehabilitative services.

“Communicating Transit Information to People with Sensory Disabilities,” Katharine Hunter-Zaworski, Trisha O’Connell, Madeleine Rothberg and Geoff Freed, *18th ITS World Congress*, 2011.

Citation at <https://trid.trb.org/view/1253498>

From the abstract: This paper discusses an initiative to identify gaps in addressing the needs of people with sensory disabilities in transit communications standards, systems, policy and practice. The study notes that there are few systemic barriers to accessibility within transit communications standards and data formats, which offer text-based, flexible information delivery that can meet the needs of travelers with sensory disabilities. Instead, barriers to information for people who are deaf, hard-of-hearing, blind or have low vision rest in policies and practices related to the implementation of consumer-facing applications using this data. This includes third-party applications as well as the hardware used to display the information.

Signs, Crossings and Roundabouts

During interviews for this report, advocates for people with visual impairment reported that the key transportation concern of this community, outside of access to transportation, was navigating roundabouts. Approaches to roundabout concerns focus on signage and pedestrian crossings. The following citations address pedestrian safety at crossings and roundabouts and navigating these facilities.

Visually Impaired Pedestrian Safety at Roundabout Crossings. Eleni Christofa, Aura Ganz, Michael Knodler, Joshua Wolfram, Nicholas Fournier, Safer-Sim University Transportation Center, University of Massachusetts, Amherst, 2017.

http://safersim.nads-sc.uiowa.edu/final_reports/UM%203%20Y2_report.pdf

From the abstract: The objective of this project is to develop a new pedestrian-activated sign that can alert drivers of the presence of pedestrians at roundabout crosswalks, in an effort to increase driver yielding behavior. A thorough literature review was performed, which investigated roadway treatments at roundabouts that improve visually impaired pedestrian safety. Given the limitations of existing studies that often put the burden of responsibility on the pedestrian, a novel pedestrian-activated yield sign was designed and an experimental design was developed for testing the effectiveness of this sign through driving simulation in combination with participant questionnaires. The goal is to determine whether drivers will intuit the meaning of the new roundabout signage after repeated exposure. Anticipated results should confirm the initial hypothesis that drivers will observe the new sign and respond by yielding to pedestrians. With multiple encounters of the new signage, an increase in yielding rates is expected compared to yielding rates associated with conventional yield signs at roundabout crossings. This study can help inform design, education, and other countermeasures for safer roundabout operations for all users.

NCHRP Research Report 834: Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities: A Guidebook, Bastian Schroeder, Lee Rodegerdts, Pete Jenior, Edward Myers, Christopher Cunningham, Katy Salamati, Sarah Searcy, Sarah O'Brien, Janet Barlow, Billie Bentzen, 2016.

<https://www.nap.edu/catalog/24678/crossing-solutions-at-roundabouts-and-channelized-turn-lanes-for-pedestrians-with-vision-disabilities-a-guidebook>

This report “presents guidance on the application of crossing solutions at roundabouts and channelized turn lanes at signalized intersections for pedestrians with vision disabilities.” The report “builds on previous work on crossing challenges for pedestrians with vision disabilities presented in NCHRP [National Cooperative Highway Research Program] Report 674.”

Related Resources:

Accessibility Guidance for Roundabouts and Channelized Turn Lanes, Bastian Schroeder, Pete Jenior and Janet Barlow, Transportation Research Board, July 26, 2017.

Webinar presentation slides at <http://onlinepubs.trb.org/onlinepubs/webinars/170726.pdf>

This webinar presents the findings of NCHRP Research Report 834.

NCHRP Report 674: Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians With Vision Disabilities, Bastian Schroeder, Ronald Hughes, Nagui Roupail, Christopher Cunningham, Katy Salamati, Richard Long, David Guth, Robert Wall Emerson, Dae Kim, Janet Barlow, Billie Bentzen, Lee Rodegerdts and Ed Myers, 2011.

https://download.nap.edu/cart/download.cgi?record_id=14473

This report presents the findings from NCHRP 3-78. *From the abstract:* This report explores concerns over the accessibility of two complex intersection forms for pedestrians who are blind: intersections with channelized right turn lanes and modern roundabouts with one-lane and two-lane approaches. Based on the findings of this research project, significant impediments to the accessibility of these sites exist for pedestrians who are blind, but some crossing solutions can increase the accessibility in terms of improving safety and reducing delay.

