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Pedestrians

Research Problem Statements

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Pedestrians

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Transportation Research Board
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Introduction

Over the past decade, national policy and legislation have reflected a goal to increase the amount of pedestrian activity and the safety of pedestrians. The 1991 Intermodal Surface Transportation Efficiency Act and 1997 Transportation Equity Act for the 21st Century transportation bills promote planning for pedestrians and bicyclists as a part of statewide and metropolitan transportation planning efforts. The Americans with Disabilities Act (ADA) has also had a significant impact on pedestrian research in the last decade. The U.S. Department of Transportation's (USDOT) 1994 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%. Many of the research topics in this document are related to these goals.

Pedestrians are an important and omnipresent part of a multimodal transportation system that includes also bicycle, transit, and automobile travel. Pedestrian travel is a non-polluting mode that allows people to exercise as they move from place to place. The presence of pedestrians on local streets can also indicate a healthy community environment. An emerging area of research is the relationship between pedestrian activity and personal and community health.

Pedestrian research involves a wide range of topics, from designing individual crosswalks and intersections to accommodate all pedestrians, to installing continuous sidewalks throughout neighborhoods and roadway corridors, to altering roadway design to slow traffic, to providing pedestrian access to buildings and transit stops. Research on signal timing, intelligent transportation systems (ITS) applications, the design of sidewalks and crossings, driver yielding behavior, and pedestrian detection should consider impacts on different groups of pedestrians, including children, the elderly, and people with all types of physical disabilities, including those in human-powered and motorized wheelchairs. When the word "pedestrian" is used in this document, it refers to all types of pedestrians.

This document presents the top 16 pedestrian Research Problem Statements, prioritized from a list of approximately 80 Research Problem Statements by the Transportation Research Board (TRB) Committee on Pedestrians (ANF10).

The original list of approximately 80 Research Problem Statements comprised statements garnered by the TRB over several years, plus a list of research topics gathered from researchers and practitioners around the country during 2001 by Charles Zegeer of the Pedestrian and Bicycle Information Center. The top 15 rankings of each of the committee member respondents were combined by the Subcommittee on Research to determine a final top 15 list. Members of the subcommittee also chose to add a 16th Research Problem Statement on the Segway Human Intermodal Transporter (SHT).

The topics in the original list of statements can be classified into nine categories that suggest the broad agenda of pedestrian research:

1. Demand management and forecasting,
2. Crash and risk analysis,
3. Design and engineering (standards and guidelines),
4. Pedestrian facility evaluation,
5. Policy and planning,

6. Land use and urban design,
7. Enforcement and education,
8. Health and physical activity, and
9. Pedestrians with disabilities.

The titles and objectives of the original research problem statements are provided in the appendix of this document.

ACKNOWLEDGMENT

While obviously a collaborative effort, this circular is largely due to Robert Schneider's incredibly effective job of organizing, circulating, collating, and editing the research problem statements. The Transportation Research Board Pedestrians Committee thanks him.

Prioritized Ranking for the Top 16
Pedestrian Research Problem Statements

1. OPTIMIZING TRAFFIC SIGNAL TIMING FOR PEDESTRIANS

Problem

The current standards for traffic signal design are outlined in Chapter 9 of the *Highway Capacity Manual* (HCM). This chapter does not include pedestrian concerns in its discussion of level of service (LOS) and signal timing. Chapter 12 in the HCM addresses pedestrians, but it is often ignored by practitioners. The challenge is to achieve an intermodal analysis of vehicles and pedestrians, with the goal of achieving minimal delay for all people using intersections. This intermodal analysis should be included 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;
- Trade-offs in number of lanes and pedestrian delay;
- Consideration of signal coordination on pedestrian delay for the length of a roadway corridor;
- Use of all-red signals for vehicles (exclusive pedestrian phases) or giving pedestrians a head start on concurrent walk intervals;
- 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);
- Using a pushbutton to give extra crossing time for elderly, blind, or other people with disabilities; and
- Better audible signals to assist people with visual disabilities.

Objective

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

Key Words

Traffic signals, delays, and actuation.

Cost

$250,000 over 2 years.

User Community

Traffic engineers and pedestrian planners.

Implementation

Instruction manual, technical monogram, and revised chapters of the HCM.

Effectiveness

Improved operation of signals for pedestrians, less jaywalking, and fewer pedestrian crashes.

2. EFFECT OF VEHICLE SPEED ON MOTORISTS' DECISION TO YIELD TO PEDESTRIANS

Problem

Pedestrians often have a difficult time crossing roadways with high speed traffic, particularly on wide streets. Even when pedestrians use marked crosswalks, they may not be able to find sufficient gaps in traffic or may be hesitant to risk crossing in a short gap because many motorists do not yield as required by law. Traffic calming techniques aim to slow traffic so that pedestrians feel more comfortable walking along and crossing roadways. Slower speeds have been shown to result in less severe injuries when crashes occur, and it is likely that vehicles traveling slower will be more aware of pedestrians trying to cross the roadway in both marked and unmarked crosswalks.

Research should be undertaken to show the relationship between slower vehicle speeds and motorist yielding behavior. Investigators should attempt to find the percentage of motorists that yield to pedestrians in marked and unmarked crosswalks for a range of vehicle speeds under a variety of roadway cross-sections. For example, the research should determine the vehicle speed threshold at which 90%, 50%, and 10% of motorists yield to pedestrians in marked crosswalks on four-lane roadways with a raised median. Yielding in other types of roadway cross-sections, at typical intersections, roundabouts, and in free right-turn lanes should also be tested. This research has implications for determining roadway design speeds and implementing effective traffic calming measures.

Objective

Understand the relationship between vehicle speeds and motorists' decision to yield to pedestrians at marked crosswalks, intersections, and other locations where signage and pavement markings instruct motorists to yield to pedestrians.

Key Words

Yielding behavior, vehicle speeds, crosswalks, intersections.

Related Work

Current FHWA study: Improving Pedestrian Safety at Unsignalized Roadway Crossings.

Cost

$250,000.

