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Research Problem Statements for Pedestrians

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RESEARCH PROBLEM STATEMENTS FOR PEDESTRIANS

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Introduction

Since the early 1990s, national policy and legislation have reflected the interest to increase the amount and safety of walking. The U.S. Department of Transportation's (U.S.DOT) National Transportation Policy states it is federal policy to improve pedestrian safety, promote increased use of bicycling, and encourage accommodating bicycle and pedestrian needs. The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) required planning for pedestrians and bicyclists as part of statewide and metropolitan transportation planning efforts. ISTEA also mandated that each state establish and fund a Bicycle and Pedestrian Coordinator in its State Department of Transportation to promote and facilitate increased use of non-motorized transportation. The U.S.DOT's *National Bicycling and Walking Study*, mandated by Congress, made policy recommendations for doubling the number of trips made by bicycling and walking and for decreasing pedestrian and bicycle injuries and fatalities by 10 percent. The goals to increase walking and decrease pedestrian accidents are potentially conflicting. Research can provide answers as to how to elevate both the level of usage and the level of safety.

The TRB Committee on Pedestrians identified a need to provide a Circular on Research Problem Statements that provides a summary of the areas of pedestrian research that require attention. The following procedure was used by the Subcommittee on Research Problem Statements in the development of these research problem statements. Members and friends of the Committee on Pedestrians were asked to submit research problem statements on topics requiring research attention. Over 40 research problem statements were submitted to the Subcommittee for review. The Subcommittee members individually reviewed and prioritized these research problem statements as high, medium, or low priority. Within the high and medium categories, the subcommittee members ranked each research problem statement relative to the other problem statements within those categories considering the importance of the suggested research topic, its relationship to the scope of the committee, and the feasibility and probability of success of the research. The Subcommittee chair subsequently compiled the individual rankings and consolidated the research problems statements into this Circular.

The chair of the Subcommittee on Research Problem Statements presented results to the Committee on Pedestrians at their Annual Meeting in January 1997. The Subcommittee recommended to the full Committee on Pedestrians that the research problem statements be submitted to Group 3 for publication.

Forty-four research problem statements were selected to be included in this Circular. The priority distribution of the research problem statements is as follows:

- 6 High priority
- 8 Medium priority
- 30 Low priority

The high and medium priority research problem statements are presented in full. The low priority problem statements are listed by title only.

High Priority Research Problem Statements

Title: **ITS Applications for Pedestrians**

Problem: Pedestrians affect the efficiency, safety, and cost of traffic movement on streets and highways. However, USDOT's Intelligent Transportation System (ITS) effort to date has been largely focused on highways and vehicles. Many automation technologies under study have potential pedestrian applications with only minor adaption or extension. Stand-alone systems currently being developed for pedestrian applications include sensors at sidewalk intersections for input to and actuation of traffic control devices; infrared and radio-frequency transmission of information about traffic cycles, user location, transit schedules and vehicle routes, area mapping and wayfinding information for pedestrians with vision impairments, and least-effort route calculations for persons who use wheelchairs.

Objective: 1) Identify and characterize key pedestrian (including pedestrians with disabilities) information and automation needs; 2) assess the potential of current and proposed pedestrian and ITS technology applications to provide solutions for these needs; 3) identify opportunities to integrate pedestrian and vehicular technologies in ITS research and development, and 4) recommend a plan to effectuate this integration.

Key Words: ITS, pedestrians, pedestrians with disabilities, traffic control devices, wayfinding

Related Work: The bodies of pedestrian and ITS research

Urgency/Priority: High

Cost: $200,000

User Community: USDOT/ITS and its grantees

Implementation: This study will develop an action plan to institutionalize pedestrian planning in the ITS effort. The Pedestrian Committee could aid implementation of the recommendations of this study through the Research and Technology coordinating Committee of the Transportation Research Board.

Effectiveness: Integrated systems that serve the needs of all modal users will be safer, more efficient for both vehicular and pedestrian users, and more economical to design, implement, and maintain. Additionally, some applications have the potential to satisfy ADA communications requirements for pedestrians with vision impairments.