Accessible Pedestrian Signals: A Guide to Best Practices, Accessible Design for the Blind, July 2014.

Project website: <http://www.apsguide.org/about.cfm>

The project website is a product of NCHRP 3-62, Guidelines for Accessible Pedestrian Signals, a research study that used extensive field testing to determine which APS features and locations are most beneficial for pedestrians who are blind or have with visual impairment. Materials developed through this project include a comprehensive guide to installation of APS, and a report of research which led to revised recommendations and guidance for the Manual on Uniform Traffic Control Devices (MUTCD). The website content was adapted from the guide produced as a part of this study and includes links to an online version of the guide, an online workshop about APS installation and other resources.

Related Resources:

“APS Guide Overview,” *Accessible Pedestrian Signals: A Guide to Best Practices*, Accessible Design for the Blind, undated.

http://www.apsguide.org/chapter_overview.cfm

This web page provides links to each chapter of the Accessible Pedestrian Signals: A Guide to Best Practices.

NCHRP Web-Only Document 117B: Guidelines for Accessible Pedestrian Signals. David Harkey, Daniel Carter, Janet Barlow, Billie Bentzen, Linda Myers and Alan Scott, 2007.

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w117b.pdf

From the report summary: The objective of this research was to develop guidelines and training materials for implementation of accessible pedestrian signals (APS). The guidelines explain how APS provide optimal information through media such as tones and tactile or verbal indicators, and under what circumstances their installation is recommended. The training materials are intended to facilitate application of the guidelines and installation and operation of APS. This training is oriented toward technical issues and public education. ... The results of this research have produced a set of recommended guidelines for APS installation and operation that will make it easier and safer for pedestrians with visual impairments to cross streets at signalized intersections. In time, the results will make their way into the MUTCD and other guides, which will lead to greater uniformity in the field.

“Mobility of Visually Impaired Pedestrians Crossing Behavior and Assistive Design/Technologies at Signalized Pedestrian Crossings,” Koh Puay Ping, Wong Yiik Diew, A.P. Gopinath Menon and Chandrasekar Palanisamy, *ITE Journal*, Vol. 82, Issue 4, pages 33-37, April 2012.

Citation at <https://trid.trb.org/view/1218373>

From the abstract: Audible pedestrian signals (APS) can communicate essential information to assist visually impaired pedestrians in crossing the road. However, the noise from the signals can be disturbing to nearby residents. This study investigates if a “tap-as-you-use” technology could be used to balance the needs of visually impaired pedestrians and residents. The new activation device uses radio frequency identification technology for the APS based on demand at night and in the early morning. A pre-trial perception survey was conducted to gather views from 28 visually impaired pedestrians regarding their difficulties in navigating pedestrian crossings and their activity at night. Seven subjects then participated in a trial of an on-demand APS system. Participants were asked to locate the traffic light and tapping box without the use of a locator tone. Most trial subjects were able to easily and successfully complete the trial. The findings from this trial indicate that the “tap-as-you-use” audio-tactile concept could successfully serve the needs of visually impaired pedestrians without disturbing nearby residents.

“Working Concept of Accessibility: Performance Measures for the Usability of Crosswalks by Pedestrians With Vision Impairments,” Bastian Schroeder, Nagui Rouphail and Ronald Hughes, *Transportation Research Record* 2140, pages 103-110, 2009.

