Wayfinding at Intersections: Efforts Toward Standardization—A Joint Workshop of the Institute of Transportation Engineers and the U.S. Access Board

AT A RECENT WORKSHOP ON WAYFINDING AT INTERSECTIONS, PARTICIPANTS RECOMMENDED STEPS TOWARD STANDARDIZING INTERSECTION DESIGN TO OPTIMIZE DIRECTIONAL CUEING FOR PEDESTRIANS WHO DO NOT USE VISUAL CUES WHEN CROSSING STREETS.

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INTRODUCTION AND WORKSHOP OBJECTIVES

In late October 2004, a two-day workshop at ITE Headquarters brought together U.S. and international highway engineers, orientation and mobility professionals, accessibility specialists, regulators and consumers. They considered steps toward standardizing intersection design to optimize directional cueing for pedestrians who do not use visual cues when crossing streets.

Workshop attendees heard background presentations on the wayfinding techniques of pedestrians who are blind or visually impaired and on the geometric design and signaling issues that are key to resolving issues such as curb ramp orientation, curb radius, detectable warning placement, gutter counterslope, pedestrian pushbutton type and placement and audible signal features.

Workshop participants recommended that design engineers, traffic engineers and construction inspectors work together to develop standard plans to accommodate all users to the greatest extent feasible. Full discussion papers and PowerPoint presentations from the attendees are accessible via ITE's Web site at www.ite.org/accessible/curbramp.

The primary questions to be answered at the workshop included:

- What real-world wayfinding and orientation problems exist at intersections for pedestrians who are blind or visually impaired?
- What usability issues exist at crossings for pedestrians who use wheelchairs and scooters?
- How and to what extent can engineers provide comprehensive and cost-effective solutions at intersections that will benefit all intersection users?

Standardization of curb ramp design and associated traffic operations was identified as the most important way for intersections to provide improved wayfinding cues for safe and independent non-visual travel.

The engineer is faced with a multitude of objectives in the design of urban intersections. The lack of consensus on design criteria for sidewalks and street crossings has resulted in ramps and walks that are less usable than they could be. Many agencies do not require detailed engineering plans for ramps and walks, instead relying on standard details and plan sheets that call for the installation of ramps without providing all of the information necessary to construct them.

For the same reason that contractors should not be asked to build a roadway without a profile and horizontal alignment, they should not be expected to construct curb ramps without detailed engineering plans. Especially where ramps are added with the alteration of an existing intersection, the need to establish the tear-out limit of both walk and curb is essential to the success of the subsequent ramp installation. Sadly, the view that ramps should be engineered seems to be a minority one, even among some engineering firms that would be charged with performing that service.[1]

ISSUES AT INTERSECTIONS FOR PEDESTRIANS WHO ARE BLIND OR VISUALLY IMPAIRED

Certified orientation and mobility specialist Janet Barlow, of Accessible

Design for the Blind, outlined orientation and mobility techniques at the workshop. Blind pedestrians use a variety of auditory and tactile cues in the three prime wayfinding tasks at intersections: locating the crosswalk, aligning to cross and maintaining alignment while crossing.

Research has confirmed that many intersection designs do not incorporate cues that enable blind pedestrians to: (1) locate the crosswalk; (2) identify the onset of the walk interval; (3) align and travel in the crosswalk direction; (4) know whether pushbutton actuation is required to call pedestrian timing; or (5) locate the pushbutton.[2]

The installation of curb ramps that are aligned at various angles in relation to the intersection, crosswalk and approach sidewalk may provide contradictory cues for locating the actual street edge and maintaining alignment and balance in preparing to cross. Although blind travelers understand that curb ramps are an unreliable cue to crossing location and direction, information obtained from slope and changes in slope is used in crossing analysis.