Title: **Guidelines on the Use of Audible Pedestrian Signals and Audible Signal Messages**

Problem: Audible pedestrian signals are being used in some cities to provide information to visually impaired pedestrians. These signals may also provide helpful information to other pedestrians and supplement the pedestrian signal indications. Unfortunately, there are no guidelines on when to use audible pedestrian signals, and there is no uniformity in the use of audible signal message in different cities. This could cause more (not less) confusion for a visually impaired pedestrian when crossing at an audible signal in another city. There is at least one agency representing blind pedestrians who is opposed to the use of audible traffic signals. The lack of guidelines on when, where and how to use audible signals could pose a liability problem to a government agency, and result in not using them even if some benefit can be gained.

Objective: Develop guidelines on when it is desirable to use audible pedestrian signals at a traffic signal, and determine the best audible message to use for uniform application in different jurisdictions. The result may include a recommended practice in the MUTCD on the use of audible signals.

Related Work: A number of agencies are currently testing or utilizing audible pedestrian signals. There is considerable interest in this subject due to the ADA law. Research has been conducted in Florida on audible pedestrian signals and other improvements. Guidelines on the use of audible pedestrian signals have been developed for Canada.

Urgency/Priority: High

Cost: $200,000. Expected duration 12 months.

User Community: Practicing traffic engineers. Local/State agencies involved in building and operating traffic signals.

Implementation: Distributed results in an executive summary to state and local traffic agencies. The results could also be summarized in the ITE journal.

Effectiveness: This research will provide better guidelines to traffic signal engineers on the use of audible pedestrian signals and will allow greater use of the devices with less concern about potential liability. If implemented, the results will allow provide consistent information to pedestrians from one city to the next. This will allow for better training for visually impaired pedestrians.

Title: **Automatic Pedestrian Signal Detector**

Problem: Actuated traffic signals are much more efficient than fixed-time traffic signals at locations where traffic flow varies throughout the day, or when traffic flow is much higher on one of the two intersecting streets. Pedestrian actuation is required at mid-block traffic signals and is generally recommended where the signal is installed based on a pedestrian related signal warrant (minimum pedestrian volume or school crossing warrant).

While devices such inductive loops buried in the pavement are used to automatically detect vehicles and call the signal, pedestrian detection at actuated or semi-actuated traffic requires the pedestrian to use a push button. Even when the pedestrian push button is placed in a convenient location and is properly signed, observations of pedestrians reveal that many pedestrians fail to use the push button. Some try to cross on the vehicle interval which usually does not allow sufficient pedestrian crossing time, and some will just stand and wait until they become frustrated and cross against the signal. In a 1983 study by Zegeer for the FHWA (Pedestrian Signalization Alternatives), 64 intersection approaches equipped with pedestrian push buttons in southeastern Michigan were observed for pedestrian behavior. Only 51.3 percent of the crossing pedestrians used the push button, which may have contributed to the high violation rate of 66 percent. Studies at four semi-actuated traffic signals in Phoenix, AZ, in 1991 found that of those pedestrians who arrived at the traffic signal during the DON'T WALK interval, 21 percent to 34 percent did not use the pedestrian push button. Studies at a pedestrian activated warning flasher in Phoenix found that only 25 to 33 percent used the push button during different observations. Studies of pedestrian collisions at traffic signals reveal that 45 percent involve pedestrians crossing against the signal.

Objective: To develop and field test an automatic pedestrian detector that can be used at actuated traffic signals (or pedestrian actuated warning flashers). Detectors may also be developed to cancel a signal call if the pedestrian pushes the button and then leave, or to extend the pedestrian crossing time if the pedestrian is not yet out of the crosswalk.

Key Words: Pedestrian, Detector, Traffic Signal

Related Work: Field studies are being conducted in the Netherlands and in the United Kingdom to evaluate various automatic pedestrian detectors. Devices used include pressure plates in the sidewalk to detect pedestrians waiting at the corner, and infrared detectors. The PUFFIN traffic signals in the United Kingdom use infrared detectors to: 1) detect waiting pedestrians; 2) cancel the signal call if the pedestrian leaves the signal before crossing; and 3) extends the crossing time for pedestrians who need extra time while crossing. Video technology may be a possible way to detect pedestrians waiting to cross at a traffic signal.