Citation at <https://trid.trb.org/view/881483>

From the abstract: This research presents an analysis framework and associated performance measures for quantifying the accessibility of pedestrian crossings at modern roundabouts for pedestrians who are blind. The measures, developed under two ongoing national research projects, NCHRP Project 3-78A and a bioengineering research grant from the National Institutes of Health–National Eye Institute, attempt to isolate the components of the crossing task for a blind pedestrian into computable and replicable quantities that allow the comparison of accessibility across individuals or sites. The framework differentiates between crossing opportunities in the form of yields and crossable gaps and the utilization of these opportunities by the pedestrian. It further accounts for the amount of delay and risk involved in the crossing. The analysis framework and measures are demonstrated for two single-lane roundabouts in North Carolina evaluated under the aforementioned research projects. The application shows that the accessibility of a pedestrian crossing to a blind pedestrian is characterized by a combination of different measures and further depends on crossing geometry, traffic volume, driver behavior, and the travel skills and risk-taking behavior of the individual. With successful demonstration at roundabout crosswalks, the analysis framework is hypothesized to have broader application to unsignalized pedestrian crossings, including midblock locations.

Assistive Technology

“New App Helps Visually Impaired Riders,” *Passenger Transport*, page 6, December 16, 2016.

https://www.apta.com/passengertransport/PublishingImages/PT_12-19-16_ConnecTech%20Briefs_Blindways.pdf

The Massachusetts Bay Transportation Authority (MBTA), in collaboration with the Perkins School for the Blind, have launched BlindWays, a free app that augments publicly available GPS to help bus riders with visual impairment locate the exact spot where a bus will stop. The app uses “sequential navigational clues aligned with a user’s direction of travel to guide the transit user to within 4 to 5 feet (the length of a white cane) of an outdoor bus stop sign.”

Related Resource:

New App Helps Blind and Low Vision Customers Find Bus Stops, Massachusetts Bay Transportation Authority, September 20, 2016.

<https://www.mbta.com/news/2016-09-20/new-app-helps-blind-and-low-vision-customers-find-bus-stops>

From the abstract: The MBTA, Massachusetts Department of Transportation and Perkins School for the Blind today launched a new BlindWays app that makes it easier for customers who are blind or have low vision to find bus stops. ... Today’s commercially available GPS leaves a traveler within a 30-50 foot radius of their destination, which is a short-distance navigational challenge, often referred to as the ‘last 50 feet of frustration.’ ... Perkins developed the iPhone app that helps people who are blind or have low vision locate MBTA bus stops via crowdsourced landmark clues and provide predictive bus arrival information.

“Mobile Assistive Technologies for the Visually Impaired,” Lilit Hakobyan, Jo Lumsden, Dympna O’Sullivan and Hannah Bartlett, *Survey of Ophthalmology*, Vol. 58, Issue 6, pages 513-528, November-December 2013.

Citation at <https://www.sciencedirect.com/science/article/pii/S0039625712002512>

From the abstract: We review research and innovation within the field of mobile assistive technology for the visually impaired and, in so doing, highlight the need for successful collaboration between clinical expertise, computer science, and domain users to realize fully the potential benefits of such technologies. We initially reflect on research that has been conducted to make mobile phones more accessible to people with vision loss. We then discuss innovative assistive applications designed for the visually impaired that are either delivered via mainstream devices and can be used while in motion (e.g., mobile phones) or are embedded within an environment that may be in motion (e.g., public transport) or within which the user may be in motion (e.g., smart homes).

Ensuring the Safety Needs of Blind and Partially Sighted Pedestrians in Road Traffic, European Blind Union, September 2012.

Citation at <https://trid.trb.org/view/1279461>

From the abstract: Background information on the issue of quiet vehicles is provided in this paper, which also outlines the needs of blind and partially sighted pedestrians that should be taken into account by the European Union when drafting legislation on alerting sound devices for quiet vehicles. Blind and partially sighted people are concerned over the considerable accident risk posed by electric and silent cars. It is virtually impossible for blind and partially sighted road users to detect an electric or hybrid vehicle and assess its distance and direction early enough to avoid being hit. Research from the United States has shown that quiet vehicles are twice as likely to be involved in a pedestrian accident as vehicles fitted with an internal combustion engine. Among the demands of the European Blind Union are the mandatory installation of an Acoustic Vehicle Alerting System (AVAS) in electric and hybrid cars which will alert pedestrians of a quiet vehicle’s mode of operation and a ban on a pause switch which would allow the driver to temporarily stop the AVAS.