User Community

Transportation engineers and planners, and traffic calming specialists.

Implementation

The results should be distributed in an executive summary to state and local traffic agencies and to the traffic safety community. The results of this research would also be presented to TRB and the Manual on Uniform Traffic Control Devices (MUTCD) pedestrian committees and should be summarized in the *ITE Journal*.

Effectiveness

Improved percentages of motorists yielding to pedestrians and an increase in pedestrian comfort when crossing roadways.

3. EVALUATE THE EFFECT OF PEDESTRIAN SAFETY STING OPERATIONS ON MOTORIST YIELDING BEHAVIOR

Problem

Dangerous and illegal behaviors such as drivers speeding, running red lights, and not yielding to pedestrians in marked crosswalks and pedestrians crossing roadways without looking for traffic can lead to pedestrian crashes. One of the techniques that is being used to try to eliminate dangerous driver behaviors are pedestrian safety sting operations, where plain-clothed police officers step into marked crosswalks to see if drivers will yield to them. If the driver does not stop, the plain-clothed officer radios to a police officer in a car ahead, who stops and tickets the driver. This type of operation results in drivers receiving a penalty that is directly related to a pedestrian safety violation. Yet, the long-term effectiveness of the technique has not been investigated. Other enforcement techniques, such as programs targeting speeding vehicles in residential neighborhoods should also be evaluated.

This research should evaluate the enforcement operation at several different locations. It should examine differences at several different locations, such as the duration of the enforcement activity, the penalties assessed to drivers, and the amount of promotion and media coverage that was associated with it. Follow-up data should be collected to evaluate if driver behaviors improved and how long the improved behavior was sustained after the enforcement operation was completed.

Results should identify elements of the program that result in behavior changes that are sustained over a long time period. The results may also suggest the optimal amount of time that should pass before the enforcement operation should be repeated.

Objective

Investigate whether enforcement operations such as pedestrian safety sting operations lead to sustained motorist and pedestrian behavior change and identify elements of the program that can lead to sustained behavior change.

Key Words

Pedestrian safety "sting" operation, driver behavior, yielding to pedestrians, enforcement.

Related Work

Red light running enforcement, speed trailers, and speeding enforcement research.

Cost

$150,000.

User Community

Law enforcement and pedestrian safety specialists.

Implementation

This study will develop recommendations that can be distributed to state and local law enforcement agencies. It can also be available to local community traffic safety programs. Results should be shared with the TRB Pedestrian Committee and presented at the TRB annual meeting.

Effectiveness

Institutionalize the legal obligation for drivers to yield to pedestrians in crosswalks and at traffic signals. Educate police on how to effectively enforce the laws protecting pedestrians.

4. DEVELOPING A METHOD FOR CONDUCTING PEDESTRIAN COUNTS

Problem

One of the most significant barriers to doing research related to pedestrians is the lack of data on how many pedestrians use any given sidewalk, path, crosswalk, or other pedestrian facility. Counts can be used to account for exposure when analyzing pedestrian–vehicle crashes at

specific locations, document changes in pedestrian volumes before and after pedestrian facilities are improved, or for assessing the need for pedestrian crossing improvements, such as signals and grade separations. Pedestrian counts are often not taken because manual counts and video recording is labor intensive and expensive. Yet, even when counts are taken, they are seldom done using the same technique. An agency may take counts during random 15-min periods during the day one year and then use peak morning hour and evening hour counts the next. Another agency may take counts for 3 h on three different afternoons during the week. In each case, the counts can not be compared because there is not an accurate method to extrapolate the short count to a standardized 24-h count. This results in lack of consistency that prevents comparisons between communities in a region, comparisons between regions of the country, and a method that is simple, easy to use, and respected throughout the transportation profession.

A consistent method of pedestrian counting needs to be adopted for all communities and agencies to use. The method should be simple so that professionals without extensive experience with statistics can take accurate counts and understand the output and its limitations. It should account for the fact that pedestrian activity peaks at certain times of the day and days of the week, and is much more sensitive to weather variations than vehicle traffic. It should address how to count both pedestrians crossing and pedestrians walking along the side of the road. To determine this method, several techniques should be investigated and the pros and cons of each should be documented. Automatic pedestrian counters may also be investigated. The research should recommend a single method for taking pedestrian counts. If the research shows that a single method is not flexible enough for all situations, two or three options could be presented with a discussion of the appropriate situation for using each method.

Objective

Develop standardized technique for conducting pedestrian counts that addresses time of day, location (e.g., midblock, intersection), through pedestrian traffic versus pedestrians that stop, or make multiple stops, along a street.

Key Words

Analysis, methods, pedestrian counts.

Related Work

Methods of taking motor vehicle counts.

Cost

$200,000.

User Community

Traffic engineers, pedestrian planners, and traffic calming specialists.

Implementation

The initial results should be presented at the TRB Annual Meeting and distributed in an executive summary to state and local traffic agencies. The results of this research would also be presented to TRB and the MUTCD pedestrian committees and should be summarized in the *ITE Journal*. The resulting counting technique should be adopted by FHWA, state DOTs, and metropolitan planning organizations (MPOs).

Effectiveness

Adoption of a consistent method of taking pedestrian counts, enabling pedestrian counts to be compared between agencies and regions, and establishing a method that is respected and used by all researchers and practitioners in the transportation profession.

5. CASE STUDIES OF MODEL CITY AND COUNTY ORDINANCES THAT SUPPORT A VIBRANT PEDESTRIAN NETWORK

Problem

Several cities and counties have developed ordinances that support safe and convenient pedestrian environments. Many other communities have recently begun to take a much greater interest in pedestrian issues. These communities would benefit from hearing about efforts of the leading pedestrian-friendly communities. This research would document the history of a city or county effort to develop roadway design guidelines or subdivision, zoning or other ordinances to support pedestrian safety and mobility, including the reason behind the initiative, opportunities and political opposition, the final ordinance that was adopted, and reflection on the process.