Urgency/Priority: High

Cost: $400,000

User Community: Traffic engineers. Local/state agencies involved in operating traffic signal.

Implementation: Distributed results in an Executive Summary to state and local traffic agencies. The results could also be summarized in the ITE Journal.

Effectiveness: This research could provide a solution to detecting pedestrians at mid-block and intersection actuated and semi-actuated traffic signals. This will lead to improved pedestrian trust and confidence in the signal and better compliance. The end result will be fewer pedestrian collisions at traffic signals.

Title: **Community Experience with Pedestrian Guidelines**

Problem: The pedestrian-related requirements of ISTEA have helped to generate new interest in pedestrian oriented design around the United States. Independently, many organizations to promote the interests of pedestrians have been formed at the local level in both the United States and Canada. Both of these have caused interest and efforts in producing pedestrian guidance which can be used by developers, traffic engineers, local planning boards, and citizens. However, a great deal of the pedestrian

research on walking distances, levels of service, and so forth is very old. Research is needed to review the variety of pedestrian guidelines which have been developed at the state and local levels, and to summarize the guidance as applicable to different areas such as downtown, urban neighborhood, suburban, and rural. In addition, case studies are needed of "walkable communities" to quantify the extent of walking (volumes and walk distances) and to characterize and compare the features of these communities with the emerging guidelines.

Objective: Develop a summary document of existing pedestrian guidance which will help communities in the development of their own guidelines. Provide concrete examples of successful pedestrian oriented areas to assist communities in interpreting the emerging consensus or range of variables which are likely to be encountered.

Key Words: Pedestrian guidelines, level of service, walking distances, pedestrian volumes

Urgency/Priority: High

Cost: $200,000

User Community: Developers, zoning boards, traffic engineers, citizens groups

Implementation: Distributed results to state highway and transportation agencies, MPOs, and major city traffic departments.

Effectiveness: There is much interest and activity currently in the development of pedestrian guidelines. A summary report would greatly assist in this effort by providing the background of past efforts and also updating some of the quantitative data behind early research on pedestrians.

Title: **Incorporating Pedestrian Accessibility in Transportation Research and Planning**

Problem: Provisions of the regulations implementing the Americans with Disabilities Act (ADA) requiring accessible sidewalks and street crossings affect street and highway design and maintenance, traffic control and its devices, safety, communications, funding, and the development of new transportation technologies. Although state and local departments of transportation are responsible for providing pedestrian access, standard engineering practices, transportation handbooks and manuals, and research protocols serve vehicular interests first, treating pedestrian accommodation as an incidental consequence of provisions for vehicles. Accessibility for pedestrians with disabilities has been dealt with reactively and retroactively, as special needs engineering design, and has not been integrated into the industry body of knowledge. When construction is based upon design data that exclude a significant percentage of pedestrians, it must later be remedied and retrofitted with piecemeal accessibility solutions that are poorly integrated, rarely optimal, and usually costly.

Objective: 1) Identify and characterize the key public and private sector organizations in the transportation industry with an interest in/responsibility for pedestrian research, programming, planning, design, construction, and/or operations; 2) specify the industry standards, guidelines, manuals, instructional materials, and similar documents and projects/programs promulgated by these organizations that affect—or could affect—pedestrian access, circulations, and use; and 3) develop an action plan, including recommended objectives, strategies, and priorities, to incorporate accessibility considerations into these products and programs and institutionalize accessibility planning into the transportation industry's body of knowledge.

Key Words: ADA, access, pedestrian, pedestrians with disabilities

Related Work: None known

Urgency/Priority: High.

Cost: $150,000

User Community: All elements of the transportation industry

Implementation: An action plan for the institutionalization of pedestrian access considerations within the transportation industry, its organizations, and the design standards it promotes. Recommendations implemented via the AASHTO, MUTCD, and other processes by which design guidelines, planning manuals, highway policies, and recommended engineering practices are regularly revised and updated. Pedestrian Committee could aid implementation of the recommendations of this study through the Research and Technology Coordinating

Committee of the Transportation Research Board and within the key organizations identified as stakeholders.