Today's sidewalks and street crossings are substantially less standardized than their adjacent roadways. The sidewalk approach may not be in line with the crosswalk. Large radius corners mean that cars can turn faster, but the approach sidewalk may curve, compromising alignment for pedestrians who are blind. Curb ramps at large radius corners may slope radially toward the center of the intersection to avoid warping and cross slopes that can negatively affect wheelchair users. Research has confirmed that pedestrians who are blind are more likely to veer out of a crosswalk where curb ramps are at the apex.[3] Pedestrian crosswalks also are lengthier at locations with large radius corners.

For crosswalks that are not parallel to traffic lanes or where the distance from travel lanes changes (such as a location where there is a dedicated right-turn lane), the task of maintaining alignment while crossing is complicated further. When the crosswalk is not located at the corner (such as at offset intersections, mid-block crossings and roundabout crosswalks), auditory traffic cues may not be adequate for locating the appropriate place to begin crossing. Locations where additional cues may be needed include:

- Where curb ramps slope toward the center of an intersection;
- Where traffic movement and/or stop lines are not parallel to the crosswalk;
- Where the crosswalk is not parallel to the traffic movement;
- At skewed intersections;
- Along wide streets;
- At roundabout crosswalks;
- Where crosswalks are offset from the corner;
- At mid-block crosswalks;
- Where complex vehicle travel and turning patterns require audible gap selection; and
- Where exclusive pedestrian phases or lead pedestrian intervals are used.

STANDARDIZATION OF CURB RAMP DESIGN WAS IDENTIFIED AS THE MOST IMPORTANT WAY FOR INTERSECTIONS TO PROVIDE IMPROVED WAYFINDING CUES FOR SAFE AND INDEPENDENT NON-VISUAL TRAVEL.

Information may be carried by slopes, edges (including landscaping) and surfaces. Useful cues may be audible, tactile, or vibro-tactile. Choices include:

- Design and construction techniques;
- Curb ramp types;
- Curb radii;
- Tactile cues; and
- Accessible pedestrian signals (APS), including features such as tactile arrows and locator tones.

Many questions need to be answered regarding the installation of cues to provide information to pedestrians who are blind. It is essential to understand the techniques and cues that are used in travel and to obtain feedback from users. Some of the proposed solutions may impact the travel of wheelchair users. Individuals who are blind often travel to unfamiliar intersections and cross; consistency of information and standardization of details are important to usability.

SOLUTIONS

Design and Construction Techniques

Problems with the standard detail approach: The typical practice is to show the location on a street plan and use a single standard detail to convey intent. Contractors and inspectors make field adjustments to construct a ramp by interpreting the standard detail according to the particular location.

Curb return profiles that are set without regard to ramp location, slopes, utilities, storm drainage structures and elevations do not consider ramp and walk transitions. Do we want inspectors and contractors to be responsible for Americans with Disabilities Act (ADA) compliance?

Slope and cross-slope: In constructing sidewalks and ramps, if the cross-slope is specified at 2 percent, the actual constructed slope often is more than 2 percent. Longitudinal slopes are similarly difficult to control during construction. As a result, contractors and inspectors tend to err on the side of caution and, wherever it is possible to do so, construct ramps and walks that are flatter than the maximum values. This tendency to flatten slopes and transition sidewalks as smoothly as possible removes the cues that abrupt changes in grade could provide; detectable warnings replace the cues.

Workshop participant Michael Ross, P.E., of Overland Park, KS, USA, presented

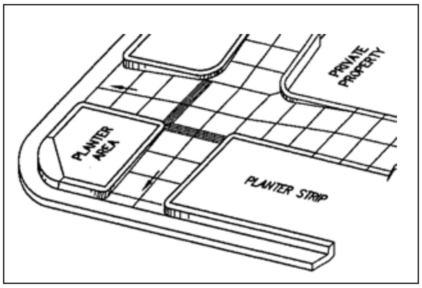

Figure 1. A curb ramp in Sacramento, CA, USA, uses two planter areas.

the geometric design issues that underlie intersection design—considerations of slope, counter-slope, cross-slope, drainage and topography in addition to the effects of existing right-of-way improvements.