Objective

Document the efforts of cities and counties to support the development of a quality walking transportation network, including building and lot design requirements and the creation of pedestrian facilities.

Key Words

Model ordinances, pedestrian legislation, administration, law.

Related Work

The Bicycle Engineering Best Practices Report (1998) and the Pedestrian Engineering Best Practices Report (Forthcoming 2002)

Cost

$125,000.

User Community

Local and county government agencies, citizens, and developers.

Implementation

Case studies of model ordinances would be gathered into a "best practice" document that could be published and distributed through FHWA or a professional organization and posted online for public access. Results will also be shared with the TRB Pedestrian Committee.

Effectiveness

Case studies would provide ideas for new ordinances related to pedestrian engineering, education, and enforcement programs for local communities that are just beginning to take an interest in pedestrian issues. This would help more communities to provide the legal and administrative basis for establishing safe and convenient environments for pedestrians.

6. ITS APPLICATIONS FOR PEDESTRIANS

Problem

Pedestrians affect the efficiency, safety, and cost of traffic movement on streets and highways. However, USDOT's ITS effort to date has been largely focused on highways and vehicles. Many automation technologies under study for vehicles can be adapted or extended easily to help enhance pedestrian safety and mobility. Stand-alone systems currently being developed for pedestrian applications include sensors at sidewalk intersections for input to and actuation of traffic control devices or extending crossing intervals; automated vehicle enforcement that benefits pedestrians; and 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

This study should

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.

Cost

$300,000.

User Community

USDOT/ITS and state and local jurisdictions.

Implementation

This study will develop an action plan to institutionalize pedestrian planning in the ITS effort.

Effectiveness

Integrated systems that serve the needs of all 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 and mobility impairments.

7. EVALUATING THE EFFECTS OF RED LIGHT CAMERAS, SPEED MONITORS, AND OTHER AUTOMATED ENFORCEMENT TECHNOLOGY ON PEDESTRIAN CRASHES

Problem

Dangerous and illegal behaviors such as drivers speeding, running red lights, and not yielding to pedestrians in marked crosswalks and pedestrians crossing roadways without looking for traffic can lead to pedestrian crashes. Some of the techniques that are being used to try to eliminate dangerous driver behaviors include red light cameras, speed monitors, and other enforcement technology. While some of these technologies assess penalties, others simply make drivers aware of their own behavior. These techniques should be evaluated in terms of pedestrian crash reduction.

Several types of enforcement technologies should be compared. The research should examine differences at several different locations, such as the type of technology used, duration of the enforcement activity, the penalties assessed to drivers, and the amount of promotion or media coverage that was associated with it. Follow-up data should be

collected to evaluate if driver behaviors improved and how long the improved behavior was sustained after the enforcement operation was completed. The number of crashes that occurred over several years before and after the enforcement technology was implemented should be compared.

Results should identify the types of technologies that have the greatest impact on pedestrian crash reduction. In addition, other factors associated with the enforcement technology, such as educational programs and physical roadway engineering changes should be noted.

Objective

Investigate the effect of various enforcement mechanisms on pedestrian crash rates. Identify "barriers" to implementing these technologies. Recommend model laws to allow effective use of these technologies.

Key Words

Pedestrian safety, crashes, driver behavior, effectiveness, automated enforcement, enforcement, red light enforcement, photo-speed enforcement, enforcement technology, ITS.

Related Work

Pedestrian and motorist behavior enforcement research.

Cost

$250,000.

User Community

Law enforcement and pedestrian safety specialists.

Implementation

This study will develop recommendations that can be distributed to state and local police. It can also be available to local community traffic safety programs. Results should be shared with the TRB Pedestrian Committee and presented at the TRB annual meeting.

Effectiveness

Decrease vehicle speeds, red light running, and decrease pedestrian crashes, injuries, and fatalities through improved enforcement technologies.

8. DETERMINING FACTORS THAT INCREASE CRASHES, INJURIES, AND PERCEIVED RISK AT MIDBLOCK LOCATIONS

Problem

Many pedestrian injuries and fatalities occur at midblock locations with and without crosswalks.

Objective

Use case study analysis or regression analysis identify design characteristics of midblock locations that result in an increase in crashes and injuries. A sample of midblock pedestrian crashes (taken from police reports) should be analyzed. Factors that should be included in the analysis include traffic volume, pedestrian volume, the number of travel lanes, travel speed, traffic, crosswalk presence, warning signs, driveways and curb cuts, pedestrian crossing signals, nearby building setbacks, character of the surrounding land use, etc. By identifying factors with a significant relationship to pedestrian crashes, roadways, signage, and the surrounding built environment can be changed to be safer for pedestrians. Individual factors can also be analyzed, such as pedestrian age, gender, and physical ability, so that education programs can be targeted to specific groups, as needed. This research project should also provide general guidelines for when a midblock crosswalk is appropriate, given a variety of roadway and land use factors.

Key Words

Pedestrian crash factors, midblock, pedestrian crossing.

Related Work

Studies have looked at exposure, roadway, and land use factors related to pedestrian crash factors at intersections, on campuses, and in neighborhoods. Pedestrian and driver perception has been used to complement police crash reports and assess pedestrian crash risk. A study of pedestrian crashes at signalized midblock crossings is about to begin.

Cost

$150,000.

User Community

Traffic engineers and transportation planners.

Implementation

The results should make recommendations for new roadway design guidelines. The research should also be summarized in *Transportation Research Record: Journal of the Transportation Research Board* and the *ITE Journal*.

Effectiveness

New roadway design manuals, subdivision guidelines, and sign regulations can be created that recommend safer pedestrian environments.

9. 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 midblock 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% of the crossing pedestrians used the push button, which may have contributed to the high violation rate of 66%. Studies at four semi-actuated traffic signals in Phoenix, Arizona, in 1991 found that of those pedestrians who arrived at the traffic signal during the “Don’t Walk” interval, 21% to 34% did not use the pedestrian push button. Studies at a pedestrian activated warning flasher in Phoenix found that only 25% to 33% used the push button during different observations. Studies of pedestrian collisions at traffic signals reveal that 45% involve pedestrians crossing against the signal.