Effectiveness: The recommendations of this study would facilitate implementation of the ADA and minimize compliance costs to state and local governments.

Title: **Design of Pedestrian Signal Heads**

Problem: The current pedestrian signal head is inconsistent with vehicle signal heads. Pedestrian signal heads have two messages; vehicle heads have three. Pedestrian heads use red and white; vehicle heads use red, yellow and green. Consistently, pedestrians are shown to be confused with the blinking DON'T WALK indication. With the advent of LED technology and recent advances to be able to produce a green indication, the pedestrian head should be reevaluated to develop a three-message head: WALK (green); DON'T START (yellow); and DON'T WALK (red). In addition, data indicate that motor vehicle-pedestrian conflicts at signalized intersections are highly correlated with whether the pedestrian looks for turning vehicles while crossing. Signs and pavement markings have been shown to increase pedestrian observing behavior and decrease conflicts. Another strategy would be to use an LED pedestrian head to prompt pedestrians to watch for turning vehicles.

Objective: 1) Develop a more clear pedestrian signal head consistent with vehicle signals. 2) Determine whether an LED pedestrian signal head with a prompt for pedestrian to watch for turning vehicles.

Key Words: Pedestrian signals, pedestrians, walkways, LED signs, signalized intersections

Related Work: Zegeer, 1983; Van Houten & Malenfant, 1995

Urgency/Priority: High

Cost: $150,000

User Community: Highway designers, maintenance personnel, state, county and other transportation engineers and traffic signal engineers

Implementation: Findings should be given to both ITE for inclusion as a recommended practice and to the National Committee on Uniform Traffic Control Devices

Effectiveness: To provide a safer crossing environment and less confusing message for pedestrians.

Medium Priority Research Problem Statements

Title: **Optimizing Traffic Signal Design for Pedestrians**

Problem: In many cases, modern intersection designs for islands, medians and pedestrian displays reflect the priority of traffic design to service vehicles first. The opportunities to create a pedestrian-friendly environment for crossing busy intersections has not been fully explored. The intermodal challenge is to improve the design features for pedestrians, especially those which are likely to be long-term features of the intersection.

Design features include:

- sizing of medians and islands for pedestrian flows
- use of pilot lights to demonstrate that someone has pushed the pedestrian button
- introduction of new features, such as a variable-frequency flashing display or countdown clock which would indicate the amount of time until the WALK phase ends or begins.
- for certain low-volume intersections, replace the DON'T WALK indication with YIELD—so that pedestrians could cross as long as they did not interfere with any through vehicle flow.
- consider following a WALK indication with alternate clearer message.

Key Words: Traffic signals, displays, islands and medians, pedestrian signals, intersections

Related Work: Zegeer, 1983; Staplin, etal., 1997

Urgency/Priority: Medium

Cost: $150,000

User Community: Traffic engineers, pedestrian planners

Implementation: Instruction manual, technical monogram

Effectiveness: Improved operation of signals for pedestrians, with clearer displays and less friction with vehicles.

Title: **Evaluation of Alcohol Related Pedestrian Crashes in Relation to the Location of Drinking or Liquor Sales Establishment**

Problem: Pedestrians under the influence of alcohol represent the leading risk factor contributing to pedestrian crashes. Very little information is available on the precipitating factors related these crashes. Any additional information learned about these crashes would help in creating countermeasures.

Objective: Produce a database that could be used to develop laws, engineering and/or education countermeasure activities to reduce crashes of pedestrians under the influence of alcohol.

Key Words: Pedestrian, alcohol, crashes

Related Work: New Orleans (1980's) and Baltimore (1990's) studies by Dunlap and Associations for NHTSA.

Urgency/Priority: Medium

Cost: $100,000

User Community: Federal and state government highway safety agencies, communities, restaurant industry, traffic safety officials, advocacy groups, alcohol agencies, State ABC Boards.