“NAVCOM–WLAN Communication With Public Transport Vehicles to Support Visually Impaired and Blind People,” Werner Bischof, Elmar Krajnc, Markus Dornhofer and Michael Ulm, *19th ITS World Congress*, 2012.

Citation at <https://trid.trb.org/view/1264990>

From the abstract: This paper presents the results of a study in which standard WLAN components and a smartphone were used to allow visually impaired and blind people to use public transport systems.

Designing for Persons With Visual Impairment

Accessible Public Transportation: Designing Service for Riders With Disabilities, Aaron Steinfeld, Jordana Maisel and Edward Steinfeld, eds., New York: Routledge, August 2017.

Citation at <http://udeworld.com/dissemination/publications.html>

From the abstract: This book looks at public transit and transportation systems with a focus on new and emerging needs for individuals with disabilities, including the elderly. The book covers the various technologies, policies, and programs that researchers and transportation stakeholders are exploring or putting into place. Examples of innovations are provided, with close attention to inclusive solutions that serve the needs of all transportation users.

“Best and Bad Practices in Public Transport: Approaches to a Barrier-Free Design for the Visually and Hearing Impaired,” Elmar Fürst and Christian Vogelauer, *European Transport Conference 2013: Strands*, 2013.

Citation at <https://trid.trb.org/view/1330058>

From the abstract: In a large scale research project at the Institute for Transport and Logistics Management of WU Vienna, the needs and barriers to sight impaired passengers in public transport were investigated and evaluated. Based on these findings, possible solutions were developed and best and bad practices throughout Europe were identified. These practices were then rated with a newly developed indicator method incorporating the benefits to the target group as well as the technical and economic feasibility. ... [The authors] present the best and bad practices of solutions currently employed in public transport systems ... [and] derive guidelines for public transport operators and public authorities on how to best address the needs of sight impaired passengers in their systems, while also keeping them economically efficient.

Research in Progress

Travel Behavior of Blind Individuals Before and After Receiving Orientation and Mobility Training (Phase 2: Full-Scale Study), Office of the Assistant Secretary for Research and Technology, project start date: September 2016; expected completion date: August 2018.

<https://trid.trb.org/view/1422722>

From the project description: The primary objectives of the proposed study are to produce immediate knowledge about the actual travel behaviors of blind individuals and to objectively and subjectively evaluate the effectiveness of a course of Orientation and Mobility (O&M) training. Examination of the travel behaviors of blind pedestrians traditionally relied on subjective data supplied by research participants in the form of travel diaries or surveys. However, recent studies have found substantial disparities between subjective and objective measures of pedestrian activity. In addition, a Cochrane Review on research in the area of O&M [suggested] the need for valid quantitative assessment of the effectiveness of O&M training. The proposed study builds on the project team’s Phase 1 Transportation Research Center for Livable Communities (TRCLC) effort in which they devised, tested, and refined a new method for the assessment of O&M training. Preliminary analysis of the Phase 1 pilot study data suggest that the project team’s new method involving Global Positioning Systems (GPS), accelerometers, and Geographic Information Systems (GIS), will enable the project team to collect objective, quantitative, and valid measures of blind individuals’ travel behavior and O&M training’s effectiveness.

Development, Design and Calibration of the Vulnerable Road User Mobility Assistance Platform (VRU-MAP), Office of the Assistant Secretary for Research and Technology, project start date: February 2017; expected completion date: January 2020.

<https://trid.trb.org/view/1458247>

From the project description: The objective of this project is to develop a Vulnerable Road User Mobility Assistance Platform (VRU-MAP), a platform designed to assist vulnerable road users (VRUs) in moving through the world. The VRU-MAP will include personalized, proactive, real-time, multimodal information. The personalization and proactivity aspects of the technology are designed to understand and anticipate user needs instead of passively awaiting input. The real-time aspect is designed to provide constant updates about information relevant to user needs, including current weather, traffic, and route considerations. The multimodal aspect is designed to allow whole-trip planning, including information from the internet (e.g., bus schedules and traffic delays), predictive information (e.g., likely future traffic conditions) and local-scale connectivity (e.g., collision warning systems). ... The VRU-MAP will consist of a personalized, integrated platform that will incorporate environmental, infrastructure, and connected information with individual needs, conveyed in a