Visually impaired pedestrians are at a distinct disadvantage at pedestrian-actuated signals. Even if they could be informed that they needed to push a button, they would need to know where it is. Locations with two buttons at a corner can very confusing to pedestrians, requiring custom signage and pedestrian education.

Objective

To develop and field test an automatic pedestrian detector that can be used at actuated traffic signals (or pedestrian actuated warning flashers) to accommodate pedestrians more effectively. 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. Testing should also examine the effectiveness of automatic pedestrian detectors for people with disabilities.

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 PELICAN (Pedestrian Light Actuated) traffic signals in the United Kingdom use infrared detectors to detect waiting pedestrians, cancel the signal call if the pedestrian leaves the signal before crossing; and extend 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.

Cost

$300,000 to $350,000.

User Community

Traffic engineers and local and state agencies involved in operating traffic signals.

Implementation

The results should be distributed in an executive summary to state and local traffic agencies. The results should also be summarized in the *ITE Journal*.

Effectiveness

This research could provide a solution to detecting pedestrians at midblock 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.

10. IDENTIFYING THE TOOLS AND RESOURCES NECESSARY TO INTEGRATE PEDESTRIAN TRIPS INTO TRANSPORTATION MODELS

Problem

Pedestrian and bicycle trips are not typically included in the four-step transportation modeling process (trip generation, trip distribution, mode choice, and route assignment). Because pedestrian travel does not produce air pollution and does not add to vehicular congestion, long-range land use and transportation scenarios would benefit by including these trips.

Objective

Develop the computer software and planning and engineering techniques necessary to integrate pedestrian travel into local and regional transportation models. A brief overview of current traffic modeling processes and pedestrian travel estimation methods should also be undertaken. Research is likely to involve the Nationwide Personal Transportation Survey and regional travel surveys. The research should address whether or not pedestrian and bicycle trips should be modeled separately from other modes, or if they should be integrated within the mode choice step of the four-step modeling process.

Key Words

Modeling, computer software, four-step process.

Related Work

Guidebook on Methods to Estimate Non-Motorized Travel

Cost

$250,000.

User Community

Local highway engineers and transportation planners.

Implementation

The results of the research should be distributed to MPOs, state transportation departments, and other transportation forecasting agencies. The research should also be presented at the TRB annual meeting and ITE conference.

Effectiveness

The effects of this research will help develop accurate, multimodal transportation planning models. They will be more accurate in predicting demand for pedestrian facilities, roadway congestion, and air pollution.

11. RELATIONSHIP BETWEEN OF INCREASES IN TRAFFIC VOLUME AND SPEEDS AND PEDESTRIAN ACCIDENTS IN RESIDENTIAL COMMUNITIES

Problem

When highway or regional traffic is diverted into residential areas, or new development increases traffic in adjacent residential neighborhoods, residents often perceive that the quality of life in

their neighborhood has been lowered. There is also a perception that increased traffic volume raises the risk of pedestrian crashes. Traffic calming has been suggested as an intuitive response to mitigate pedestrian safety problems and improve pedestrian comfort. However, the impacts and relationships between speed or volume and accidents in residential neighborhoods are unknown.

Objective

The purpose of this study is to quantify the effects of speed and volume increases in residential areas on pedestrian safety.

Key Words

Pedestrian accidents, traffic speeds, traffic volumes.

Related Work

Traffic calming research in Europe and the United States.

Cost

$200,000.

User Community

Local highway engineers and transportation planners responsible for the design of local roads.

Implementation

The results of the research should be distributed in an executive summary to state and local highway and transportation agencies. The research should also be presented at the TRB annual meeting and ITE conference.

Effectiveness

The effects of this research will help determine the benefits of traffic calming on safety and the impacts of development on adjacent neighborhood pedestrian accidents. The results of such a study could be useful in adopting more traffic calming in residential neighborhoods as a mitigation of increased demands on major highways.

12. INCORPORATING PEDESTRIAN ACCESSIBILITY INTO TRANSPORTATION RESEARCH AND PLANNING

Problem

Provisions of the regulations implementing the 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 DOTs are responsible for providing pedestrian access, standard engineering practices, transportation handbooks and manuals, and research protocols serve vehicular interests first, treating pedestrian accommodation as incidental provisions, often only meeting the bare minimum standards. 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

The purposes of this study are

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, andr operations;
2. Specify the industry standards, guidelines, manuals, instructional materials, and similar documents and projects and programs promulgated by these organizations that affect—or could affect—pedestrian access, circulations, and use; and
3. Develop a model 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. This action plan should also recommend a state or local authority to enforce implementation of ADA improvements by local governments and private developers.

Key Words

ADA, accessibility, pedestrian, pedestrians with disabilities.

Related Work

None known.

Cost

$150,000.

User Community

All elements of the transportation industry.

Implementation

The study should present an action plan for the institutionalization of pedestrian access considerations within the transportation industry, its organizations, and the design standards it promotes. Its recommendations should be implemented via AASHTO, MUTCD, and other processes by which design guidelines, planning manuals, highway policies, and recommended engineering practices are regularly revised and updated. The Pedestrian Committee should oversee implementation of the recommendations of this study through the Research and Technology Coordinating Committee of TRB 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.

13. EFFECT OF ROADWAY FEATURES ON VEHICLE SPEEDS

Problem

Pedestrian injuries (in fact, all injuries in a crash) are more severe when vehicles are traveling at higher speeds. The concept of traffic calming intends to reduce vehicle speeds by modifying roadway features, such as narrowing lanes, and installing raised crosswalks, chicanes, and traffic circles. Other roadways, such as wide, straight arterial streets may have posted speed limits that are far below the design speed of the roadway. If drivers travel faster under these conditions, they put pedestrians, other vehicle passengers, and themselves in danger. Traffic calming features also help facilitate pedestrian access, as pedestrians feel more comfortable walking along or crossing roadways with lower vehicle speeds.