Ross highlighted the difficulties in applying design guidelines developed for the built environment (ADA Accessibility Guidelines) to the blended realities of intersection design and welcomed the proposed stand-alone guidelines for the public right-of-way (PROWAAC), although he outlined many constructability concerns in the June 2002 draft.

Ross also noted a necessary role for the highway engineer: "If you would not ask contractors to build a road without a profile, why ask them to design part of what can be a very complex intersection? It is one of the most complex problems you face when you build an intersection—trying to get all of the elements that make up those corners to work for a range of purposes. Engineers must complete shop drawings for the contractors.

"Overland Park, KS, has started using one-tenth-foot contour maps of intersections. The shop drawing will show and dimension every critical point on the curb ramps. Every elevation is shown, and all the slopes are shown. The landings, transitions, elevations and the dimensions of your detectable warning surfaces are shown.

"Curb ramp design should not be done in a vacuum. You have to design all of the elements of an intersection—the drainage, the utilities, the signage, the signals—all of these must be designed together. This is the new model for U.S. engineering and public works agencies."

Figure 2. The City of Sacramento uses planter strips within curb ramp areas.

Curb Ramps

Consultant Michael Whipple presented the City of Sacramento, CA, USA's curb ramp standards. The keys to the highly directional system utilized in older parts of the city are a landscaped border and very small curb radii, as shown in Figure 1.

The City of Sacramento encourages dual curb ramps with opposing ramps aligned wherever feasible. The City acknowledges that the four corners of an intersection may be different. It subscribes to the belief that curb ramps do not have to be beautiful and do not have to match on the corners. Functionality in design is a must as opposed to uniformity in design. No variances from adopted standards have been granted. Figure 2 provides examples of the City of Sacramento's use of planter strips within curb ramp areas.

Curb Radii

For collector or local streets, the use of a 25- to 30-foot curb return radius has become common practice so that a school bus or trash truck can negotiate right turns without leaving the lane. This issue needs to be re-examined.

There are many proponents of short curb return radii. Short radii provide more opportunities for directional ramps to intersect the curb at right angles and, therefore, to shorten the crosswalk distance and minimize delay for waiting vehicles. They can require less right-of-way, keep waiting pedestrians closer to the driver's visual triangle and offer more options for the placement of wheelchair ramps.

Many designers believe that shortening curb return radii would encourage pedestrians to wait at a point where semitrailer rear tires occasionally overtop the curb. Pedestrians at depressed corners and apex curb ramps might be particularly vulnerable. Clear zone recommendations discourage the placement of poles and standards, bollards, or bollard-and-chain enclosures that might discourage vehicle overrun. These issues must be addressed before changes can be implemented.

Cues for Directionality

Rather than treating ramps as a separate part of the sidewalk system (analogous to the ramps added to the side of a building with steps), they could be integrated into the sidewalk system as directional ramps, beneficial to all users with the incorporation of a detectable warning at the street edge. However, the need to design ramps to optimize wheelchair and scooter usability has made achieving both objectives difficult.

RATHER THAN TREATING RAMPS AS A SEPARATE PART OF THE SIDEWALK SYSTEM, THEY COULD BE INTEGRATED AS DIRECTIONAL RAMPS, BENEFICIAL TO ALL USERS WITH THE INCORPORATION OF A DETECTABLE WARNING AT THE STREET EDGE.

Curb ramp design requires that the detectable warning be placed immediately behind and parallel to the curb. For a directional ramp installed on the radius, where the sides of the ramp are of different lengths, this practice aligns the domes so that they may not be parallel to the direction of travel, therefore removing the possibility of wheelchair tracking between the domes and any directional cueing from the detectable warnings.