Implementation: TRB annual meeting, traffic safety newsletters and magazines, NSC congress and Lifesavers conference.

Effects: Laws, regulations, engineering changes and/or education programs to reduce likelihood of crashes to pedestrians under the influence of alcohol.

Title: **Sidewalk Influence on Pedestrian Travel and Vehicle Trips and Encouragement of Sidewalks Provisions and Requirements**

Problem: Municipalities are often reluctant to build or require sidewalks within, between, or adjacent to developments. The lack of sidewalks in commercial and residential developments encourages vehicle trips, discourages the use of transit, and prohibits easy access to nearby shopping or services. Another impeding factor may be the cost of maintenance and

a fair method of distributing cost across beneficiaries. However, the actual extent to which the provision of sidewalks may induce pedestrian trips or reduce vehicle trips is unknown.

Objective: 1) Determine the influence of sidewalks on pedestrian travel and vehicle trips; 2) identify methods to encourage municipalities or states to build or require sidewalks between or adjacent to developments to encourage pedestrian travel; 3) complete a literature search and nationwide review of small, medium, and large cities; and 4) identify common maintenance requirements, ordinances or agreements.

Key Words: Pedestrian, vehicle trips, maintenance, sidewalks, access.

Related Work: Unknown.

Urgency/Priority: Medium

Cost: $100,000 to $150,000.

User Community: Zoning boards, planners, and local, county, and state officials charged with the review of proposed developments or the provision of sidewalks.

Implementation: Distributed results in an Executive Summary to zoning and planning boards, city and county planning departments, MPO's, transit agencies, and consulting engineers.

Effectiveness: The impact of this research will encourage communities to build or require more sidewalks which allow residents and employees to walk between homes, developments, shopping centers, or other services, and to access public transit.

Title: **Optimizing Traffic Signal Timing for Pedestrians**

Problem: Current traffic signal design emphasizes reliance of Chapter 9 of the HCM and does not include pedestrian concerns in LOS and signal timing. By contrast, Chapter 12 on pedestrians is largely ignored. The challenge is to achieve an intermodal analysis of vehicles and pedestrians, with the goal of optimizing on minimal delay for inclusion in an updated Chapter 9 of the HCM. The methods should be flexible to deal with the quality of available pedestrian data.

Optimization considerations should include:

- reduction in the cycle times to reduce delays
- tradeoffs in number of lanes and pedestrian delay
- use of all-red clears to give pedestrians a head start on concurrent walk phases
- determining pedestrian delay for sequential crossings (using more than one crosswalk at an intersection)
- use of vehicle detectors to sense traffic gaps - and transfer the extra time to the pedestrian phase. (For under-capacity locations in the peak hour and everywhere in the off-peak)
- holding a pushbutton down for 3 seconds gives extra crossing time for elderly or blind
- better audible signals to assist the blind

Objective: Improve the timing and operation of traffic signals to be more responsive to pedestrian needs.

Key Words: Traffic signals, delays, actuation

Urgency/Priority: Medium

Cost: $150,000, 2 years

User Community: Traffic engineers, pedestrian planners

Implementation: Instruction manual, technical monogram

Effectiveness: Improved operation of signals for pedestrians, with less jaywalking.

Title: **Effects of Advance Stop Lines on Pedestrian Crashes at Midblock Crosswalks and Unsignalized Multilane Crosswalks**

Problem: A major cause of high energy pedestrian crashes is the multiple threat situation in which one vehicle passes another vehicle that has stopped in another lane for a pedestrian. If the vehicle stops close to the crosswalk, its presence can obscure other motorist's view of the motorists of the pedestrian's view of other vehicles. Research has shown that the use of advance stop lines used in conjunction with a "STOP HERE FOR PEDESTRIANS" signs can influence motorists to stop further back from the crosswalk and thereby reduce pedestrian motor vehicle conflicts by 80 percent. Although data show that the use of advanced stop lines along with educational signs can reduce conflicts at midblock

crosswalks located on multilane roads, no one has examined whether the large scale use of this strategy would lead to a reduction in pedestrian crashes.