Objective

Investigate how roadway features affect vehicle speeds, including roadway characteristics, walking and bicycling elements, and land use and environmental characteristics. By determining the characteristics that have the greatest impacts on speed, roadways can be designed to be safer for pedestrians. The research should involve sampling vehicle speeds under a variety of roadway characteristics with various surrounding land use patterns under different congestion levels. Mathematical models should be used to identify statistically significant relationships between vehicle speeds and roadway, land use, and other variables.

Key Words

Vehicle speeds, traffic calming, roadway design, design speed.

Related Work

Engineering guidelines for roadway design speed.

Cost

$200,000 to $300,000.

User Community

All elements of the transportation industry.

Implementation

The results of the study should be published in the *Transportation Research Record: Journal of the Transportation Research Board* and *ITE Journal* and should be implemented by updating the AASHTO Green Book and any other design guidelines, planning manuals, highway policies, and recommended engineering practices are determined.

Effectiveness

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

14. EVALUATION OF MUTCD SIGNING, MARKINGS, AND TRAFFIC SIGNALS FOR PEOPLE WITH VISUAL IMPAIRMENTS, CHILDREN, AND ELDERLY ADULTS

Problem

Many pedestrian signs, markings, and signals have been approved or are waiting for approval for inclusion in the MUTCD. Though these devices and markings may work well for typical healthy, adult pedestrians with good vision, but children who can not read, elderly adults, and pedestrians with visual disabilities may not be able to understand or use them effectively.

Objective

Investigate the effectiveness (safety and comfort) of visual, audible, and tactile markings signs and traffic signals for special needs populations. This will require field testing of all markings and signals in the MUTCD. Pedestrians of all ages and with various levels of visual impairment should be included in the test groups. The ability of the pedestrians to understand and follow the signs, markings, and signals correctly should be observed objectively. Yet, the participants

should also be asked to report the difficulties that they experienced and to provide their input on how to make the devices more functional for them.

Key Words

Visual disabilities, physical disabilities, MUTCD, traffic signs, traffic markings, traffic signals, elderly pedestrians.

Related Work

Evaluation of the effectiveness of intersection and crosswalk treatments and signal timing for pedestrians with disabilities. Research on audible pedestrian signals.

Costs

$250,000 to $350,000.

Implementation

A report should be published by FHWA and Public Rights-of-Way Access Advisory Committee (PROWAAC), and the results should recommend changes to be included in the next update of the MUTCD. The research should also be presented at the TRB annual meeting and ITE conferences.

User Community

Traffic engineers, public transportation planners, city planners.

Effectiveness

Will make the traffic signs, signals, and pavement markings more understandable and more functional for all pedestrians.

15. PEDESTRIAN LEVEL OF SERVICE: DENSITY OR DELAY?

Problem

Research is needed to determine a pedestrian LOS scale based on pedestrian delay at intersections. Much of John Fruin's pioneering work on pedestrian analysis is now a quarter-century old and warrants an effort towards updating the concept of pedestrian LOS. While Chapter 13 of the 1985 HCM has adopted definitions for pedestrian LOS based on pedestrian *density*, Chapter 9 specifies the LOS measures for vehicles based on vehicle *delay*. This inconsistency and lack of intermodal integration of pedestrian factors into traffic capacity studies has resulted in pedestrian LOS and delay being ignored at intersections.

Pedestrians tend to respond more overtly to issues of delay and safety, so it is likely that they will be motivated to jaywalk by perceptions of excessive delay, not by overcrowding. An important topic for this research to address is the length of time that pedestrians are willing to wait for a walk phase or a gap in traffic under a variety of different intersection conditions.

The research effort should consider the delay implications of different types of traffic signal phasing, including pedestrian exclusive phases. The delay-based pedestrian LOS measure should be applicable for signalized and unsignalized intersections and for a wide variety of intersection geometries. Further, the research should define pedestrian LOS in a way that represents all types of pedestrians, including those with physical disabilities.

Objective

Define a new pedestrian LOS scale for intersections based on pedestrian delay. The scale should be applicable for signalized and unsignalized intersections, for a wide variety of intersection geometries, and for pedestrians of all ages and physical abilities. The results of this study should be used to incorporate pedestrian delay into a multimodal LOS measure at intersections (Chapter 9, HCM).

Key Words

Pedestrian LOS, density, delay, traffic signal timing.

Cost

$150,000 (literature review, intersection analysis), 1 year.

User Community

Traffic analysts, all users of HCM Chapters 9 and related computer capacity models, traffic signal engineers.

Implementation

Monogram, committee review, addendum to Chapter 9. The research should also be presented at the TRB annual meeting and ITE conferences.

Effectiveness

Inclusion of pedestrian LOS in overall intersection capacity analysis, with criteria that better reflects pedestrian concerns. Better balance of concurrent and exclusive pedestrian phase applications.

16. DEFINING THE PLACE OF THE SEGWAY HUMAN INTERMODAL TRANSPORTER IN THE TRAFFIC STREAM

Problem

The SHT is being marketed as a viable transportation option for relatively short trips. However, there has been no research to determine whether the SHT is appropriate for traveling in motor vehicle travel lanes, on sidewalks, on sidepaths and trails, or in separate dedicated roadway space. The SHT weighs about 95 lb, can travel relatively fast (12 to 18 mph) and is quiet, which can represent a hazard to pedestrians on the sidewalk. It is important to conduct these types of analyses to discover potential impacts on pedestrians and other travelers before laws and regulations related to travel on public streets and paths are changed. Typical travel speeds, stopping distance, space requirements, and maneuverability need to be researched to help determine guidelines for use of the SHT. It is reported that more than half the states have adopted legislation that allow SHTs to use the sidewalks, overriding local jurisdictions to do otherwise.

Objective

To define the place of the new SHT in the traffic stream. The SHT has two wheels and an electric motor for propulsion. Other small motorized vehicles such as wheelchairs, carts, and scooters should also be considered as a part of this research. Detailed evaluation of the operating characteristics each of these devices and laws related to them should help determine what other types of vehicles or devices might end up being permitted if the SHT legislation is adopted.