usable, flexible format. While the project believes that the foundational technology proposed here could benefit all VRUs, the project particularly focused on pedestrians who by virtue of age and/or disability have an increased likelihood of being involved in an injury or fatal crash. The first phase [development of the VRU-MAP concept] focuses on creating a platform that includes personalized, proactive, real-time, multimodal information. Focus groups will be conducted to determine VRU needs on individual and societal levels while simultaneously examining applicable technology applications. Parameters of the VRU-MAP will be created based on all information gathered. Expert consultation will be included to connect the technologies and parameters together to create a mock-up demonstration of the VRU-MAP to conclude the first phase. Phases 2 & 3, Interface Design and System Calibration, will be iterative to support effective system development. Phase 2 will focus on embedding concepts developed in Phase 1 into a platform that transparently incorporates trip information and information about the world into the user's experience. The project will also anticipate the conceptualization of alternative displays for the visually-impaired, including touch-based or haptic feedback to provide warnings and basic wayfinding information. A key element of Phase 2 is to develop strong system usability and reliability that will enable the user to trust the information being presented. Phase 3 system calibration will provide optimal notifications for VRUs, including exploration of both system/human response lag and the optimal balance of notifications and human information processing ability.

Deploy and Test a Smartphone Based Accessible Traffic Information System for the Visually Impaired, Minnesota Department of Transportation, project start date: July 2018; expected completion date: August 2020.

<https://trid.trb.org/view/1511100>

From the project description: Previous research developed a smartphone-based accessible pedestrian system to support wayfinding and navigation for people with vision impairment at both signalized and un-signalized intersections. A digital map was also created to support the wayfinding app. This system allows a visually impaired pedestrian to receive signal timing and intersection geometry information from a smartphone app for wayfinding assistance. The proposed project will leverage the previous development by installing the system at a number of intersections in downtown Stillwater, where MnDOT operates the signalized intersections. The smartphone-based accessible system will be tested and evaluated on the effectiveness and usefulness of the system in supporting their wayfinding and navigation while traveling through signalized and unsignalized intersections. Furthermore, this project will evaluate the efficacy of Virtual Private Network (VPN) to provide a secure wireless environment for communicating with traffic signal controllers. In addition, our approach can also be applied for providing the visually impaired with sidewalk work zone bypass or bus arrival information at bus stops.

Appendix A

Involving Individuals With Visual Impairment in Project Decision-Making: Survey Questions

State Transportation Agencies

The following survey was distributed to selected state departments of transportation and other agencies expected to have experience with communicating and engaging persons with visual impairment in transportation facility planning and design.

Learning About the Needs of Persons With Visual Impairment

1. What are the most effective methods your organization has used to learn the transportation needs and priorities of individuals with visual impairment? (Please select all that apply.)
 - Surveys.
 - Face-to-face meetings.
 - Behavioral research.
 - Other (please describe).

Communicating Facility Plans to Persons With Visual Impairment

2. When your organization meets with individuals with visual impairment to communicate new facility plans, what technologies and tools (such as tactile mapping and scale modeling) have you found effective for sharing new facility design features?

Identifying Effective Transportation Agencies

3. Please identify any local, metropolitan, state or national transportation agency you have worked with that communicates plans effectively with individuals with visual impairment. Provide contact information (name, phone and email) for these agencies or organizations.

Participating in Multistate Research

4. Would you be potentially interested in participating in a national or multistate research effort into effective ways of involving individuals with visual impairment in transportation facilities planning decision-making?

Advocacy and Service Organizations

The following survey was distributed to selected state agencies, advocacy groups and service organizations expected to have insight about communicating and engaging persons with visual impairment in transportation facility planning and design.

Learning About the Needs of Persons With Visual Impairment

1. What are the most effective methods transportation agencies can use to learn the transportation needs and priorities of persons with visual impairment? (Please select all that apply.)
 - Surveys.
 - Face-to-face meetings.
 - Behavioral research.
 - Other.