Objective: To determine whether the large scale application of advance stop lines at midblock crosswalks and at unsignalized crosswalks on multilane roads can reduce the number of pedestrians struck at these sites.

Key Words: Midblock crosswalks, multilane crosswalks, advance stop lines, pedestrian crashes.

Related Work: Van Houten and Malenfant have demonstrated that advanced stop lines used in conjunction with education signs reduces pedestrian motor vehicle conflicts at midblock crosswalks. This strategy has not yet been evaluated on a large scale.

Urgency/Priority: Medium

Cost: $160,000 to $200,000

User Community: Municipal traffic engineers, state officials involved in pedestrian safety.

Implementation: Submit an executive summary to state and municipal traffic engineers. Present research at TRB.

Effectiveness: The effects of this research will indicate whether the wide scale use of advance stop lines can reduce pedestrian crashes at midblock crosswalks.

Title: **Accessible Pedestrian Overpass/Underpass Design**

Problem: DOT/FHWA and the Architectural Barriers Act of 1968 require that pedestrian overpasses and underpasses built with Federal monies be accessible. Most such crossings are served by extensive ramp-and-landing construction accommodating differences in level of eight to 16 feet and runs of 120 to as much as 240 feet in length for each approach. Many persons with disabilities do not have the stamina for such extended travel at the maximum permitted slope of 1:12, even with required landings at 30-foot intervals. Furthermore, state and local high departments cannot always acquire enough right-of-way to provide ramps of such length. Many pedestrians will make at-grade crossings in such locations, even at substantial risk to their safety. A few jurisdictions have used exterior elevators to serve skyways, elevated public walkways, and similar roadway crossings. It appears from the few installations that are known that pedestrians are less apt to shortcut crossings served by elevators, thus requiring less investment in countermeasures. However, anecdotal reports suggest that safety concerns, vandalism, and high maintenance requirements, in addition to higher first costs, are substantial disincentives to the specification of elevators on the public right-of-way. Designers do not have the data necessary to make informed choices.

Objective: 1) Gather data on life cycle costs, usability, maintenance, safety and other factors appropriate to a comparison of over crossings and under crossings served by ramps (with and without stairs) and elevators (depressed and elevated roadways and operational alternatives may also be considered) and 2) to develop minimum criteria for the design and manufacture of accessible exterior elevators.

Key Words: Overpass, underpass, ramp, exterior elevator, pedestrian, accessibility

Related Work: Overpasses and underpasses have been well-studied by a number of researchers.

Urgency/Priority: Medium

Cost: $100,000

User Community: State DOTs

Implementation: Distribute the executive summary of this research to state highway and transportation agencies. Findings should be incorporated in the appropriate manuals and guidelines of the industry.

Effectiveness: This study will provide a cost/benefit calculation that will enable designers to make appropriate choices in accommodating pedestrian and vehicular circulation.

Title: **New Methods to Measure Pedestrian Movement**

Problem: Measuring pedestrian movements with traditional traffic counters can result in inexact counts, with errors greater than ten percent. An hourly count does not reflect localized surges of pedestrian flows, especially near transit stops. New

technologies may be helpful in recording and describing the dynamic pedestrian environment at intersections and along sidewalks. Possible new methods of describe pedestrian movement are:

- Shadowing or following random groups of pedestrians to sample their walking speeds, routes, destinations, intersection crossings, etc.
- Using photographs and videos to document pedestrian conflicts, especially jaywalking behavior.
- Detailed overhead video recording and subsequent time-lapse photography to track pedestrian movements over time through an intersection.
- Use of laptop computers to measure and record pedestrian movements and events.

Time-lapse photo analysis is very labor intensive and can probably be done for only a five or ten minute segment at one location.

Objective: To determine how well new measurement techniques can be applied to pedestrian movements for either regular monitoring or specialized research purposes.

Key Words: Pedestrian surveys, photos, videos, computers, measurement

Related Work: A comparable study of automobile stopping and starting on a highway in Germany was done in considerable detail during the 1960s by Prof. Leutzbach

Urgency/Priority: Medium

Cost: $100,000

User Community: Urban traffic analysts and planners

Implementation: Distribution of review and methodology report to major city traffic departments, FHWA, state engineers, Internet.