Key Words

Pedestrian, sidewalks, Segway, Segway Human Intermodal Transporter, electric-powered vehicle.

Related Work

The Segway company is actively lobbying state legislators to have the device classified as a pedestrian, not a motorized vehicle, to allow its use on pedestrian-only paths and sidewalks. Similar research is needed on motorized skateboards which are less expensive and more plentiful, especially for teens and preteens.

Costs

$150,000

User Community

Public transportation planners, city planners, traffic engineers, legislators, manufacturers, and police.

Implementation

The results of the study should be published in the *Transportation Research Record: Journal of the Transportation Research Board* and *ITE Journal* and should be implemented by updating the AASHTO Green Book and any other design guidelines, planning manuals, highway policies, and recommended engineering practices are determined.

Effectiveness

Help improve the efficiency of all modes using the same right-of-way and increase the comfort and safety of all roadway users.

APPENDIX

Pedestrian Research Problem Statement Topics Considered by the TRB Pedestrians Committee

The following is a list of titles and objectives of the 80 Research Problem Statements considered by the TRB Pedestrians Committee. The top 15 statements were selected from this original list.

CATEGORIES

- Areas demand management and forecasting,
- Demand management and forecasting,
- Crash and risk analysis,
- Design and engineering (standards and guidelines),
- Pedestrian facility evaluation ,
- Policy and planning,
- Land use and urban design,
- Enforcement and education,
- Health and physical activity, and
- ADA.

DEMAND MANAGEMENT AND FORECASTING

Method for Conducting Pedestrian Counts

Develop standardized technique for conducting pedestrian counts that addresses time of day, location (i.e., midblock or intersection), through pedestrian traffic versus pedestrians that stop, or make multiple stops, along a street.

Model for Estimating Trail Demand

Develop model to estimate pedestrian demand for new trail facilities based on usage patterns of existing trails.

Model for Estimating Pedestrian Overpass Demand

Develop model to estimate pedestrian demand for proposed overpasses.

Effect of Pedestrian Facility LOS on Walking

Conduct a before and after study of pedestrian trips and usage following improvements to walking infrastructure.

Analysis of Pedestrian Queuing

Measure pedestrian queue factors and behavior, for implication in crossing delay and maximum sidewalk concentrations.

Analysis of Simple Sidewalk Pedestrian Flow

Provide a simpler reference method to estimate pedestrian capacities and LOS on conventional sidewalks.

New Methods to Measure Pedestrian Movement

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

Typical Urban Pedestrian Walking Distances

Update outdated information on desirable and maximum walking distances for different types of pedestrians and different trip purposes.

CRASH–RISK ANALYSIS

Factors That Increase Crashes, Injuries, and Risk at Trail–Roadway Intersections

Use case study analysis and regression analysis identify design characteristics of trail–roadway intersections that result in an increase in crashes and injuries.

Factors That Increase Crashes, Injuries, and Risk at Midblock Locations

Use case study analysis and regression analysis identify design characteristics of midblock locations that result in an increase in crashes and injuries.

Effect of Vehicle Speed on Motorists' Decision to Yield to Pedestrians

Investigate the relationship between vehicle speeds and motorists' decision to yield to pedestrians at marked crosswalks, intersections, and other locations where pedestrians cross the roadway.

Determining and Mapping High-Hazard Locations for Pedestrian and Bicycle Crashes

To develop a means to map high accident locations (HLs) for pedestrian crashes.

Pedestrian Crossing Safety Analysis

Develop a rapid cost-effective procedure for safety analysis of pedestrian crossings on various types of roadways, such as suburban and rural roads, under various traffic speeds and volumes, functional classes, and levels of pedestrian activity.

Pedestrian–Vehicle Conflicts In and Around School Zones

Analyze the pedestrian–vehicle conflicts within school zones with improved pedestrian safety features versus areas around school zones without pedestrian safety features.

Relationship Between of Increases in Traffic Volume and Speeds and Pedestrian Accidents in Residential Communities

Quantify the accident effects of speed and volume increases in residential areas.

PEDESTRIAN FACILITY EVALUATION

Facilities at Uncontrolled Crossings

Investigate the effectiveness (in terms of safety and comfort) of various pedestrian facilities at uncontrolled crossings.

Traffic Signal Innovations for Pedestrian Safety

Evaluate the effectiveness (in terms of safety of comfort) of various traffic signal innovations.

Roadway Features Related to Vehicle Speed

Investigate how roadway features affect vehicle speeds, including roadway characteristics, walking and bicycling elements, and land use and environmental characteristics.

Safer Design of Trails and Paths

Investigate how trail design affects user safety and comfort.

Safer Lighting Levels for Pedestrians

Investigate the affect of lighting fixture design and intensity of light on visibility of pedestrians.

Pedestrian Safety and Mobility at Roundabouts

Investigate potential conflicts between pedestrians and motorists at roundabouts and pedestrian mobility.

Automatic Pedestrian Signal Detector

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.

Conflicts Between Pedestrians and Vehicles

Improve understanding and predictability of conflict effects pedestrians and traffic.

Crosswalks at Unsignalized Intersections

Explore the effects on accidents of giving pedestrians instructions different from those given to side street drivers when crossing a major road at an intersection. Explore the safety benefits of enforcing crosswalk laws.

Effects of the Use of Retroreflective Materials on Pedestrian Accident Rates

Determine the effects on pedestrian accidents of the quantity and placement of retroreflective materials worn on the person of pedestrians in urban, residential, and rural lighting conditions.

Effects of an Advanced Stop Line on Pedestrian Crashes at Midblock Crosswalks

Determine whether the large scale application of advance stop lines at midblock crosswalks can reduce the number of pedestrians struck at these sites.

Effects of an Advanced Stop Line on Pedestrian Crashes at Unsignalized Multilane Crosswalks

Determine whether the large scale application of advance stop lines at unsignalized crosswalks on multilane roads can reduce the number of pedestrians struck at these sites.