However, providing the minimum 2-foot dimension in the direction of travel can result in detectable warnings being so far from the street edge that the waiting pedestrian may not be easily recognized by drivers or able to gather useful audible cues from traffic.

Clearly, detectable warning surfaces are not intended to provide directional information. However, if the simple requirement to align them in the direction of travel would do that as well as satisfy wheelchair users' desire to minimize friction on the surface, should that not be possible?

Additionally, the intersected curb edge often is curved, requiring the construction of non-rectangular detectable warning surfaces. Many detectable warning materials are manufactured in large rectangular panels that are difficult to cut and adhere to a non-rectangular surface. Would the warning be as effective if it were a rectangle where one corner was 6 to 8 inches from the curb line?

Tactile Cues

In the U.S. Access Board's research, ramps with truncated dome detectable warnings were found to be safer, more slip resistant, more stable and to require less effort to negotiate than concrete curb ramps.[4]

Blended (low slope) transitions provide less tactile feedback that the sidewalk is joining the street. Properly installed detectable warnings are essential. It is desirable to reduce ramp slopes to ensure compliance and to minimize grades for walkers and wheelchair users.

Use of a tactile cue across the sidewalk, such as bar tiles, to indicate the location of a crosswalk at offset intersections, roundabouts and mid-block crossings may be appropriate. Questions that need to be considered include:

- How wide (deep) should it be?
- Should it be the full width of sidewalk or partial?
- Does it cause problems for wheelchair users? Is it too bumpy?
- What is detectable for blind pedestrians?
- How to determine/define locations where such a cue is needed?
- Should the cue be aligned with the middle of the crosswalk or on one side?

Use of a tactile alignment surface, such as specially aligned truncated dome detectable warnings, bar tiles, blind signs, or Canadian grooves provided on or near the curb ramp, may be appropriate to provide a street crossing alignment cue. Questions that need to be considered include:

- Where should it be installed to be useful to a pedestrian who is unfamiliar with the intersection?
- What material and type of surface is consistently detectable both under foot and by use of a long cane and consistently discriminable from a detectable warning?
- What material and type of surface is easy to align?
- How and what should be installed (materials, durability and maintenance in sidewalk environment)?
- What is the effect on other pedestrians, including walking aid and wheelchair users?

The use of a guidestrip in the roadway to trail while crossing may be appropriate in certain situations. Questions that need to be considered include:

- Where should it be located to be usable by pedestrians who are blind (the center of the crosswalk, crosswalk lines, or other)?
- Is a cue needed to find the guidestrip?
- What materials will hold up in the roadway environment?
- How can the integrity of the guidestrip be maintained?

Accessible Pedestrian Signals

Are APS required at all new intersections? The *Manual on Uniform Traffic Control Devices* (MUTCD), issued by the U.S. Federal Highway Administration (FHWA), is the national standard for all traffic control devices, including APS. Section 4E.06 of the 2003 edition of MUTCD states: "If a particular signalized location presents difficulties for pedestrians who have visual disabilities to cross reasonably safely and effectively, an engineering study should be conducted that considers the safety and effectiveness for all pedestrians in general, as well as the information needs of pedestrians with visual disabilities."

MUTCD provides information that is crucial both in conducting such a study and in the decision-making process for determining if there is a need for APS. Draft guidelines developed by the U.S. Access Board call for APS to be installed at all newly signalized or altered intersections that include the installation of visual pedestrian signals. If visual pedestrian signals are warranted, audible and vibro-tactile output is necessary as well. The federal rulemaking process to adopt the U.S. Access Board's guidelines into ADA regulations is not yet complete.