Effectiveness: Offer guidance on the use of video equipment and computers for supplementing traffic counts and understanding the process of pedestrian crossings at busy intersections.

Title: **Technology Applications for Accessible At-Grade Rail Crossings**

Problem: Horizontal flangeway gaps at pedestrian/rail crossings may be as wide as 4 inches where heavy freight must be accommodated; light rail requires as much as 2.5 inches of clearance. There have been several reports of wheelchair entrapment at such crossings. The ADA Accessibility Guidelines (ADAAG) limit horizontal gaps in the accessible rout to 0.5 inch. New, highly maneuverable wheelchairs may have front wheels with a diameter of three inches or less. Wheels of any diameter may swivel and drop into the flangeway when they hit an obstruction. Although gap fillers are available for locations where railcars travel at very low speeds, as in rail yards, no products are manufactured for more demanding environments characterized by heavy freight loadings and moderate to high speeds. As light rail systems, transit malls, and transit-oriented development expand, there will be a great increase in pedestrian crossings of rail lines.

Objective: 1) Identify and assess the most promising technologies or research directions for the development of a product or system to render at-grade rail crossings accessible for persons using wheelchairs and 2) formulate a plan for research, development, testing, and demonstration.

Key Words: Flangeway, at-grade crossings, rail, ADA, accessibility, wheelchairs

Related Work: None known

Urgency/Priority: Medium

Cost: $150,000

User Community: Grade crossing manufacturers, FRA, AMTRAK, railroads and transit agencies, state public utility commissions, state highway engineers

Implementation: This study should be used to develop a research program regarding this topic.

Effectiveness: An accessible at-grade crossing product would eliminate the need for overpass/ underpass construction or alternative routes where public sidewalks are interrupted by rail lines.

Low Priority Research Problem Statements

- Analysis of Pedestrian Queuing
- Analysis of Simple Pedestrian Flow
- Behavioral Study on Pedestrian w/ Disabilities on Sidewalks and at Intersections
- Conflicts Between Pedestrians and Vehicles
- Continuous Rumble Strips
- Crosswalks at Unsignalized Intersections
- Determining and Mapping High Hazard Locations for Pedestrian and Bicycle Crashes
- Effect of Shape and Placement of Retroreflective Material on Nighttime Pedestrian Accidents
- Effect of Vehicle Speed on the Pedestrian Environment
- Effects of a Multifaceted Approach to Reduce Pedestrian Injuries at Marked Unsignalized Crosswalks
- Effects of Amount and Placement of Retroreflective Material Pedestrian Accident Rates
- Effects Retroreflective Material Pedestrian Accidents Involving Motor Vehicle Drivers Under Drug or Alcohol Influence
- Effects Retroreflective Material Worn on Headgear, Handwear, or Footwear on Pedestrian Accident Rates
- Environmental Impacts on Pedestrians
- European Experience with Crosswalks and Intersection Control
- Incorporating Pedestrian Accessibility in Transportation Research and Planning
- Pedestrian Accessibility and Surface Drainage Control Conflicts
- Pedestrian Level of Service: Density or Delay?
- Pedestrian Reconnaissance Study
- Pedestrian Safety Crossing Analysis
- Pedestrian/Vehicle Conflicts In and Around School Zones
- Public Understanding and Effectiveness of Pedestrian Actuated Signals
- Relationship of Increases in Traffic and Pedestrian Accidents in Residential Communities
- Relationship of Traffic Speeds and Pedestrian Accidents in Residential Communities
- Roadway Design and Sidewalk Accessibility in Hilly Terrain
- Safety Effects of Winter Conditions on Older Pedestrians
- Sidewalk Flow Volumes With Obstructions
- Simulation Methodology for Assessment of Innovative Access Solutions for the Visually Impaired Traveler
- Typical Urban Pedestrian Walking Distances
- Utilization of Lost Urban Space for Pedestrian/Bicycle Thoroughfares: Inventory, Characterization, and Design