Effects of a Modified Pedestrian Signal Indication on Pedestrian Conflicts at a Signalized Intersection

Determine whether a light emitting diodes (LED) pedestrian sign that included a brief prompt to alert motorists to watch turning vehicles at the start of the walk cycle could reduce pedestrian–motor vehicle conflicts. The prompt would consist of a brief presentation of two eyes with the eyeballs scanning from side to side.

Effects of Retroreflective Material Worn on Headgear, Handwear, or Footwear on Pedestrian Accident Rates

Determine if the additional motion of retroreflective materials worn on rapidly moving parts of the pedestrian body, such as handwear, footwear, or headgear, results in additional visibility or noticeability of the pedestrian.

Effect of Retroreflective Materials on Pedestrian Accidents Involving Motor Vehicle Drivers Who Are Under the Influence of Drugs or Alcohol

Measure the effect of the type, placement, and amount of retroreflective materials worn by pedestrians on the frequency and severity of pedestrian accidents involving drug or alcohol impaired drivers.

Effect of Shape and Placement of Retroreflective Material on Nighttime Pedestrian Accidents

Determine the relative conspicuity, recognition, and effect on pedestrian accidents of retroreflective materials worn in shapes which suggest a real person or in shapes not related to the shape of a person.

Effects of Vehicle Speed on the Pedestrian Environment

To identify design elements that would reduce vehicle speeds and frictions with pedestrians, while maintaining capacity flows.

Optimizing Traffic Signal Design for Pedestrians

Improve the design features for pedestrians, especially those which are likely to be long-term features of the intersection.

Public Understanding and Effectiveness Pedestrian Actuated Traffic Signals

Determine the public's knowledge of and compliance with pedestrian indications. It would also seek to determine if a community education program could improve compliance and public knowledge. It would also seek out existing public information programs for children and adults.

DESIGN AND ENGINEERING

Standards for Grade Separations-Based on Reported Crashes and Risk Perceptions

Develop guidelines for when grade separations are appropriate based on reported crashes and risk perceptions.

Trail Design for Improved Safety, Mobility, and Increased Use

Develop guidelines for trail design that maximize user safety and comfort.

Continuous Rumble Strip Shoulders

Develop clear guidelines as to when continuous rumble strip shoulders should be used, when they should not be used, and the width of the treatment.

Design of Pedestrian Signal Heads

Develop a more clear pedestrian signal head consistent with vehicle signals.

Environmental Impacts on Pedestrians

Understand the effect of environmental variables on pedestrian behavior, and include consideration within design parameters.

European Experience With Crosswalks and Intersection Controls

Provide a reference text for American planners to use in planning for pedestrian improvements. It should include both successes and failures, as well as special conditions of application. As much as possible, the emphasis should be on solutions likely to be adopted in the United States, rather than exotic solutions such as *woonerfs* (a Dutch term for a common space created to be shared by pedestrians, bicyclists, and low-speed motor vehicles).

ITS Applications for Pedestrians

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.

Optimizing Traffic Signal Timing for Pedestrians

Analyze delay at intersections to both vehicles and pedestrians, with the goal of optimizing minimal delay for inclusion in an update of Chapter 9 of the HCM.

Pedestrian Accessibility and Surface Draining Control Conflicts

The purpose of this study is to investigate, develop, and propose (an) engineering design system(s) that will reconcile the conflict between surface drainage and accessibility provisions for pedestrian circulation.

Pedestrian LOS: Density or Delay?

Determine the adequacy of the density LOS criterion for pedestrians and whether it should be replaced by a delay criterion. Incorporate pedestrian delay into overall intersection delay LOS at signalized intersections (Chapter 9, HCM).

Pedestrian Reconnaissance Study

Improve the quality and consistency of pedestrian data for use in traffic analysis. Make specific measurements of jaywalking activity. Survey pedestrians to determine priority factors for measurement.

Sidewalk Flow Volumes with Obstructions

To improve understanding and assessment of sidewalks subject to obstructed flow.

Assessing the Use of the Segway Human Intermodal Transporter on Public Sidewalks

Safety, mobility, and health—define the place of the new SHT in the traffic stream. The SHT has two parallel wheels and an electric motor for propulsion. This research should also determine what other types of vehicles or devices might end up being permitted if the SHT legislation is adopted.

POLICY AND PLANNING

Tools and Resources Necessary to Integrate Walking into Transportation Models

Describe the computer software and planning and engineering techniques necessary to integrate pedestrian travel into local and regional transportation models.

Effects of ITS on Walking

Investigate the potential positive and negative impacts of ITS technologies on walking and test hypotheses by studying existing applications of ITS technologies.

Cost–Benefit Techniques for the Evaluation of Pedestrian Facilities

Develop techniques for the application of cost–benefit analysis in the planning and design of pedestrian facilities.

Community Experience with Pedestrian Guidelines

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.

Can Sidewalks Increase Pedestrian Travel and Reduce Vehicle Trips, and How Can Municipalities and States Be Encouraged to Provide or Require Sidewalks?

The purposes of this study are to

1. Identify methods to encourage municipalities or states to build or require sidewalks between or adjacent to developments to encourage pedestrian travel;
2. Complete a literature search and nationwide review of small, medium, and large cities; and
3. Identify common maintenance requirements, ordinances, or agreements.

LAND USE AND URBAN DESIGN

Impact of Land Use and Development Patterns on Walking and Factors Affecting Mode Choice

Investigate the land use and development characteristics, such as scale of development and the degree of the mix of land uses that affect people's decision to choose walking as a mode of transportation.

Case Studies of Model Cities and County Ordinances that Support a Vibrant Pedestrian Network

Document the efforts of cities and counties to support the development of a quality walking transportation network, including building and lot design requirements and the creation of pedestrian facilities.