Communicating Facility Plans to Persons With Visual Impairment

2. When transportation agencies meet with people with visual impairment to communicate new transportation facility designs, what technologies and tools (such as tactile mapping, scale modeling and spoken presentations) are or would be most helpful in conveying facility design features to individuals with visual impairment?

Identifying Effective Transportation Agencies

3. Please identify any local, metropolitan, state or national transportation agency you have worked with that communicates plans effectively with persons with visual impairment. Provide contact information (name, phone and email) for these agencies or organizations.

Appendix B

Involving Individuals With Visual Impairment in Project Decision-Making: Contact Information

Below is the contact information for individuals responding to the surveys for this report.

State Transportation Agencies

Alaska

Rashaud Joseph
DOT Statewide Americans with Disabilities Act
Coordinator
Alaska Department of Transportation and Public
Facilities
907-351-0884, rashaudjoseph@yahoo.com

Kentucky

Troy Hearn
Bike/Ped Program Coordinator
Kentucky Transportation Cabinet
859-967-8359, troybikesandwalks@gmail.com

New Hampshire

Victoria Sheehan
Commissioner
New Hampshire Department of Transportation
603-271-1484, victoria.sheehan@dot.nh.gov

Oklahoma

Jenny Droscher
Public Involvement Officer
Oklahoma Department of Transportation
405-246-6975, jdroscher@odot.org

Rhode Island

Marc Malkasian
Administrative Services Division
Rhode Island Department of Transportation
401-222-3260, ext. 4515,
marc.malkasian@dot.ri.gov

Barry Simpson
Chief, Program Development, Office of Civil Rights
Rhode Island Department of Transportation
401-563-4000, barry.simpson@dot.ri.gov

South Dakota

June Hansen
ADA Coordinator
South Dakota Department of Transportation
605-773-3540, june.hansen@state.sd.us

Washington

Larry Watkinson
Deputy Director, Office of Equal Opportunity
Washington State Department of Transportation
360-705-7097, watkinsl@wsdot.wa.gov

Wyoming

Amy Inama
Public Affairs Specialist
Wyoming Department of Transportation
307-286-0965, aimee.inama2@wyo.gov

Advocacy and Service Organizations

Accessible Design for the Blind

Janet Barlow
Principal
Accessible Design for the Blind
770-317-0611, jmbarlow@accessforblind.org

American Foundation for the Blind

Bonnie O'Day
Director of Research
American Foundation for the Blind
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Arizona Rehabilitation Services Administration

Richard Sorey
Program Manager, Services for the Blind, Visually
Impaired and Deaf, Department of Economic
Security
Arizona Rehabilitation Services Administration
602-542-6289, rsorey@azdes.gov

Carroll Center for the Blind

Nancy Sharon
Director of Education and Community Services
Carroll Center for the Blind
617-969-6200, nancy.sharon@carroll.org

Colusa County (California) Office of Education

Joan Tolla
Certified Orientation and Mobility Specialist,
Certified Low Vision Therapist
Colusa County Office of Education
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Illinois Bureau of Blind Services

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Iowa Department for the Blind

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Kentucky Office of Vocational Rehabilitation

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Massachusetts Commission for the Blind

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Minnesota State Academy for the Blind

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Minnesota State Services for the Blind

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National Federation of the Blind

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National Federation of the Blind of Minnesota

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New York State Commission for the Blind

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Oakland (Michigan) Schools Intermediate School District

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Oklahoma Department of Rehabilitation

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Pittsburgh (Pennsylvania) Public Schools

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Practical and Creative

Ivonne Schmidt
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Sound Transit

Donna Smith
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Sound Transit
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Appendix C

Involving Individuals With Visual Impairment in Project Decision-Making: Other Potential Sources

A number of service and advocacy organizations were contacted by phone, email or survey solicitation that did not respond to the survey. These organizations, as well as others identified via email or phone conversation, may respond to direct inquiry from MnDOT officials. Recommended organizations are listed here; contact information is provided, when available.

Academy for Certification of Vision Rehabilitation and Education Professionals, Tucson, Arizona.

<https://www.acvrep.org>

This certification and professional organization for orientation and mobility specialists maintains professional contacts with specialists around the country.