Results from recent APS research included the following:[5]

- U.S. research on locator tone repetition rate: Pedestrians who are blind located a pushbutton more quickly and easily when the tone repeated once per second rather than either faster or slower. MUTCD states that where there is a locator tone, it shall repeat once per second.
- Research on detectability of signals: Rapidly repeating percussive signals were more detectable than others in the presence of recorded traffic sound (multiple sharp onsets at mixed frequencies).
- The presence of a locator tone during the clearance interval, audible from the middle of the intersection, greatly facilitated crossing accuracy.
- APS at least 10 feet apart and close to the curb line resulted in the most accurate judgment regarding which crosswalk had the walk signal.
- Where an APS had a rapid percussive sound, responses were more accurate than where APS had two different sounds.
- Where two pushbuttons were on one pole, regardless of the distance from the curb, speech messages resulted in greater accuracy than two tones.

The street environment features many difficult acoustic problems. Ambient noise levels vary greatly, even during a single traffic signal cycle. Dense urban settings have tall buildings that reflect sound in unexpected ways. The spoken voice does not "cut through" background noise as well as certain tones, but the spoken voice can provide valuable cues for visually impaired pedestrians.

Portland, OR, USA, uses a combined tone and verbal message in some locations. For example, a "standard" tone for east-west and north-south crossings is used, followed by the phrase "Division Street, walk sign is on to cross Division Street," where the appropriate cross street name is inserted for Division.[6]

Audible signals with beaconing features may be used for alignment and directional assistance while crossing. Consider the following:

- How can the signal function to provide adequate alignment information?
- How can it be indicated to pedestrians who are blind when a signal has additional features?
- Have nuisance effects been adequately addressed by new technology?

Tactile arrows on APS devices may be used for alignment. Consider the following:

- What type of arrow is most usable?
- Is it possible to align well with small arrows, such as are mounted on the pushbutton?
- What orientation of arrow is most usable?
- How can consistent pushbutton location be provided in line with the crosswalk?
- How can proper installation be assured?

How can accessible pedestrian signals help?

- Finding the crosswalk;
- Aligning to cross;
- Starting during the walk interval; and
- Ending the crossing within the crosswalk.

CONCLUSIONS

It may appear that this discussion raises more questions and issues than answers when it comes to wayfinding at intersections for pedestrians who are visually impaired or blind and the effect of different solutions on wheelchair users. As with other areas of professional practice, education, inquiry, consultation and research can lead to trials and pilot installations that will further progress toward standardization.

With proposed requirements from the U.S. Access Board and the U.S. Department of Justice to assist, the profession's ability to implement accessible solutions is growing rapidly. The next steps are to refine intersection design elements to optimize wayfinding.

In truth, curb ramps have been required since 1973. The profession has been slow to understand and implement the requirements. There is a great need to take on this engineering challenge.

Designs that improve wayfinding at intersections must be made on a case-by-case basis due to variances in locational, geometric, operations, environmental, historic and other factors. No cookbook can be provided. Numerous alternatives have been presented in this feature. However, the most important message one can take away is that curb ramps are an integral part of an intersection. Typical sections and standard detail drawings alone will not suffice.

ONGOING RESEARCH

- The yielding behavior of drivers for blind pedestrians at different types of crosswalks and approaching with various degrees of assertiveness (FHWA, National Institutes of Health [NIH]/ National Eye Institute [NEI])
- The ability of pedestrians who are blind to detect yielding vehicles using information provided by noise-generating strips or by prototype yield detection systems using loop detectors that actuate a speech message indicating that a vehicle has yielded (FHWA, NIH/NEI)
- The ability of pedestrians who are blind to align to cross using detectable warning and guiding surfaces (NIH/NEI)
- Comparison of APS features based on objective and subjective data (National Cooperative Highway Research Program [NCHRP])
- Comparison of crossing safety, accuracy and independence at complex signalized intersections with and without APS (NIH/NEI)

- Pedestrian crossings of roundabouts and slip lanes (NCHRP)

Billie Louise “Beezy” Bentzen, Ph.D., has developed an extensive bibliography of references on wayfinding systems for pedestrians who are blind. This bibliography is accessible via the ITE Web site at www.ite.org/accessible/curbramp.

ACKNOWLEDGMENTS

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