Utilization of Lost Urban Space for Pedestrian–Bicycle Thoroughfares

Stage I: Inventory

The initial portion of the study, Stage I, should provide an inventory of usable urban space, within a defined study area, that can be utilized as thoroughfares for pedestrian/bicycle traffic. The area to be inventoried exists within the city limits of Baltimore, Maryland, and is known as Little Italy. Specifically, the research should inventory the utilizable space that exists within the area bounded by President Street to the west, Aliceanna street to the south, Central Avenue to the east, and Pratt Street to the north. This comprises an area of approximately 35 square blocks. The inventory consists of spatial delineation and a survey of opportunities and constraints relative to the context.

Stage II: Characterization

The second portion of the study, Stage II, should characterize the urban space identified during Stage I. A list of conditions with accompanying score would be assembled and each identified space evaluated as to its suitability according to its cumulative score. The physical condition of the identified space would be investigated and a summation of suitable space presented. The area to be characterized exists within the city limits of Baltimore, Maryland, and is known as Little Italy. Specifically, the research characterize the utilizable space that exists within the area bounded by President Street to the west, Aliceanna street to the south, Central Avenue to the east, and Pratt Street to the north.

Stage III: Design

The final portion of our study, Stage III, should provide a practical design of pedestrian/bicycle thoroughfares utilizing lost urban space. The design would encompass an area within the city limits of Baltimore, Maryland, known as Little Italy. Specifically, the project should characterize the utilizable space that exists within the area bounded by President Street to the west, Aliceanna street to the south, Central Avenue to the east, and Pratt Street to the north.

ENFORCEMENT AND EDUCATION

Evaluate the Effect of Pedestrian Safety "Sting" Operations on Motorist Yielding Behavior

Investigate whether special enforcement programs lead to positive motorist behavior changes.

Effects of Red Light Cameras, Speed Monitors, etc., on Pedestrian Crashes

Investigate the effect of various enforcement mechanisms and speed monitoring devices on pedestrian crash rates.

Pedestrian Safety Education Programs

Develop new pedestrian safety education programs for differing age groups and walking environments.

Motorist Education Programs Related to Proper Behavior When Interacting With Pedestrians

Develop new motorist education programs to reduce conflicts between motorists and pedestrians.

Effects of a Multifaceted Approach to Reduce Pedestrian Injuries at Marked but Unsignalized Crosswalks

Evaluate in a middle-sized U.S. city the effects of the *Courtesy Promotes Safety* crosswalk program on yielding to pedestrians at unsignalized crosswalks.

Evaluate Alcohol-Related Pedestrian Crashes (Pedestrians Under Influence of Alcohol) as to the Location and Relationship of Drinking Establishment or Liquor Sales Establishment

This study will produce a data base that could be used to develop laws, engineering and education countermeasure activities to reduce crashes of pedestrians under the influence of alcohol.

HEALTH AND PHYSICAL ACTIVITY

Determine the Variables That Influence the Amount of Routine Walking for Leisure and Transportation

Investigate the different variables that affect people's decision to walk and identify actions that can increase walking.

Objective Measures of Walkability of Communities for Large Physical Activity Studies

Develop a set of measures of walkability for a community (i.e., vehicle speeds, perceived threat of crime) and design program to ask these questions to people who participate in large physical activity studies.

Strategies to Increase Walking to School

Document successful strategies for increasing walking to school and the types of infrastructure that are needed to support walking and bicycling for school trips.

Relationship Between Childhood Obesity and the Pedestrian and Neighborhood Environment

Develop measures for how supportive a child's bicycle and neighborhood environment is for activity and investigate the relationship between a child's environment and obesity levels.

AMERICANS WITH DISABILITIES ACT

Evaluation of MUTCD Signing, Markings, and Signals for People with Visual Impairments, Children, and Older Adults

Investigate the effectiveness (safety and comfort) of visual, audible, and tactile with special needs populations.

Access at Roundabouts to Pedestrians with Visual Impairments

Investigate accessibility issues of pedestrians with visual impairments at roundabouts.

Refine Truncated Dome Specifications of Detectable Warnings

Investigate the effectiveness of alternate truncated dome designs on pedestrians, wheelchair users, skateboarders, etc.

Effects of Speed Bumps and Humps on Drivers and Passengers with Disabilities

Investigate the effects of speed bumps and humps on the accessibility of persons with disabilities as well as motorists and passengers with disabilities.

Accessible Pedestrian Overpass and Underpass Design

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. Develop minimum criteria for the design and manufacture of accessible exterior elevators.

Behavioral Study on Pedestrians with Disabilities on Sidewalks and at Intersections

Observe and assess the behavioral responses of pedestrians with disabilities to obstructions, confusion, and complexities along sidewalks and at intersections. The study will synthesize information obtained during videotaped during site observations and problem-solving meeting with the study groups.

Guidelines on the Use of Audible Pedestrian Signals and Audible Signal Messages

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.

Incorporating Pedestrian Accessibility in Transportation Research and Planning

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 operations;
2. Specify the industry standards, guidelines, manuals, instructional materials, and similar documents and projects and 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.

Safety Effects of Winter Conditions on Older Pedestrians

Study the effects of winter conditions (snow, ice, and cold temperatures) on walking behavior and safety of elderly pedestrians and to relate sensory and mobility impairments to these effects.

Roadway Design and Sidewalk Accessibility in Hilly Terrain

Reconcile the geometric design criteria for steeply sloping roadways with requirements for accessible sidewalks and to recommend necessary changes in current roadway design guidelines, manuals, and practices.

Simulation Methodology for Assessment of Innovative Access Solutions for the Visually Impaired Traveler

Design a mathematical simulation model capable of creating large scale environments. Based on available software, data bases of pedestrians with visual impairments could be used in the conduct of simulation research in the assessment of the safety and access consequences of architectural and environmental design. This design would utilize the data from the model of cane travel by visually impaired pedestrians called RoboCane®. This model provides information concerning foot placement and cane coverage for blind travels and can be used in Monte Carlo assessments of the impact of individual environmental features on the simulated travelers. This model could be expanded to include facilities to easily input complex large-scale environments and design features (e.g., curb cuts of different configurations, placement of stairs, design and placement of telephone kiosks).

Technology Applications for Accessible At-Grade Rail Crossings

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.

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