Contact: css@acvrep.org, 520-887-6816.

American Council of the Blind, Alexandria, Virginia.

<https://www.acb.org>

This prominent national advocacy organization “strives to increase the independence, security, equality of opportunity, and quality of life for all blind and visually impaired people.”

Contact: Eric Bridges, Executive Director, American Council of the Blind, ebridges@acb.org, 202-467-5081.

American Council of the Blind of Minnesota, Minneapolis, Minnesota.

<https://www.acb.org/minnesota>

Formed under a different name in the 1970s, this organization joined the American Council of the Blind in the 1980s.

Contact: Marian Haslerud, President, American Council of the Blind of Minnesota, mhaslerud@comcast.net, 612-206-5883.

Association for Education and Rehabilitation of the Blind and Visually Impaired, Alexandria, Virginia.

<https://aerbvi.org>

This professional organization provides services to blind persons and individuals with visual impairment.

Contact: aer@aerbvi.org, 703-671-4500.

Blind Rehabilitation Services, U.S. Department of Veterans Affairs, Washington, D.C.

<https://www.rehab.va.gov/blindrehab>

Blind Rehabilitation Outpatient Specialist, U.S. Department of Veterans Affairs, Washington, D.C.

<https://www.rehab.va.gov/PROSTHETICS/blindrehab/outpatient.asp>

Both Blind Rehabilitation Services and Blind Rehabilitation Outpatient Specialist were recommended as professional organizations that work with individuals with visual impairment and maintain networks of contacts.

Guide Dog Users, Inc., American Council of the Blind, Imperial, Missouri.

<https://guidedogusersinc.org>

This membership group of guide dog users is affiliated with the American Council of the Blind.

Contact: 866-799-8436.

Minnesota Braille and Talking Book Library, Faribault, Minnesota.

<https://education.mn.gov/MDE/fam/mbtbl/index.htm>

A library service for persons with visual impairment, the Minnesota Braille and Talking Book Library is part of the Minnesota Department of Education.

Contact: Catherine A. Durivage, catherine.durivage@state.mn.us, 507-333-6340.

National Aging and Disability Transportation Center, Washington, D.C.

<https://www.nadtc.org>

The mission of this organization “is to increase accessible transportation options for older adults, people with disabilities and caregivers nationwide.” It is administered by Easterseals and the National Association of Area Agencies on Aging, and funded by the Federal Transit Administration.

Contact: Carol Wright Kenderdine, Assistant Vice President, Mobility and Transportation, Easterseals, Inc., cwright@easterseals.com, 202-403-8365.

National Association of Guide Dog Users, National Federation of the Blind, Baltimore, Maryland.

<https://www.nagdu.org>

This membership group is for guide dog users and guide dog service organizations.

Contact: Marion Gwizdala, President, National Association of Guide Dog Users, president@nagdu.org, 813-626-2789.

Ogden Resource Center, Washington State School for the Blind, Vancouver, Washington.

<https://www.wssb.wa.gov/wp/departments/orc/>

The Ogden Resource Center provides printing and graphics services to clients, including Washington State DOT. The center uses braille printers and embossers to produce braille documents, a thermaform machine for thermal printing of simple maps and designs. It prints large projects, including textbooks, as well as simple, short documents for Washington State DOT and other agencies. The braille translation process entails work with a state women's prison where transcription is done.

The default braille style is the Unified English Braille code, though the center does work in other formats. For mathematics, the center uses Nemeth Braille Code.

Contact: Jennifer Fenton, Director, Ogden Resource Center, Washington State School for the Blind, jennifer.fenton@wssb.wa.gov, 360-947-3340.

Talking Information Network, Marshfield, Massachusetts.

<https://ticnetwork.org>

This organization provides audio narration and transcriptions of news and other information to persons with visual impairment and other listeners with disabilities in Massachusetts. Similar services may be available in many states.

Contact: general@ticnetwork.org, 781-834-4400.

Vision Loss Resources, St. Paul, Minnesota.

<http://www.visionlossresources.org>

This organization provides services that help people regain independence after vision loss.

Contact: info@vlrw.org, 612-871-2222.